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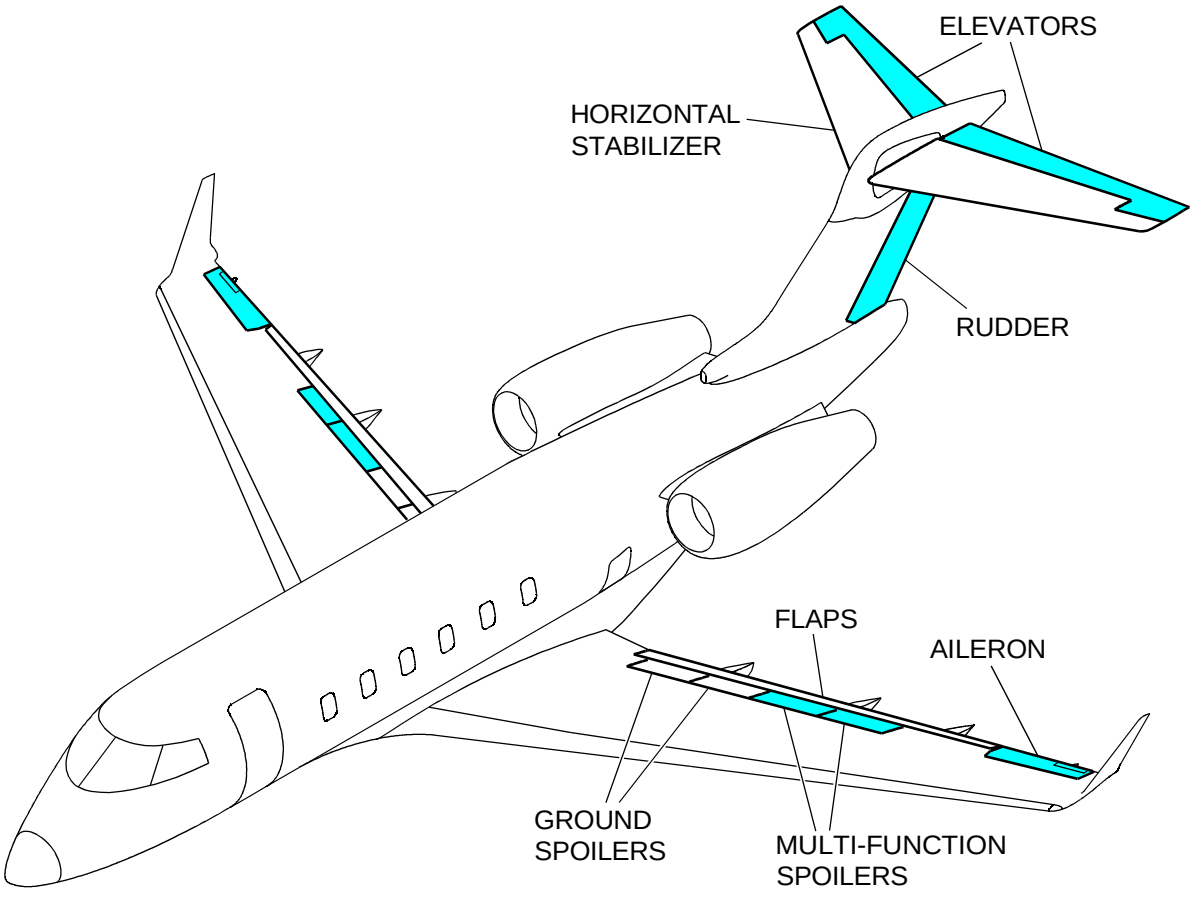
INTRODUCTION

The primary flight controls are the elevators, rudder, ailerons and roll spoilers. The ailerons are cable operated. The spoilers are electrically actuated and hydraulically operated. Cables connect the control column and rudder pedals to the hydraulic power control units for the elevators and rudder. The elevators and rudder have a mechanical reversion capability in the event of a dual hydraulic system failure.

The secondary flight controls consist of horizontal stabilizer, aileron, and rudder trims, flaps, and spoilers when operated symmetrically (flight and ground spoilers).

DESCRIPTION

The primary flight controls are arranged conventionally with rudder pedals and a control wheel and column for both the pilot and copilot. The roll spoilers, ailerons, elevators, and rudder are operated by means of conventional dual control wheels, dual control columns, and dual rudder pedal assemblies. The aileron system is a reversible mechanical cable system. The spoilers are controlled through an electronic/hydraulic fly-by-wire system. The elevator and rudder are mechanically controlled and hydraulically powered systems. The elevator and rudder has a manual reversion capability in the event of a dual hydraulic failure.



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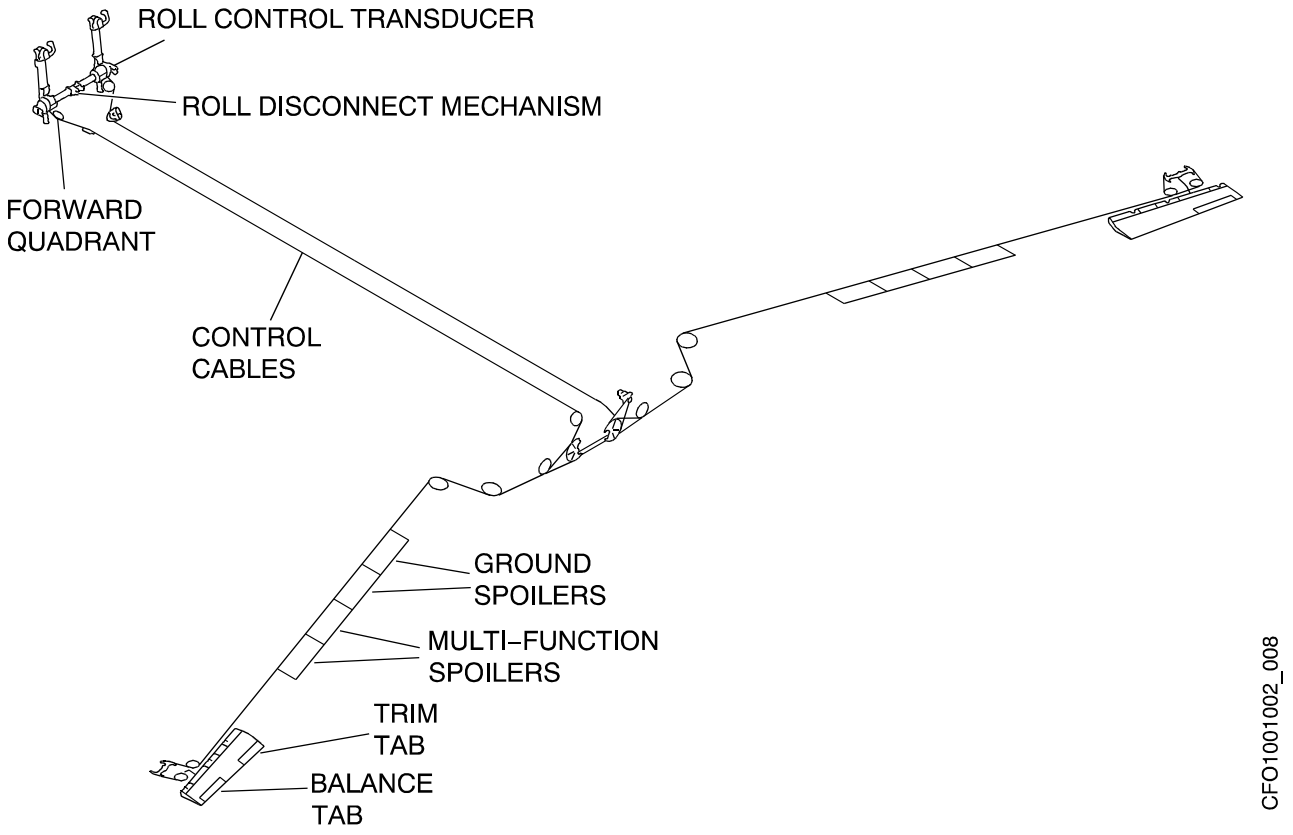
PRIMARY FLIGHT CONTROLS

COMPONENTS AND OPERATION

AILERONS AND MULTIFUNCTION SPOILERS

The aileron control cable runs to both control wheels and both ailerons. The roll disconnect mechanism disconnects the pilots control wheel from the aileron circuit. When disconnected, the pilot controls the roll spoilers and the copilot controls both ailerons. Normally the aileron and roll spoilers are interconnected and there is a simultaneous and coordinated movement of all lateral control surfaces from either pilot station.

Moving the control wheels also generates a signal that is sent to the spoiler electronic control units (SECU 1 and SECU 2). Dual redundant modules within the SECU control the extension/retraction of the multifunction spoilers (MFS). The SECUs combine the control wheel signals with other information to determine the required multifunction spoiler panel deflection for any given airplane configuration. There are four spoiler panels on each wing. The two outboard panels are the multifunction spoilers that operate asymmetrically in a roll, symmetrically for flight spoilers, and on the ground as ground spoilers. The two inboard spoilers only operate on the ground. A single power control unit is used on each spoiler. The MFS operate on the down-going wing only to assist the ailerons in roll control. In order to reduce roll control forces, an aileron balance geared tab is mounted on each aileron. The balance tabs have a maximum ±15 degrees of travel each side of the aileron chord line. It consists of a constant length push rod hinged at both ends on brackets rigidly mounted on the wing at one end and on the balance tab at the other end. The mechanism acts as a linkage with the aileron surface being the driving link and the geared balance tab being the driven link. The aileron balance tab is geared to move in the opposite direction of its corresponding ailerons movement. A roll damper is mounted on the pilot control column. Under normal operation, the roll damper acts like a quadrant and transmits all of the crew member's inputs. In case of any one aileron cable failure, the roll damper limits the rate the control wheel deflects (driving the roll spoilers) to a recoverable level. To prevent damage to the aileron surfaces from wind gusts when the aircraft is parked, a gust lock mechanism is incorporated to lock the left drive quadrant in the neutral position. The mechanism is actuated by the crew, via a telescoping gust lock lever mounted in the throttle quadrant. The lever moves a cable, that engages a spring loaded pawl into a quadrant mounted cam recess. When the gust lock is engaged, the throttles are physically prevented from being moved above idle. Aileron position is displayed on the EICAS FLIGHT CONTROL synoptic page. A full-scale deflection of the AIL position indicator corresponds to maximum aileron deflection.



