INTRODUCTION

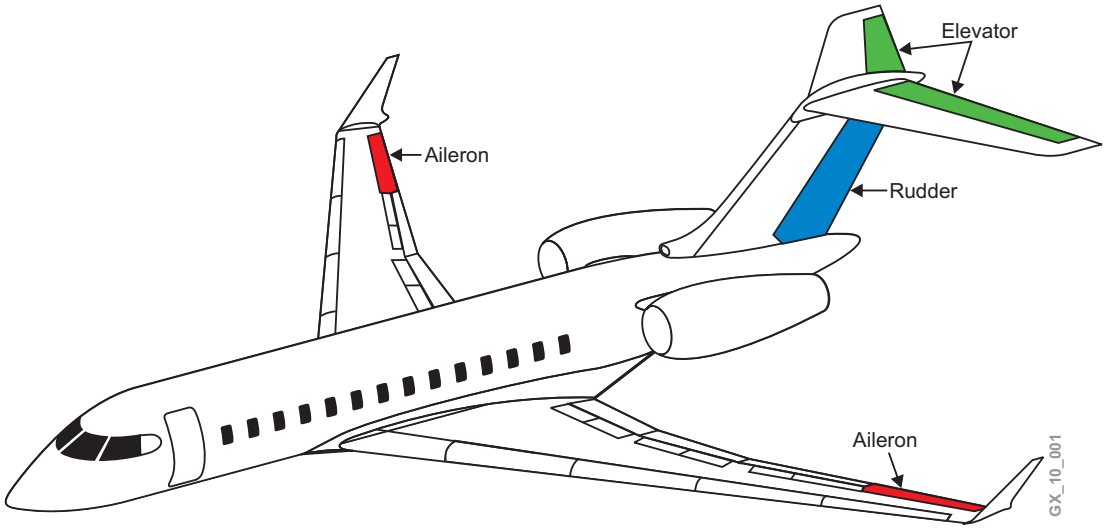
The Global Flight Controls System includes primary flight controls, secondary flight controls and stall protection systems. Primary flight controls are responsible for the roll, pitch, and yaw attitudes of the aircraft. Roll control is achieved through the use of ailerons, pitch control through elevators and a pitch trim system while yaw is controlled by the rudder. Aileron and elevator PCUs are designed so they will provide adequate dynamic stiffness for flutter protection in the event of a supply hydraulic system failure. Flutter dampers, therefore, are not required on the aircraft.

Secondary flight controls include all lift altering devices. Multifunction spoilers provide automatic roll assistance and manual lift dumping in flight. Automatic ground lift dumping on landing is provided by the multifunction spoilers in conjunction with the ground spoilers. Leading edge slats and trailing edge flaps alter the wing profile in response to pilot inputs to provide increased lift at low airspeeds.

Stall protection is provided to alert the flight crew if the aircraft nears the stall angle. Various warnings are provided to the crew and, if corrective action is not taken, a stick pusher will activate before the stall angle is reached.

DESCRIPTION

PRIMARY FLIGHT CONTROL



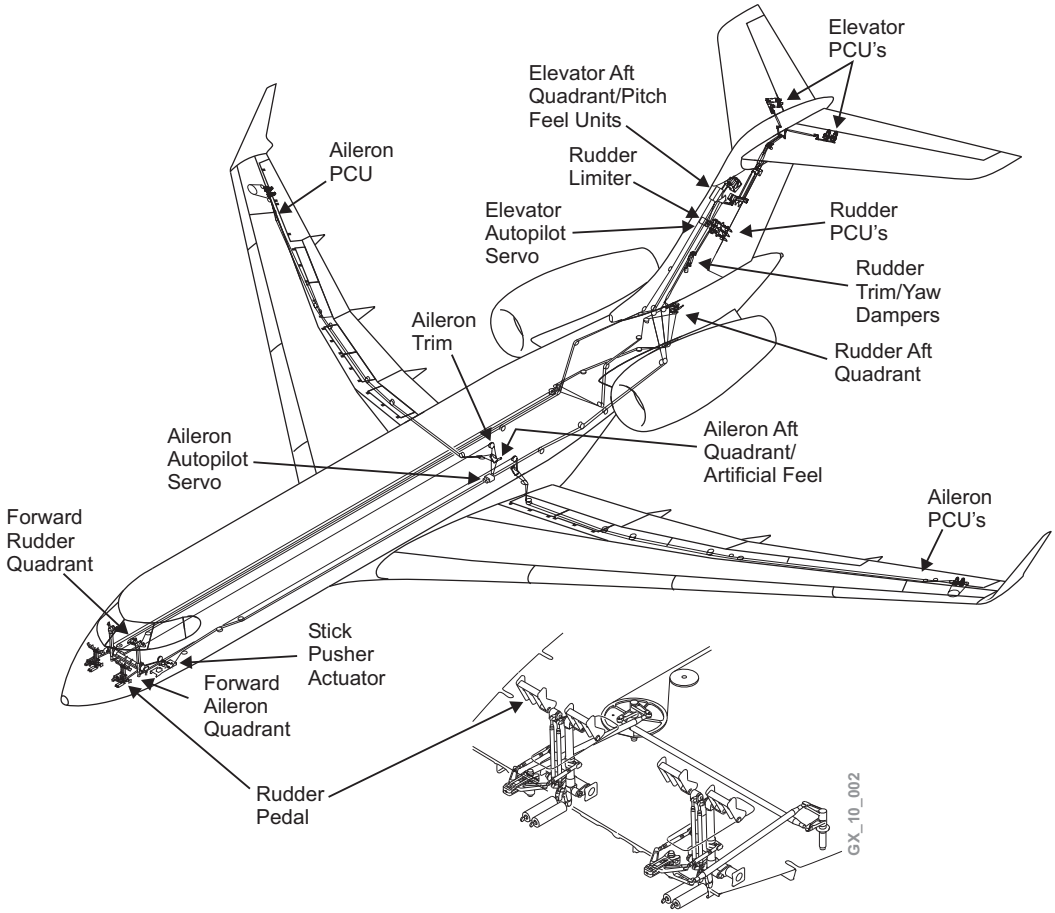
The primary flight controls consist of two separate elevators and ailerons, and a single rudder. The primary flight surfaces are actuated by Power Control Units (PCUs) that are hydraulically powered and mechanically controlled. Artificial control loading (tactile feedback) is provided to the control wheels and rudder pedals. Surface positioning is shown on the FLIGHT CONTROL synoptic page and on the EICAS display. Trim position is displayed on the EICAS display.

Each primary control system consists of cable run circuits connected to quadrants. The quadrants receive input from primary control command (flight compartment) using control rod assemblies. The cable circuit output transmits command to the hydraulically powered primary control surfaces, using control rods and artificial feel assemblies.

Lateral control is accomplished by a dual mechanical aileron control system hydraulically powered by two power control units (PCUs) per aileron. Four multifunction spoilers per side assist the ailerons in roll control (see SPOILER SYSTEM this chapter). Aileron disconnect is provided for anti-jam protection. Artificial feel and centering are incorporated within the system.

Pitch control is provided by a dual mechanical elevator control system, hydraulically powered by two power control units (PCUs) per elevator. Pitch disconnect is provided for anti-jam protection. Variable pitch artificial feel is provided to vary the load on the elevator control wheel as a function of airspeed and horizontal trim setting.

Yaw control is provided by means of three hydraulic PCUs to the rudder. Rudder travel limiting as a function of airspeed is provided to limit loads on the structure. The rudder system uses dual cable circuits (aft fuselage) to protect the system from effects of engine rotor burst.



Flutter damping for the primary flight controls is provided through the PCUs internal operation. Ground gust damping (gust locks) is provided through PCUs on the elevators, ailerons and rudder. The PCUs provide gust damping, when the hydraulic systems are depressurized.

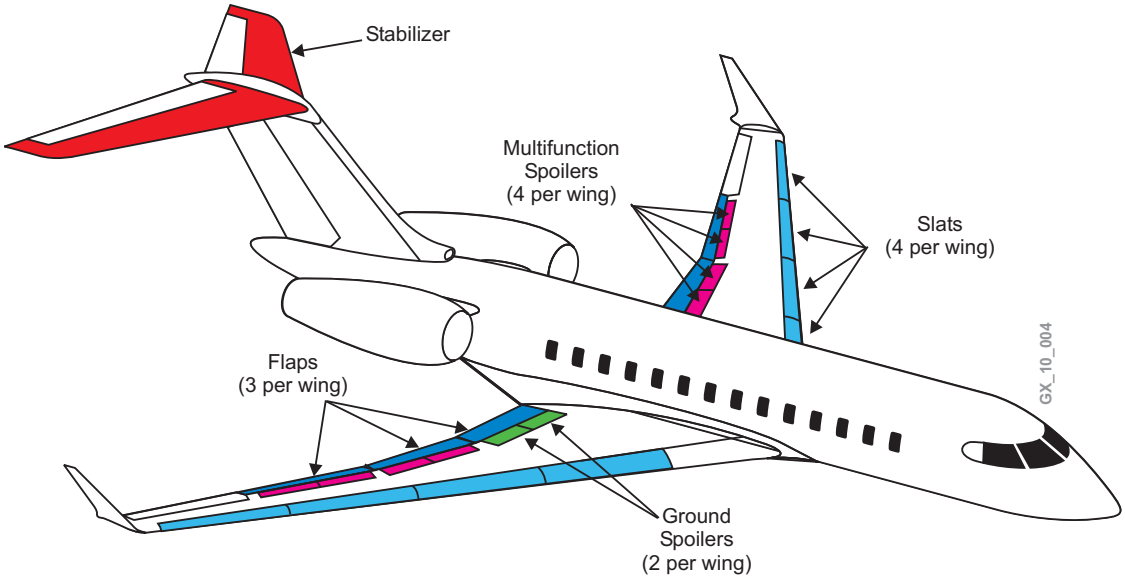
The roll disconnect mechanism allows the flight crew to isolate the left and right control wheel and cable system from each other. Roll disconnect separates the control wheel interconnect (torque tube) system. Single side aileron control is then available (either left or right aileron), using the operable wheel path, along with full multifunction spoiler control.

Pitch disconnect will operate automatically in the event of a cable jam in one circuit. When sufficient force is applied, approximately 50 pounds, the roller will ride up on the cam, allowing the use of the free circuit. Here, however, the disconnect mechanism does not lock out. The spring-loaded roller continues to ride up and down along the cam as inputs are provided to the elevator. Therefore, operation of the unjammed circuit requires the pilot to maintain the disconnect pressure on the column.

SECONDARY FLIGHT CONTROLS

The secondary flight controls consist of the flap/slat system, multifunction spoilers, ground spoilers and various trim systems.

Two computers (Flight Control Units (FCUs)) provide control to the hydraulically powered spoiler PCUs and the electrically powered horizontal stabilizer trim actuator. These computers also control a pitch feel system and rudder travel limiting system.



SPOILER SYSTEM

Eight multifunctional spoiler panels are electrically controlled and hydraulically actuated by a single PCU on each surface. The multifunction spoilers are used for in-flight operation as roll assistance, symmetrically for proportional lift dump and on ground for ground lift dumping.

Four ground spoiler panels are electrically controlled and hydraulically actuated by a single actuator on each surface and are used for ground lift dumping only.

TRIM CONTROL

Lateral trim is accomplished by a dual position switch on the center pedestal that operates an electric trim actuator located at the aft quadrant. The lateral trim will cause rotation of the control wheel neutral position.

Directional trim is achieved by a single rotary switch on the pedestal that operates an electric trim actuator at the summing unit in the vertical fin. Directional trim is summed into the pilot pedal command, and no pedal displacement occurs.

Longitudinal trim is achieved by inputs from auto pilot, mach trim and trim switches on the pilots' control wheels. Trim operation is through a dual electric motor and screw jack assembly at the horizontal stabilizer.

Aileron, elevator and pitch trim indications are as shown on the EICAS display.

HIGH LIFT DEVICES

The high lift devices consist of leading edge slats and trailing edge fowler flaps. The flap/slat systems are mechanically independent. Each system contains ballscrew actuators, linked through a rigid drive line to dual electric motors, contained within a central power-drive unit.

Electrically there are two independent channels for both flaps and slats systems. An integrated flap/slat selector lever is located in the flight compartment, on the center pedestal.

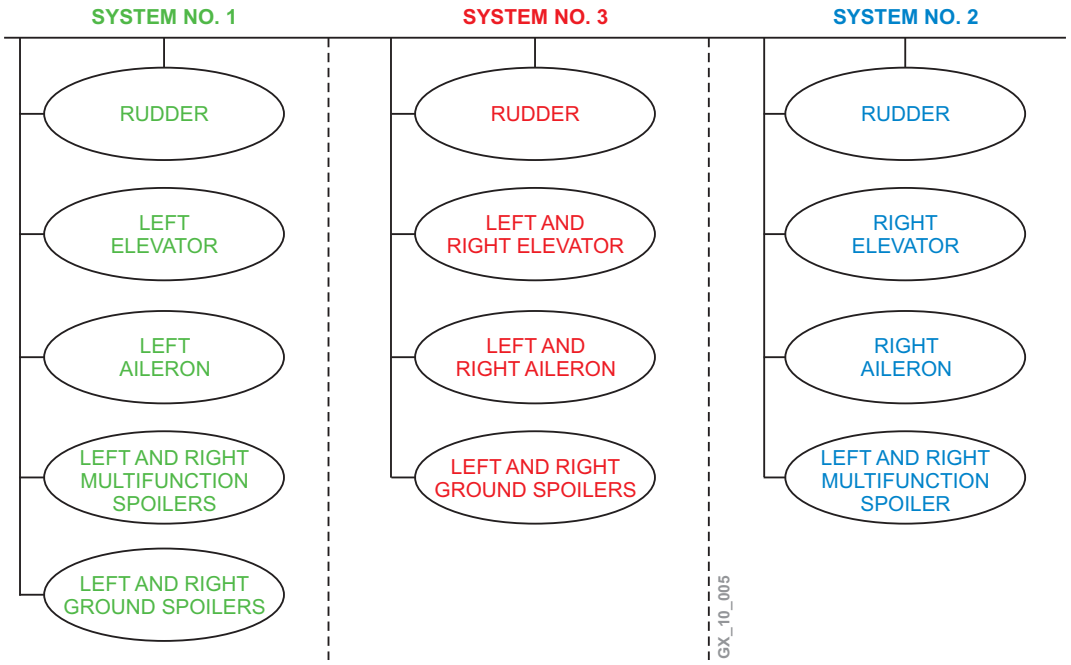
System control provides protection against asymmetry and uncommanded movement. Interface to EICAS and central maintenance are provided for system failure detection and isolation.

STALL PROTECTION

Two subsystems, stall warning and a stick pusher system comprise the stall protection system.

HYDRAULIC POWER DISTRIBUTION

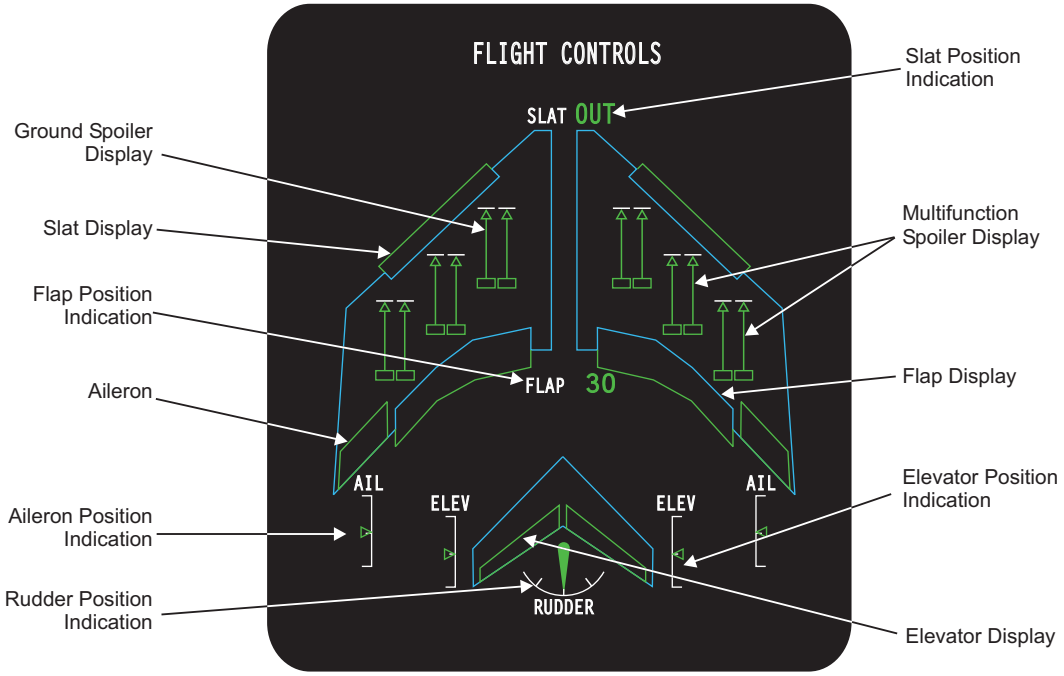
The primary and secondary flight controls, powered by the hydraulic systems, are listed as follows:

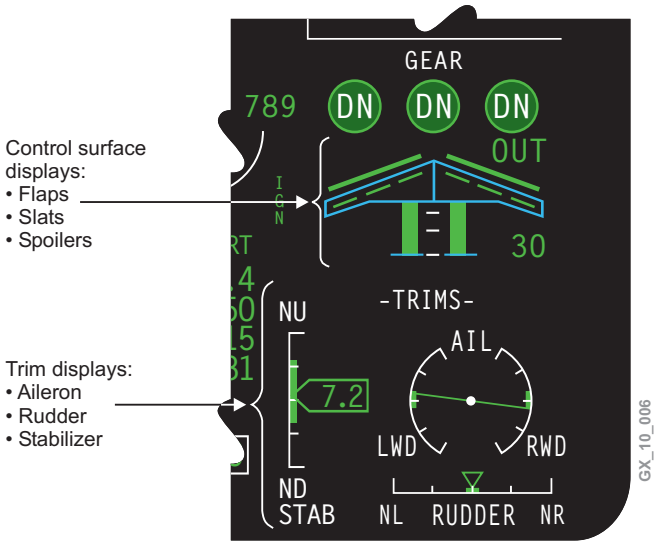


INDICATING SYSTEM

The flight control synoptic page provides position indications of the primary control surface, flap/slats and spoiler system. The roll, pitch and yaw trim indications are shown on the EICAS display.

FLIGHT CONTROL SYNOPTIC PAGE



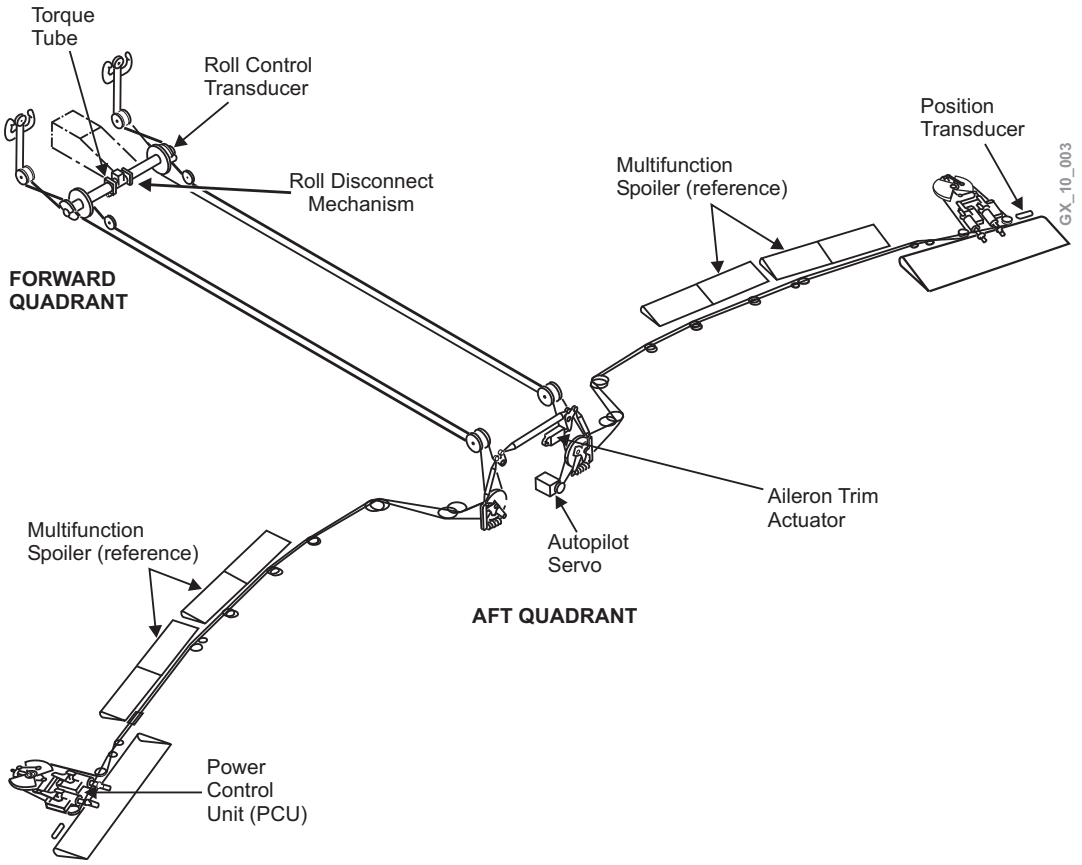


EICAS PAGE

AILERON CONTROL

Lateral (roll) control is provided by ailerons operating in relation to control wheel displacement and controlled via control rods, cable runs and quadrants. The ailerons are assisted by four multifunction spoilers per wing, which are electrically controlled.

AILERON CONTROL GENERAL ARRANGEMENT



Aileron Control System

Two separate lateral control systems are provided: the pilot's side operates the left-hand aileron and the copilot's side operates the right-hand aileron.

Normally, both control systems are interconnected through the forward torque tube interconnect assembly, and there is simultaneous movement of both ailerons.

Aileron Control System Operation

The Pilot's and copilot's roll controls are interconnected through a torque tube. At the midpoint of the torque tube is a roll disconnect mechanism designed to allow for separation of the left and right side control circuits once a design torque is achieved.

Separation of control circuits would occur in response to a jammed control situation. As an example: If the pilot's aileron jammed so that he was unable to physically move his aileron control, it would necessitate turning control over to the copilot. As the copilot applies pressure to his aileron control he will meet with some initial resistance. As he continues to apply pressure the designed torque limit of the roll disconnect mechanism will be reached and a physical separation of the torque tube will occur. The copilot would now have full control of his onside aileron and through the Flight Control Units (FCUs) control over the Multifunction Spoilers (MFS).

NOTE

The autopilot should be disconnected if a jammed aileron control circuit condition occurs.

A transducer is mounted at the outboard end of each torque tube assembly (forward quadrant). They provide the command inputs to the multifunctional spoilers system for roll assist.

Rotating either control wheel provides an input (via cables and pulleys) to the aileron forward quadrant which directs the control cable to the aft quadrant.

Each aft quadrant has an artificial feel and centering unit. An aileron trim unit is installed with input to each aft quadrant and provides trim input to the aileron control system.

A separate cable circuit is provided for the autopilot servo motor (controlled by the AFCS) assembly which inputs the right aft quadrant.

Disconnecting the autopilot by the pilot overpowering the aileron servo will not cause the roll disconnect system to separate the control wheels.

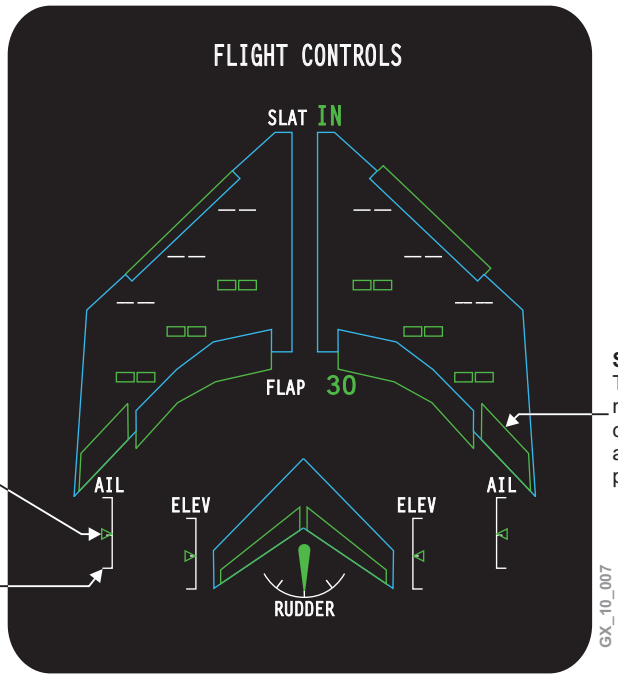
NOTE

Overpowering the aileron servo to disconnect the autopilot is not recommended.

The control cables from the aft quadrant continue outboard to the hydraulically driven PCUs. There are two PCUs for each aileron control surface.

Aileron Surface Position Indication

Left and right aileron positions are displayed by a moving pointer on the EICAS FLIGHT CONTROL page. Separate pointers indicate the aileron surface position on each wing.



Scale Pointer
Unfilled triangle moves vertically to indicate the range of travel. The surface position pointer will change color (green or amber) based on hydraulic pressure availability.

