SECTION 2-13

FLIGHT CONTROLS

TABLE OF CONTENTS

GENERAL

The primary flight control system consists of elevators, ailerons and rudder. Elevators are mechanically actuated. The ailerons and rudder are hydraulically powered and may also be mechanically actuated in case of loss of both hydraulic systems.

Trim system is provided in all axis. Tabs are provided for pitch control only, and are not available for ailerons and rudder.

A gust lock system blocks elevator controls on the ground, avoiding damage to the control systems in case of strong wind gusts. The rudder and ailerons are hydraulically damped for the same purpose.

An electrically operated flap system is provided with five discrete positions.

Speed brakes installed overwing allow increased descent rate and help in decelerating the airplane. Ground spoilers destroy lift, thus providing better braking effectiveness.

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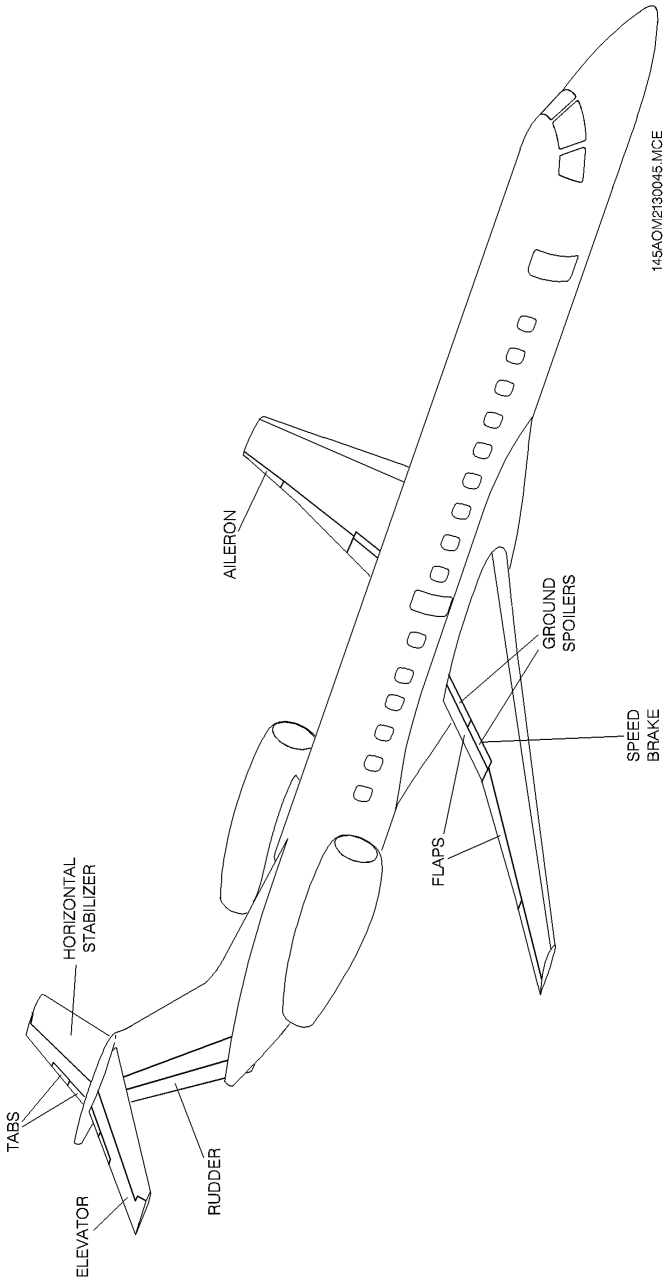

FLIGHT CONTROL SURFACES

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PITCH CONTROL

GENERAL

Pitch control is provided by mechanically-actuated elevators and an electrically-positioned horizontal stabilizer which is commanded through the Pitch Trim System. Tabs are automatically positioned, thus reducing pilots effort.

ELEVATOR

GENERAL

The primary pitch control system is performed by the elevators, which are actuated through a fully duplicated set of command circuits.