PRIMARY FLIGHT CONTROLS (Cont)

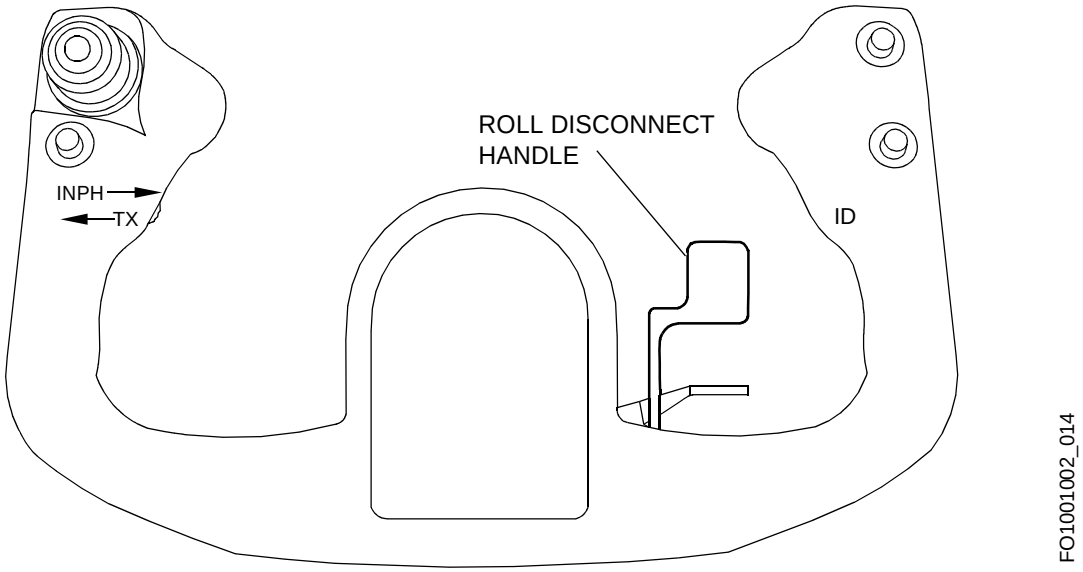
ROLL DISCONNECT

The roll disconnect allows the flight crew to isolate the left control wheel from the aileron control system. The roll disconnect mechanism is mounted on the left control wheel. It is comprised of a lever, a shaft, a stud roller, a cam, and two torsion springs. The lever and the shaft are held in axial alignment by two bushings.

During normal operation, the roller position is held into the cam detent by the torsion springs, allowing the pilot control wheel and the input quadrant to rotate as one single unit.

In the event of a jam in the mechanical circuit, the pilot can disconnect from the aileron circuit and retain roll control through the multifunction spoilers. However, if a jam occurs in the pilot control wheel, the pilot can disconnect from the circuit thus permitting the copilot to retain control of the ailerons.

A pull of the roll disconnect mechanism lever retracts the roller which is held in the disconnect position by a spring-loaded hook. This action uncouples the pilot control wheel and the pilot input quadrant and allows the control wheel to rotate freely. This disconnect feature allows in-flight reset once the roller and the cam are realigned and the disconnect lever is released. A microswitch senses the retraction of the roller and sends a signal of the disconnect status and a ROLL DISCONNECT (W) CAS message will be illuminated.



RUDDER

RUDDER CONTROL SYSTEM

The rudder provides directional control about the yaw axis. The system is mechanically controlled and hydraulically powered. The mechanical part of the system has control pedals, levers, pulleys and cables which connect to two hydraulic power control units (PCUs) in the vertical stabilizer. The PCUs cause the rudder to move in proportion to the flight-crew's control pedal input. A rudder-control feel unit supplies a simulated pedal load to the flight crew.

The pilot and copilot rudder pedal assemblies are both connected to the forward quadrant assembly, with no means to disconnect one from the other. Two cable systems beginning at the forward quadrants follow the same path in the fuselage until they reach the engine rotor burst zone, where they are routed separately towards the rear fuselage. In the event of a severed single cable in the rotor burst zone, the aft quadrant still receives input from the unaffected cables, thus retaining rudder system functionality. On the ground, trapped hydraulic fluid provides rudder control surface gust lock damping when the hydraulic systems are depressurized.

Rudder position is displayed on the EICAS FLIGHT CONTROL synoptic page. A full-scale deflection of the rudder position indicator corresponds to maximum rudder travel.

PRIMARY FLIGHT CONTROLS (Cont)

RUDDER POWER CONTROL UNIT (PCU)

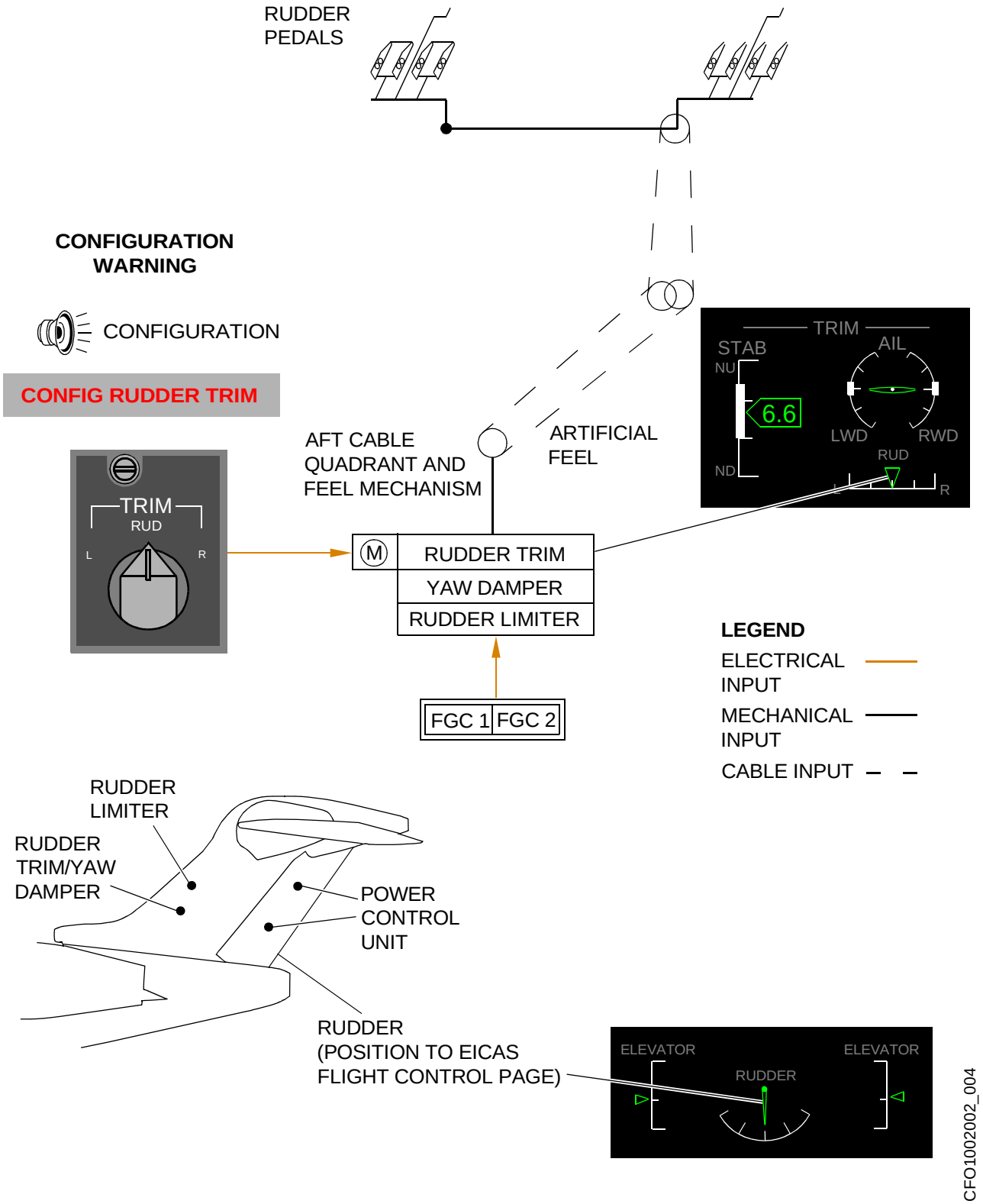
There are two hydraulic rudder PCUs attached to the rear spar of the vertical stabilizer. The left hydraulic system energizes the upper rudder PCU and the right hydraulic system energizes the lower rudder PCU. If the right hydraulic system loses pressure, the lower rudder PCU is powered by the auxiliary hydraulic system.

The rudder PCUs also give protection to the rudder control surface against gust loads while the aircraft is on the ground.

RUDDER TRAVEL LIMITER

The rudder travel limiter actuator puts a limit on the movement of the rudder control surface, as a function of airspeed. This insures that the aerodynamic force on the rudder is not more than the structural limit of the vertical stabilizer. The horizontal-stabilizer-trim electronic-control unit (HST ECU) controls the movement of the rudder travel limiter-actuator.

PRIMARY FLIGHT CONTROLS (Cont)



PRIMARY FLIGHT CONTROLS (Cont)

YAW DAMPER

The yaw damper (YD) provides damping of the aircraft inherent dutch roll characteristic using yaw rate information from an attitude heading computer. It also provides turn coordination using roll attitude from the attitude heading computer.

Since the yaw damper is installed in a series configuration, yaw damper movement will not move the pilot's pedals. The system is mechanically limited to a ±5° of rudder motion.

The yaw damper is active while on the ground if YD has been selected on the flight guidance panel. This allows the flight crew to observe YD activity for system checks. When the aircraft accelerates above 60 kt IAS, the damping function is smoothly disabled until weight is off the wheels, at which point it is re-enabled. The yaw damper may be engaged independently of the autopilot, but if the autopilot is engaged, the yaw damper is automatically engaged.

The functions of the flight guidance YD switch are as follows:

- Engages or disengages the yaw damper, if no detected failures and/or cutout conditions exist
- Disengaging the YD disengages the autopilot

The FGP AP/YD DISC bar is used to the control the YD as follows:

- Provides a positive means of disengagement. The switch is manually positioned and the YD cannot engage when the bar is in the down (disconnect) position

When the yaw damper channel fails or disconnects, an amber YAW DAMPER FAIL (C) CAS message is displayed.