Scale
Indicates the full range available for aileron up and down travel.

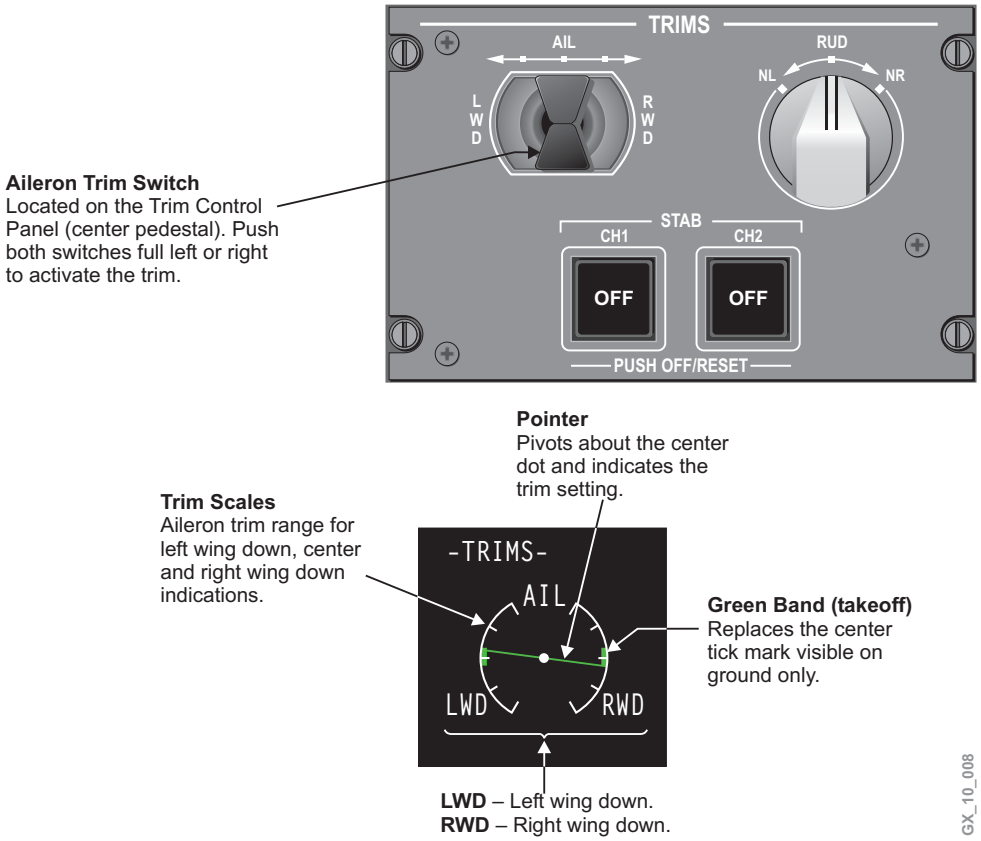
Surface Outline
The surface outline has no movement but will change color, (green or amber) based on hydraulic pressure availability.

SLAT/FLAP SURFACES EXTENDED

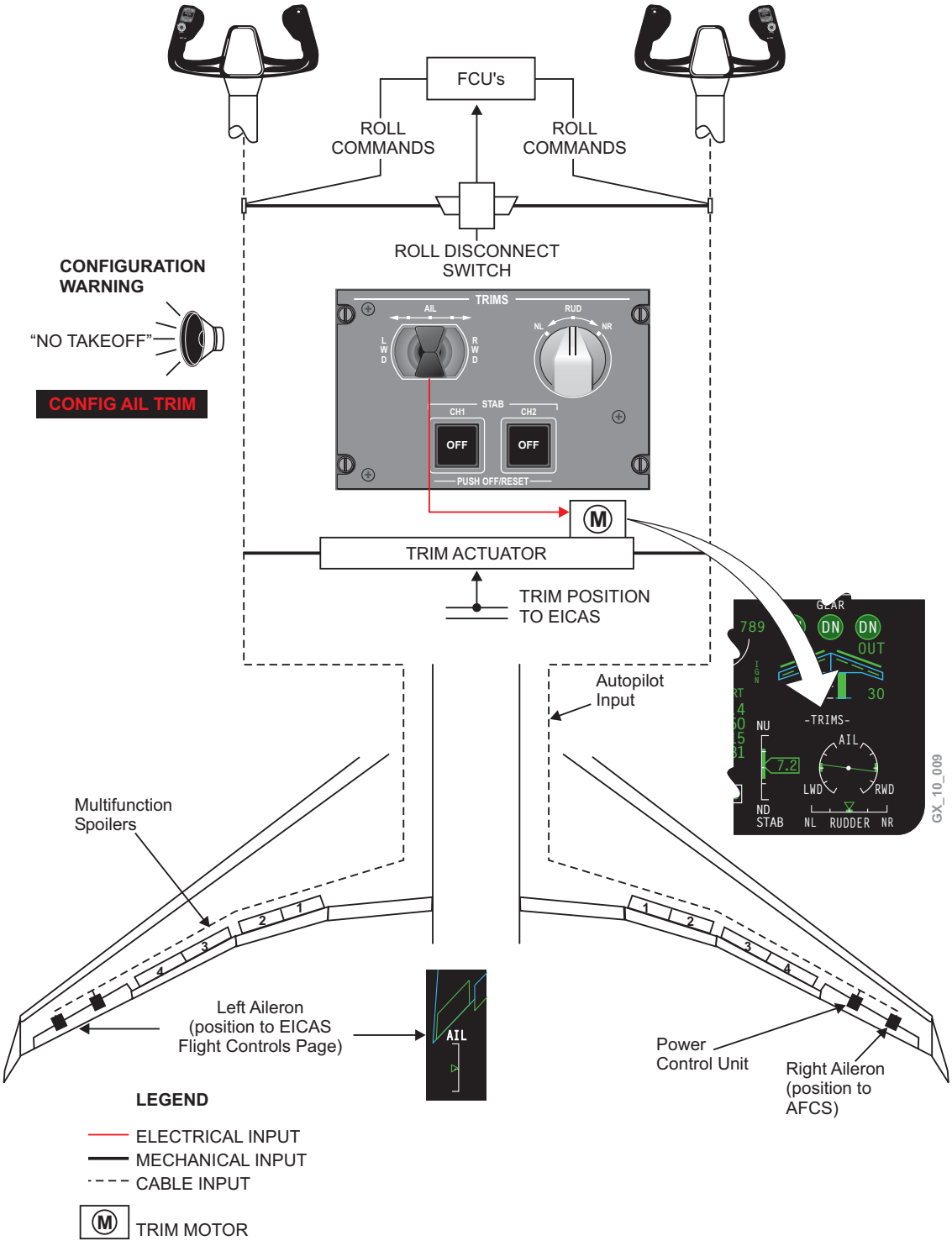
Aileron Trim

Aileron trim is accomplished by selecting the AIL TRIM switches on the trim control panel (pedestal) in the desired direction. Actuating both switches provides arming and direction signals to reposition the ailerons through the use of a trim actuator. Since trim is commanded through the PCUs it is necessary to have hydraulic system pressure to trim the aircraft. Aileron trim position is displayed on the EICAS page, along with the allowable takeoff green band.

A "**CONFIG AIL TRIM**" red warning message is accompanied by a "NO TAKEOFF" voice message. These indications occur during the takeoff roll if the aileron trim is set outside the allowable takeoff range.



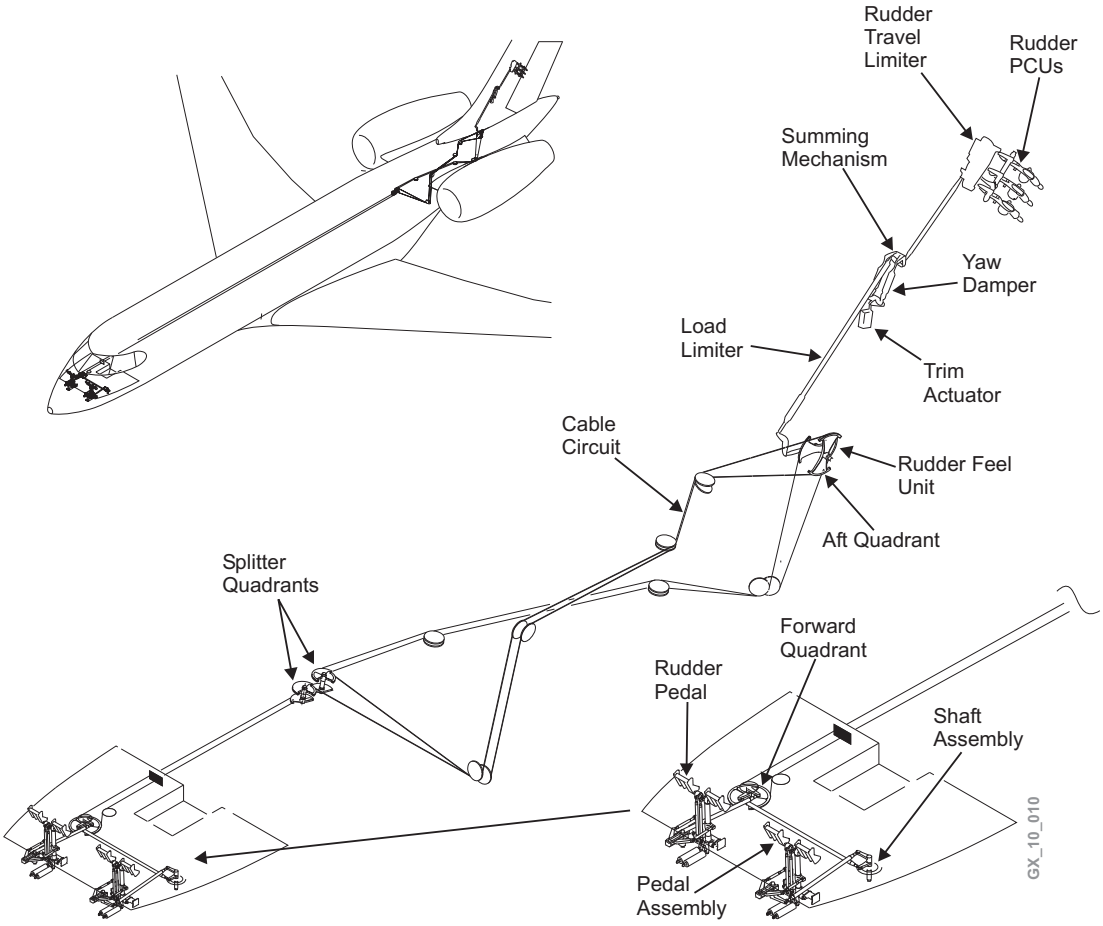
Aileron Control Schematic



RUDDER CONTROL

Directional control about the yaw axis is provided by the rudder control system. The rudder is hydraulically powered through displacement of either pilot's rudder pedals, and controlled via control rods, cable runs and quadrants.

RUDDER CONTROL GENERAL ARRANGEMENT



Rudder Control System Operation

Each rudder pedal assembly allows for transmission of pedal input via control rods to the forward quadrant and shaft assembly. The cable system has a single path in the fuselage and is doubled in the rotor burst zone. The forward cable quadrant (one in each control circuit) transmits the cable circuit to the aft quadrant. Artificial feel is provided by a linear spring unit (rudder feel unit), connected to the aft quadrant.

Rudder input from the aft quadrant is received by a load limiter (telescopic rod) which protects the system from rapid inputs. The load limiter delivers pilot input to a summing mechanism which adds the trim and yaw damping commands to the pilot commanded rudder input.

Yaw dampers are used to improve the airplane's lateral/directional stability and turn coordination. Dual yaw dampers operate in an active/standby mode to provide continuous yaw damping in the event of one failed yaw damping channel. The active/standby status will be switched automatically with the switching of active flight guidance computers.

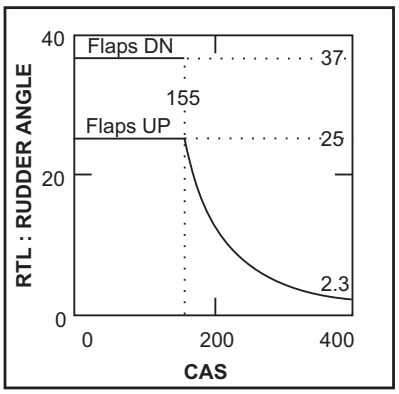
Initial yaw damper engagement is controlled by flight guidance computer at IAC power up. In flight the pilot will have to select the YAW switch located on the guidance panel if re-engagement of the yaw damping system is necessary.

Yaw damper condition is continuously monitored and any fault detected is displayed on EICAS. To ensure full performance in cold conditions, each actuator has a thermofoil heater which is powered, controlled, and monitored by the Heater Brake Monitor Unit (HBMU). For the damping control systems characteristics please refer to Chapter 2, AUTOMATIC FLIGHT CONTROL SYSTEM of this manual.

The summing mechanism output is transmitted via a control rod to the Rudder Travel Limiter (RTL). The RTL limits the rudder surface travel at high speeds and allows full rudder surface travel at low speeds. The RTL output drives a torque tube which is connected (via load limiting bungees) to the input lever of the associated hydraulic PCUs. There are three PCUs powering the rudder system.

Rudder Travel Limiter

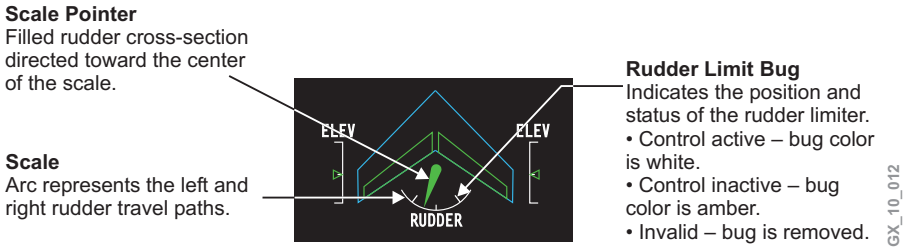
The RTL limits rudder authority as a function of Calibrated Airspeed (CAS) and flap position to ensure that the deflection of the rudder surface will not cause exceedance of the structural capability of the vertical stabilizer, while allowing for sufficient authority to control the airplane. The RTL also allows for full rudder authority in the event of total loss of FCU control at high airspeed.



After takeoff the amount of rudder travel will be limited as a function of flap retraction or airspeed increasing above 155 knots.

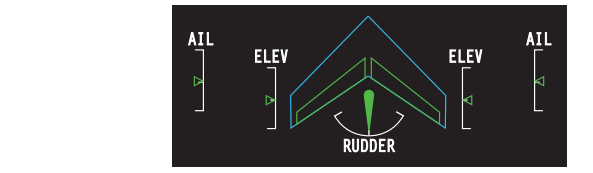
Rudder Surface Position Indication

Left and right rudder surface position is displayed by a moving pointer on the FLIGHT CONTROL page. A single pointer indicates left and right rudder surface positions.

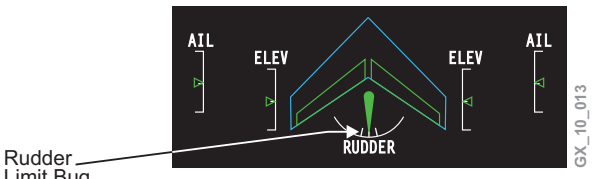


Rudder Surface Position Indication – Rudder Limiting

Rudder limiting at high speed will be displayed on the flight control synoptic with a reduction in the rudder travel arc.



LOW SPEED



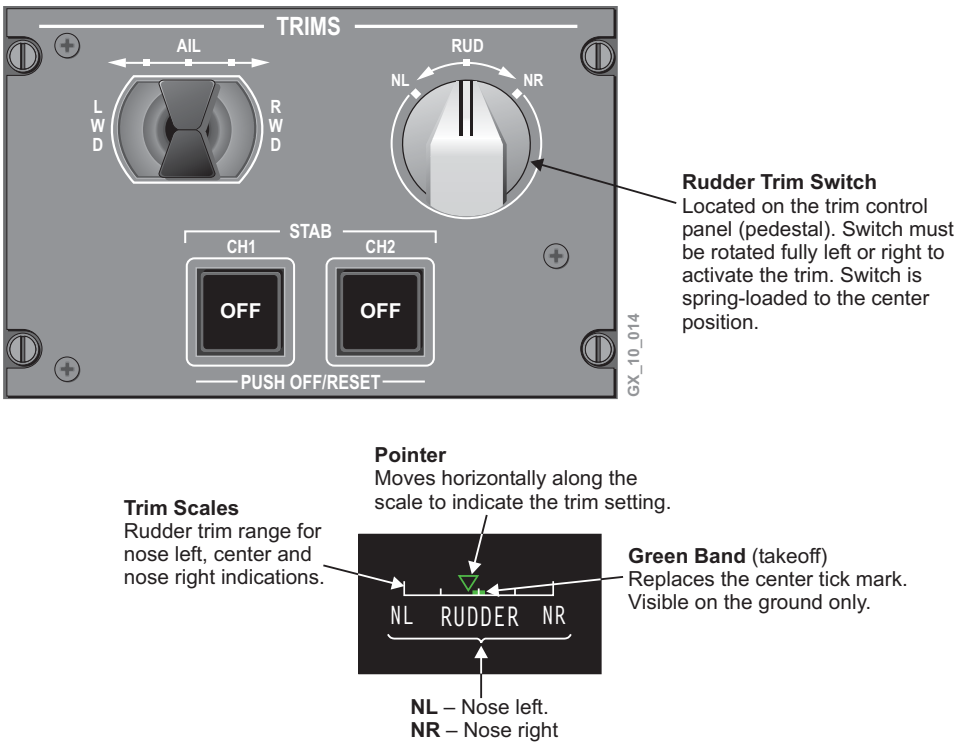
HIGH SPEED

Rudder Trim

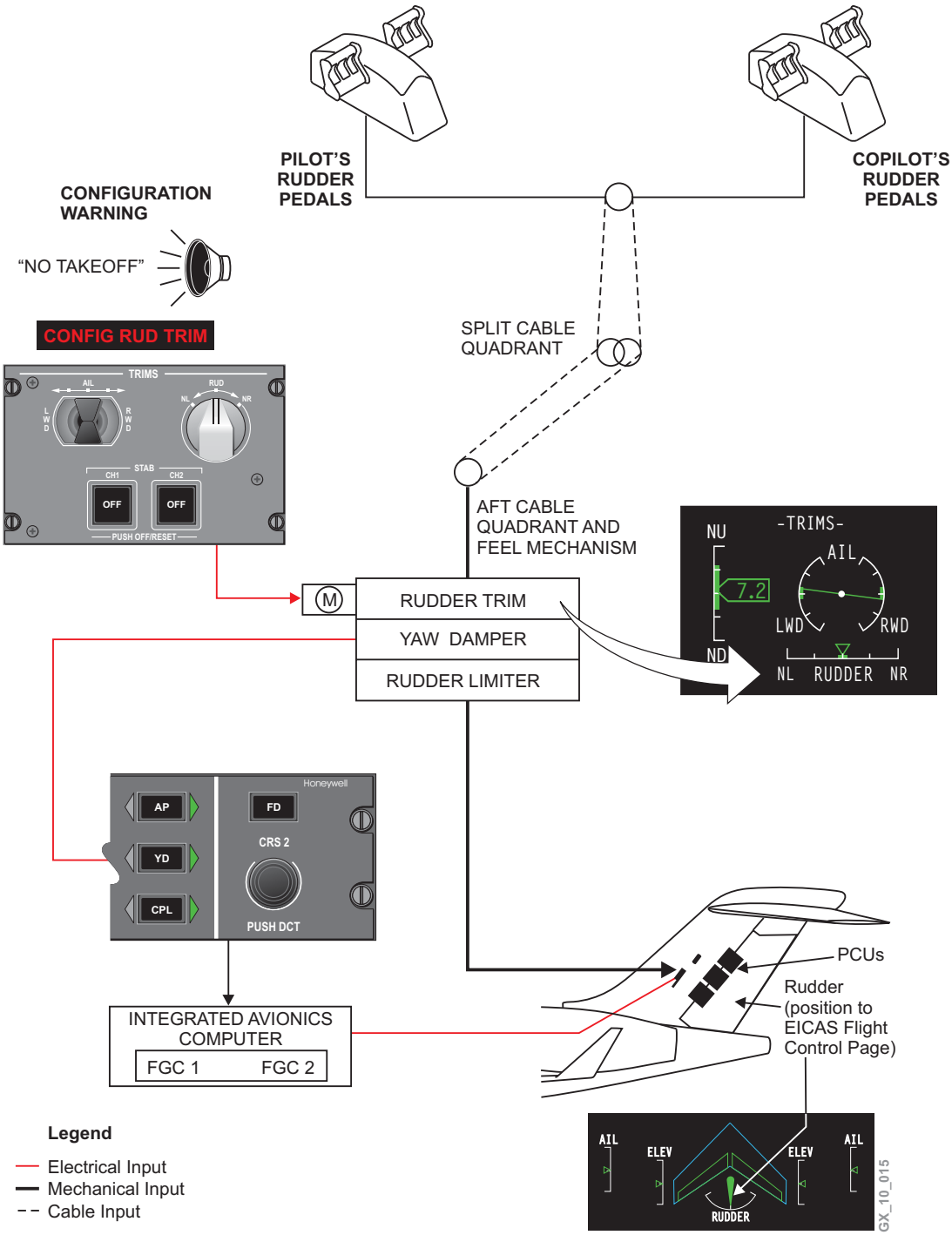
Rudder trim is available by rotating the RUD TRIM control switch on the trim control panel (center pedestal) in the desired direction. The control provides signals to a trim actuator that repositions the rudder neutral point.

Hydraulic power is necessary to set rudder trim. Rudder trim position is displayed on the EICAS page, along with the allowable takeoff green band.

A "**CONFIG RUD TRIM**" red warning message is accompanied by a "NO TAKEOFF" voice message, and is displayed during the takeoff roll if the rudder trim is set outside the allowable takeoff range.



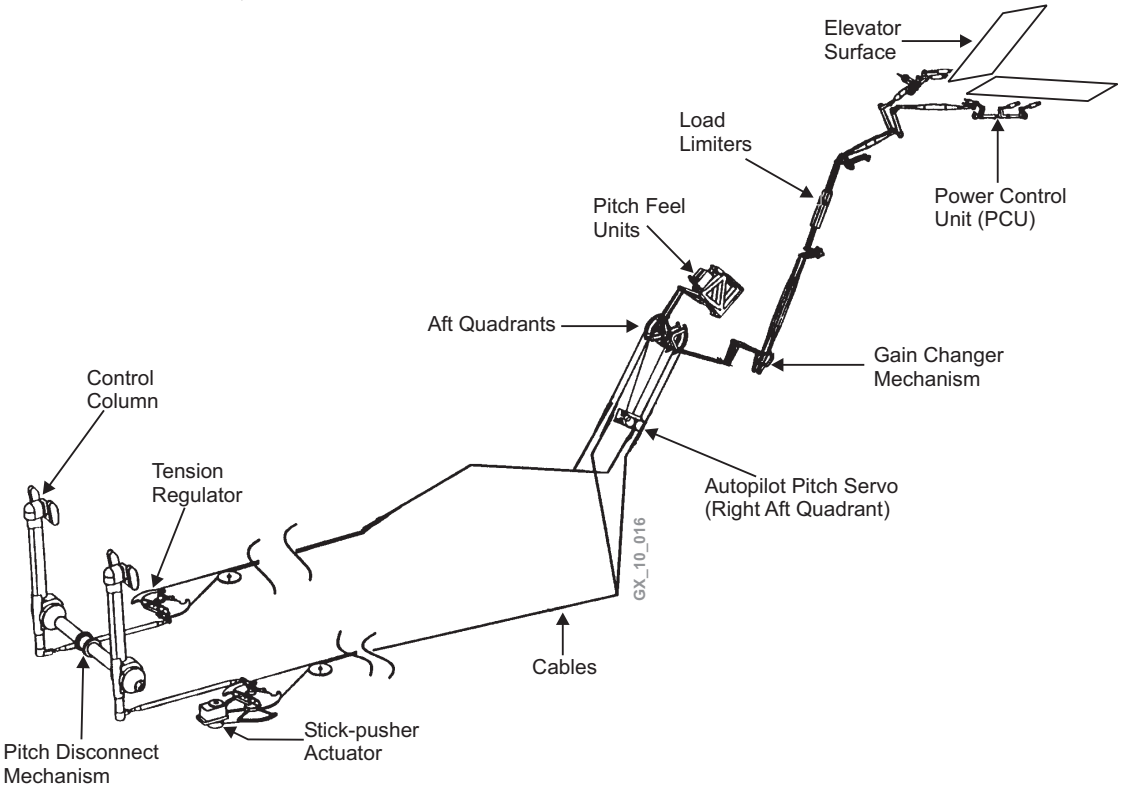
Rudder Control Schematic



ELEVATOR CONTROL

Longitudinal control is provided by elevators operating in relation to control column displacement, and supplemented by a moveable horizontal stabilizer for maintaining longitudinal (pitch) trim. Pilot inputs to the elevator circuit are from the dual control columns which are normally interconnected through a pitch disconnect mechanism.