JAMMED ELEVATOR

In case of jamming of one of the circuits (left or right), both elevator panels may be disconnected through a handle located on the control pedestal. This procedure will release the free elevator panel from its jammed counterpart, allowing the free panel to be commanded.
When disconnected, an amber light illuminates on the control stand. Controls cannot be reconnected during flight, requiring maintenance action.

JAMMED ELEVATOR OPERATION

The autopilot elevator servo and the stick pusher servo are connected on the left side of the disconnection device. Once disconnection is actuated, the stick pusher will actuate only on the left side and autopilot must not be used.

TABS

GENERAL

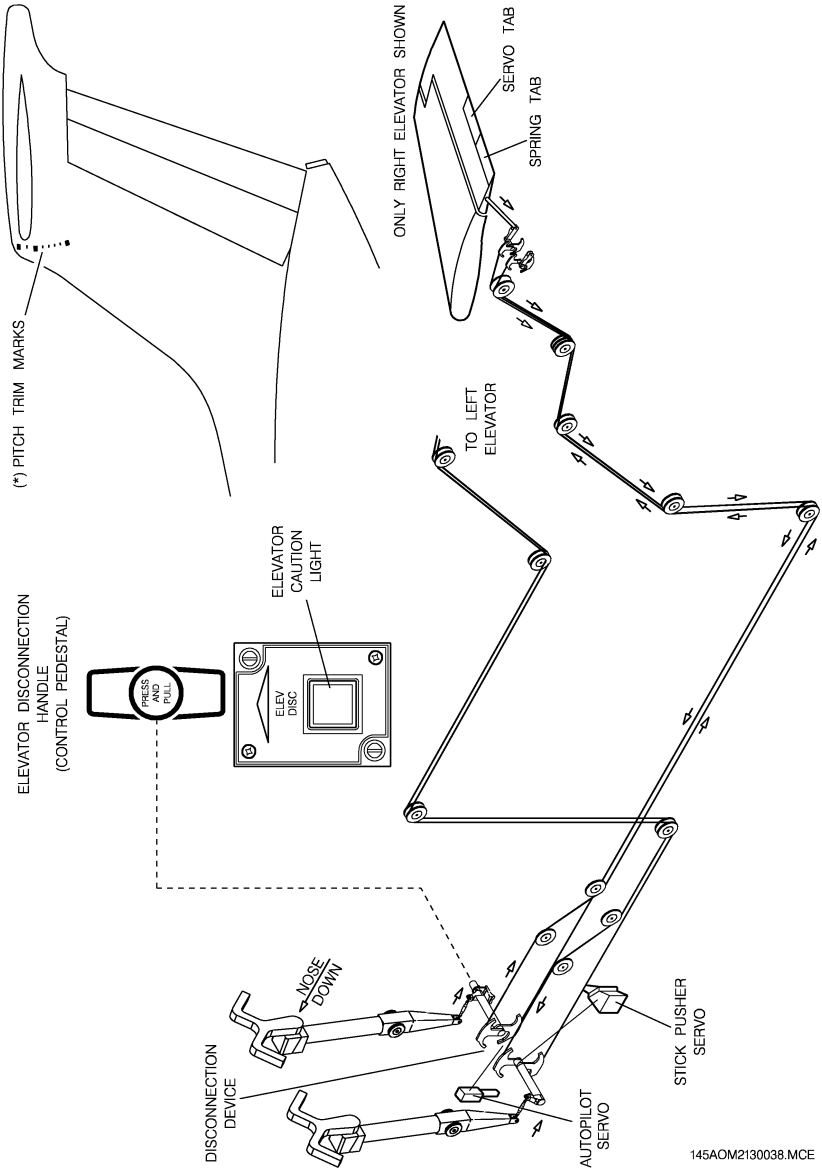
There are four tabs, two on each elevator panel, located near the elevator root. The outer tabs are servo tabs and the inner tabs are spring tabs.

SERVO TABS

The deflection of the servo tabs is proportional to the elevator deflection. Since the servo tabs proportionally deflects in the opposite direction to the elevators, it promotes a reduction in the forces required.