PRIMARY FLIGHT CONTROLS (Cont)

ELEVATORS

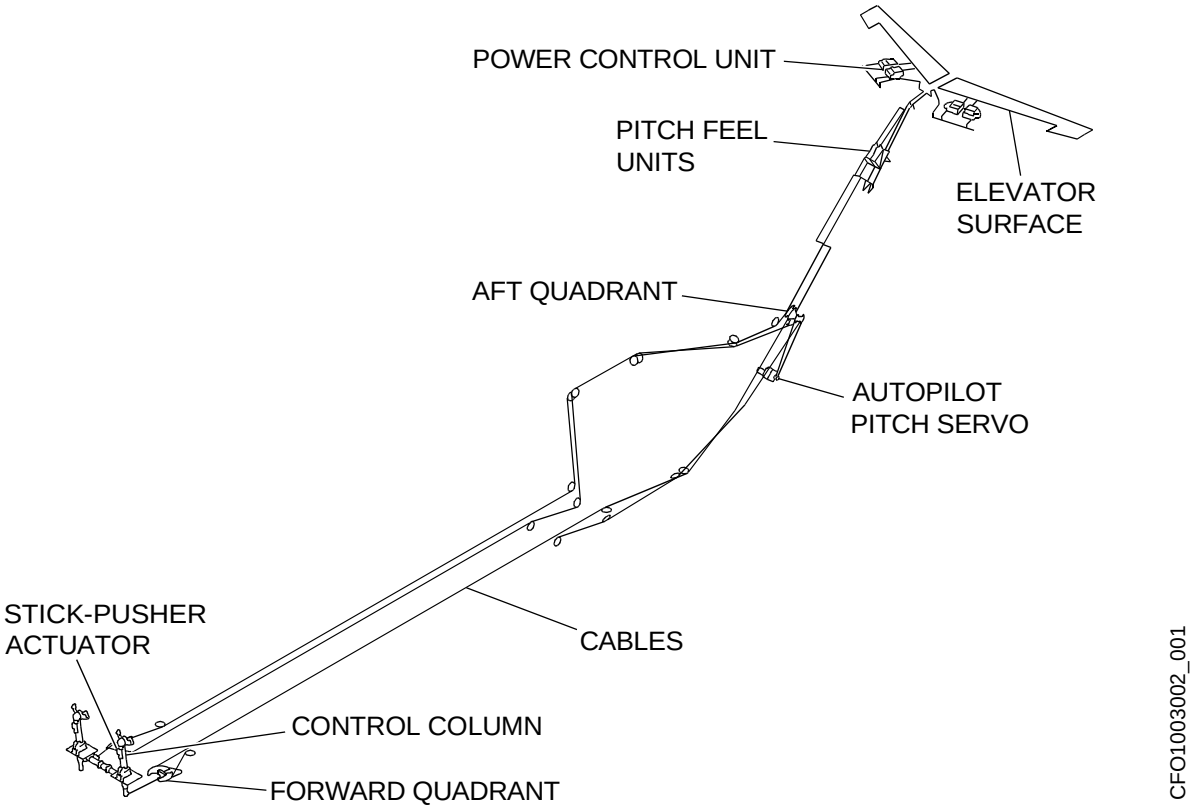
Pitch control is provided by the elevators and supplemented by a moveable horizontal stabilizer. Each elevator is hydraulically powered by two power control units and mechanically controlled via cable runs and quadrants through fore and aft displacement of either control column. Normally, the control systems are interconnected and there is simultaneous movement of both elevators. If the elevator split is greater than 7.5°, an ELEVATOR SPLIT (C) CAS message will be displayed.

Elevator position is displayed on the FLIGHT CONTROLS synoptic page. A full-scale deflection of the elevator's position indicator corresponds to maximum travel.

Pilot inputs to the elevator are through dual control columns. The control columns are normally connected through a torque tube, so they rotate in unison.

A control rod transmits pilot commands to the left and right forward quadrants. The left side quadrant assembly includes a cable interface with the stick pusher servo of the stall protection system.

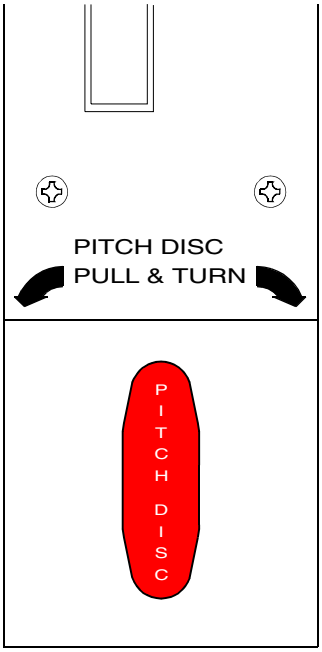
Separate left and right cable circuits carry the elevator command through the fuselage and terminate at the respective aft quadrants located in the rear section of the fuselage. The aft quadrants each drive an output rod that is connected to two control rods in series. The first control rod is connected to a gain changer mechanism, which is a four bar linkage that provides a non-linear gearing between control column movement and elevator surface. The second rod is connected to a pitch feel simulator that provides artificial feel forces. Aft of the gain changer mechanism, a series of control rods, levers, and a torque tube transmit the elevator command to two elevator power control units per elevator.



PRIMARY FLIGHT CONTROLS (Cont)

PITCH DISCONNECT

When pulled, the PITCH DISC handle isolates a jammed elevator control system. Pulling the handle, then turning 90° will allow the pilot or copilot to control the non-jammed elevator. A PITCH DISCONNECT (W) CAS message will also be illuminated on the MFD.



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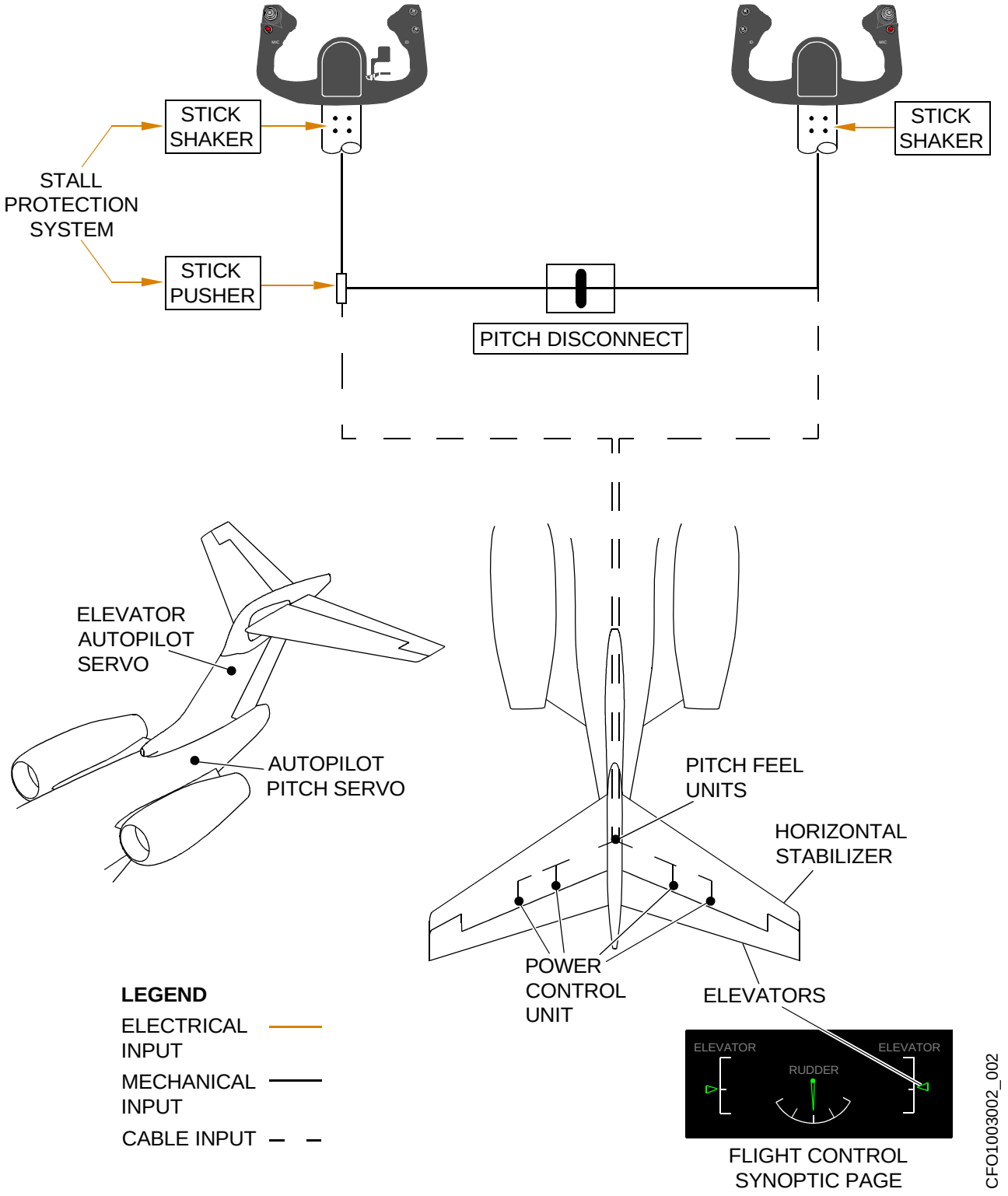
PITCH DISC LEVER

PRIMARY FLIGHT CONTROLS (Cont)

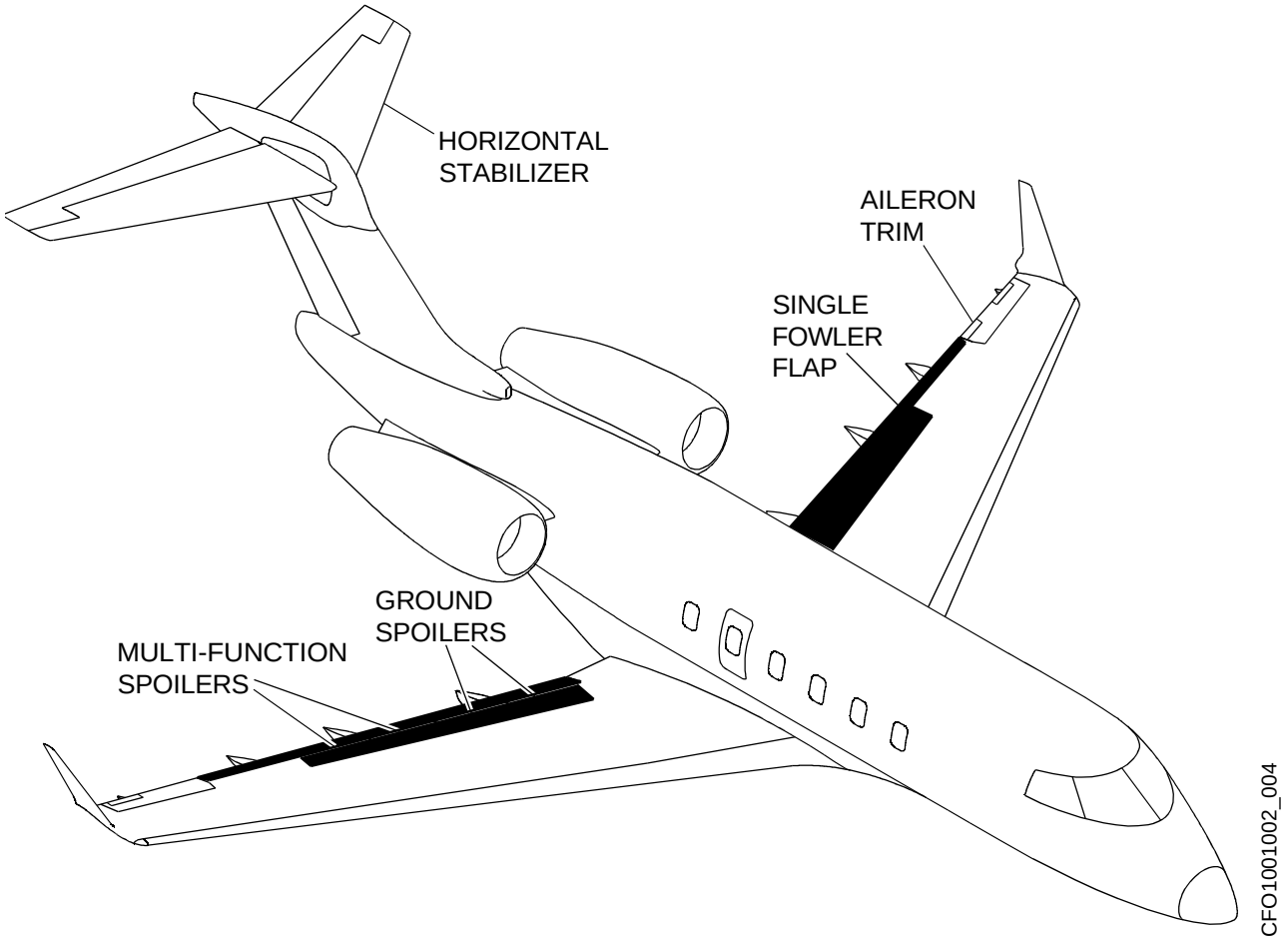
ELEVATOR CONTROL SCHEMATIC



SECONDARY FLIGHT CONTROLS

DESCRIPTION

Secondary flight controls include flaps, multifunction spoilers, ground spoilers, aileron, rudder, and horizontal stabilizer trims. Flaps are electrically controlled and hydraulically actuated. Horizontal stabilizer, aileron, and rudder trims are electrically operated. The multifunction spoilers and ground spoilers are operated hydraulically but controlled via electrical signals generated by the SECU. Position indicators for the secondary control surfaces are located on the MFD and the FLIGHT CONTROLS synoptic page.