ELEVATOR CONTROL GENERAL ARRANGEMENT



Elevator Control System

Two separate pitch control systems are provided: the pilot's side operates the left-hand elevator and the copilot's side operates the right-hand elevator. Normally, both control systems are interconnected through a torque tube assembly, and there is simultaneous movement of both elevators.

Elevator Control System Operation

The pilot and copilots pitch controls are interconnected through a disconnect mechanism which is designed to operate when a design torque is developed across the mechanism.

NOTE

The autopilot should be disconnected if a jammed elevator control circuit condition occurs.

A jammed elevator control circuit can be isolated through activation of the pitch disconnect mechanism. This procedure will allow limited pitch control using one elevator through the operable control circuit.

A control rod located at the base of each column transmits pilot command to the left and right forward quadrants. The left forward quadrant includes a cable interface with the stick pusher servo of the stall protection system.

The cable circuit travels independently from the forward quadrant to the aft quadrant located in the vertical stabilizer. A separate cable circuit is provided for the autopilot servo motor assembly which inputs the right aft quadrant.

Disconnecting the autopilot by the pilot overpowering the pitch servo will not cause the pitch disconnect system to disconnect the control columns.

NOTE

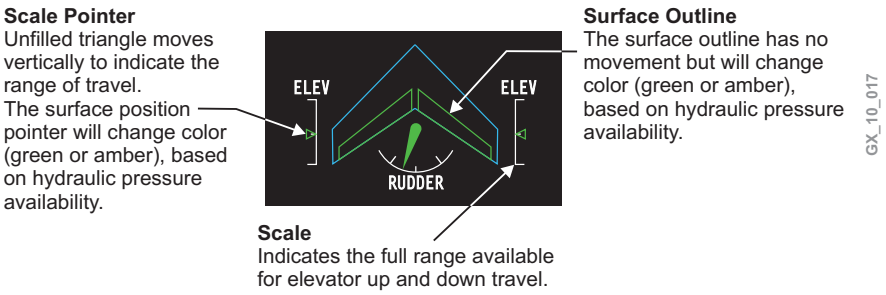
Overpowering the servo to disconnect the autopilot is not recommended.

Two electrical actuators positioned at the pitch feel units provides input to the aft quadrant for force feel requirements. The actuators receive command input from the FCUs, based on airspeed and horizontal trim position.

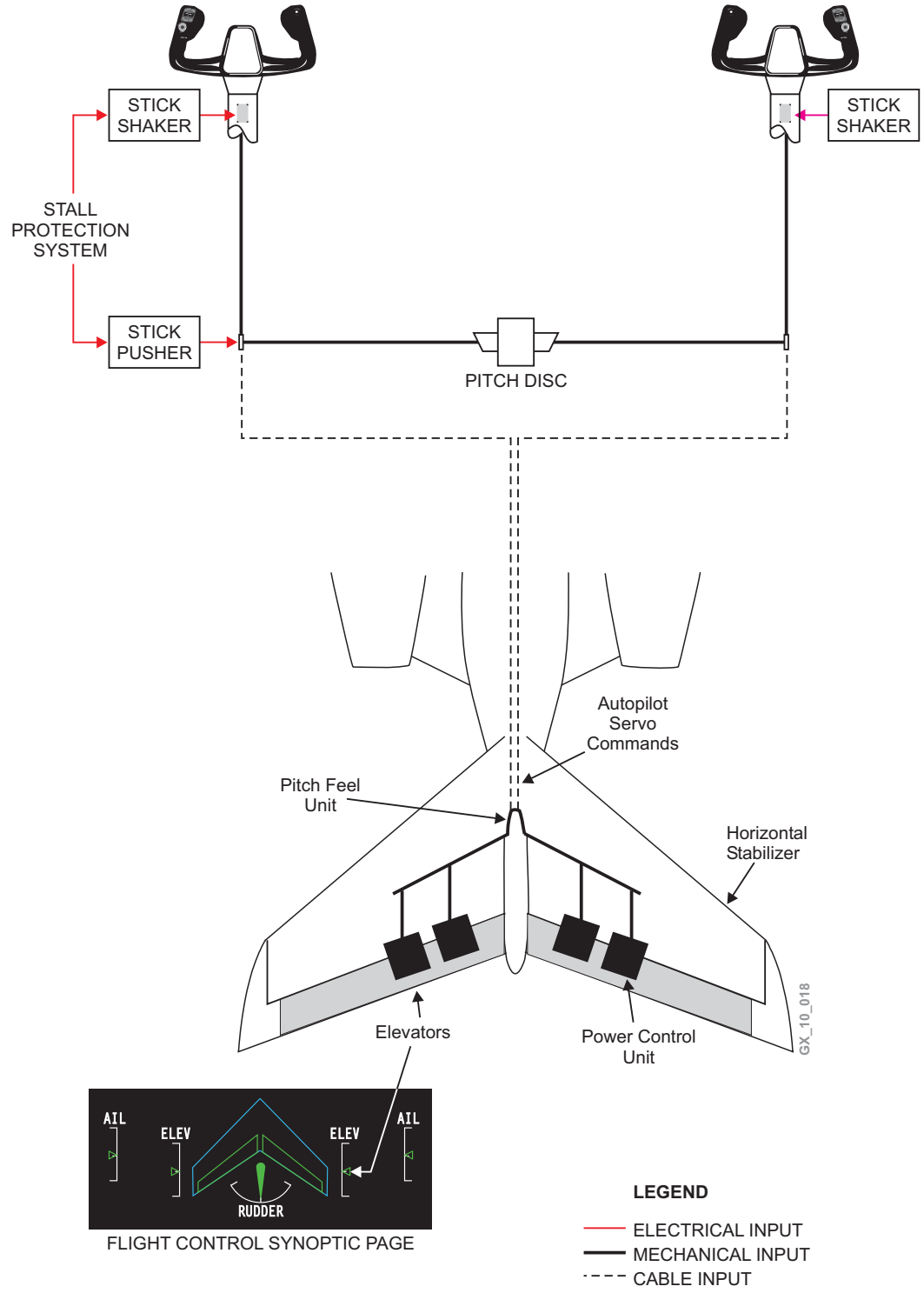
The aft quadrants drive a series of control rods, and levers which input a torque tube assembly to position the hydraulic PCUs. Two PCUs are used for each elevator.

Elevator Surface Position Indication

Left and right elevator positions are displayed by a moving pointer on the FLIGHT CONTROL page. Separate pointers indicate the left and right elevator surface positions.



Elevator Control Schematic



SECONDARY FLIGHT CONTROLS

HORIZONTAL STABILIZER

The stabilizer trim control system provides pitch trim by varying the angle of incidence of the horizontal stabilizer. The system consists of two Flight Control Units (FCUs), dual channel Motor Drive Unit (MDU) and a dual electric channel trim actuator which drives a screw jack assembly to position the horizontal stabilizer. Activation of the horizontal stabilizer trim can occur through manual trim, auto trim and mach trim.

The pilot's controls consist of switches on each control column and the stabilizer trim control panel. Pilot trim commands have priority and will override copilot trim command inputs. The horizontal stabilizer can be trimmed from 2° (0 units on EICAS) airplane nose down to 12° (14 units on EICAS) nose up.

The FCUs are responsible for the monitoring of the trim system. They have their own dedicated interfaces with other airplane systems and with pilot/copilot controls to perform trim control and monitoring. The horizontal stabilizer system provides two redundant channels in an active/standby basis such that full performance requirements can be met with either channel.

Pitch Trim Input

The FCUs receive inputs from the following systems:

- Integrated Avionic Computer (IACs)
- Air Data Computer (ADCs)
- Automatic Flight Control System (AFCS)
- STAB switches, and
- Pitch trim and disconnect switches

For manual stabilizer trim control, the FCUs receive commands from the pilot and copilot trim switches. To perform the Mach trim function, the FCUs receive the airplane Mach number from three ADCs. Two IACs which comprise the AFCS function provide stabilizer trim command when the autopilot is engaged. The ADCs provide mach data used for mach trim and rate scheduling.

The FCUs in turn command the MDU to drive the motors of the horizontal stabilizer trim actuators. The FCUs monitor the results of the command inputs to ensure correct control trim rate and direction is achieved.

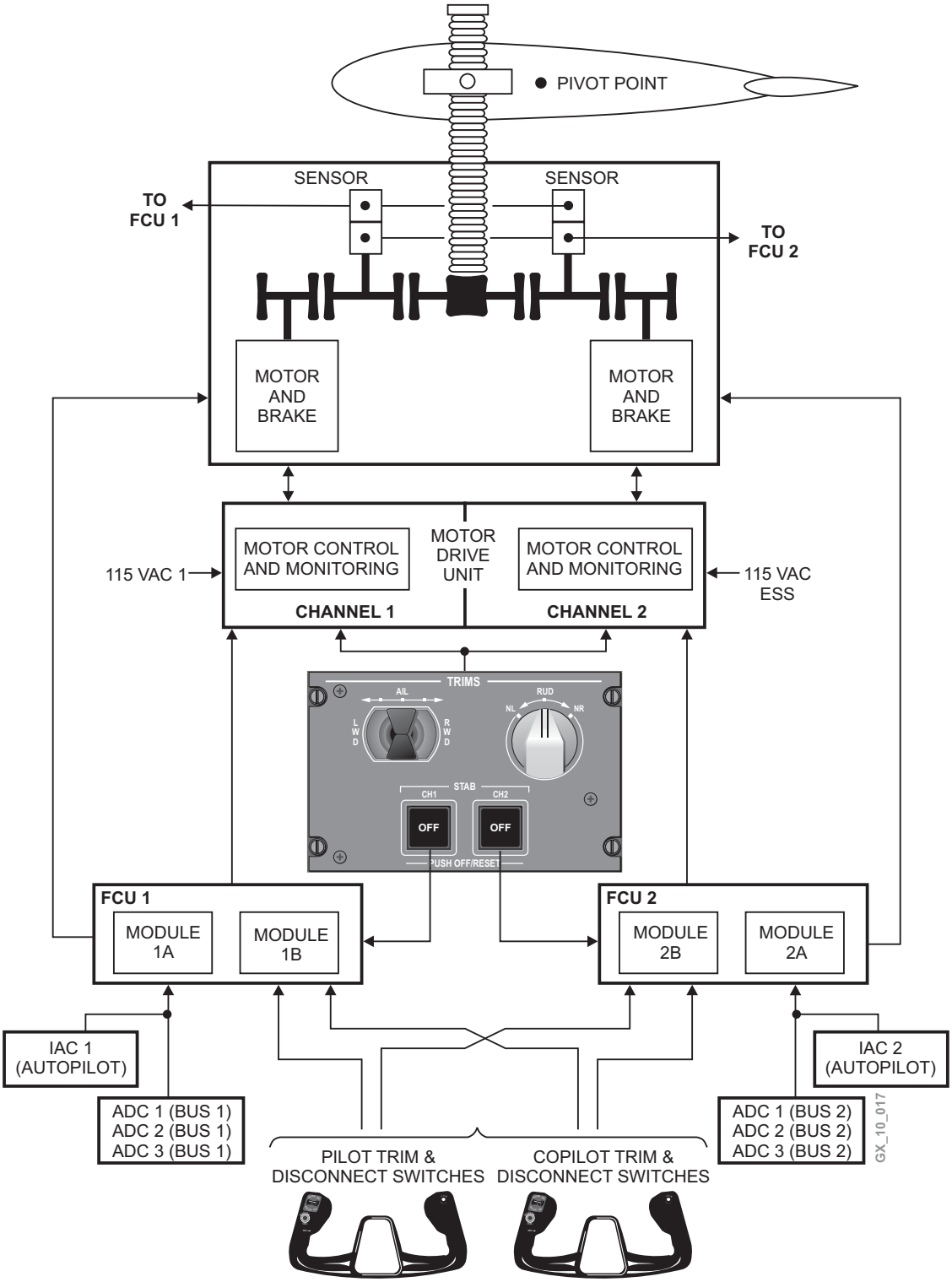
The Stab trim switches on the STAB control panel send signals to the FCUs for engagement and disconnect. These switches also send a signal direct to the MDU to ensure disconnect of the applicable trim actuator.

Stabilizer Actuator Assembly

Please refer to Pitch Trim Schematic.

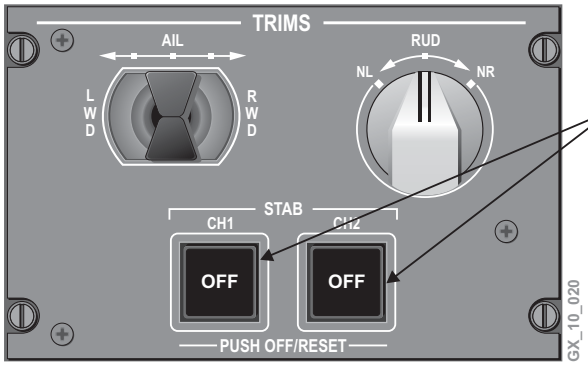
The actuator assembly positions the surface in response to electrical signals from the MDU. The stabilizer is positioned by a jack screw driven by electric trim motors within the actuator assembly. The actuator assembly has brakes which provide a secondary means of preventing creeping in flight under aerodynamic loads. A sensor mounted on each motor sends signals to the MDU to determine each motor position.

Pitch Trim Schematic



Stabilizer Trim Control Switches

The STAB trim control switches are located on the flight control trim panel (center pedestal). For normal operations, both switches are normally released (not pushed in) and remain dark. A white OFF legend is displayed only when the switch is selected. This action will disconnect the channel from the trim system, and will remain disconnected as long as the switch has been selected.



STAB Switches
Used to disconnect each channel of the trim system or reset certain latched transient faults.
Selecting the switch will disengage the pitch trim channel and the “OFF” light will illuminate.

Failure monitoring within the FCUs provides automatic failure detection and transfer to the opposite channel. Disabling of the failed channel will also automatically occur.

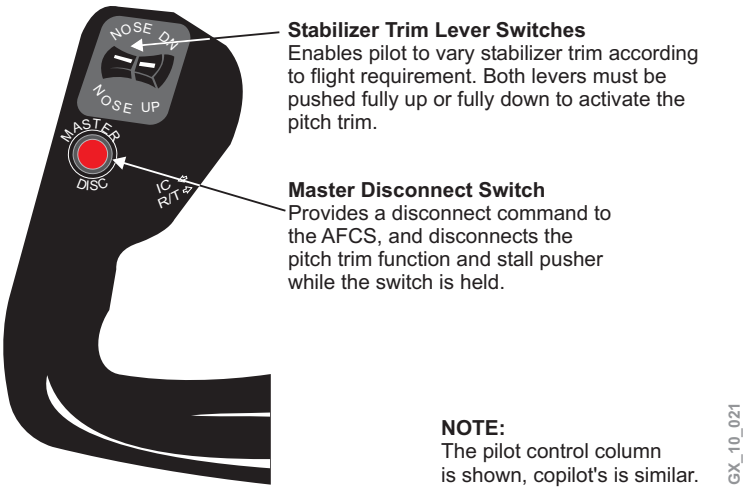
PITCH TRIM MODES OF OPERATION

The pitch trim operating priorities are shown in the table below:

PRIORITY	MODE
1	MANUAL TRIM COMMAND - PILOT SWITCHES
2	MANUAL TRIM COMMAND - COPILOT SWITCHES
3	AUTOMATIC TRIM - AUTOPILOT (A/P 1 or 2)
4	MACH TRIM - AVAILABLE ONLY IF A/P OFF

Manual Pitch Trim

The horizontal stabilizer trim is commanded through trim switches located on the pilot and copilot control columns. The switches command airplane nose up or nose down movement of the actuator with a controlled trim rate, dependent on the airplane Mach number.



The manual trim rate is 0.5 degrees per second at low Mach number and decreases gradually to 0.3 degrees per second as the Mach number increases.

Mach Trim

Mach trim is available only if autopilot is off (manual pitch trim mode). The Mach trim system provides longitudinal stability, using Mach speed information from the ADCs and varies the angle of incidence of the horizontal stabilizer by commanding the horizontal stabilizer actuator. Mach trim provides automatic compensation of airplane pitching with changes of Mach number. The trim rate follows a schedule dependent on Mach number. The Mach number is transmitted to the FCUs from the airplane Air Data Computers (ADCs) which pass command signals to the MDU.

The Mach trim authority ranges from 0.5° nose up at 0.85 Mach to 1.8° nose up @ 0.9 Mach. The trim rate varies between 0.06 and 0.03 degrees per second as Mach increases.

Automatic Pitch Trim

In the auto mode, the Mach trim inputs are inhibited. When automatic flight is engaged, the trim system will take its commands from the AFCS. The AFCS function is performed by the Integrated Avionics Computers (IACs). The FCU will receive motor commands from the AFCS through the IACs, then pass the command signals to the MDU. Trim rate and motion is received by the AFCS and monitoring is also performed in the FCU.

Manual trim has priority over autopilot pitch trim and mach trim. If the pilot or copilot trim switches are activated with the autopilot engaged, the FCU will generate a signal, causing the autopilot to disengage. The automatic pitch trim rate operation is from 0.5 to 0.015 degrees per second.

Stabilizer Trim Display

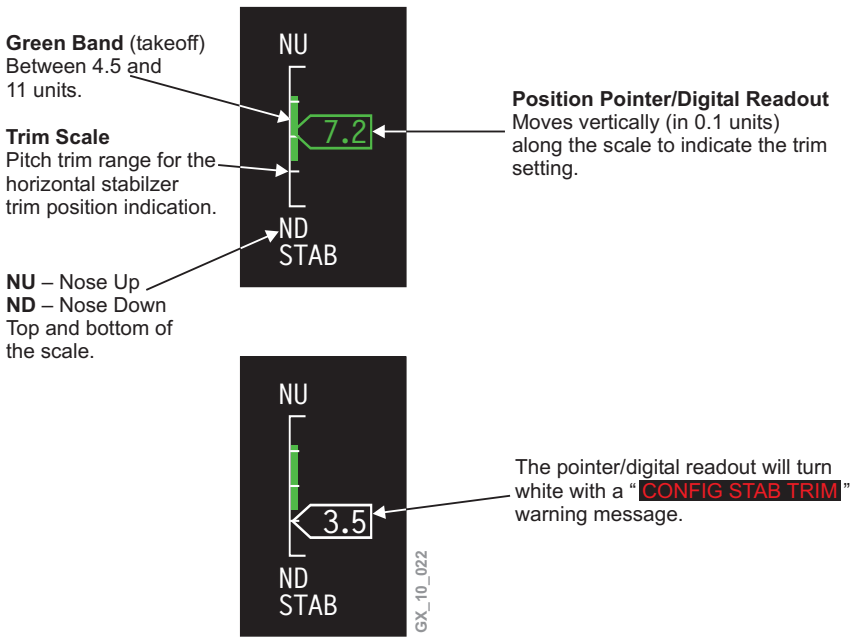
The EICAS page provides a full time display of the horizontal stabilizer trim position and system status. The display is grouped with the display for the aileron and rudder trims. The horizontal stabilizer trim position is represented by a pointer, moving on a vertical linear scale. The pointer includes a digital readout of the trim value. The range of stabilizer movement in degrees is converted to units from 0 to 14 for the purpose of position display.

A "**CONFIG STAB TRIM**" red warning message is accompanied by a "NO TAKEOFF" voice message, and is displayed during the takeoff roll if the stabilizer trim is set outside the allowable takeoff range.

The color of the pointer and digital readout is dependent on system status:

- WHITE - on ground or during takeoff if the horizontal stabilizer trim is trimmed outside the takeoff range (green band)
- GREEN - operative, and when on the ground or during takeoff, trimmed within the takeoff range

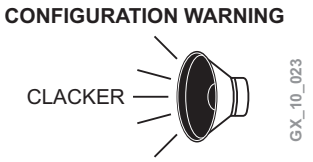
When the airplane is on the ground or during takeoff, the trim takeoff range is displayed as a green band within the white scale. In flight, the takeoff range (green band) is removed.



Stabilizer in Motion Aural Warning

The stabilizer in motion aural clacker signals operation of the horizontal stabilizer under the following conditions:

- Operation of more than 3 seconds at a rate greater than 0.2 deg/sec OR
- More than 6 seconds at a rate greater than 0.08 deg/sec

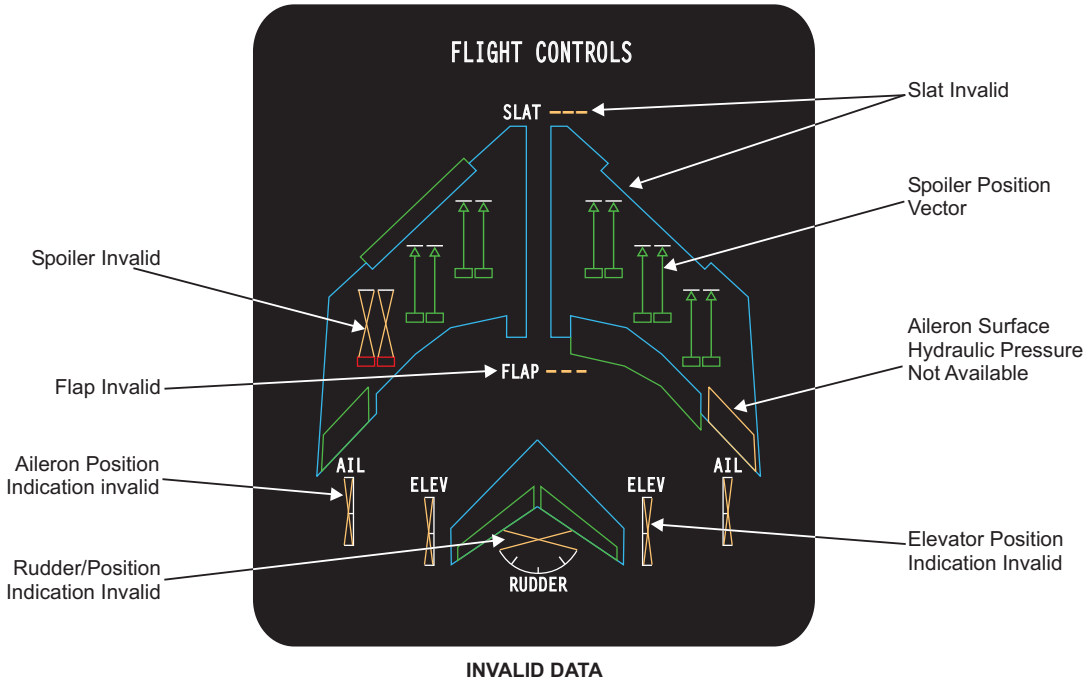


Horizontal stabilizer trim position and condition is continuously monitored and any fault detected is displayed on EICAS.

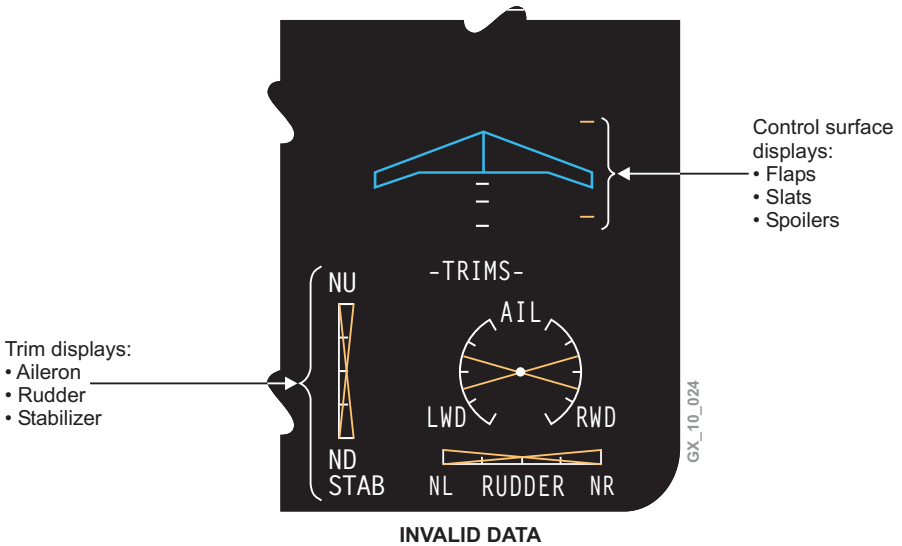
SPLRS/STAB In Test

An advisory message "**SPLRS/STAB IN TEST**" will be displayed when the spoilers and stab trim systems are performing self test once hydraulics are applied. The horizontal stabilizer system is inoperative through the duration (approximately 20 seconds) of the test. Refer to the EICAS MESSAGES in the spoiler section of flight controls for the message display.