SPRING TABS

The spring tabs are connected in such a way that elevator deflection in one direction causes the spring tab to move in the opposite direction, thus reducing the amount of force required to move the elevator.
Spring tab deflection is proportional to the control column force and, therefore, to the aerodynamic load imposed on the elevator. At low speeds, the spring tab remains in the neutral position. At high speeds, where the aerodynamic load is greater, the tab functions as an aid in moving the elevator.



ELEVATOR SCHEMATIC

(*) The thick marks represent, respectively, 4° nose down (top of the scale), neutral, and 10° nose up (bottom of the scale) and each intermediate marks represent a 2° variation.

PITCH TRIM SYSTEM

GENERAL

Pitch trim is accomplished by an electrically-actuated movable horizontal stabilizer. The system may be either automatically or manually commanded. In both cases, the pitch trim signal is sent to the Horizontal Stabilizer Control Unit (HSCU) channels, which after processing it, command the electric motor in the Horizontal Stabilizer Actuator (HSA).

SYSTEM COMPONENTS

Horizontal Stabilizer Control Unit (HSCU)

The Horizontal Stabilizer Control Unit (HSCU) is located in the rear electronic compartment at the rear fuselage. It incorporates two identical control channels, main and backup. These channel operations are totally independent from each other. If the pitch trim main channel is inoperative, the horizontal stabilizer can still be commanded through the backup channel.

The HSCU controls the trimming rate (in degrees/second) based upon the airplane airspeed. The trimming rate reduces as the airspeed increases. The HSCU also checks the stabilizer surface position. When the Takeoff Configuration Check Button is pressed, if the surface is not within the takeoff green band limits, an aural warning message is sounded to the crew.

Horizontal Stabilizer Actuator (HSA)

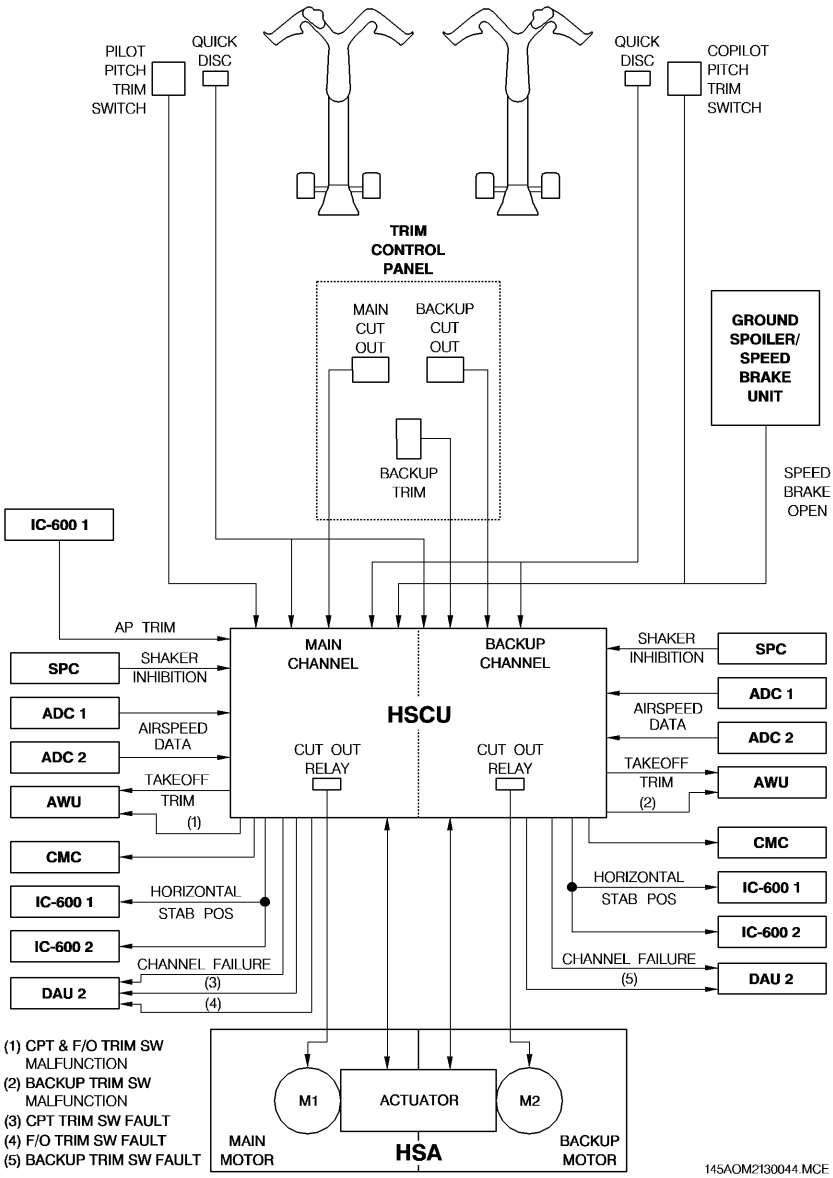
The Horizontal Stabilizer Actuator (HSA) consists of an electromechanical actuator driven by two DC motors. One of the motors is driven by the main control channel of the Horizontal Stabilizer Control Unit (HSCU) and the other motor is driven by the backup channel of the HSCU. Only one motor will be driven at a time.