SECONDARY FLIGHT CONTROLS (Cont)

COMPONENTS AND OPERATION

AILERON TRIM

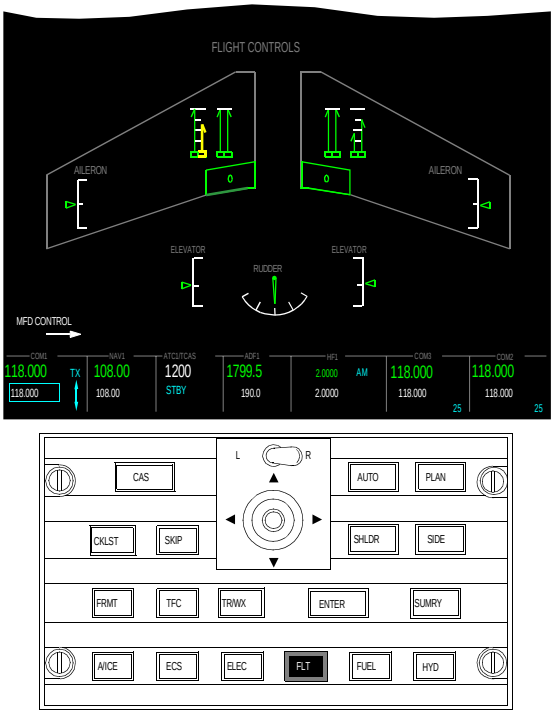
Aileron trim is achieved by means of an aileron trim tab located on the left aileron. The trim tab is moved by an electro-mechanical actuator located in the left aileron. The trim actuator is activated by movement of the aileron trim switches on the pilot and copilot's control wheels.

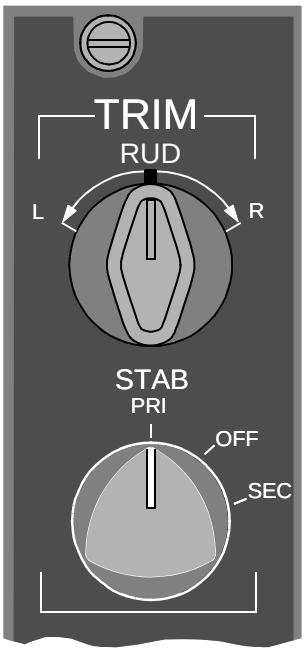
The aileron trim tab has ±20 degrees of travel with respect to the aileron surface. The aileron trim switches consist of a single unit containing a split-pole-four throw toggle button (left and right for aileron trim and up and down for horizontal stabilizer trim) and a single-pole single-throw push button to arm. To activate aileron trim, the button must be pressed down and simultaneously pushed left or right.

The CONFIG AILERON TRIM (W) CAS message illuminates if takeoff is attempted with the aileron trim not within the takeoff trim band.

RUDDER TRIM

Rudder trim is provided through an electromechanical rudder trim actuator. Rudder trim is activated by the flight crew by means of a RUD TRIM switch on the pedestal. Trimming of the rudder is done directly with the rudder surface. There are no trim tabs on the rudder. Activation of the RUD TRIM switch causes electrical inputs to the rudder power control units that move the rudder to the position selected by the pilot. A CONFIG RUDDER TRIM (W) CAS will also be illuminated if not properly configured for takeoff.





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HORIZONTAL STABILIZER TRIM

The stabilizer trim controls pitch trim by varying the horizontal stabilizers angle of incidence. The stabilizers are positioned by a jack screw driven by electric motors and controlled by the horizontal stabilizer trim control unit. Each trim motor has a brake to prevent trim runaway. The trim control unit receives inputs from the control wheel trim switches, the autopilot (AFCS), flaps (FCU) and Mach (ADC).

The stabilizer trim position indicator and readout is displayed on the EICAS and the FLIGHT CONTROLS synoptic page. The digital readout indicates the stabilizer position in units of trim, which corresponds to horizontal stabilizer angle of incidence. The stab trim range of movement is 0 to 15 degrees, with the normal takeoff range of 2.5 to 8.0 units (green).

A CONFIG STAB TRIM (W) CAS will be displayed if the stabilizer trim is not in normal takeoff range.

SECONDARY FLIGHT CONTROLS (Cont)

HORIZONTAL STABILIZER TRIM

The stabilizer trim can be moved manually by control wheel trim switches or automatically via computer-controlled inputs from the autopilot, spoilers, or flaps.

Manual trim rates differ, depending on which channel is engaged. When the primary channel is engaged, the trim rate is a function of airspeed (mach). When the pitch trim secondary channel is engaged, the trim rate is a constant 0.2 degrees per second.

The primary channel trim rate limit is 0.4 degrees/second at airspeeds up to Mach 0.4, decreasing linearly to 0.1 degrees/second at Mach 0.8, and 0.1 degrees/second above Mach 0.8. If Mach data is not available, the trim rate limit defaults to 0.2 degrees/second.

CONFIGURATION TRIM

The aircraft has configuration trim, which is automatic trim movement when the flaps are extended or retracted and the spoilers are extended or retracted. The aircraft has a nose down pitching moment with flap extension and nose up pitching moment with spoiler extension. When these control surfaces are deflected, the horizontal stabilizer trim moves so as to reduce the control column forces.

MACH TRIM

The Mach trim function makes allowances for the rearward shift of the aerodynamic center of pressure as the Mach number increases. Without correction, this shift in the center of pressure decreases longitudinal stability.

The horizontal stabilizer trim control unit automatically adjusts the stabilizer as a function of the Mach number when the autopilot is not engaged.

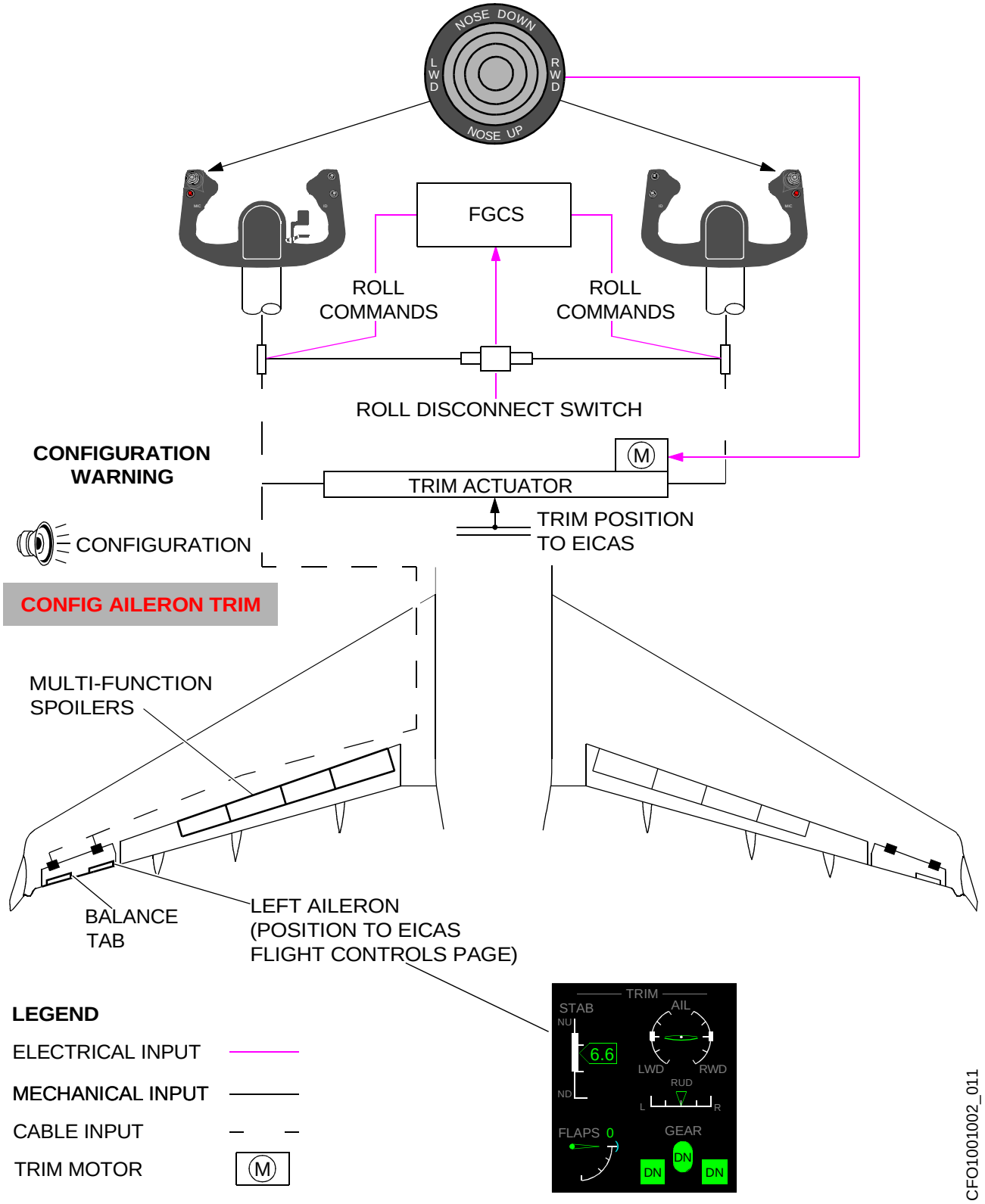
The Mach trim system, using Mach information from the air data computers (ADCs), varies the angle of incidence of the stabilizer by commanding movement of the horizontal stabilizer actuator.

When Mach trim is active, increasing speed from a trimmed condition results in Mach trim inputting slight nose up trim, increasing the aircraft's natural speed stability. Likewise, decreasing aircraft speed from a trimmed condition results in Mach trim inputting slight nose down trim.

The Mach trim system is continuously monitored and any fault detected is displayed on the EICAS display.