Flight Control Invalid Data Displays



INVALID DATA



INVALID DATA

SLAT/FLAP CONTROL SYSTEM

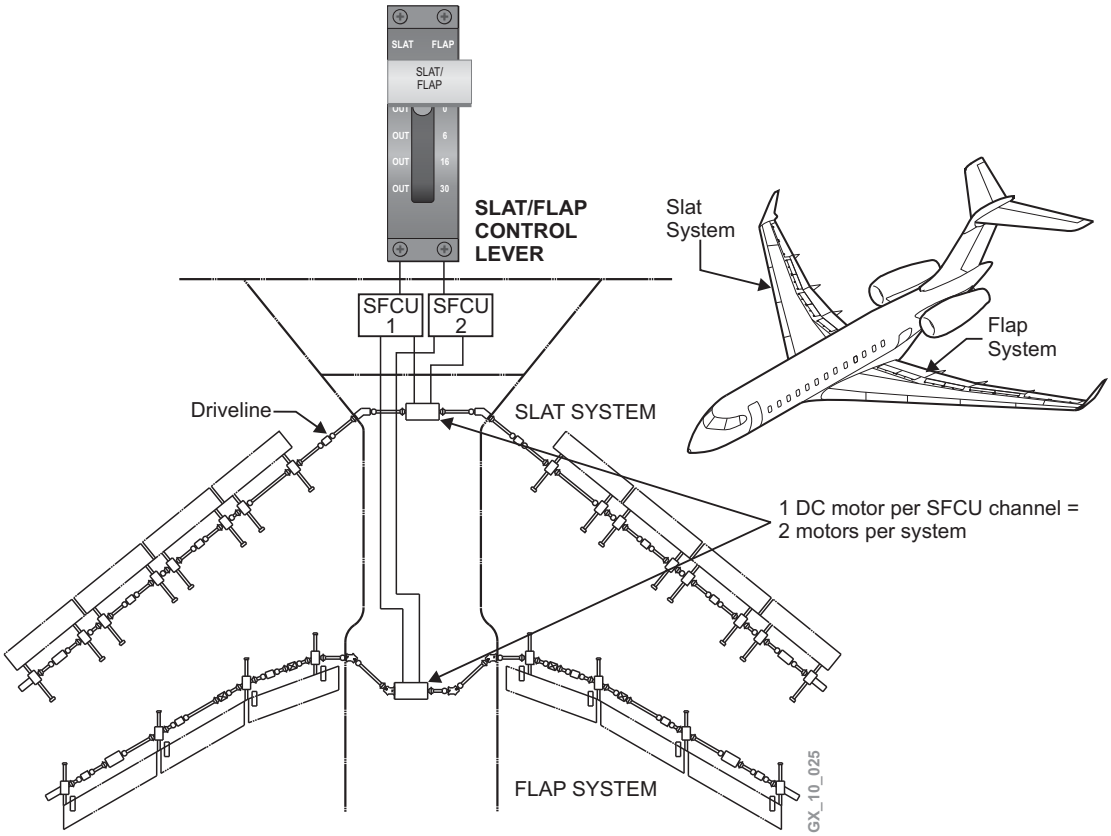
The slat and flap control system is an integrated electromechanical system which operates both slats and flaps from a single flight compartment control lever. The slat and flap control systems are mechanically independent. Each system is comprised of actuators, linked through a rigid driveline, to a central Power Drive Unit (PDU). Each PDU incorporates dual electric motor/brake assemblies. The slats and flaps will continue to operate at half-speed with a single motor operating.

Asymmetry brakes for both slats and flaps are installed to provide driveline braking in the event of shaft failures. Dual sensors are located at the outboard-most ends of the driveline. They are used by the control units for system positioning and fault monitoring. Position sensors are located next to each flap actuator to provide position feedback to the control units.

The slats are extended first if both slat and flap extension are required. The flaps are retracted first if both slat and flap retraction is required.

Two Slat/Flap Control Units (SFCUs) control the operation of the slats and flaps. Electrically there are two independent channels for slats, and two independent channels for flaps. Each SFCU controls and monitors the slats and flaps independently of the other unit. Each SFCU controls one slat PDU motor and asymmetry brake, and one flap PDU motor and asymmetry brake. System control provides protection against asymmetry and uncommanded movement.

SLAT/FLAP System Schematic

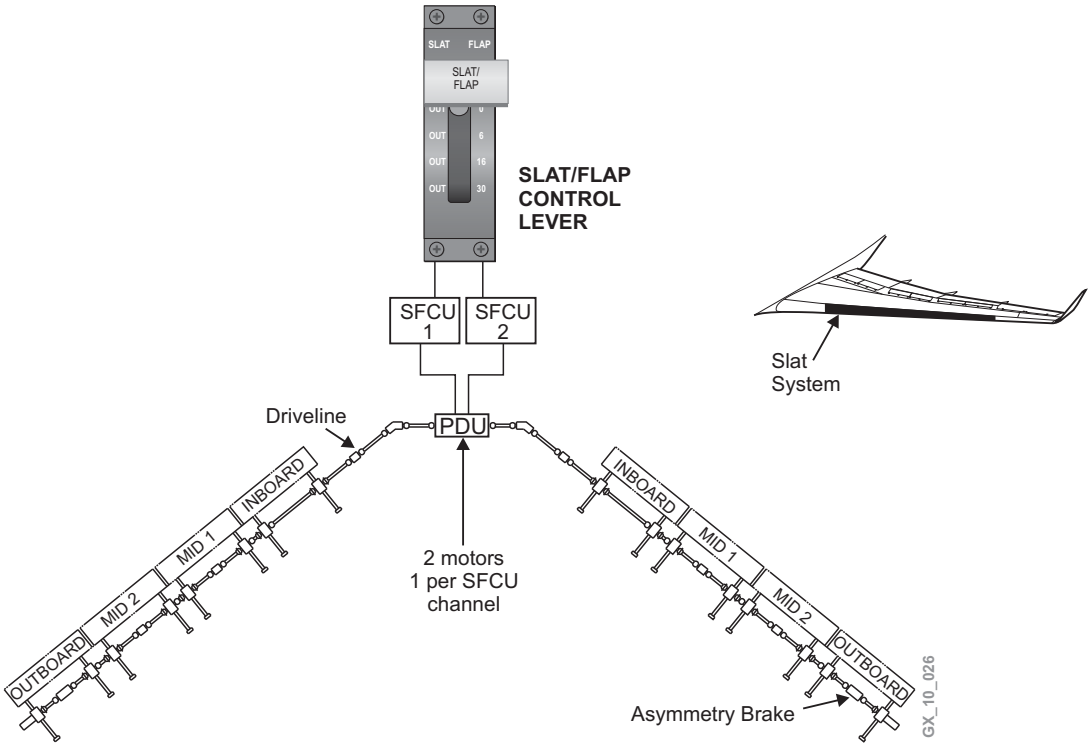


SLAT CONTROL SYSTEM

The slat system has four leading edge slat panels with two actuators per slat, connected to a slats Power Drive Unit (PDU), linked through a rigid driveline (torque tubes/ bearings), and controlled by the slat/flap handle position. The PDU is driven by two DC motors connected together in a speed sum configuration. Each motor is controlled by a single channel SFCU. There is a brake on each slat motor that is also controlled by the SFCU. The PDU provides protection against overload and jam conditions. To protect against asymmetry, there are dual coil brakes and position sensors, located on each outboard station, left and right, that interface with both SFCUs.

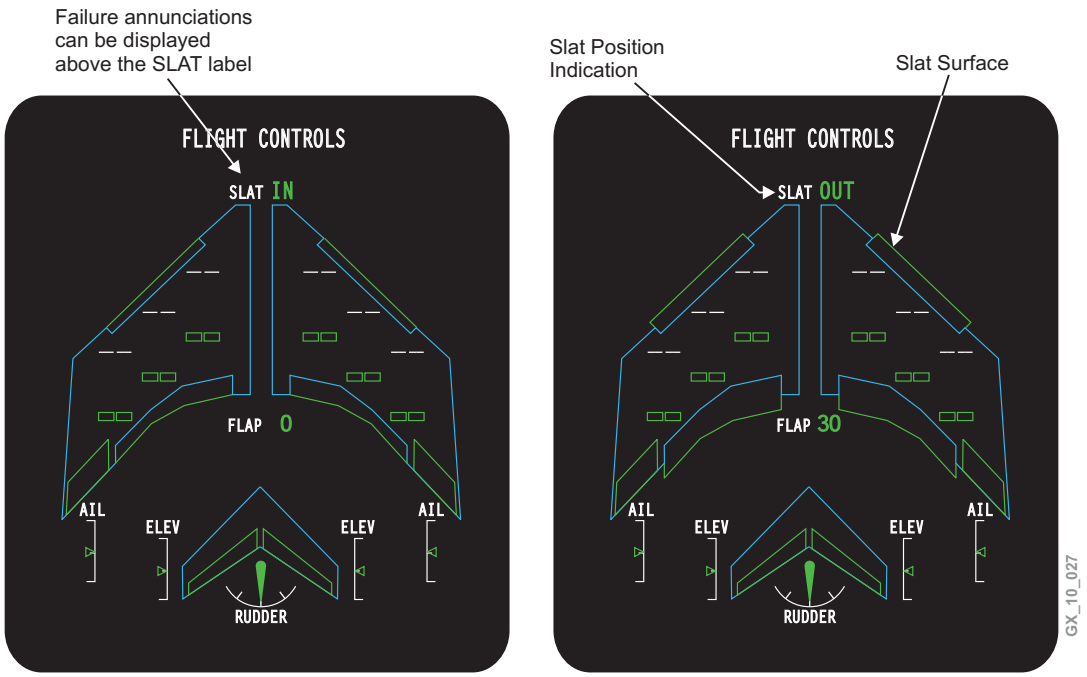
Anti-icing of the slats is controlled by the ice detection system. Telescopic ducting is installed between the inboard fixed leading edge and the outboard slats for anti-icing. Refer to Chapter 3 for additional information on the anti-icing/bleed system.

Slat System Schematic



The slat position (in or out) and surface position is displayed on the FLIGHT CONTROL synoptic page. Slat indication is also shown on the EICAS PAGE.

Slat Position and Surface Indications



SLAT/FLAP SURFACES RETRACTED

SLAT/FLAP SURFACES EXTENDED

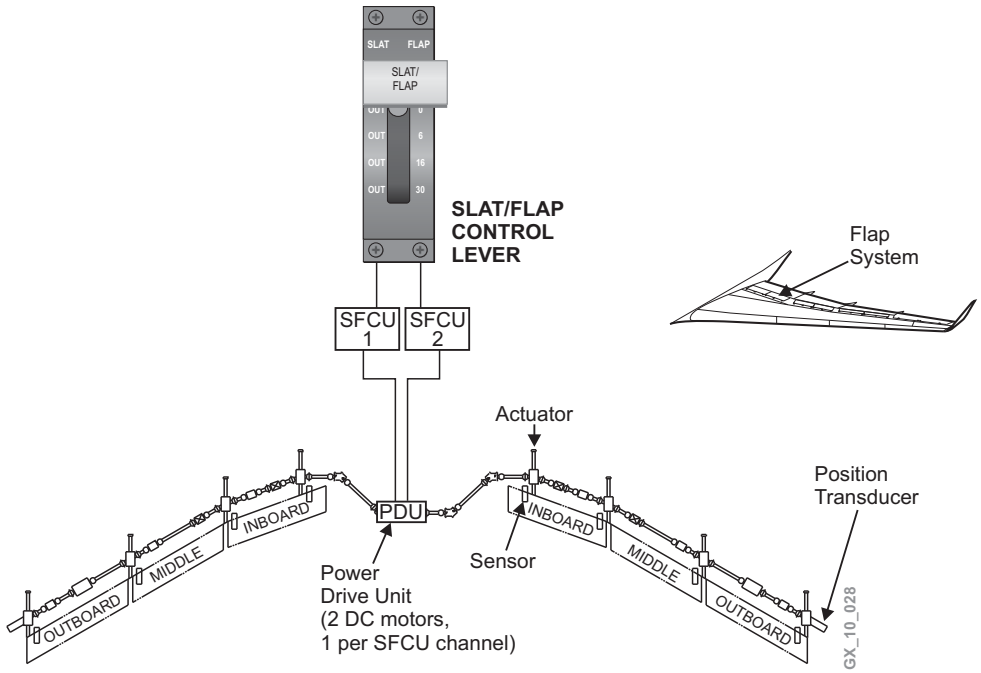
SLAT POSITION INDICATION AND SURFACE COLOR	
If the slats are at commanded position, the slat position indication and slat surface will turn green.	
If the slats are in motion, the slat position indication and slat surface will turn white.	
If the SLAT FAIL or SLAT FAULT message is displayed, the slat position indication and slat surface will turn amber.	
SYNOPTIC FAILURE ANNUNCIATIONS LOCATION: ABOVE SLAT POSITION	**LOGIC**
HALFSPEED	If SLAT HALFSPD message is on
DRIVE OVERHEAT 1	Overheat detected by channel 1
DRIVE OVERHEAT 2	Overheat detected by channel 2
DRIVE OVERHEAT 1-2	Overheat detected by channel 1 and 2

FLAP CONTROL SYSTEM

The flap system has three flap panels with four actuators connected to a flaps Power Drive Unit (PDU), linked through a rigid driveline (torque tubes/bearings), and controlled by the slat/flap handle position. The PDU is driven by two DC motors connected together in a speed sum configuration. Each motor is controlled by a single-channel SFCU. There is a brake on each flap motor that is also controlled by the SFCU. The PDU provides protection against overload and jam conditions.

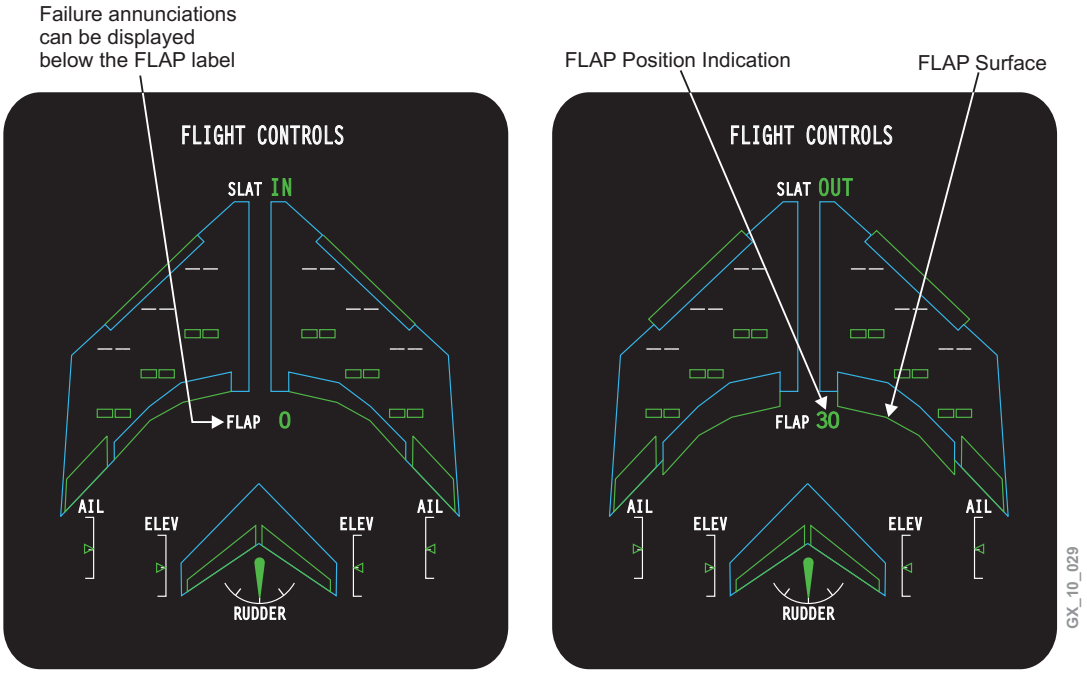
To protect against asymmetry, there are dual coil brakes and position sensors located on each outboard station, left and right, that interface with the SFCU. There are also direction sensors on the flap system used to detect actuator disconnects. The sensors on the left wing report to SFCU 1 and the sensors on the right wing report to SFCU 2.

Flap System Schematic



The flap position (degrees of travel) and surface position is displayed on the FLIGHT CONTROL synoptic page. Flap indication is also shown on the EICAS page.

Flap Position and Surface Indications



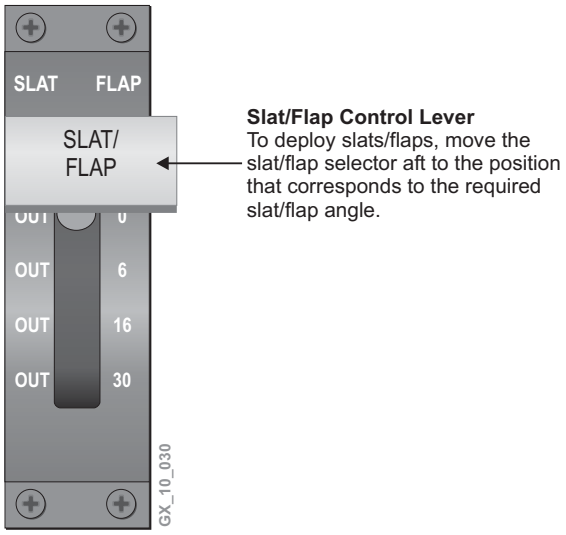
SLAT/FLAP SURFACES RETRACTED

SLAT/FLAP SURFACES EXTENDED

FLAP POSITION INDICATION AND SURFACE COLOR	
If the flaps are at commanded position, the flap position indication and flap surface will turn green.	
If the flaps are in motion, the flap position indication and flap surface will turn white.	
If the FLAP FAIL or FLAP FAULT message is displayed, the flap position indication and flap surface will turn amber.	
SYNOPTIC FAILURE ANNUNCIATIONS LOCATION: BELOW FLAP INDICATION	**LOGIC**
HALFSPEED	If FLAP HALFSPD message is on
DRIVE OVERHEAT 1	Overheat detected by channel 1
DRIVE OVERHEAT 2	Overheat detected by channel 2
DRIVE OVERHEAT 1-2	Overheat detected by channel 1 and 2

SLAT/FLAP Control Lever

An integrated slat/flap selector located in the flight compartment (center pedestal) will command position of the slat/flap system operation.

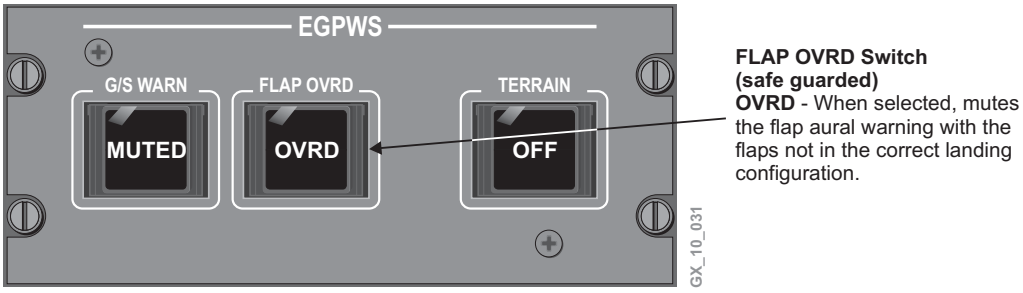


The slat/flap configuration is as follows:

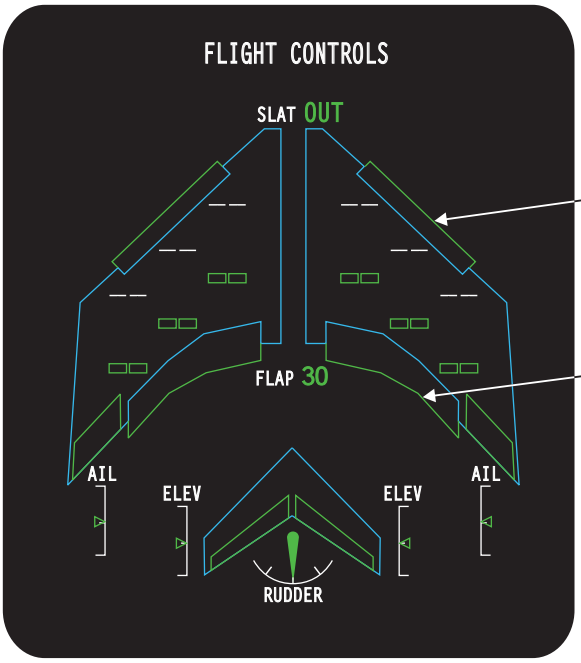
SLAT POSITION	FLAP POSITION	PLACARD SPEED	PROTECTION
IN	0	N/A	LATCH
OUT	0	225	GATE
OUT	6	210 kts	GATE
OUT	16	210 kts	DETENT
OUT	30	185 kts	LATCH

Flap Override Switch

A flap override switch is located on the EGPWS panel (center console) in the flight compartment. The switch is used to cancel the flap aural warning if the flaps cannot be correctly configured for an OUT/30 landing.



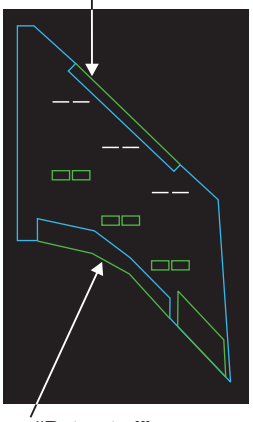
FLIGHT CONTROL SYNOPTIC DISPLAY



Slat Surface "Retracted" Position
The outline of the slat surfaces align with the wing leading edge.

Slat Surface "Extended" Position
Slat extended – The outline of the surface is as shown.

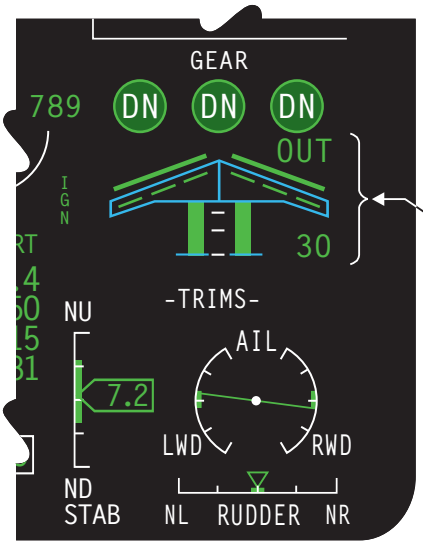
Flap Surface "Extended" Position
Flap extended – The outline of the surface is as shown.

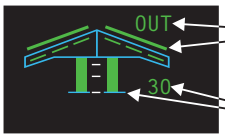


Flap Surface "Retracted" Position
The outline of the flap surfaces align with the wing trailing edge.

GX_10_032

SLAT/FLAP Primary EICAS Display





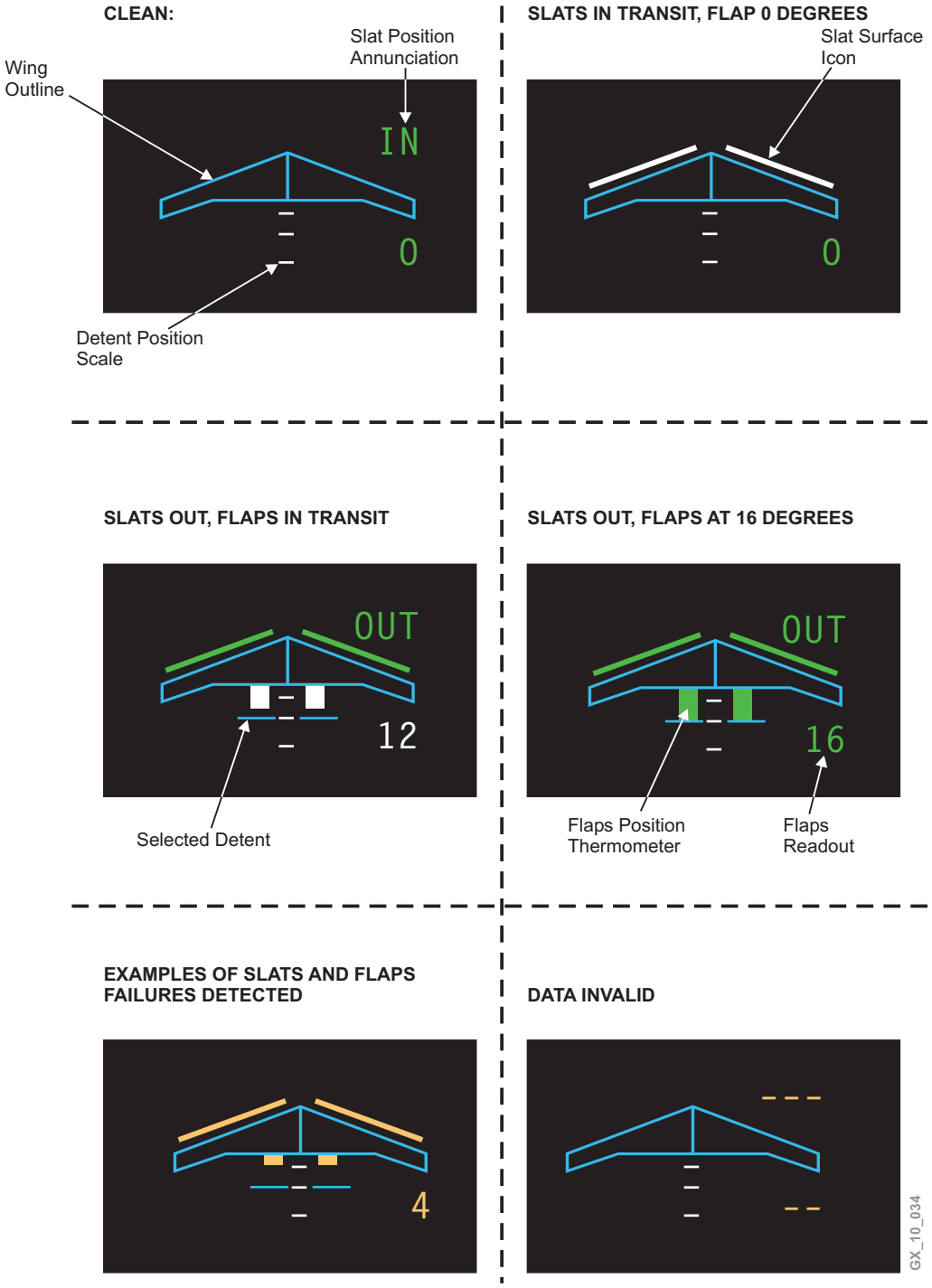
Slat Position Indication
Displays symbol and position annunciation.