SYSTEM OPERATION

Pitch trim commands may be done manually through the main switches on the control wheels or through backup switch on the control pedestal aft panel and automatically commanded through the autopilot or speed brake actuation.

When using the main control wheel trim switches or the backup trim switch, it is necessary to command both halves simultaneously because, if just one half is commanded, the control unit will not provide any command to the actuator.

In the case of activation of any stick shaker, the pitch trim up command will be inhibited.



PITCH TRIM SCHEMATIC

PITCH TRIM CHANNELS PRIORITY

Command priorities are: LH switch actuation overcomes the RH switch actuation, which, in turn, overcomes the autopilot. There is no priority with respect to the actuation of the main pitch trim switches and the backup pitch trim switches, the first being commanded taking priority. The main and backup pitch trim switches should not be commanded simultaneously. For the case of a simultaneous command of both channels, there is an specific logic inside the HSCU:

– For airplanes equipped with an HSCU P/N 362100-1009, -5009 or newer, the message PIT TRIM 1 (2) INOP will be displayed on the EICAS, associated to the second switch commanded. This message will disappear around 4 seconds after the second pitch trim switch is released.

– For airplanes equipped with an HSCU P/N 362100-1007, if the switches are commanded in different directions, the secondly commanded channel will become inoperative for the remainder of the flight and the respective message, PIT TRIM 1 (2) INOP, will be displayed on EICAS.

PITCH TRIM SYSTEM PROTECTION

Switch Protection

When only one half of the main control wheel trim switch or backup trim switch is commanded for more than 7 seconds continuously, the control unit will recognize that one half of the switch is failed stuck at the commanded position and will disregard any other command coming from that faulty switch.

NOTE: For airplanes equipped with HSCU -1009 or -5009 or newer and AWU -5 a TRIM voice message is provided to alert pilots that just one half of switch is being commanded and those equipped with HSCU -1009 or -5009 or newer and EICAS version 18 and on the messages PTRIM CPT SW FAIL, PTRIM F/O SW FAIL and PTRIM BKP SW FAIL will be displayed on the EICAS.

Runaway Protection

A quick-disconnect button on each control wheel allows disconnection from the entire pitch trim system. In case of a runaway horizontal stabilizer, the button must be kept pressed until a definite disengagement is accomplished through the cutout buttons on the control pedestal.

Inadvertent Actuation Protection

A continuous command of any trim switch is limited to 3 seconds, even if the trim switch is pressed longer than 3 seconds. As a result, when manually actuating the trim, it is necessary to release the switch after a 3-second actuation, then actuate it again to continue the trim command. This feature intends to minimize the effects of an inadvertent trim command of the main and backup trim switches or Ground Spoiler/Speed Brake Unit. The autopilot command is not limited in time and has another logic to preclude inadvertent actuation.

NOTE: For airplanes equipped with an HSCU -5009 MOD.2 or newer and AWU -5 a TRIM voice message is provided to alert pilots that the trim switch is being pressed for more than 3 seconds.