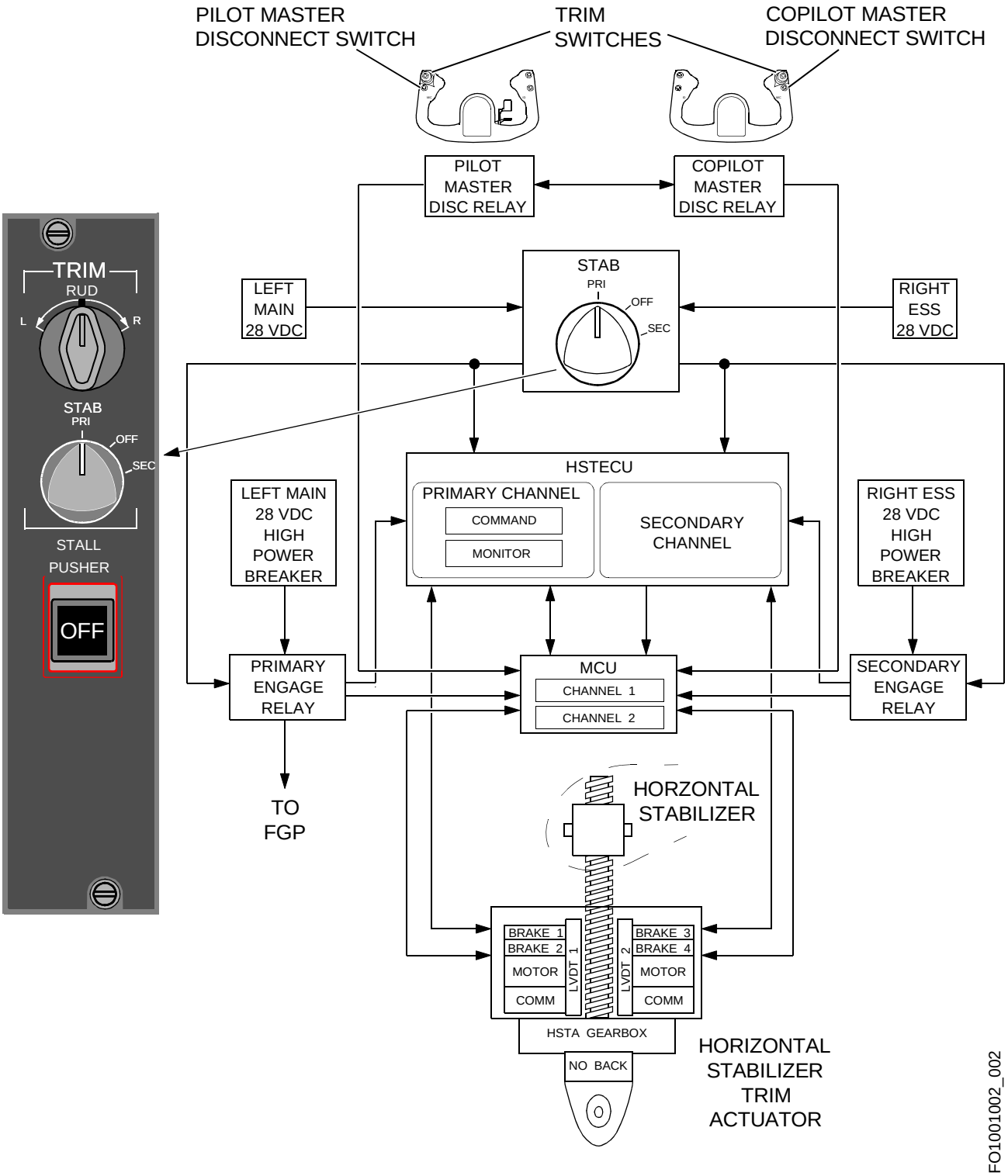
SECONDARY FLIGHT CONTROLS (Cont)

AILERON TRIM SCHEMATIC



SECONDARY FLIGHT CONTROLS (Cont)

HORIZONTAL STABILIZER TRIM SCHEMATIC



SECONDARY FLIGHT CONTROLS (Cont)

FLAPS

The single-slotted Fowler flaps are electronically controlled and operated by a hydraulic motor in the flap power unit. There are two hydraulic systems. Under normal conditions, the flaps will operate with the right hydraulic system. When ALTN FLAPS is selected ON, flaps will operate from the left hydraulic system and a FLAPS ALT PRESS lamp will illuminate in green on the EICAS. FLAPS RATE LOW (A) CAS will illuminate if the flap control unit is controlling the system at a lower than nominal speed in order to reduce the hydraulic flow. This is the case if either the pressure switches of the hydraulic system indicate that the engine driven pump for the main system is not working, or the alternate hydraulic supply is selected. Normal flap extension from 0 to 30 does not exceed 20 seconds with the right engine-driven hydraulic pumps operating. However, time extends up to 60-70 seconds while lowering flaps from 0 to 20 in flight when using ALTN FLAPS or when using the right DC hydraulic pump. Each flap panel, one on each wing, has three safe-life flap tracks and is driven by two screw jack actuators. A stainless steel shaft transfers power from the hydraulic motor to each flap actuator. The flap control lever is located on the center pedestal and is recessed to prevent inadvertent operation.

COMPONENTS AND OPERATION

The flap power unit (FPU) is located aft of the wing center section behind the wing attachment fitting and contains the hydraulic motor, servo control valve, arming solenoid valve and pressure switch. The servo valve responds to electrical signals from the flap control unit and meters hydraulic pressure to extend or retract the bidirectional hydraulic motor. The arming solenoid valve must be opened by the flap control unit before hydraulic pressure is available to the servo valve. The pressure switch monitors system pressure between the arming solenoid valve and servo valve. If hydraulic pressure is not available on flap selection, flaps are inoperative. If the FPU detects a fault, the flaps may deploy at a reduced speed when selected and FLAPS RATE LOW CAS will illuminate.

Stainless steel shafts routed along the rear wing spar transmit the rotary motion of the flap power unit to the input shaft of each of the flap actuators. Two rotary variable differential transformers (RVDTs) mounted on the outboard side of each outboard flap actuator provide position information to the flap control unit (FCU) and the flap position indicating unit. The flap actuators incorporate a screw jack and are attached to the rear spar. These actuators convert the rotary input motion into linear output motion through these screw jacks, driving the flaps. Each actuator has overtravel end stops. The screw jack design of the flap actuators prevents uncommanded retraction due to airloads or vibration.

The flap control unit (FCU) performs the following functions:

- Controls flap panel movement according to pilot commands
- Monitors critical system conditions (runaway/uncommanded movement, surface asymmetry, system jam, overspeed and speed differential)
- Switches the system to fail safe condition after detection of a critical failure
- Monitors FPU for internal and external hydraulic leakage and provide annunciation to the aircrew
- Flap position to the stall protection system
- Provides data for cockpit indication and for maintenance purposes

In addition to control and monitoring, the FCU also contains the left hand and right hand flap position indication unit (FPIU) and provides flap panel position to the EICAS

FLAP ALERTING

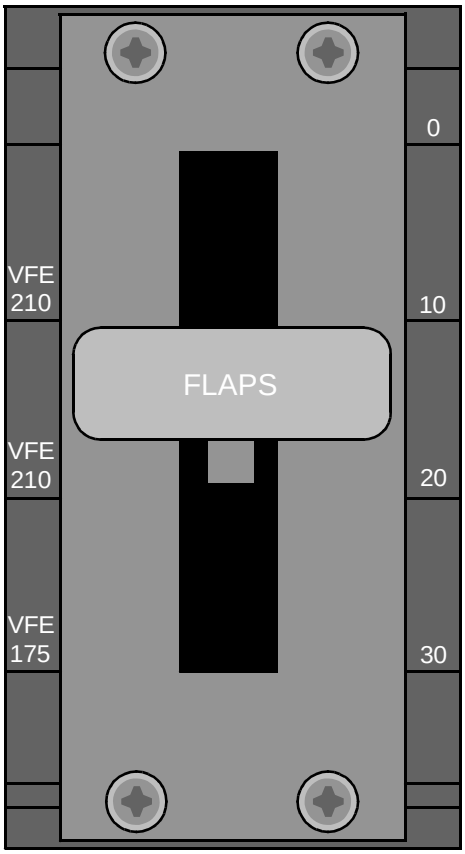
The flap position alerting system is monitored by airspeed, flap position, spoiler, gear position, and altitude. An overspeed warning horn is activated if flaps are extended above the following speed:

- V_{FE} 210 kt — 10°
- V_{FE} 210 kt — 20°
- V_{FE} 175 kt — 30°

SECONDARY FLIGHT CONTROLS (Cont)

FLAP CONTROL LEVER

The FLAP control lever operates in one of four positions, (0, 10, 20, and 30) with detents at the 10 and 20 positions.To prevent inadvertent retraction of flaps from 30 to 0 in one motion during a go-around maneuver, a gate is located at the 10 position and must be pulled up slightly when retracting the flaps to 0. The lever is attached to dual RVDTs co-located with a flap lever detent switch below the flap handle. These dual RVDTs transmit the selected position to a flap control unit. Moving the lever between positions actuates the flap lever detent switch and energizes a 75-second timing circuit within the flap control unit. This circuit allows the arming solenoid valve within the flap power unit to energize open for 75 seconds and then de-energize.



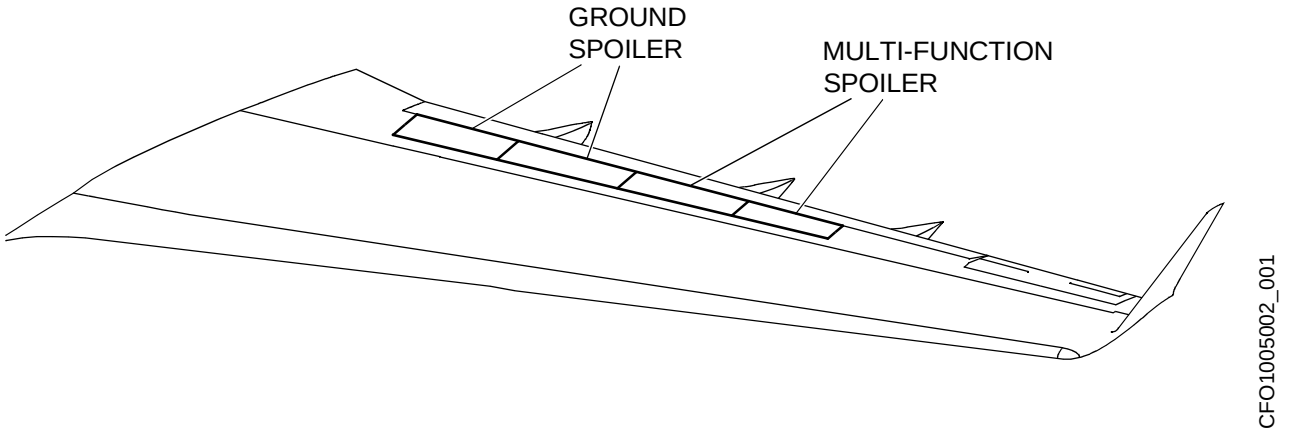
FLAP POSITION INDICATION

Flap position is shown in a digital display on the (EICAS) and flight control synoptic page.

SECONDARY FLIGHT CONTROLS (Cont)

SPOILER SYSTEM

On the upper surface of each wing there are four spoiler panels. The two inboard panels are the ground spoilers, and the two outboard panels are the multifunction spoilers.