Flap Position Indication
Displays symbol and numerical value.

Slats/Flaps, Spoilers and Gear Position Pop-Up
The pop-up display will be removed from the EICAS page (in flight only), 30 seconds after the gear and flaps indicate up, spoilers retracted and no predetermined malfunctions exist.
The pop-up display will appear with flap selection greater than zero degrees, gear selected down, spoilers deployed and/or if any predetermined malfunctions exist.

GX_10_033

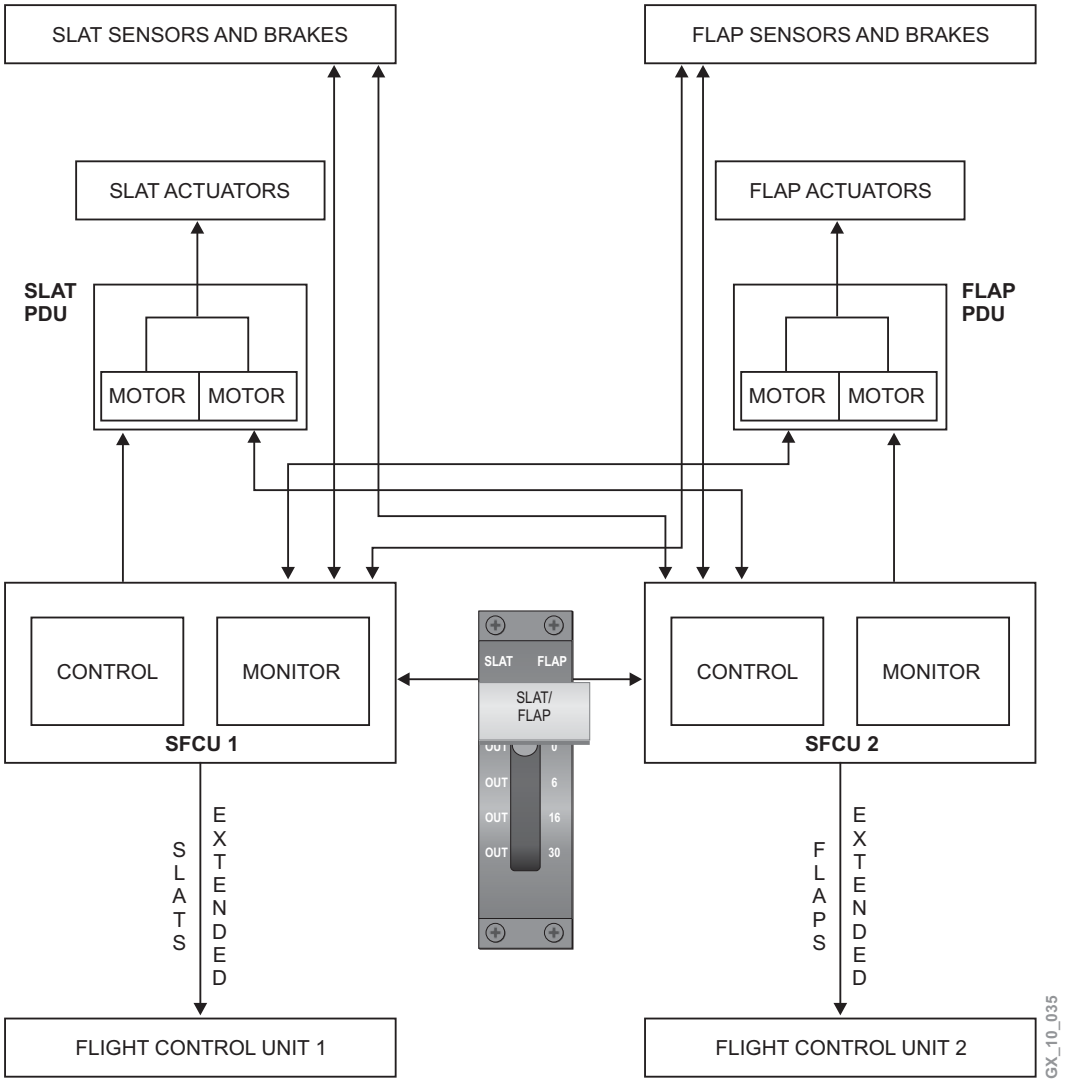
The following represents slat and flap configurations in both serviceable and failure conditions.



SLAT/FLAP OPERATION

Both SFCU 1 and 2 receive input signals from the slat/flap control lever. The SFCUs then release the brakes from the motor drive units of the PDUs and asymmetry brake detectors. The PDU powers the driveline and actuators to achieve slat/flap travel.

The position sensors return signals to the SFCUs to confirm correct operation of speed, rotation and position. Each SFCU sends signals to Flight Control Units (FCUs) 1 and 2 which process this logic for system(s) operation.



FLAP/SLAT/GEAR EXTENSION SPEED BUGS

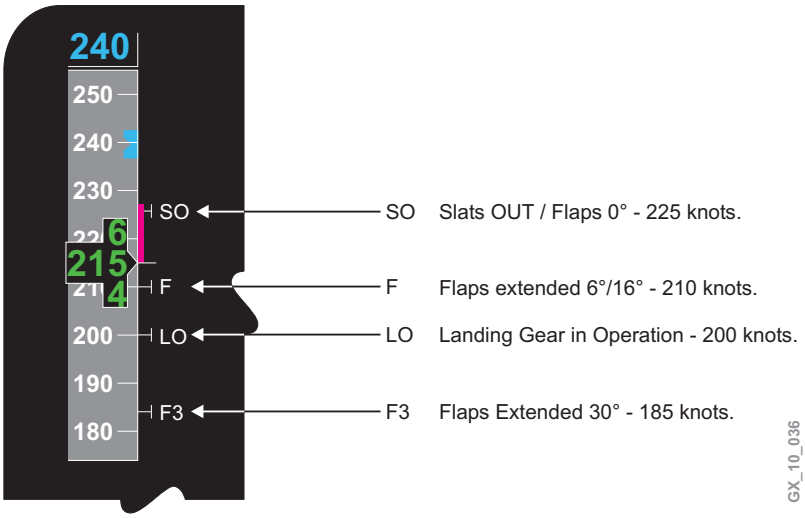
The slat/flap/gear extension speed bugs are displayed as illustrated below.

The slat/flap/gear extension speed bugs are displayed in a fixed position on the airspeed tape, and will go out of view beyond the end of the airspeed tape.

NOTE

Speed bugs are only displayed at 18,000 feet and below, or with Slat/Flap/Gear out.

The slat/flap/gear extension speed symbols are as follows:

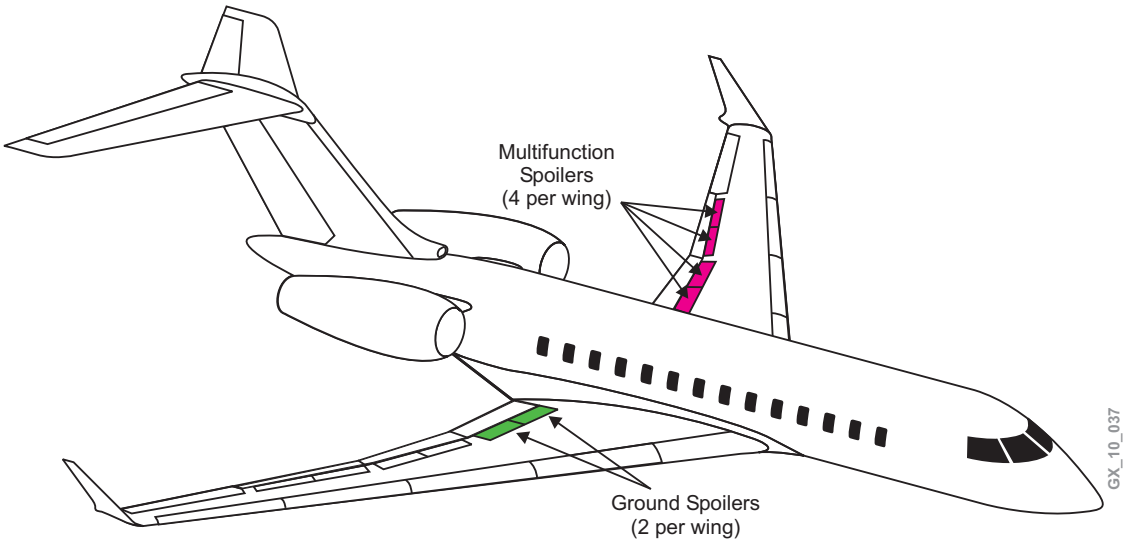


SPOILER SYSTEM

There are four Multifunctional Spoiler (MFS) panels and two Ground Spoiler (GS) panels, located on the upper surface of each wing, just forward of the flaps. MFS and GS position is shown on the EICAS and flight control synoptic pages.

A Flight Spoiler Control Lever (FSCL) in the flight compartment is used to control the MFS symmetrically for in flight lift dumping. The FSCL provides input to the two FCUs to control the extension/retraction of each MFS panel. Deployment angle is proportional to the position of the FSCL. When the flaps are retracted, all four pairs of MFS are available for lift dumping; with the flaps extended, only the two inboard pairs are used.

The MFS panels provide roll assistance, in flight lift dumping (speed brakes) and ground lift dumping. They are also used as a backup to the ailerons, in the event of an aileron failure. The MFSs are electrically controlled by the FCUs which actuate hydraulic PCUs, one per surface. The MFSs are hydraulically powered by systems 1 and 2. To prevent lift asymmetry, a failed panel will automatically disable the corresponding symmetric panel on the opposite wing.



The GSs (inboard spoilers) deploy on ground only as part of the ground lift dumping function. The GSs are controlled symmetrically to either the fully extended or fully retracted position through hydraulically powered PCUs, one per surface. The GSs are hydraulically powered by hydraulic systems No. 1 and 3. Hydraulic supply for PCU operation is provided by an electrically controlled selector valve. Extension of a pair of GSs is controlled by energizing two solenoid valves in the selector valve. Retraction occurs as soon as electrical power is removed from one (or both) solenoids which control valve movement.

The GS together with the MFSs are used to dump lift and increase drag to assist other braking systems on landing, or in the event of a rejected takeoff. Each spoiler surface is equipped with one proximity sensor to detect when the surface is retracted. When a proximity sensor indicates a non-retracted surface and no deployment has been commanded, an EICAS message will be displayed on the EICAS page.

Spoiler Functions

The spoiler system performs the following:

- ROLL ASSIST - by asymmetric deployment of up to four pairs of MFS to augment aileron control. The surface deflection is a function of the handwheel roll angle (derived from the average of two sensors) compensated for airspeed and flap position. Right wing down command deploys the right spoilers, left remain stowed. Left wing down deploys the left spoilers, right spoilers remain stowed
- PROPORTIONAL LIFT DUMPING - by symmetric deployment of up to four pairs of MFS commanded by the FSCL. Proportional lift dumping and roll commands are mixed to provide differential right and left MFS deployment. Four pairs of MFS are available when the flaps are fully retracted. Two pairs (inboard) of MFS will deploy at low altitude when the flaps are in any of their extended position detents. Under this condition the outboard MFS will be available for roll assistance only
- GROUND LIFT DUMPING - through the symmetric full extension of all spoilers upon landing or during a rejected takeoff. At initial touchdown with at least one left or right main landing gear indicating on-ground (wheels spinning up), the two pairs of GS deploy first. The deployment of the two pairs of MFS is delayed (until weight on wheels) for continued roll control
- COMBINATION ROLL ASSIST AND PROPORTIONAL LIFT DUMPING - MFS control mixes the roll command and proportional lift dumping command. To command a handwheel command and a FSCL command, spoiler deployment of one wing decreases and increases on the other. The roll effect is obtained by the differential deployment of left and right spoilers

SPLRS/STAB In Test

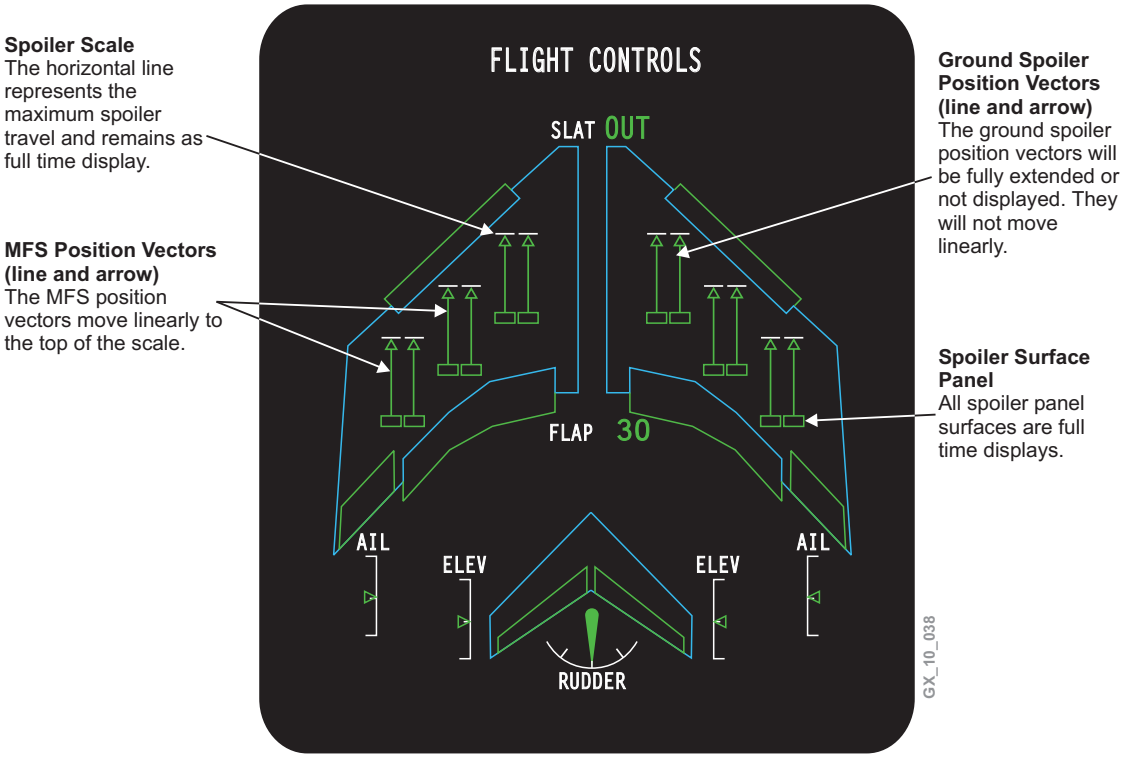
An advisory message "**SPLRS/STAB IN TEST**" will be displayed when the spoilers and stab trim systems are performing self test once hydraulics are applied. The spoiler system is inoperative throughout the duration (approximately 20 seconds) of the test.

Spoiler Synoptic Display

The deployment position of all spoilers is shown on the EICAS page and flight controls page. When there is no spoiler deployment, all position vectors disappear. Symbology at each spoiler panel display the following:

- Spoiler panel status
- Deployed or retracted indications

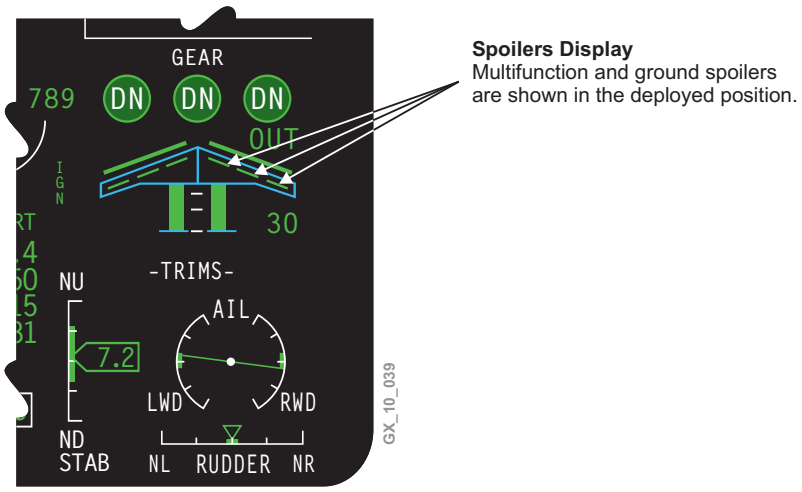
Spoilers position and condition is continuously monitored and any fault detected is displayed on EICAS.



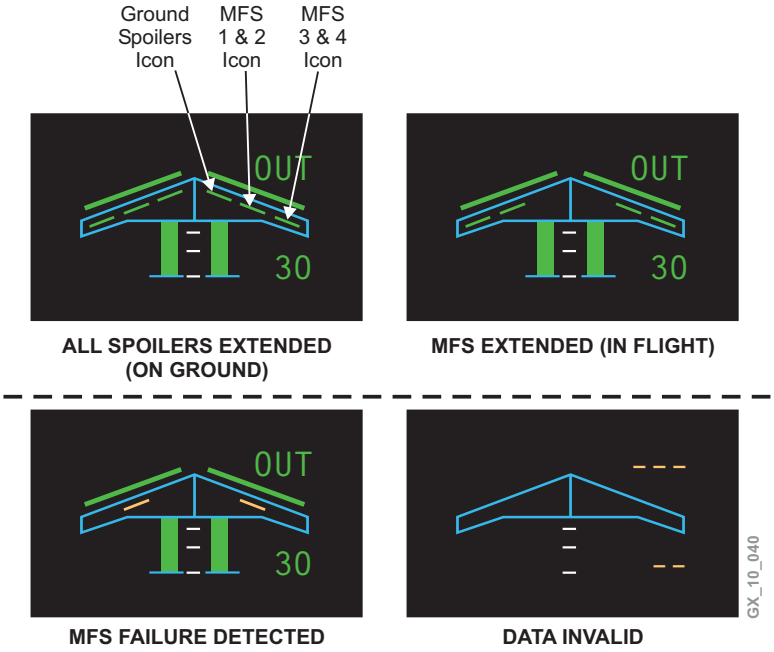
MFS AND GS POSITION VECTORS AND SCALE COLORS	
Item	Color
Position Vector	Green if surface is green
Position Vector	Amber if surface is amber
Position Scales (upper tick mark)	Remain white

Spoiler Primary EICAS Display

Spoiler operation can be monitored when the pop-up window is displayed on the EICAS page.



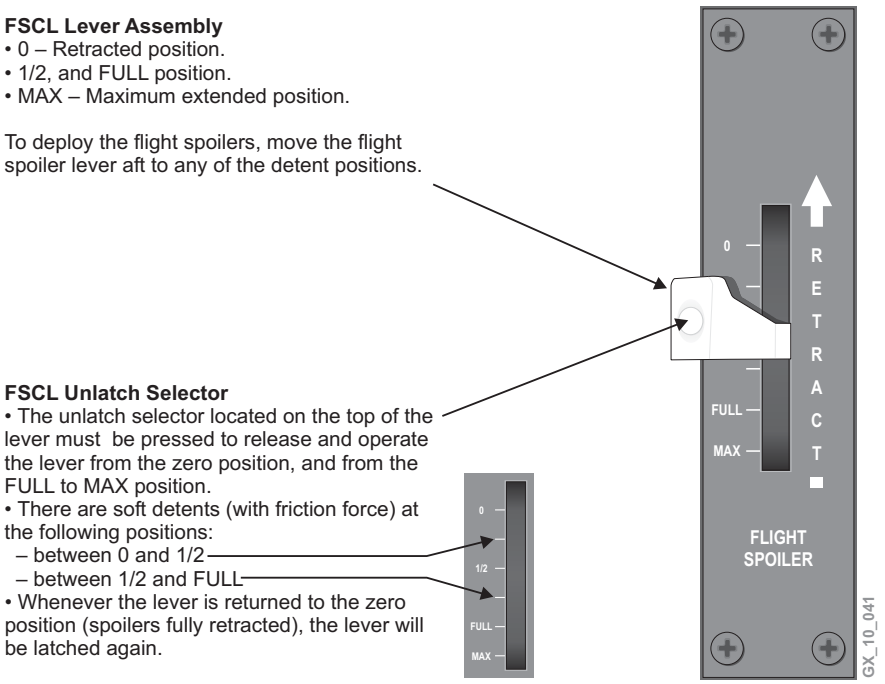
The following are examples of spoiler configurations displayed on the EICAS page:



Flight Spoiler Control Lever

The flight spoiler control lever (FSCL) located in the center pedestal (flight compartment) is the input handle which controls the MFS surfaces for lift dumping in flight. Markings on the mounting plate are illuminated by integral lighting located in the lever. The FSCL includes four sensors to forward input lever command to the FCUs.

The MFS may be extended to any position, between 0 and FULL, as required for the intended flight path. Only the inboard pair of MFS are used in this range. The MAX position is used for emergency descent whereby all MFS deploy if flaps are retracted to zero degrees. The FSCL unlatch selector located on top of the FSCL must be pressed to release the lever from the zero position and from the FULL to MAX position. If the flaps are extended, only the inboard MFS are available for lift dump and the MAX selection will have no effect.



For roll assist and proportional lift dumping, the spoiler scheduling depends on handwheel roll sensors and FSCL sensors. Corrections to the scheduling is a function of the airplane airspeed provided by the three air data computers and flap position under control of the SFCUs.