HSA Excessive Load Protection

The crew should keep the airplane trimmed to avoid excessive loads on the Horizontal Stabilizer Actuator (HSA), especially after takeoff. High loads on horizontal stabilizer may stall the HSA, inducing a temporary loss of pitch trim command.

For airplanes equipped with an HSCU P/N 362100-1007 if the trim switches are actuated for a period of time that totalizes 8 seconds during the period when the horizontal stabilizer actuator is stalled, the control unit will switch the associated system (main or backup) off and the message PIT TRIM 1 (2) INOP will be permanently displayed on the EICAS.

For airplanes equipped with an HSCU P/N 362100-1009, -5009 or newer, if the pitch trim switches are actuated during the period when the Horizontal Stabilizer Actuator is stalled, the message PIT TRIM 1 (2) INOP will be displayed on the EICAS. The message will disappear if the trim switch is released or any horizontal stabilizer motion is detected. If the trim switches are actuated for a period of time that totalizes 16 seconds during the period when the horizontal stabilizer actuator is stalled, the control unit will switch the associated system (main or backup) off and the message PIT TRIM 1 (2) INOP will be permanently displayed on the EICAS.

NOTE: For airplanes equipped with EICAS version 18 and on, the messages PIT TRIM 1 (2) INOP have been replaced with PTRIM MAIN INOP or PTRIM BACKUP INOP.

EICAS MESSAGES

TYPE	MESSAGE	MEANING
	PIT TRIM 1 (2) INOP	Pitch trim system 1 (main) or system 2 (backup) is inoperative, or Quick Disconnect button is kept pressed for more than 5 seconds (airplanes equipped with EICAS 17.5 only). This message will disappear after the button is released, or Pitch trim system 1 (main) or system 2 (backup) being actuated with the HSA stalled.
WARNING	PTRIM MAIN INOP (*)	Pitch trim main system is inoperative, or Quick Disconnect button is kept pressed for more than 11 seconds. This message will disappear after the button is released, or Main trim switch(es) actuation associated with the horizontal stabilizer being commanded by the backup switch, or Main trim switch being actuated with the HSA stalled.

EICAS MESSAGES (Continued)

TYPE	MESSAGE	MEANING
WARNING	PTRIM BACKUP INOP (*)	Pitch trim backup system is inoperative, or Quick Disconnect button is kept pressed for more than 11 seconds. This message will disappear after the button is released, or Backup trim switch actuation associated with horizontal stabilizer being commanded by the main channel, or Backup trim switch being actuated with the HSA stalled.
CAUTION	PTRIM CPT SW FAIL (*)	Pilot´s pitch trim switch is inoperative.
	PTRIM F/O SW FAIL (*)	Copilot´s pitch trim switch is inoperative.
	PTRIM BKP SW FAIL (*)	Pitch trim backup switch is inoperative.

(*) Applicable to airplanes equipped with EICAS version 18 and on.