The system is computer controlled and hydraulically operated, two ground spoilers provide ground lift dumping functions. The multifunction spoilers provide roll assist, proportional lift dumping and ground lift dumping functions.

The ground spoilers have only two positions: fully retracted during flight or fully deployed after landing. The inboard and outboard ground spoilers, when tied together with the multifunction spoilers, comprise the ground spoilers system.

SECONDARY FLIGHT CONTROLS (Cont)

COMPONENTS AND OPERATION

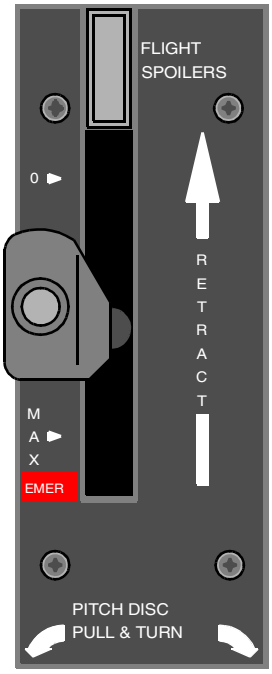
SPOILER ELECTRONIC CONTROL UNIT (SECU)

Two electronic units, SECU 1 and SECU 2, control the spoilers. The SECUs contain all the functions necessary to transmit the spoiler sensor outputs and control the spoiler actuators. The SECUs also supply crew-alerting system messages, maintenance messages, and flight-data recorder data.

FLIGHT SPOILERS LEVER

The flight spoilers lever provides symmetric deployment of two pairs of multifunction spoilers via the SECU. In normal operation there are nine detented positions between 0 and MAX. The 0 position is gated and requires pressing the push button on top of the lever to release. The 0 position can be reselected without pushing the button. A tenth position for emergency descent is also available. The EMER position is gated and requires pressing the push button to engage. The lever will return anywhere within the 0 to MAX position from EMER without pressing the button.

The spoiler graphic display on the top half of the left MFD declutters after 60 seconds when the spoilers are retracted. The graphic will automatically be displayed again when the ground or flight spoilers are extended or a spoiler failure exists.



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SECONDARY FLIGHT CONTROLS (Cont)

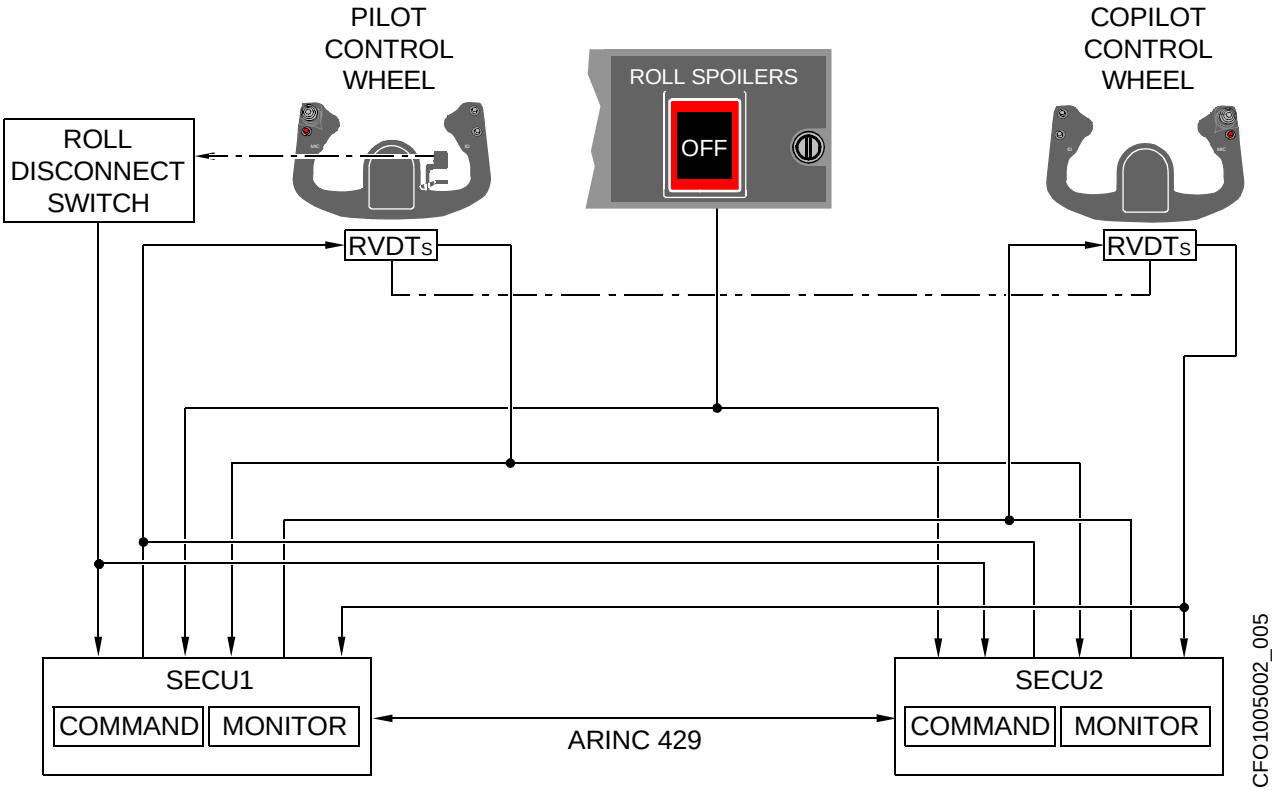
ROLL SPOILERS

Roll spoilers assist is provided through the multifunction spoilers (MFSs) to assist the ailerons in providing roll control. Each panel is electronically controlled by the SECU, and operated by a single hydraulically actuated power control unit (PCU). Pilot inputs to the roll assist system are through the control wheels, and the ROLL SPOILERS switch located on the center pedestal

ROLL SPOILERS DISCONNECT

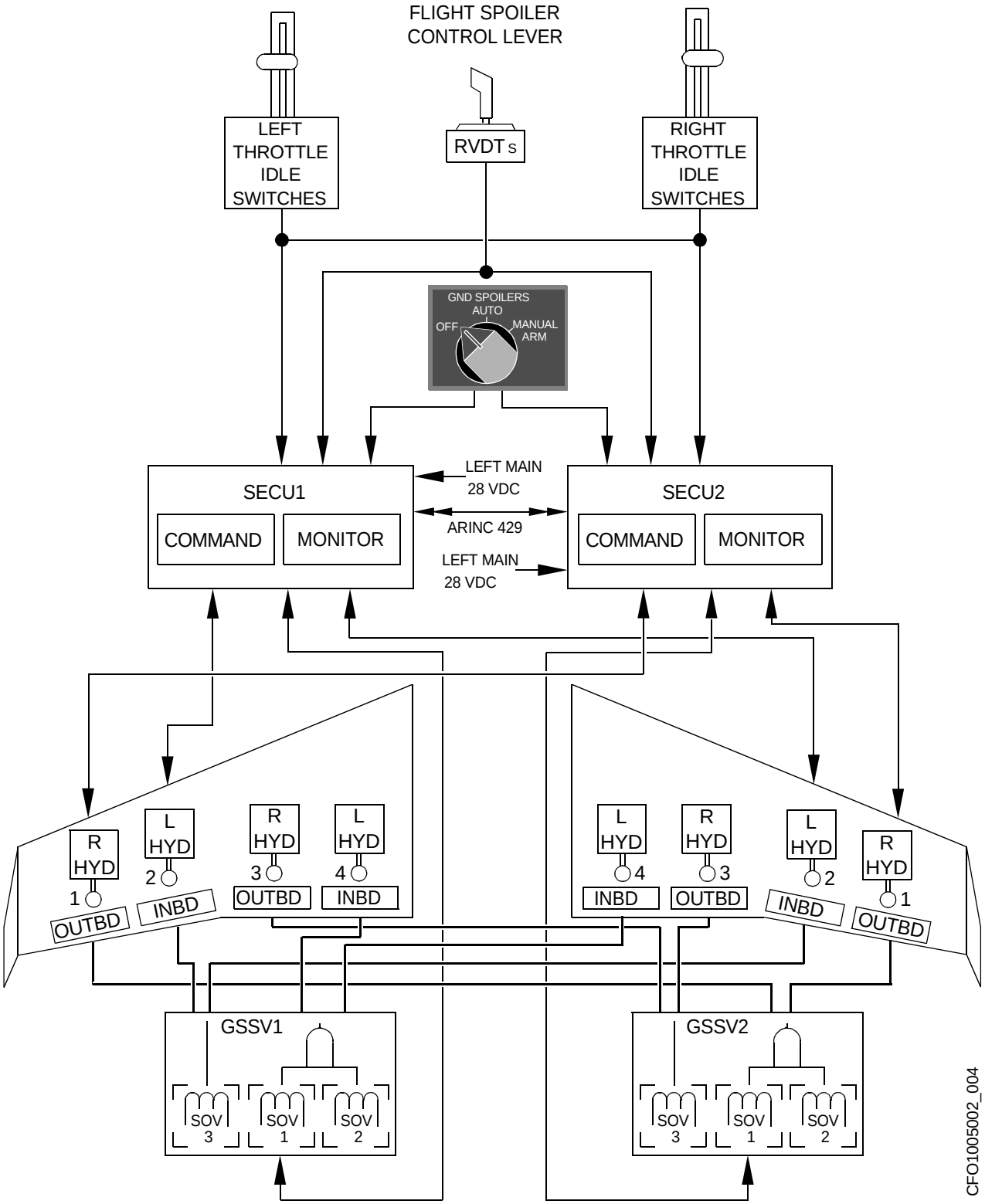
If the aileron cable system jams, the pilot must activate the roll disconnect feature on the pilot's control wheel. This action disconnects the pilot's wheel from the cable system, permitting continued roll assist by the pilot if the jam is not in the pilot's wheel.

The ROLL SPOILERS switch is located on the center pedestal. If the jam is in the pilot's wheel, raising the guarded switch and pressing OFF disables the roll assist function. A ROLL SPOILERS OFF (C) will be illuminated on the EICAS. A ROLL SPOILERS OFF (S) is illuminated when the roll spoilers have been turned off and the roll disconnect has been activated. Pressing the switch again, reengages the roll assist function and extinguishes the CAS message



SECONDARY FLIGHT CONTROLS (Cont)

FLIGHT SPOILER SCHEMATIC



SECONDARY FLIGHT CONTROLS (Cont)

GROUND SPOILERS

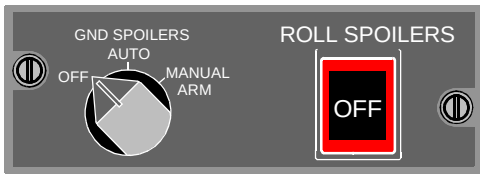
DESCRIPTION

After touchdown or during a rejected takeoff, the inboard and outboard ground spoilers in conjunction with the multifunction spoilers are extended to spoil lift and increase drag to assist in aircraft braking. The ground spoilers function is normally automatic but can be activated manually by the pilot. The ground spoilers have no in-flight function.