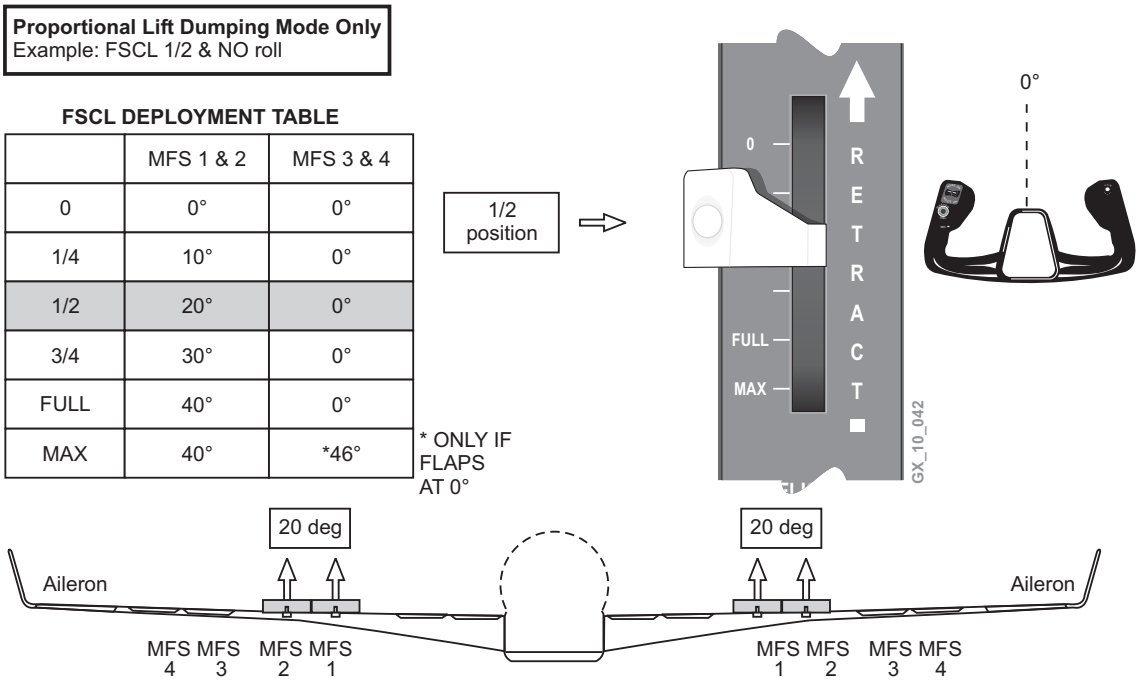
Multifunction Spoiler Operation - In-Flight

Proportional Lift Dumping Mode Only
Example: FSCL 1/2 & NO roll

FSCL DEPLOYMENT TABLE

	MFS 1 & 2	MFS 3 & 4
0	0°	0°
1/4	10°	0°
1/2	20°	0°
3/4	30°	0°
FULL	40°	0°
MAX	40°	*46°

* ONLY IF FLAPS AT 0°

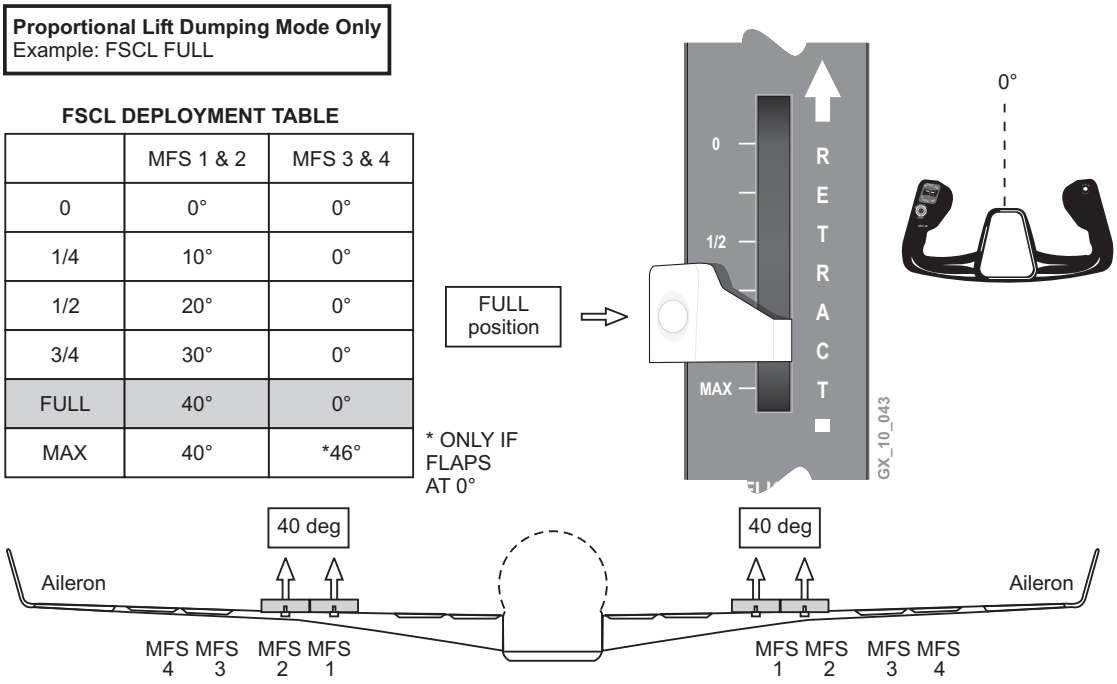


Proportional Lift Dumping Mode Only
Example: FSCL FULL

FSCL DEPLOYMENT TABLE

	MFS 1 & 2	MFS 3 & 4
0	0°	0°
1/4	10°	0°
1/2	20°	0°
3/4	30°	0°
FULL	40°	0°
MAX	40°	*46°

* ONLY IF FLAPS AT 0°

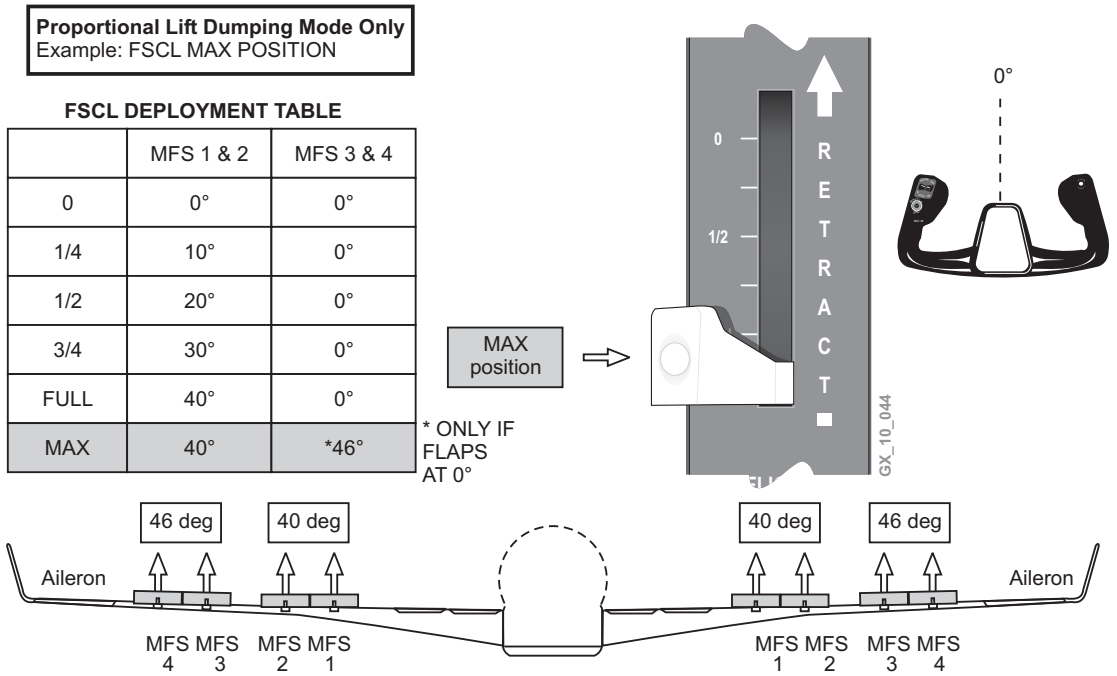


Proportional Lift Dumping Mode Only
Example: FSCL MAX POSITION

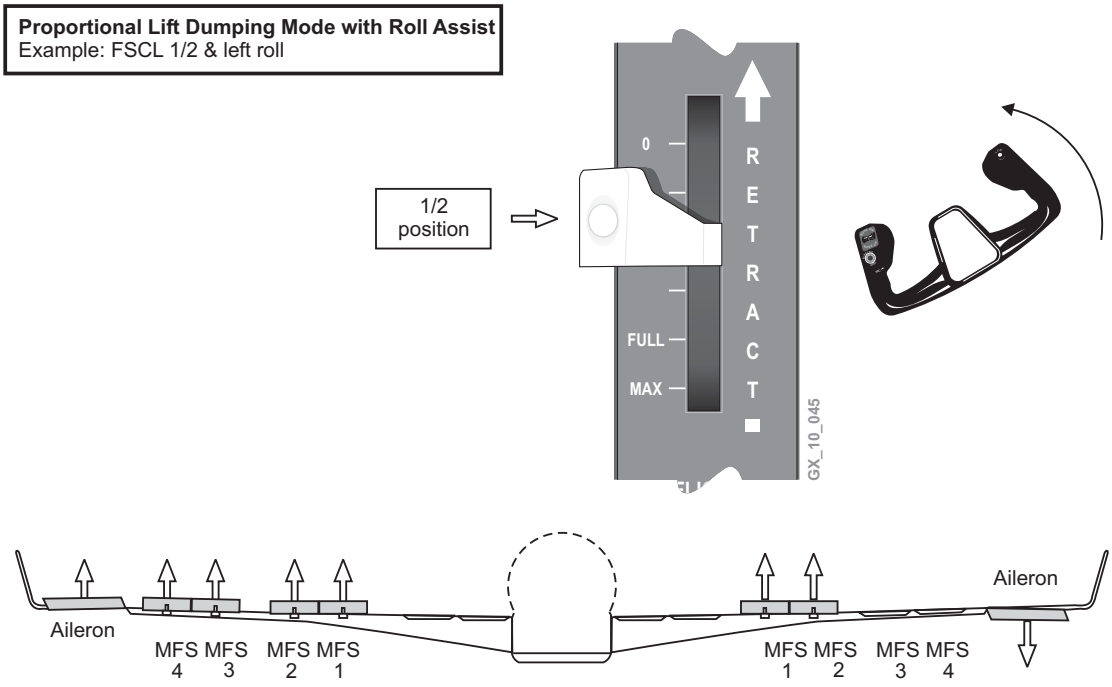
FSCL DEPLOYMENT TABLE

	MFS 1 & 2	MFS 3 & 4
0	0°	0°
1/4	10°	0°
1/2	20°	0°
3/4	30°	0°
FULL	40°	0°
MAX	40°	*46°

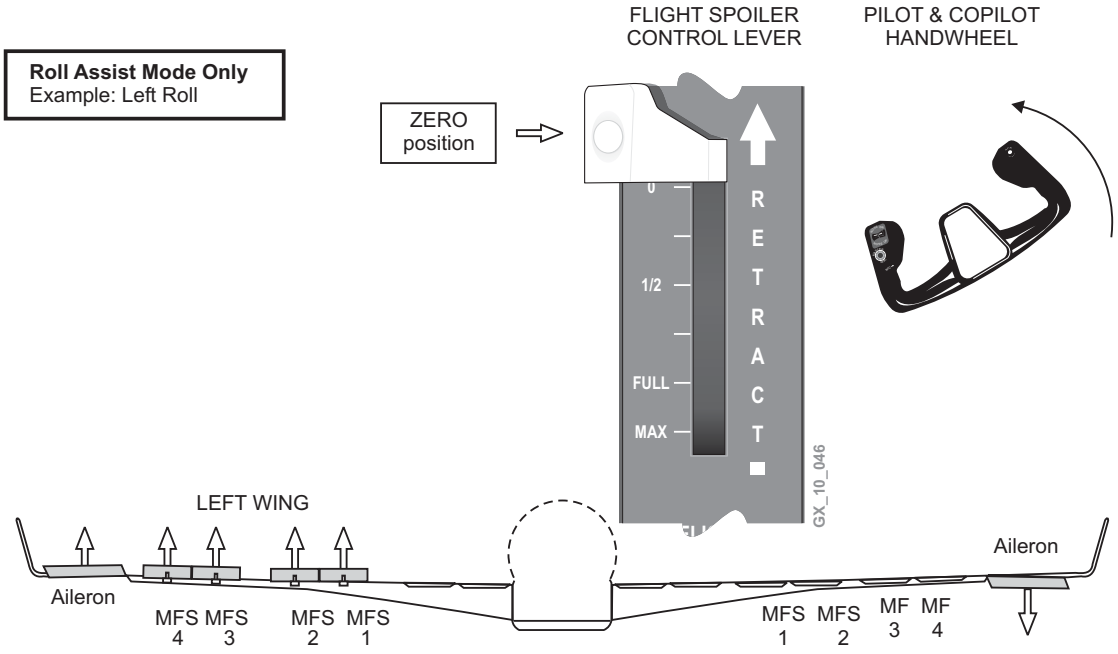
* ONLY IF FLAPS AT 0°



Proportional Lift Dumping Mode with Roll Assist
Example: FSCL 1/2 & left roll

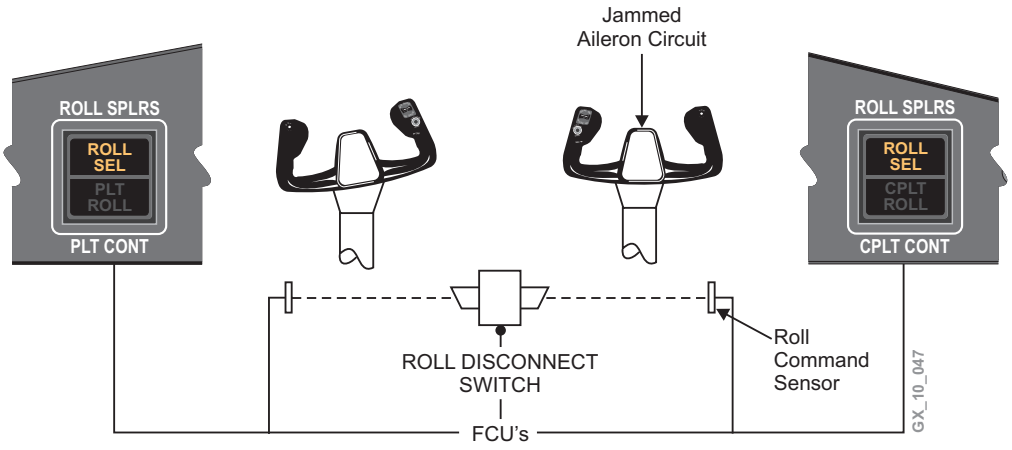


Roll Assist Mode Only
Example: Left Roll

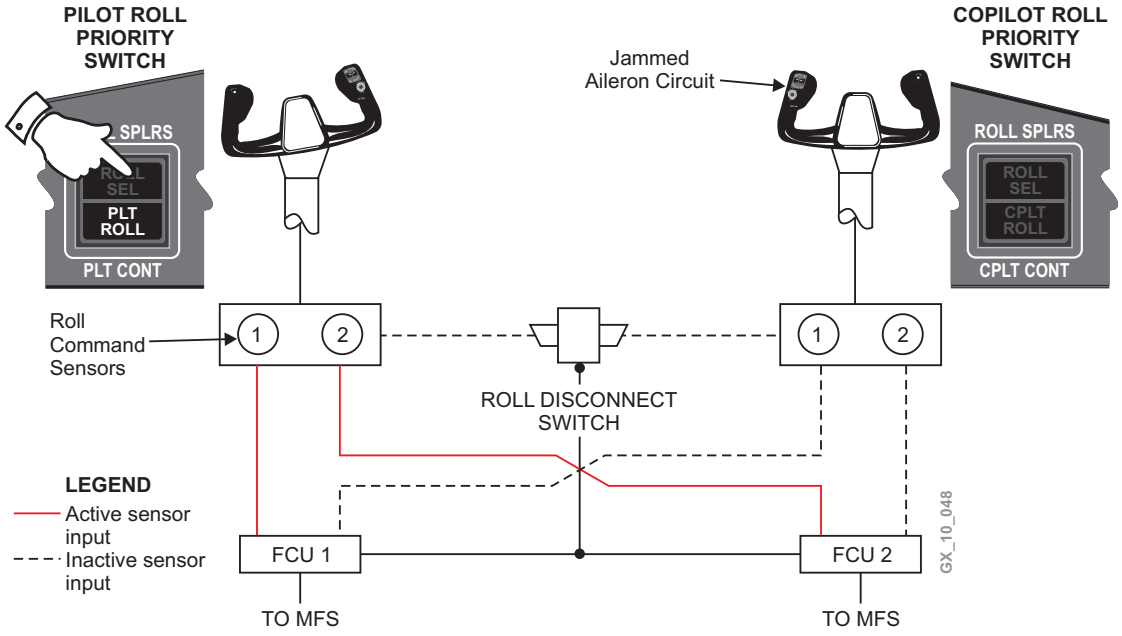


Roll Spoiler Priority

The ROLL SPLRS priority switches are located on the glareshield at each pilot position. They are released/pressed switches with a split legend, an amber ROLL SEL and a white PLT ROLL (CPLT ROLL). During normal operation, the switches are not selected and remain dark. The MFSs receive roll commands from the FCUs through sensor inputs from movement of each control column. The roll commands are averaged from the sensor inputs to the FCUs for MFS operation, with the disconnect system in the normal configuration.



In the event of a jammed aileron system, the pilots free the non-jammed system by forcing the disconnect mechanism. If no ROLL SPLRS switch selection is made within 30 seconds following disconnect, the roll disconnect switch sends a signal to the FCUs which command both ROLL SEL captions and a "**ROLL SELECT**" message to appear. Both ROLL SEL captions illuminate to indicate to the pilot that a priority is required by switch selection, for MFS operation due to disconnect. The 30-second time delay for illumination of the ROLL SEL captions is to avoid increasing pilot workload in the instant following an aileron system failure.

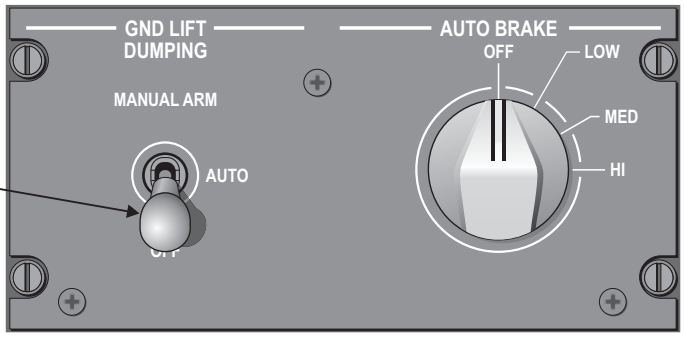


Selecting the appropriate priority switch prior to, or following a ROLL SEL indication, commands the valid side to be used by the FCUs. Example above: if pilot side is selected, both pilot and copilot ROLL SEL captions extinguish and the PLT ROLL caption illuminates, and vice versa for a copilot action. Until one side is selected, the FCUs continue to average pilot and copilot roll commands. After switch selection, both FCUs will use the corresponding roll input (unjammed side). This will enable the MFS to operate through their full range of operation with a single control column input.

GND Lift Dumping/Auto Brake Control Panel

The panel is located in the center pedestal and is used to manually arm or disarm the spoiler system.

GND LIFT DUMPING Switch
• **MANUAL ARM** – Manually arms the ground lift dumping system and when the airplane is on ground, all spoilers will be commanded to deploy. A status message will be displayed when the switch is selected to manual arm.
• **AUTO** – Arms the ground lift dumping.
• **OFF** – Selecting the switch "**OFF"** will disarm the ground lift dumping system in the event of an inadvertent deployment or failure of the automatic system. A status message will be displayed when the switch is selected to off.



Ground Lift Dumping

Ground lift dumping function commands extension of the spoilers when engines are equal or below idle, and the ground condition is recognized. Engine throttle lever position is provided by sensors in the throttle lever assembly.

Ground condition is determined from the airplane height provided by:

- Radio Altimeters (RA)
- Wheel speed, through the Brake Control Unit (BCU)
- Weight-On-Wheels (WOW), through the Landing Gear Electronic Control Unit (LGECU)

The ground lift dumping system is fully automated, or can be operated manually. Arming, deployment and retraction is controlled by the FCUs.

In the event of a malfunction or failure of the automatic arming or disarming (automatic retraction), the ground lift dumping system may be manually armed or manually disarmed through the GND LIFT DUMP/AUTOBRAKE panel.

Arming

The system is automatically armed when the throttle levers are at the minimum takeoff position (30° TLA). To prevent inadvertent deployment during taxi, automatic arming will not latch until a takeoff speed of 45 knots is reached. The flight compartment ground lift dumping MANUAL ARM switch is provided in case of auto arming failure and to test the system during pre-flight.

Deployment

All spoilers deploy automatically during a rejected takeoff.

The GSs deploy first in order to dump the airplane lift: therefore, the logic is split for GS and MFS operations.

To deploy ground spoilers, the system must be armed, engine throttles at idle position or below, and two of the three following conditions:

- Radio Altimeter (RA) below 7 feet
- One left or right main landing gear WOW indication
- One left or right wheel speed greater than 16 knots

Radio altimeter and wheel spin will normally be the first conditions satisfied. Deployment of the MFS is delayed until the airplane is more firmly on the ground to allow full pilot roll control through the use of spoiler roll assist.

To deploy multifunction spoilers, the ground lift dumping must be armed, both the left and right throttles at idle (or below) and:

- Both main landing gear have WOW
  AND
- Left and right wheel speed indication above 16 knots, or RA below 7 feet

When the MFS are fully extended for ground lift dumping, roll assist is available for multifunction spoiler operation.

Disarm

The logic automatically disarms after the airplane has been on the ground for 40 seconds following touchdown and the wheel speed has decreased below 45 knots for 30 seconds. Automatic disarming prevents the spoilers from deploying during taxiing. The system can also be manually disarmed (turned off) to override the automatic arm/disarm circuits, through the ground lift dumping OFF switch on the GND LIFT DUMP/AUTOBRAKE panel, located in the center pedestal.

Spoiler System/FCU Interface

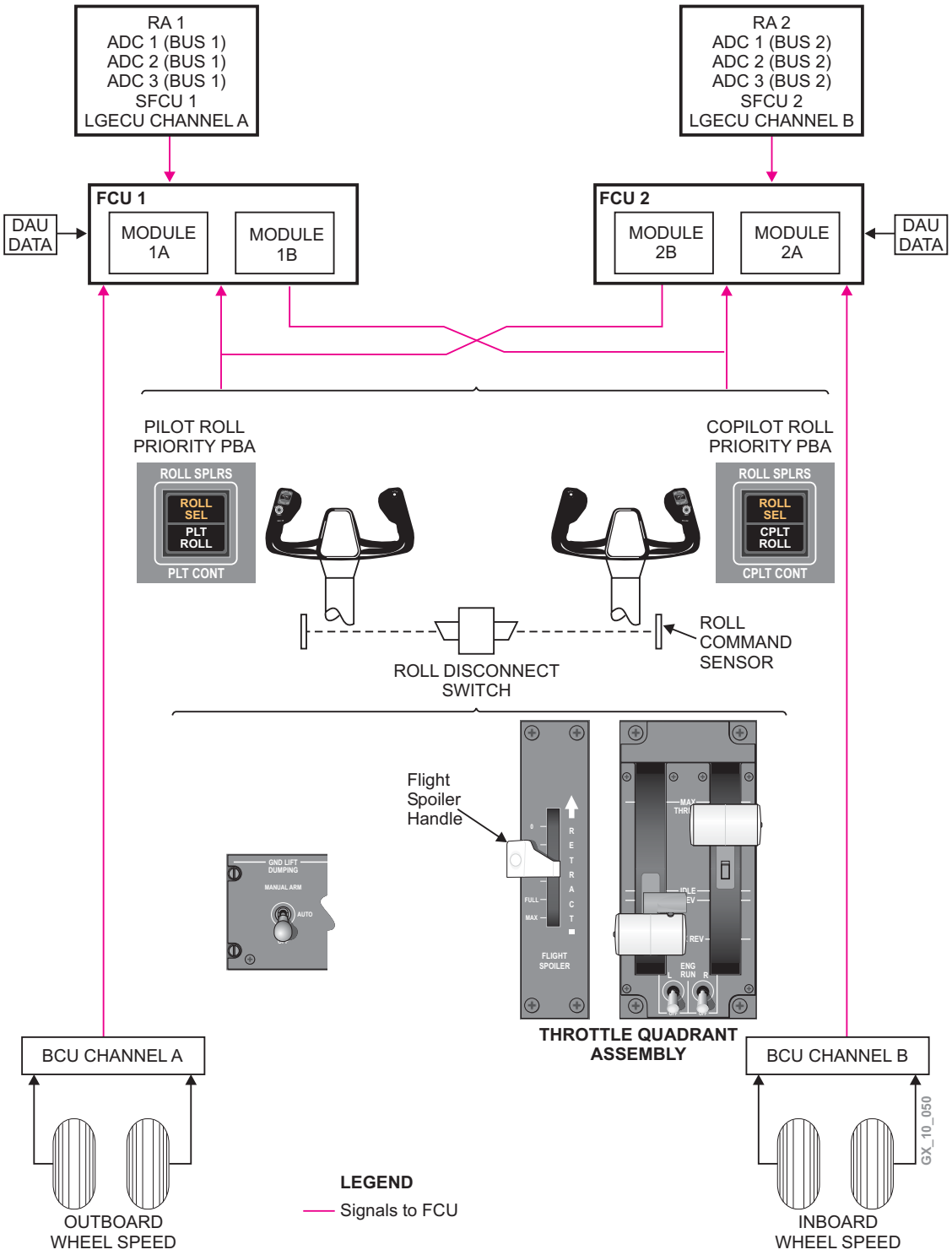
The spoiler system operation is under control of two Flight Control Units (FCUs) which have dual modules to control and monitor the spoiler surfaces in pairs. The FCUs receive input from various airplane systems and schedule the MFSs either symmetrically or proportionally, depending on airplane configuration. The FCUs also control and monitor the operation of the GS through valves within the ground spoiler selector valves. Refer to SPOILER CONTROL AND MONITORING in this chapter.

The FCUs control the priority of spoiler operations for flight and ground phases of operation, and spoiler system malfunctions are reported on the EICAS system.

The FCUs interface with the following systems for spoiler control and monitoring:

- BCU – Brake Control Unit provides wheel speed for Ground Lift Dumping (GLD) logic
- LGECU – Landing Gear Electronic Control Unit provides Weight-On-Wheels (WOW) for GLD logic
- DAUs – Data Acquisition Units provide hydraulic pressure data
- ADCs – Air Data Computers provide airspeed data
- RA – Radio Altimeter provides height for GLD
- TQ – Throttle Quadrant assembly provides left and right throttle lever position sensors for GLD logic.
- SFCU – Slat/Flap Control Unit provides flap position for Proportional Lift Dumping (PLD)

Spoiler FCU Input Schematic



Spoiler Control and Monitoring

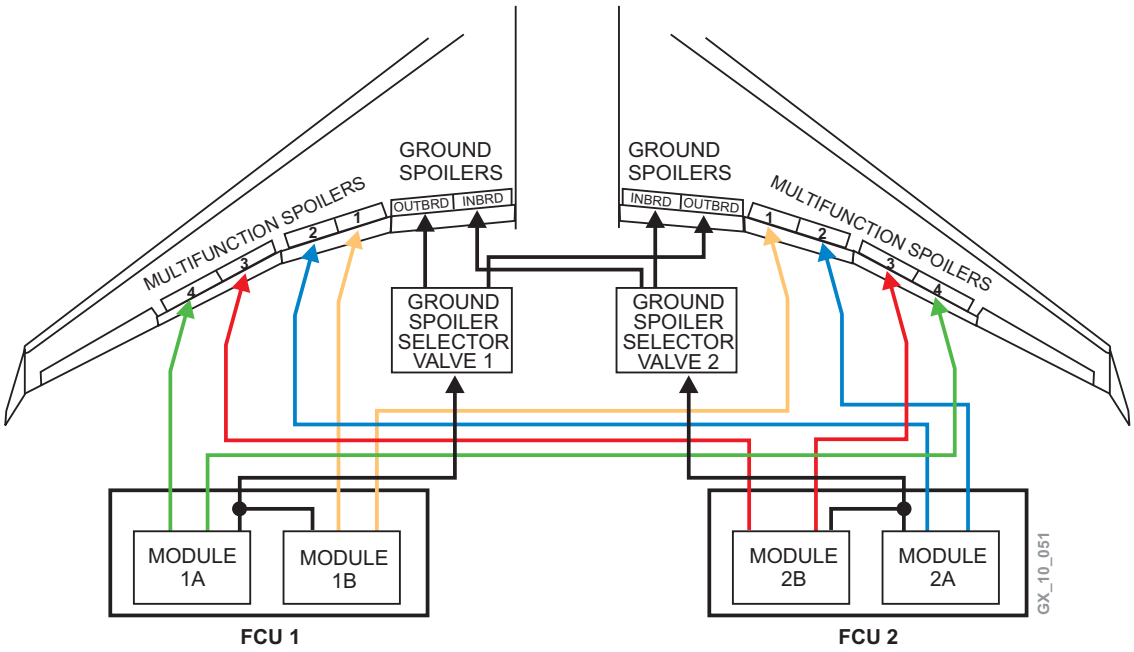
Spoiler control and monitoring of the MFS and ground spoilers are as follows:

Multifunctional Spoilers

The MFS PCUs are hydraulically powered and electrically controlled. The FCU controls each PCU servo valve and uses an integral sensor to determine their position. The PCUs incorporate a hydraulic lock to prevent upfloat in the event of a hydraulic failure. The MFS surfaces use a proximity sensor to detect that the surface is retracted.