CONTROLS AND INDICATORS

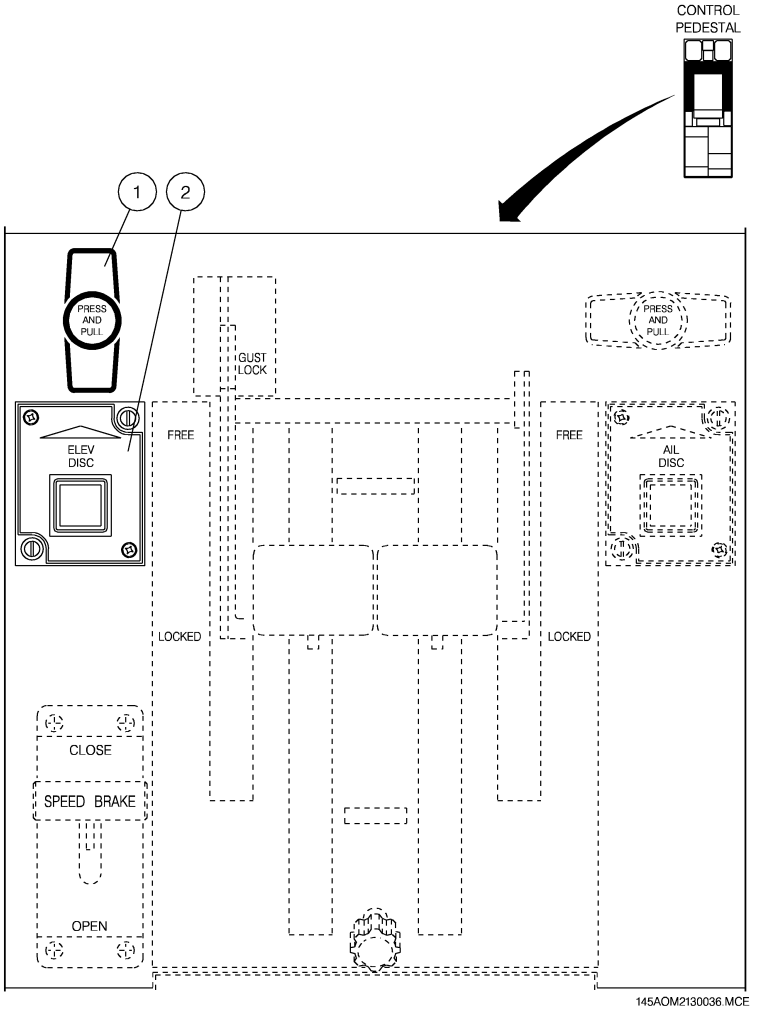
CONTROL STAND

1 - ELEVATOR DISCONNECTION HANDLE

- When pulled, disconnects pilot's from copilot's controls.
- To pull the handle, the safety lock button must be pressed.

2 - ELEVATOR DISCONNECTION LIGHT

- Illuminates to indicate that the elevator mechanism is disconnected.



CONTROL STAND

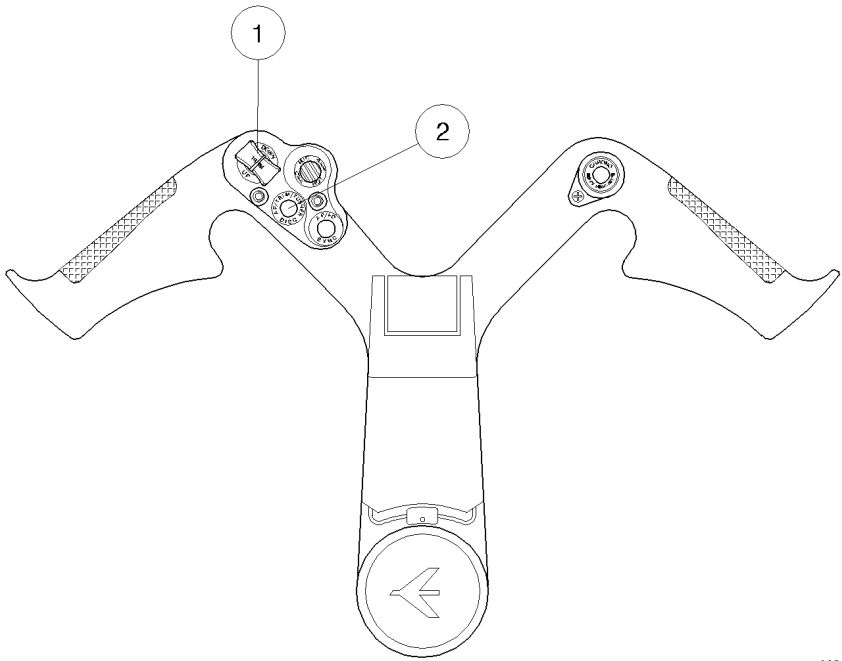
CONTROL WHEEL

1 - PITCH TRIM SWITCH (spring-loaded to neutral)

- Allows trimming the airplane when the autopilot is not engaged. The trim switch is a 3-position (UP/OFF/DN) rocker switch.
- Operating the switch while the autopilot is engaged causes the autopilot to disengage.
- It is divided into two segments, which have to be actuated together to provide command.