COMPONENTS AND OPERATION

The ground spoiler function is selected by the three position GND SPOILERS switch as follows:

- OFF — Disables the ground spoilers by disarming the function
- AUTO — Automatically arms the ground spoilers for landing and rejected takeoff in conjunction with throttle lever angle, wheel speed, weight on wheels and radio altitude
- MANUAL ARM — Arms the ground spoilers regardless of the inputs required to arm in the AUTO position



When deployed, the ground spoiler panels extend to 60° and the multifunctional panels extend to 45°, however, only the multifunction panels respond to control wheel roll assist inputs. Ground spoilers deploy when the inputs for ground spoiler deploy logic are throttles at IDLE, and 2 of the 3 following criteria are met: radio altitude less than 7 ft, weight on wheels, and wheelspeed greater than 16 kt.

The position of all panels are shown on the EICAS FLIGHT CONTROLS synoptic page. Green arrows and position scales indicate relative deflection of the surfaces.

Inboard and outboard ground spoilers are limited to two positions, either up or down. The spoilers are continuously monitored and any fault detected is displayed on the appropriate EICAS screen.

SECONDARY FLIGHT CONTROLS (Cont)

TAKEOFF CONFIGURATION WARNING SYSTEM

DESCRIPTION

The takeoff configuration warning system monitors the position of the flaps, flight spoilers, parking brake, autopilot, aileron, rudder, roll and pitch disconnect, and horizontal stabilizer trims, to ensure that they are in a safe configuration for takeoff.

COMPONENTS AND OPERATION

The warning system is armed when the airplane is on the ground. If one or more of the monitored systems is in an unsafe takeoff configuration and both throttles are at or above the climb (CLB) detent, the master warning lights flash, aural alerts sound and warning messages are presented. The configuration warning indications are canceled by correctly positioning the applicable control or retarding the thrust levers.

PROXIMITY SENSING SYSTEM

DESCRIPTION

The proximity sensing system (PSS) consists of the proximity sensing electronic unit (PSEU), proximity sensors and proximity switches. The proximity sensing system monitors aircraft systems for correct operation and configuration.

COMPONENTS AND OPERATION

PROXIMITY SENSING ELECTRONIC UNIT

The proximity sensing electronic unit (PSEU) processes information received from landing gear position, WOW position, thrust reverser position and fuselage door position and provides instructions to other aircraft systems.

Proximity switches and sensors measure the physical relationship between two aircraft components. If the components are close together, the sensors and/or switches provide a “near” signal. If the components are separated, a “far” signal is generated. The PSS uses this information to generate appropriate signals for use by other aircraft subsystems.

The PSEU receives inputs from sensors and controls the takeoff configuration warning system.

Failure of the proximity sensing system is indicated on the EICAS.

STALL PROTECTION SYSTEM

DESCRIPTION

The stall protection system (SPS) provides the flight crew with aural, visual, and tactile (stick shaker) indications of an impending stall. If the pilot does not take corrective action, the system activates the stick pusher mechanism.

COMPONENTS AND OPERATION

There is a stick shaker on each control column and a single stick pusher mechanism attached to the left pitch control system.

A dual-channel stall protection system (SPS) computer monitors the following inputs:

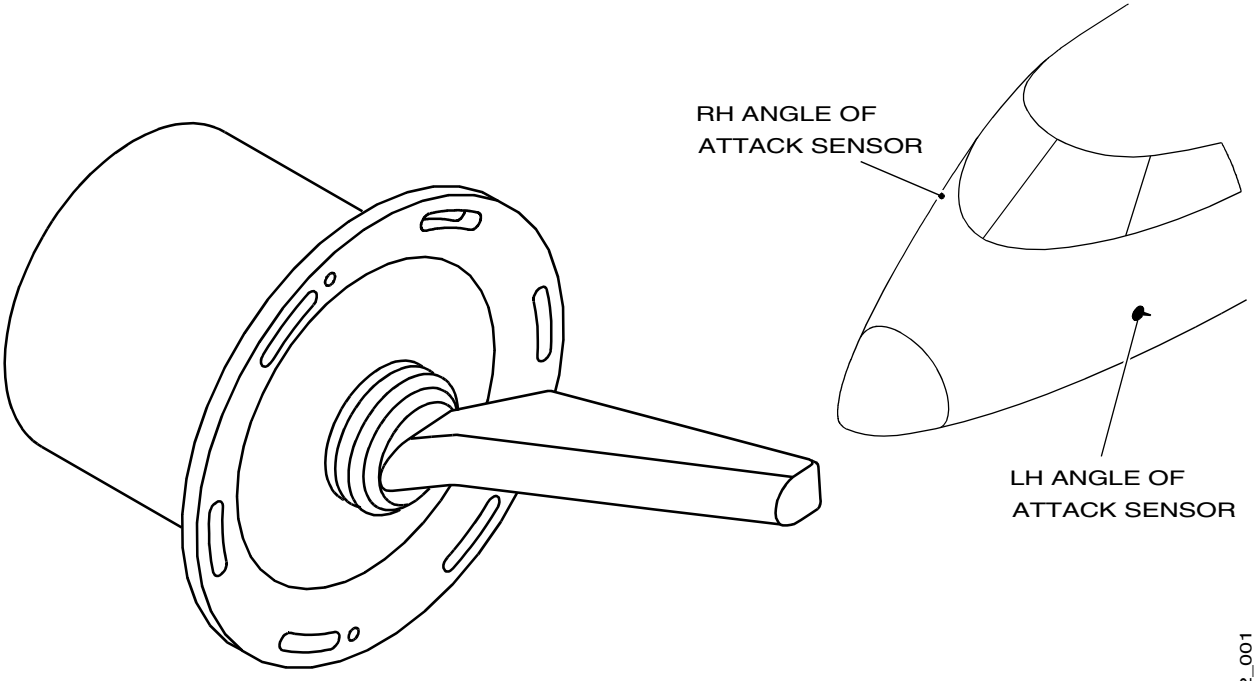
- Angle of attack - L, R Angle-of-Attack (AOA) transducers (vanes)
- Lateral acceleration - Attitude Heading Reference Systems (AHRS)
- Flap position
- Weight-on-wheels - WOW 1 and WOW 2
- Mach and airspeed - ADC 1, ADC 2, and standby instrument

STALL PROTECTION SYSTEM (Cont)

The ADCs supply primary Mach data to the SPS computer for Mach compensation of the aircraft's stall margin.

The SPS uses the above inputs to calculate the angle-of-attack trip points. The stick shaker activation and ignition activation are simultaneous.

In the event of an AOA increase rate greater than 1 degree per second, the stall protection computer lowers the activation trip point. This prevents the aircraft's pitching momentum from carrying it through the stall warning/stick pusher sequence to deep into the stall.



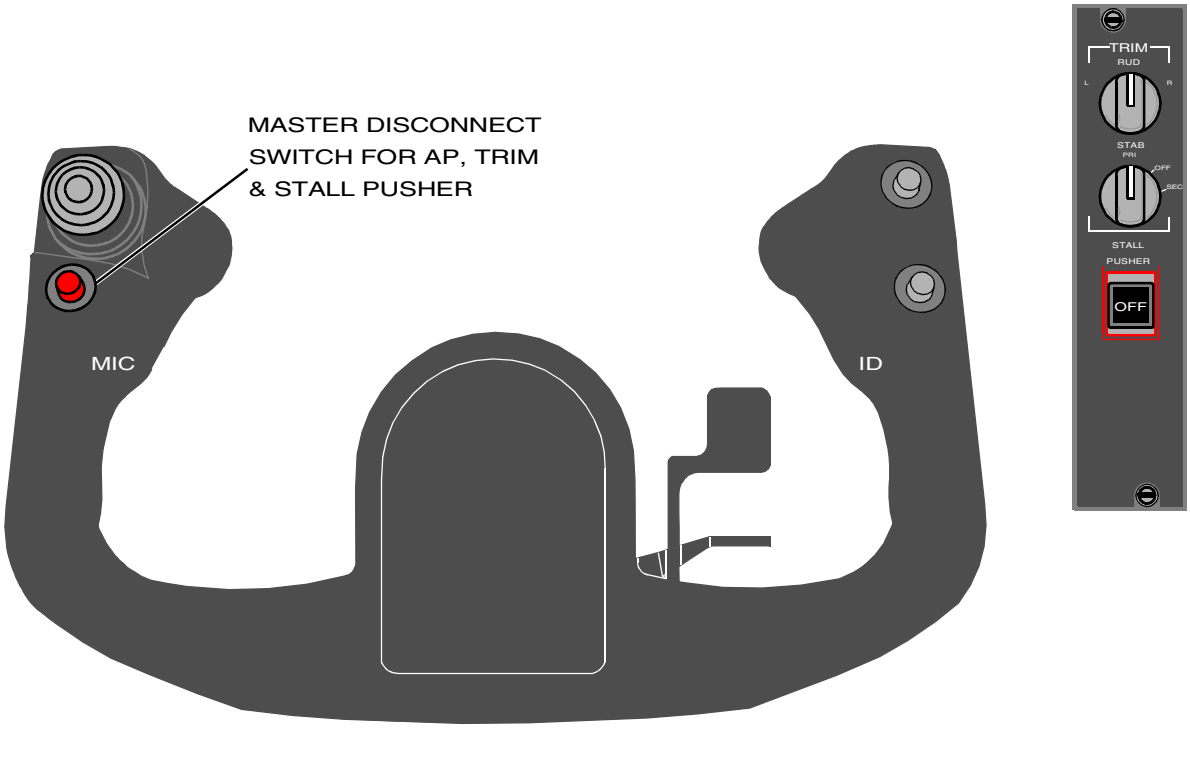
ANGLE OF ATTACK SENSOR (TYPICAL)

STALL PROTECTION SYSTEM (Cont)

STICK PUSHER DISCONNECT FEATURES

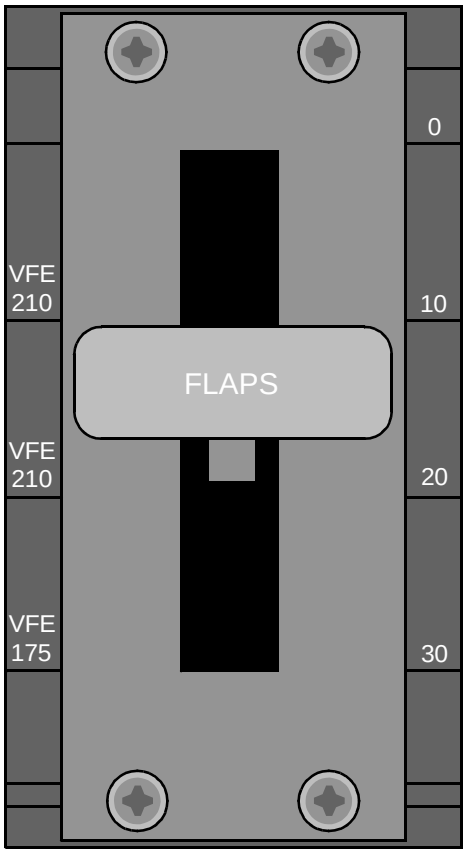
The stick pusher can be stopped by pressing and holding either control wheel master disconnect switch (MSW). The stick pusher is capable of operating immediately when the MSW switch is released. This function is inoperable on JAA approved aircraft.