The FCU provides monitoring of the PCU command, PCU response to the command, spoiler surface through the proximity sensor, and detection of interface electrical failures.

When an MFS panel failure is detected, the opposite panel will automatically be disabled, in order to ensure lift dumping remains symmetrical.



Ground Spoilers

An electrically controlled ground spoiler selector valve is used to provide hydraulic pressure to single actuators (at each panel), to either retract or extend a left or right pair of ground spoilers.

The FCU must energize two valves within the ground spoiler selector valve for a pair of ground spoilers to deploy. Proximity sensors are used for monitoring and indication, and to detect whether a ground spoiler panel is retracted or not.

The actuators at each ground spoiler panel incorporate a hydraulic lock to prevent upfloat in the event of a hydraulic failure. Each of the two FCUs controls and monitors one of the two pairs of ground spoilers.

STALL PROTECTION

The Stall Protection System (SPS) provides the flight crew with aural, visual and feel (stick shaker) indications of an impending stall and, if no corrective action is taken, the system activates the stick pusher mechanism, preventing the airplane from entering the stall.

The stall protection system consists of two (electrically anti-iced) angle-of-attack sensors, a dual-channel computer, two stick shakers, a stick pusher system, and mach sensing to back up the air data computers. Each channel of the computer controls a stick shaker. The computer provides two independent signals to the pusher system logic. Both channels of the computer have to agree to activate the stick pusher system based on similar system inputs.

The stall protection function is inhibited when both weight-on-wheels inputs indicate on ground or calibrated airspeed is recognized to be less than 70 knots.

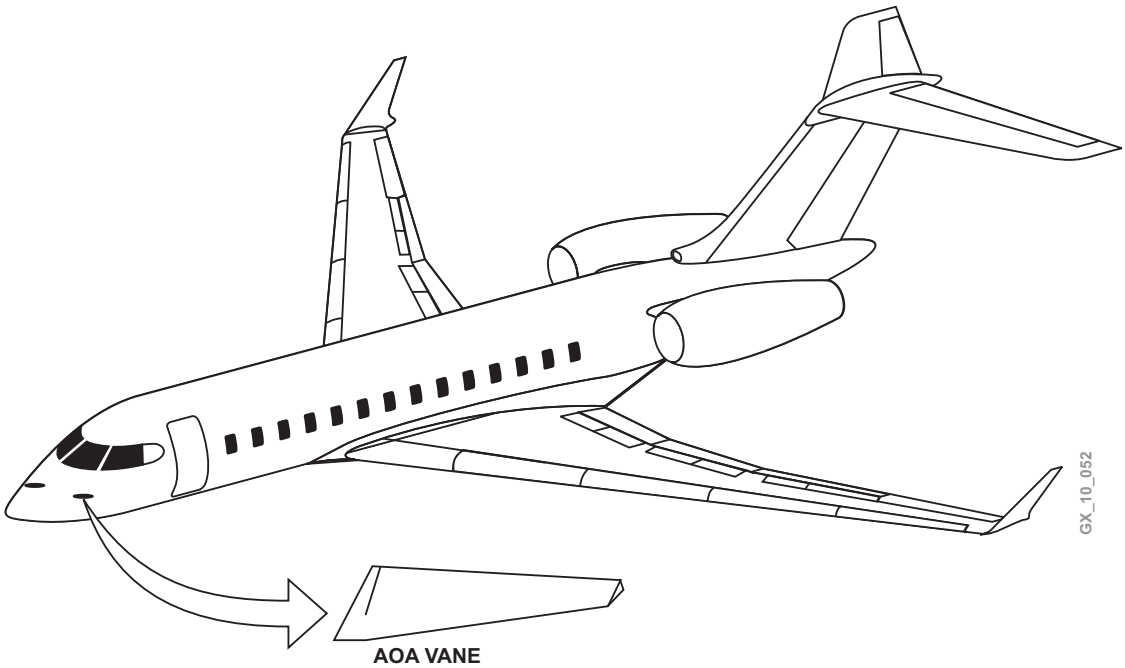
The stall protection computer continuously monitors the SPS, and faults detected are sent to EICAS for aural and/or visual annunciation.

STALL PROTECTION COMPONENTS

The stall protection system consists of the following components:

ANGLE-OF-ATTACK (AOA) VANE

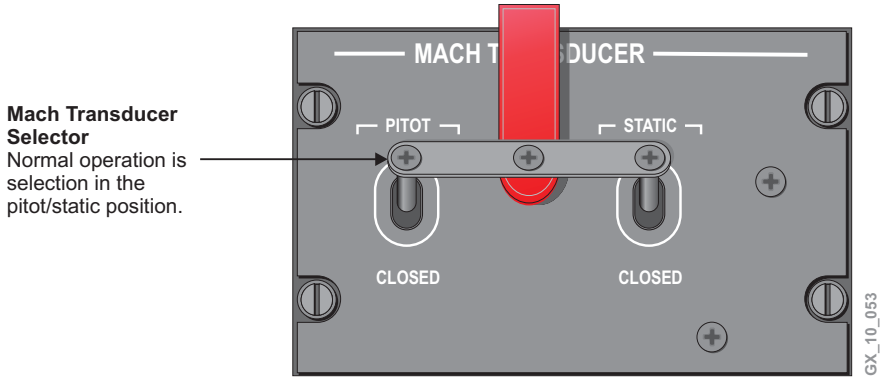
Two AOA vanes are mounted on the forward fuselage (left and right) of the airplane. They rotate to align with the prevailing airflow to measure the direction of the airflow relative to the fuselage.



The vanes provide information to both channels of the stall protection computer. There are self-regulating heaters (controlled and monitored by the Heater and Brake temperature Monitor Unit (HBMU)) located in the vanes. The heaters provide the sensors with an anti-icing capability.

MACH TRANSDUCER

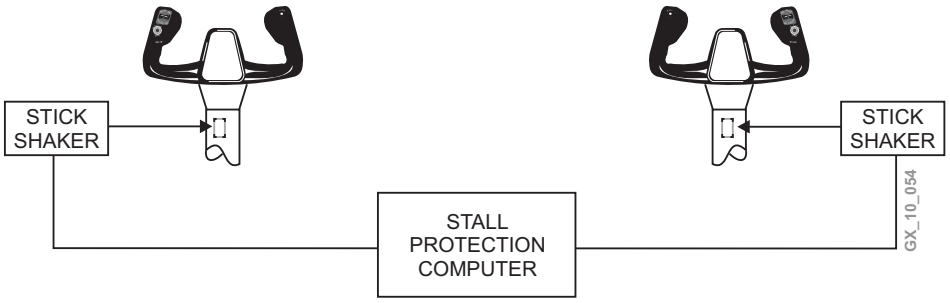
The mach transducer control is installed on the right side of the flight compartment, below the copilot's side console. It is connected to the pitot-static system through a selector/isolator switch. The mach transducer receives electrical input and pressure through connectors, and supplies secondary mach information to the channels of the Stall Protection Computer (SPC). The ADCs supply primary mach data to the channels of the SPC.



The mach transducer is operated in the pitot-static position, and is used to cross check for errors from the micro air data computer system. This is accomplished by providing dissimilar source for mach number, airspeed, and altitude inputs.

STICK SHAKER ACTUATOR

A stick shaker (mechanical vibratory device) actuator is located on each control column and provides tactile sensing, simulating airplane buffeting.

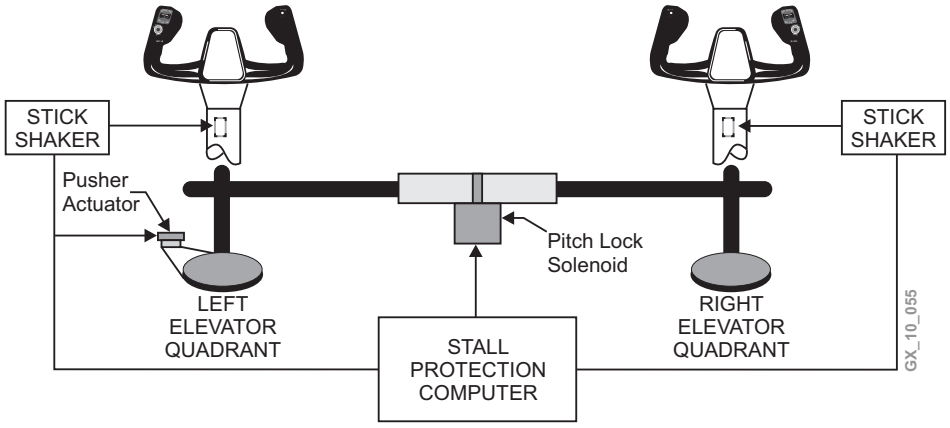


The stick shakers consist of a high speed motor, and the actuators are controlled from the SPC channels.

STALL PUSHER

If the angle of attack increases to a point where the airplane's stall margin is too small, the SPC will command a push of both control wheels. This is accomplished using a motor assembly which will drive the forward left elevator quadrant. The right control wheel will receive its input to push through the coupled automatic pitch disconnect mechanism.

The pitch disconnect mechanism has a function to engage a solenoid piston to prevent elevator split during push.



The pitch disconnect solenoid is controlled by the SPC and when operated, prevents the automatic pitch disconnect mechanism from activating when push is commanded by the SPC.

When the AOA approaches pusher firing angle (1 1/2 degrees before push occurs), the pitch disconnect locking mechanism is activated. When the push is canceled, the solenoid for the pitch disconnect locking mechanism is deactivated.

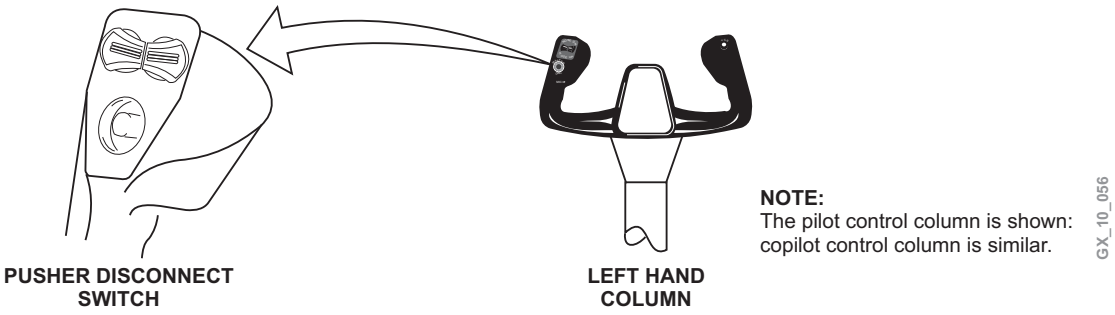
STALL PROTECTION DISCONNECT BUTTONS

The stall protection disconnect buttons are located on the pilot and copilot control column. These switches also provide a disconnect command to the autopilot and pitch trim functions.

NOTE

A STALL PROTECT FAIL caution message will be displayed if the disconnect button is held for approximately 12 seconds.

This stick pusher may be stopped by pressing and holding the autopilot/stick pusher disconnect (AP/SP DISC) switch. This will remove power to the actuator as long as either switch is depressed. The stick pusher is capable of operating immediately once the autopilot/stick pusher disconnect switch is released, and a stall push is requested by the computer.



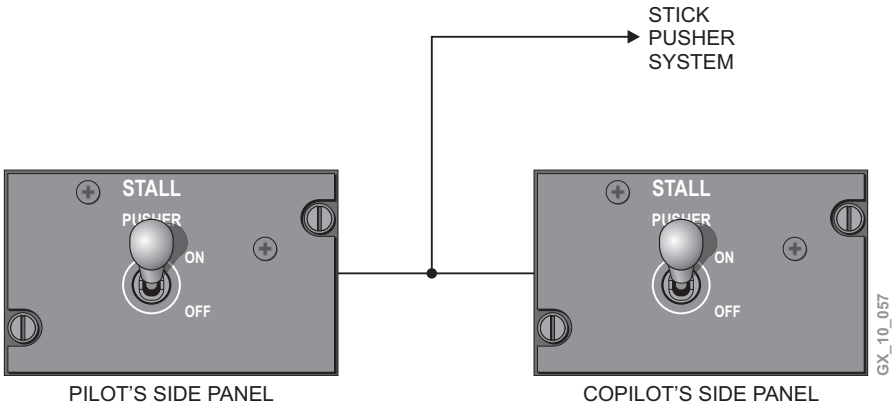
The remaining stall warning functions are available with the disconnect button held. Only the pusher function is disabled with either switch held. All other SPS events are normal.

STALL PUSHER ON/OFF SWITCHES

The stall pusher ON/OFF switches are used for long term disabling of the pusher system. The switches are located on the pilot and copilot side panels.

NOTE

Selecting either stall pusher switch to OFF will cause a STALL PROTECT FAIL caution message to be displayed.



In the event of a malfunction, the stick pusher may be disabled by selecting the PUSHER switch to OFF on the pilot's or copilot's stall protection panel. When either or both switches are selected to OFF, the SPC cannot command a push.

STALL PROTECTION COMPUTER

A dual-channel Stall Protection Computer (SPC) monitors the following inputs:

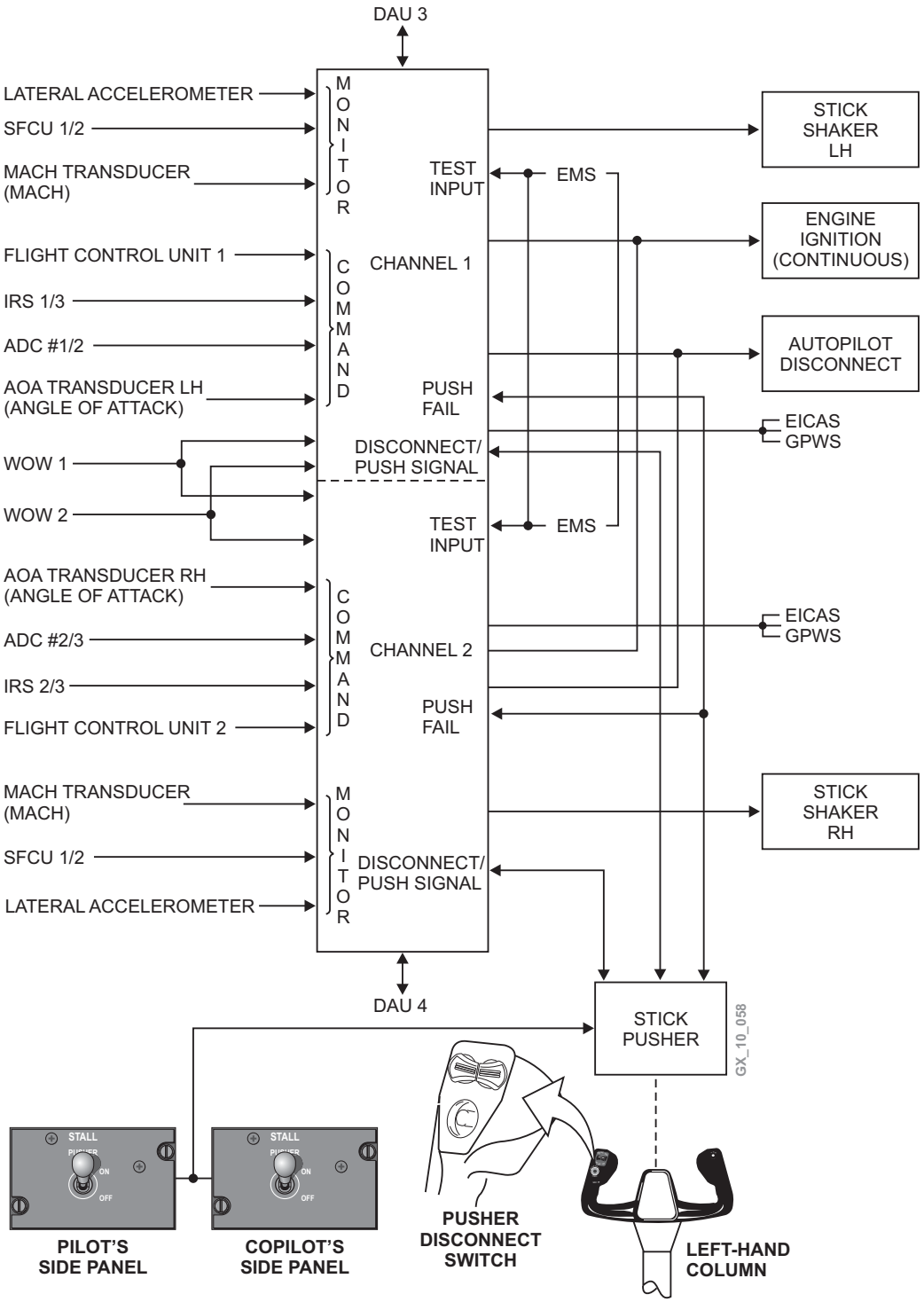
• LH, RH Angle-Of Attack (AOA) transducers	Angle of attack
• LH, RH Lateral, accelerometers	Lateral acceleration
• LH, RH Slat/Flap	Slat/Flap position
• Weight-On-Wheels 1, 2 (WOW)	WOW and SPS inhibit
• ADC 1, 2 and 3	Mach, airspeed and altitude
• Inertial Reference Unit (IRU)	Normal and lateral acceleration
• WOW Fail	Weight-On-Wheels

The SPC receives data input from the bleed management computer, landing gear electronic control unit, heater brake monitor unit and EMS/CDU through the data acquisition units.

Low speed awareness output is a function of the SPC to the Electronic Flight Instrument System (EFIS).

- Red line - Shaker or stall warning speed.

STALL PROTECTION COMPUTER SCHEMATIC



STALL PROTECTION OPERATION

The stall protection computer uses numerous system inputs to calculate the angle of attack trip points. As a high angle of attack is approached:

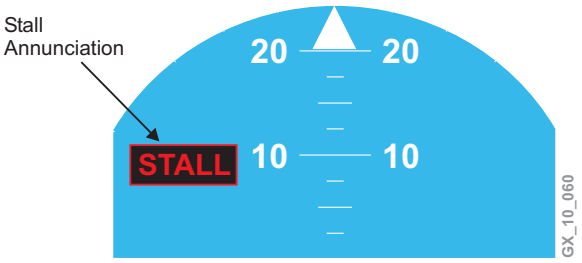
- Ignition is activated

If the angle of attack continues to increase:

- The stick shakers are activated
- Autopilot disengages, and
- The voice advisory sounds

If the angle of attack continues to increase:

- The pitch disconnect system will lock
- The stick pusher mechanism is activated
- The word STALL appears in a red box on the attitude sphere. (The stall annunciation shall initially blink at a rate of 1 second on and 1/2 seconds off for 5 seconds, and then shall remain steady)



PRIMARY FLIGHT DISPLAY

This results in both control columns advancing to the full forward limit to correct the stall condition.

When stall has been corrected the SPC will cancel:

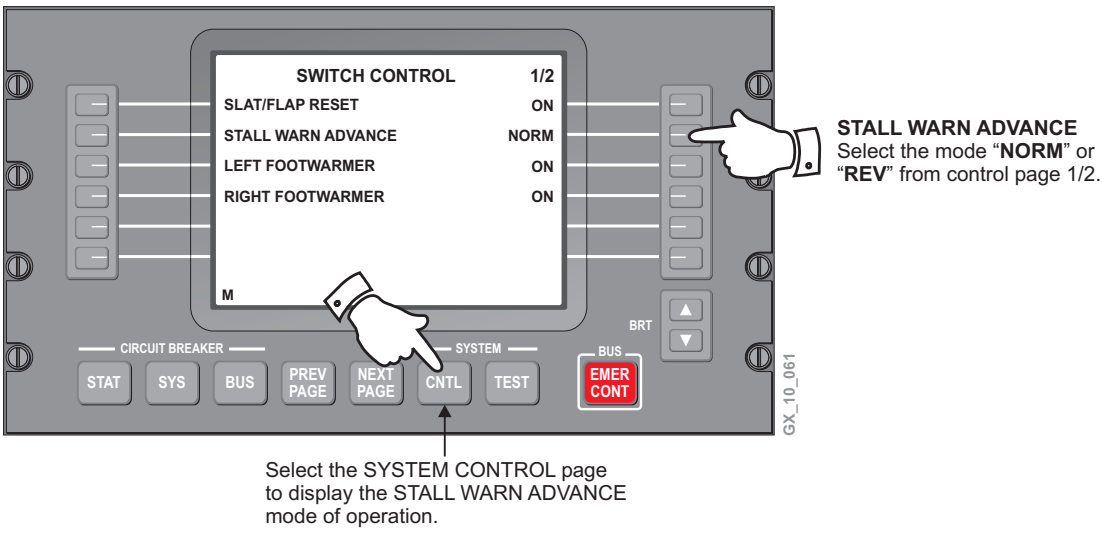
- The push and pitch disconnect locking mechanism
- Voice advisory
- STALL on the attitude sphere
- Ignition
- Stick shakers

STALL WARNING ADVANCE

In specific conditions, the SPC will cause warnings to occur sooner than normal. The stall warning advance system will advance the stick shaker firing angles through the SPC when these conditions are sensed. Examples of conditions leading to a stall warning advance are listed below.

- Slat malfunction
- Flap malfunction
- Flight in icing conditions with wing anti-ice off or failed

The pilot has an interface through the Electrical Management System (EMS)/Control Display Unit (CDU) to select the stall warning advance for undetected failures (example: damage to slat panel due to bird strike or ice accretion on the wing which cannot be dispersed). Either pilot's EMS/CDU can command mode changes from the control page 1/2. Once selected, it can only be canceled by pilot input. The two modes of operation selectable on the EMS/CDU are NORM or REV.



NOTE

Only pilot action can return the advance mode to normal mode.

Pilot command interface on EMS/CDU:

- Command mode change from the control page
- Either pilot's EMS/CDU can command mode changes

NOTE

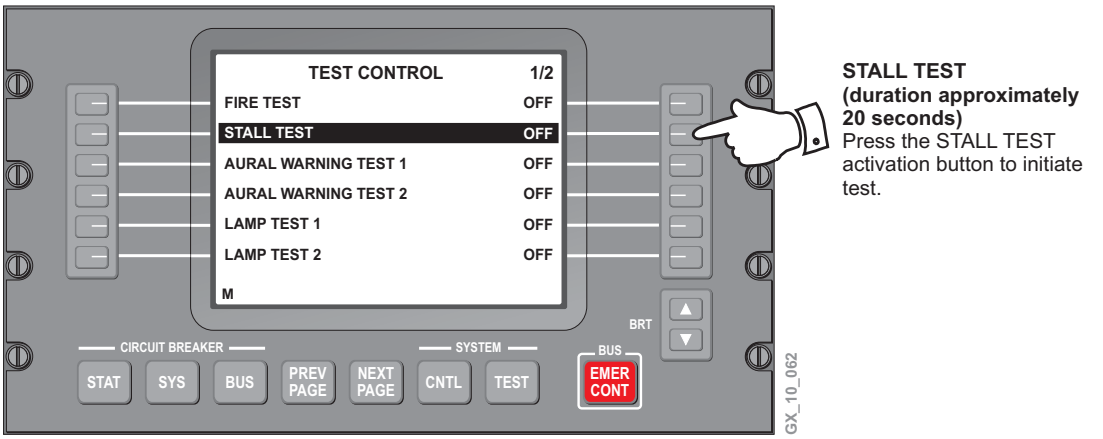
The pilot cannot override advanced mode for detected failures.

Advanced mode indication on EICAS and EMS/CDU:

- STALL WARN ADVANCE EICAS advisory message
- ADVANCE on EMS/CDU

STALL SYSTEM PILOT-ACTIVATED TEST

The pilot-activated test is initiated by the pilot during pre-flight. It takes approximately 20 seconds to complete the test. The test is initiated through the EMS/CDU. Please refer to Chapter 6, ELECTRICAL for the pilot-activated testing procedure.