Should the SPS incorrectly activate the stick pusher, the stick pusher may be disabled by selecting the STALL PUSHER switch to OFF.



CONTROLS AND INDICATIONS

FLAP CONTROL LEVER



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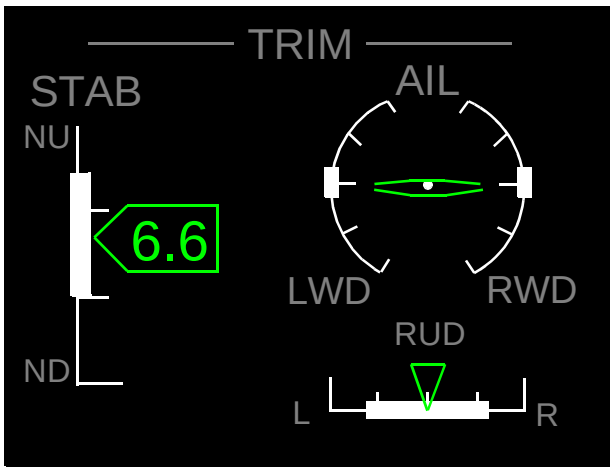
EICAS TRIM STATUS DISPLAY



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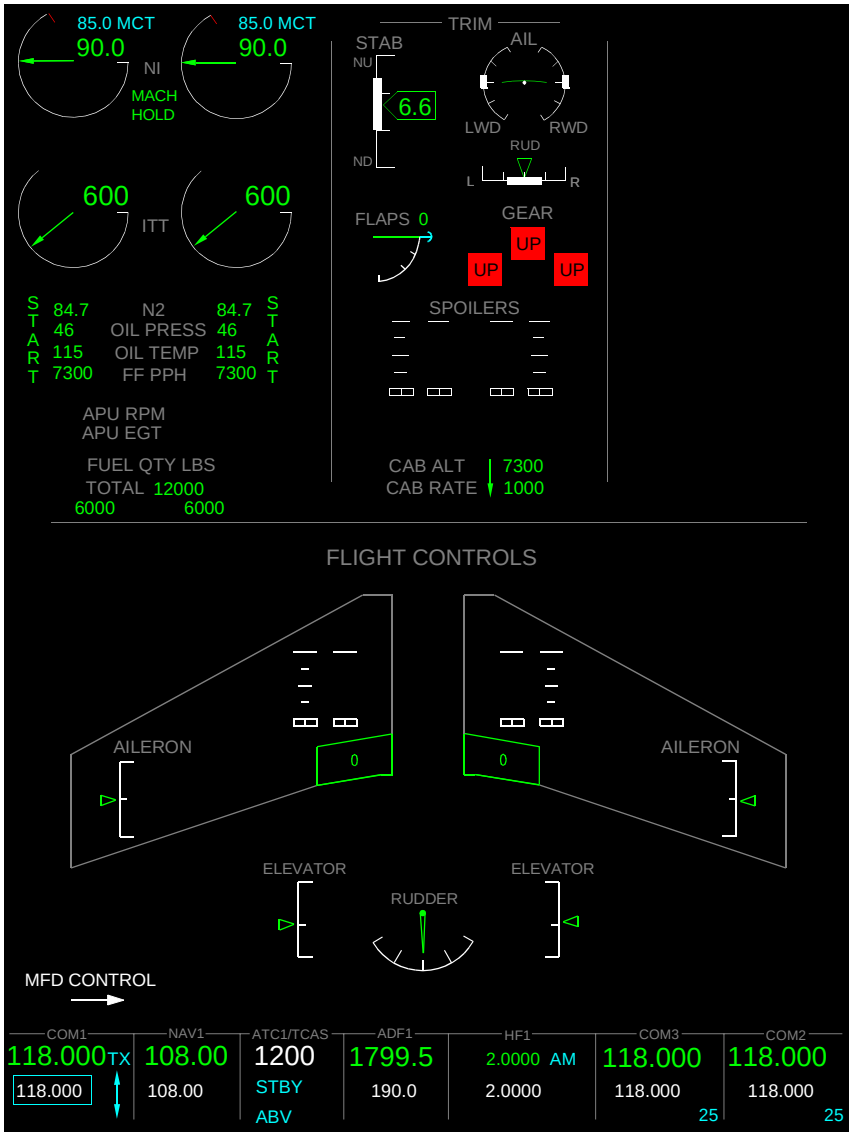
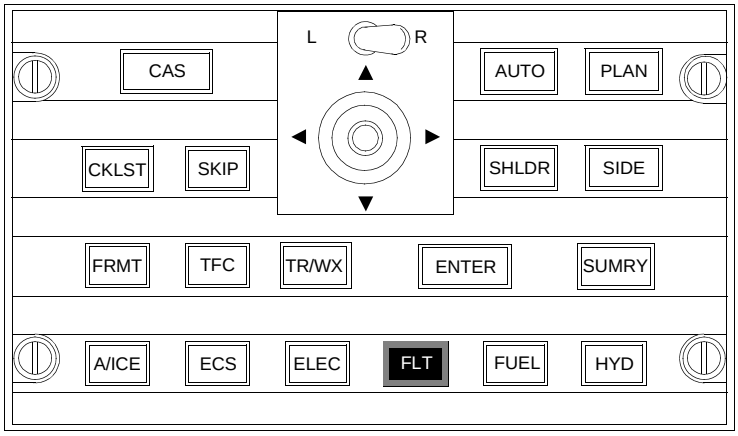
CONTROLS AND INDICATIONS (Cont)

FLIGHT CONTROL SYNOPTIC PAGE





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EICAS MESSAGES

The flight controls messages are shown on the EICAS. The flight control messages, inhibits and aural alerts are listed below. A brief explanation of each message is provided.

MESSAGE	INHIBITS	MEANING	AURAL WARNING
CONFIG AILERON TRIM		Aileron trim is not in the takeoff range (green band)	“Configuration”
CONFIG AUTOPILOT		Autopilot not configured for takeoff	“Configuration”
CONFIG FLAPS		Flaps not in takeoff position	“Configuration”
CONFIG RUDDER TRIM		Rudder trim is not in the takeoff range (green band)	“Configuration”
CONFIG SPOILERS		Spoilers is not in takeoff position	“Configuration”
CONFIG STAB TRIM		Elevator trim is not in the takeoff range (green band)	“Configuration”
PARK/EMER BRAKE ON		Emergency brake is engaged with throttles at or above climb. The CAS will be accompanied by the “CONFIGURATION” voice warning.	“Configuration”
PITCH DISCONNECT		Pitch disconnect has occurred on the ground with throttles at or above CLB	
ROLL DISCONNECT		Roll disconnect has occurred on the ground with throttles at or above CLB	
ELEVATOR SPLIT		The elevator has a split of greater than 7.5°. The split may be caused by maneuvering with the elevator disconnected	
FLAPS FAIL	TO	The flap system has shutdown due to a failure. The flaps are not resettable	
FLAPS FAULT	TO	The flaps are operating in a degraded mode. The fault may be resettable in some conditions, by movement of the flap selector handle	
FLAPS NORM PRESS LOW	TO/LAND	The flaps normal hydraulic pressure is low. This will be accompanied by a FLAPS FAULT CAS. Alternate pressure may be available	
FLT SPOILERS DEPLOY		The flight spoilers are deployed below 500 feet (FAA), {800 ft JAA} or the flight spoilers are deployed and the throttles are at CLB or above	
FLT SPOILERS FAIL		All flight spoilers have failed	
FLT SPOILERS FAULT	TO	Either the inboard or outboard spoilers have failed	
GND SPLRS NOT ARMED		The ground spoilers are not armed and not selected OFF	

EICAS MESSAGES (Cont)

MESSAGE	INHIBITS	MEANING	AURAL WARNING
GND SPOILERS FAIL		The ground spoilers have failed	
MACH TRIM FAIL	TO/LAND	The Mach trim has failed	
PRI STAB TRIM FAIL		The stabilizer trim has failed. Mach trim, flap and spoiler config trim inoperative	
ROLL SPOILERS FAIL		Roll assist function has failed but flight and ground spoilers have not. Roll control forces will be higher	
ROLL SPOILERS FAULT		Either the inboard or outboard roll spoilers have failed. Roll control forces will be higher	
ROLL SPOILERS OFF		The roll spoilers have been turned off with the ROLL DISC not activated	
RUDDER LIMITER FAIL		The rudder limiter has failed	
SEC STAB TRIM FAIL		The secondary stabilizer trim has failed. This message should not be displayed unless the primary stabilizer trim has already failed	
SPOILERS FAIL		The spoilers have failed. If the spoilers were deployed, they will retract down to a float position. The spoilers will not float up.	
SPOILERS FAULT		One or more of the spoiler panels have failed or one or more of the ground spoilers is up prior to touchdown	
STALL PROTECT FAIL		The stall protection has a failure in either channel A or B, or the pusher or AOA sensor has failed, or a miscompare has been detected between essential inputs or essential inputs are unavailable	
STALL PUSHER OFF		The control wheel master switch button has been depressed for at least ten seconds or a stall protection system failure has occurred that has inhibited operation of the stall pusher	
FLAPS FAULT	TO	There is a fault in the flap system. The flaps should operate normally	
FLAPS RATE LOW	TO/LAND	The flap extension and retraction rates are slower than normal. This message will illuminate when the right engine is shutdown, or if the engine driven pump is shutdown	

EICAS MESSAGES (Cont)

MESSAGE	INHIBITS	MEANING	AURAL WARNING
RUDDER LIMITER FAULT	TO/LAND	A minor failure resulting in the loss of redundancy has occurred in the rudder limiter system The rudder travel limiter will continue to function	
SPOILERS FAULT	TO/LAND	There is a fault in the spoiler system that does not affect spoiler operation. Selecting the roll disconnect on the ground and moving the control wheel(s) separately will result in a SPOILERS FAULT message. If this occurs, removing all power from the aircraft and re-powering will cause the message to clear	
STAB TRIM FAULT	TO/LAND	A minor failure has occurred causing a loss of redundancy in the horizontal stabilizer trim system. The stabilizer trim will continue to function	
STALL PROTECT FAULT	TO/LAND	The Stall Protection Computer has automatically reverted to settings for flaps 30	
L (R) STALL SHAKER FAIL	TO/LAND	The respective stall shaker has failed	
GND SPOILERS OFF		The ground spoilers are selected OFF	
PITCH DISCONNECT		The pitch disconnect has been selected. The pilots control column moves the left elevator. The copilot's control column moves the right elevator. Autopilot will disengage and not re-engage	
ROLL DISCONNECT		The roll disconnect has been selected. The pilot's control wheel moves the aileron. The autopilot will disengage and not re-engage	
ROLL SPOILERS OFF		The roll spoilers have been turned off and the roll disconnect has been activated	
RUD LIMITER IN TEST		The rudder travel limiter system is conducting the manually activated system test	
SEC STAB TRIM ON		The secondary channel of the horizontal stabilizer trim system is selected. The autopilot will be inoperative	
STAB TRIM OFF		The STAB TRIM switch is in the off position. The autopilot will be inoperative	
STALL PUSHER OFF		The stall pusher has been manually deactivated	