The pilot-activated test will accomplish the following system results:

- Test can be accomplished on either pilot's or copilot's EMS CDU
- Select TEST, press the STALL TEST button and note the following
  - Pilot's stick shaker only is activated along with STALL annunciator on PFD
  - Copilot's stick shaker only is activated along with STALL annunciator on PFD
  - Both stick shakers are activated along with STALL annunciator on both PFDs, IGN annunciated on EICAS and STALL aural
  - Stick pusher is activated and both control columns move full forward and then return to neutral (twice)
- After the above test is complete, press and hold the MASTER DISC button on either the pilot's or copilot's control wheel (hold for not less than 12 seconds) and note the following
  - That the following messages are displayed while holding the button
    - AP 1-2 FAIL advisory message
    - STAB TRIM caution message
    - STALL PROTECT FAIL caution message
- All messages go out once the MASTER DISC button is released

SYSTEM INTEGRATION

The integrated nature of the Global extends to the operation of the Primary Flight Control, Secondary Flight Control and Stall Protection Systems. The integration of the Flight Control System in this manner enhances aircraft control and optimizes the operation of other aircraft systems.

PRIMARY FLIGHT CONTROLS

The Primary Flight Controls provide the means by which the AFCS effects flightpath control. It follows, then, that malfunctions in this portion of the Flight Control System may impact autopilot operations. These conditions include:

- Jamming of the copilot's aileron control circuit renders the autopilot inoperable. The aileron autopilot servo cannot input the required aileron control surface
- Jamming of the copilot's elevator control circuit renders the autopilot inoperable as the associated servo is again unable to input the system
- Jamming of the pilot's elevator control circuit renders the stick pusher inoperative
- Loss of both yaw dampers renders the autopilot inoperable as these rudder components are used to input AFCS directional commands

SECONDARY FLIGHT CONTROLS

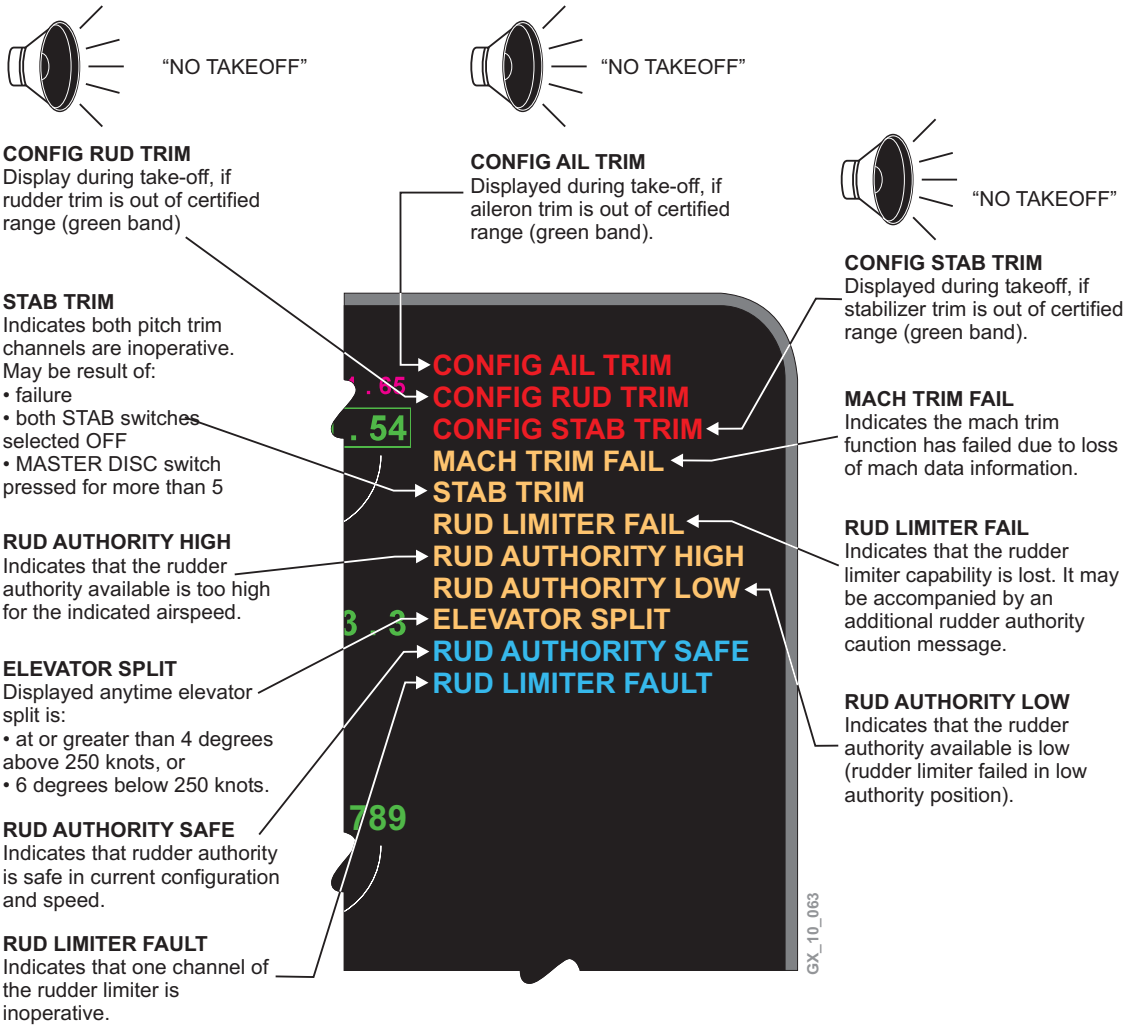
The Secondary Flight Control System is integrated with other aircraft systems through transmission of flap position information. Results of this interaction include:

- The immediate and automatic deployment of the RAT upon the loss of all AC power when the flaps are out of the zero position. This is not the case when the flaps are in the fully retracted position, at which time a 14-second delay is introduced to the automatic RAT deployment cycle
- Modification of Enhanced Ground Proximity and landing gear warning systems settings and indications on the basis of flap position. As is the case with RAT deployment, modification logic is premised on the fact that the aircraft is likely in departure or approach operations and closer to the ground when flaps are extended

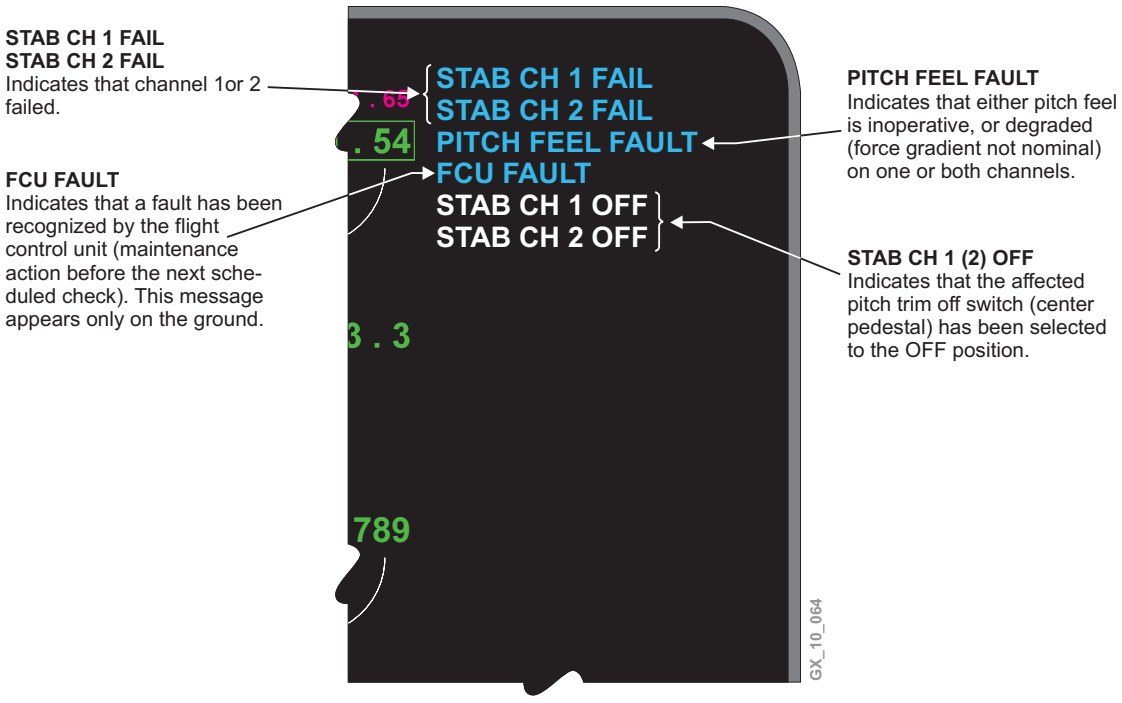
STALL PROTECTION SYSTEM

The Stall Protection portion of the Flight Control system is integrated with the EMS CDU for pilot-activated system test purposes and the manual advancement of stall warning thresholds. In addition, it is integrated with the Bleed Management Computer system to effect the automatic advancement of stall warning thresholds and indications when icing conditions are detected concurrently with a failure in the wing anti-ice system.

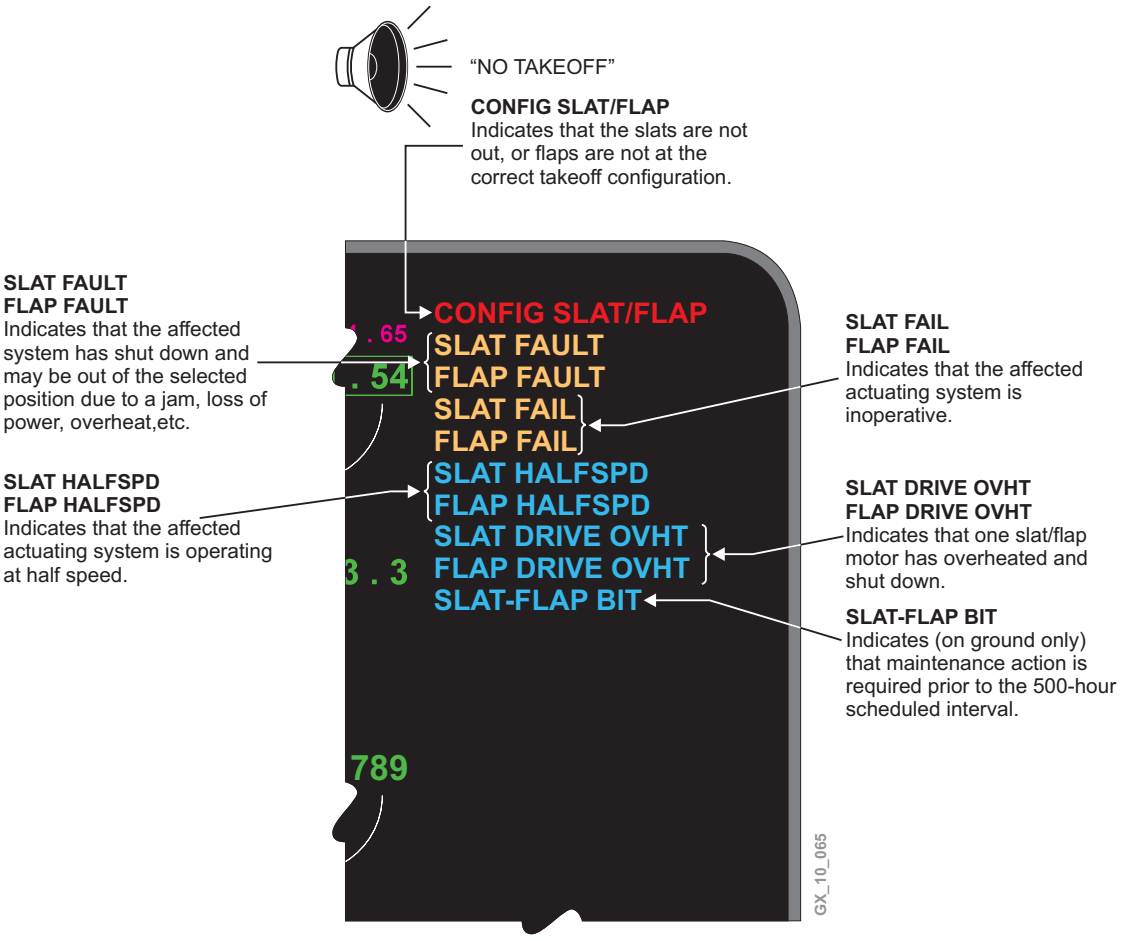
PRIMARY/SECONDARY FLIGHT CONTROL EICAS MESSAGES



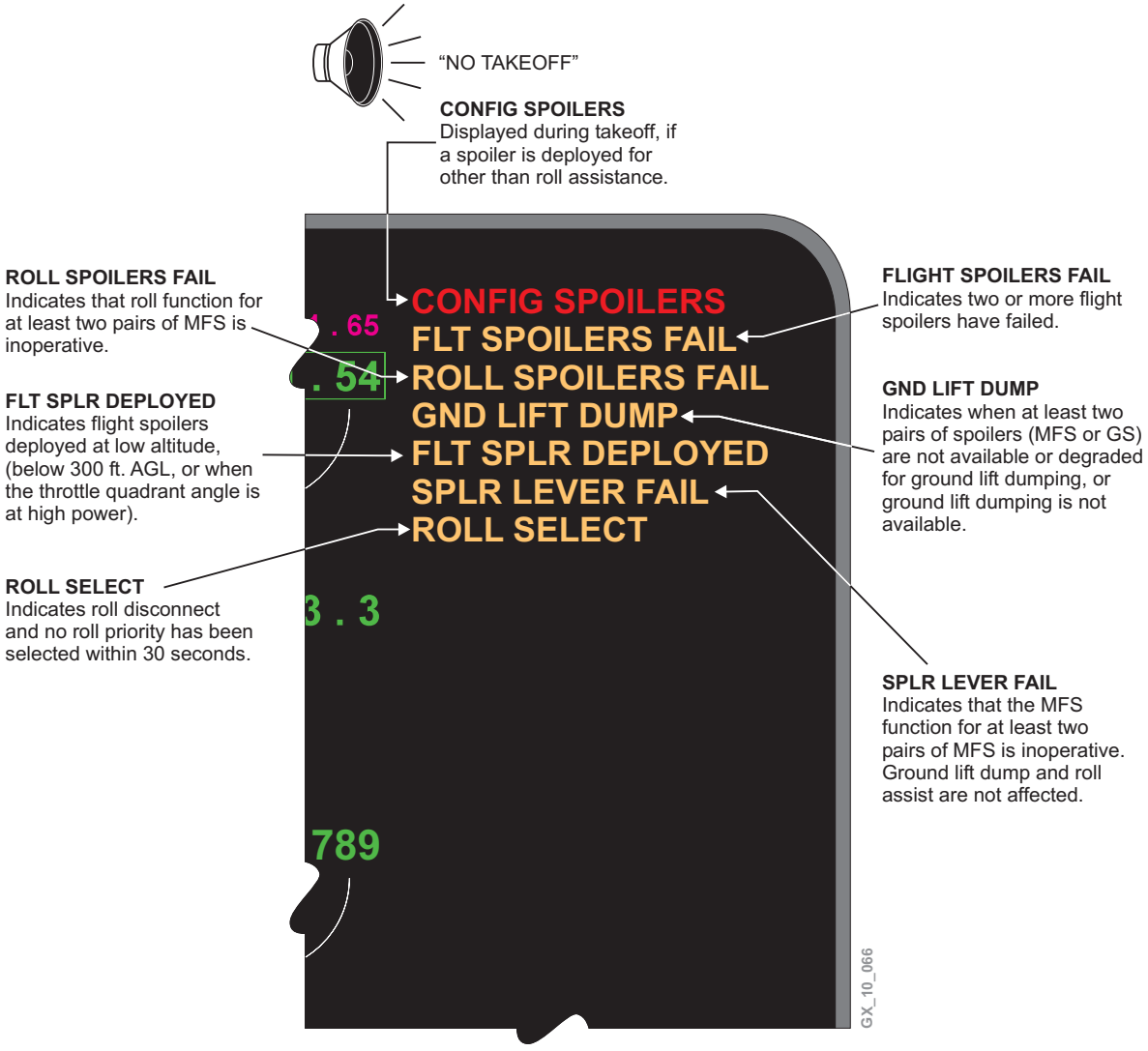
PRIMARY/SECONDARY FLIGHT CONTROL EICAS MESSAGES (Cont)



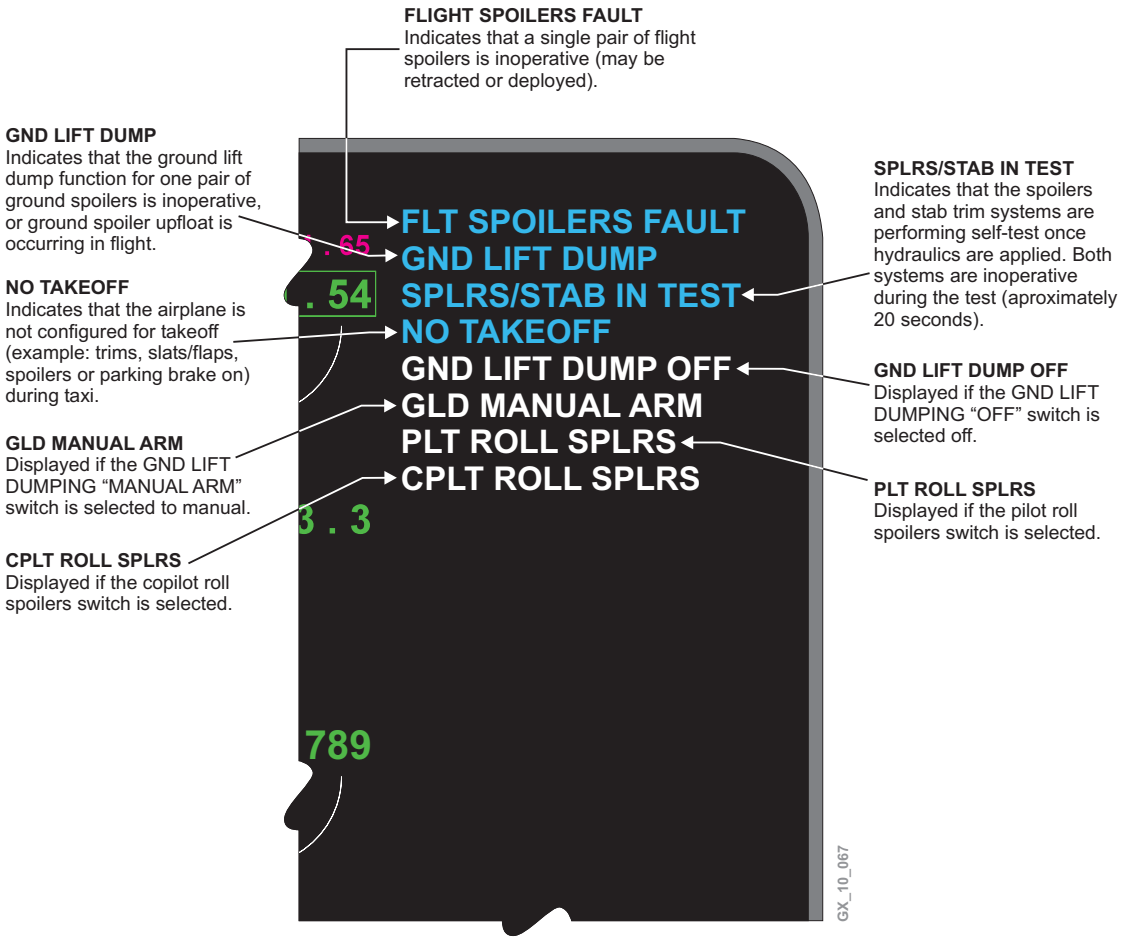
SLAT/FLAP EICAS MESSAGES



Spoiler EICAS Messages



Spoiler EICAS Messages (Cont)

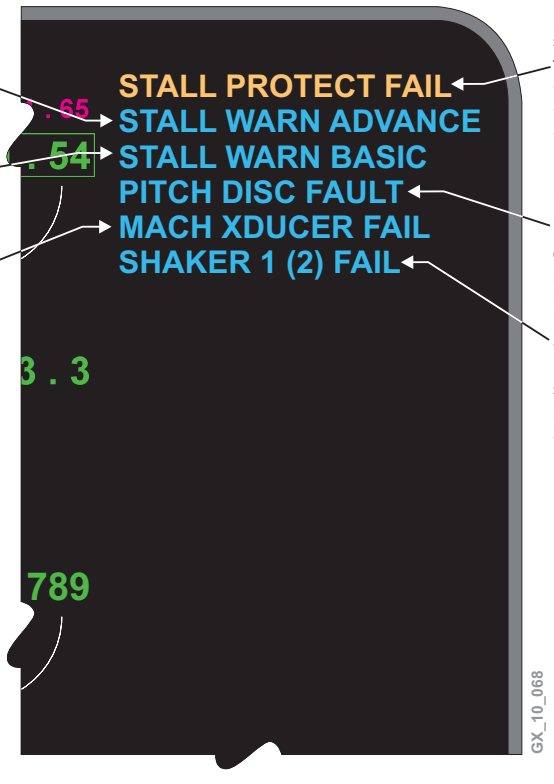


STALL PROTECTION EICAS MESSAGES

STALL WARN ADVANCE
Indicates that the stall warning advance has been activated. Can occur automatically based on airplane condition or manually through the EMS CDU.

STALL WARN BASIC
Indicates that the system is incorrectly operating in a single engine configuration (Basic mode).

MACH XDUCER FAIL
Indicates that the mach transducer has failed.

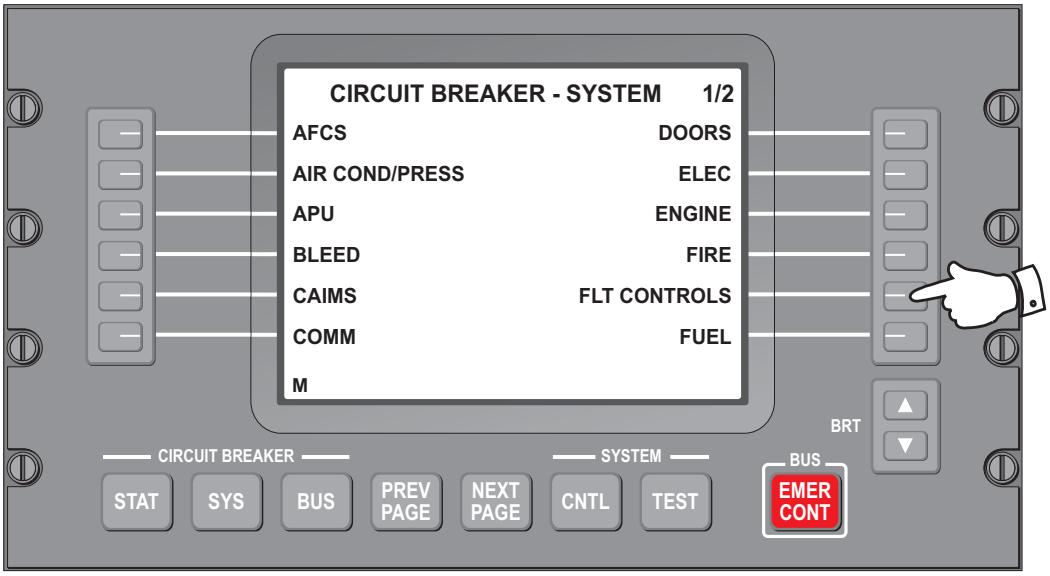


STALL PROTECT FAIL
Indicates either the pusher is manually deactivated, pusher switch is disabled, or one of the following have failed:
- a SPC channel.
- AOA sensor, or
- the pusher.

PITCH DISC FAULT
Indicates that the pitch disconnect solenoid has failed in the locked or unlocked position.

SHAKER 1 (2) FAIL
Indicates pilot or copilot's shaker has failed (actual motor) or the commanding SPC channel has failed.

EMS CIRCUIT PROTECTION



CB - FLT CONTROLS SYSTEM 1/4		
AILERON TRIM	DC 2	IN
FLT CTL 1 CH A	DC 1	IN
FLT CTL 1 CH B	DC 2	IN
FLT CTL 2 CH A	DC ESS	IN
FLT CTL 2 CH B	DC ESS	IN
MACH TRANSDUCER	BATT	IN

CB - FLT CONTROLS SYSTEM 3/4			
SLAT/FLAP CTLR 2	DC ESS		IN
SLAT/FLAP PWR 1	AC 1	CCBP	IN
SLAT/FLAP PWR 2	AC ESS	CCBP	IN
SPC CH A	BATT		IN
SPC CH B	DC ESS		IN
STAB TRIM CH 1	AC 1	ACPC	IN

CB - FLT CONTROLS SYSTEM 2/4		
P FEEL/RUD LIM 1	DC 2	IN
P FEEL/RUD LIM 2	DC ESS	IN
PUSHER LOCK CH A	BATT	IN
PUSHER LOCK CH B	DC ESS	IN
RUDDER TRIM	DC ESS	IN
SLAT/FLAP CTLR 1	BATT	IN

CB - FLT CONTROLS SYSTEM 4/4		
STAB TRIM CH 2	AC ESS	IN
STICK PUSHER PWR	BATT	IN
STICK SHAKER 1	BATT	IN
STICK SHAKER 2	DC ESS	IN

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