2 - QUICK-DISCONNECT BUTTON (momentary action)

- When pressed, disconnects all trim systems.



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CONTROL PEDESTAL AFT PANEL

1 - PITCH TRIM MAIN SYSTEM CUTOUT BUTTON (safety guarded)

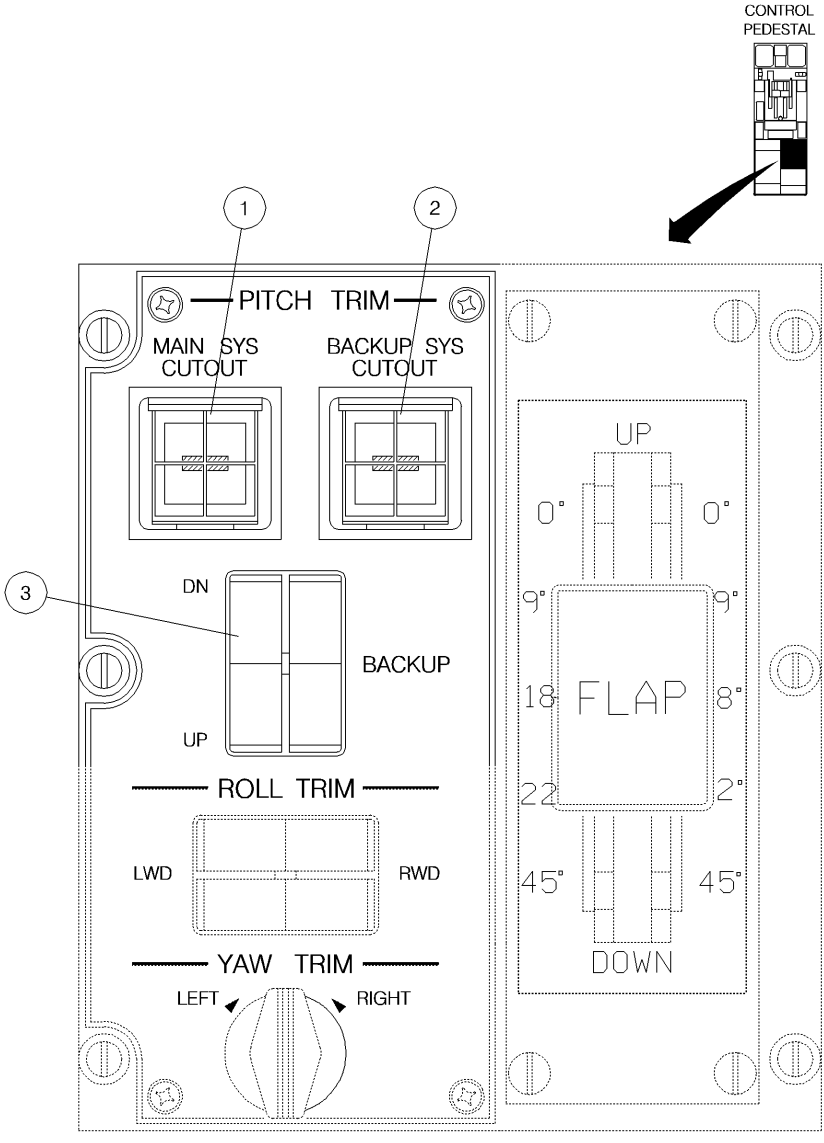
- Cuts out (pressed) or enables (released) the Main Pitch Trim system.
- A striped bar illuminates inside the button to indicate that it is pressed.
- Autopilot is not available.

2 - PITCH TRIM BACKUP SYSTEM CUTOUT BUTTON (safety guarded)

- Cuts out (pressed) or enables (released) the Backup Pitch Trim system.
- A striped bar illuminates inside the button to indicate that it is pressed.
- Autopilot is available.

3 - PITCH TRIM BACKUP SWITCH (spring-loaded to neutral)

- Pressed forward or backward actuates the pitch trim through the backup channel.
- Operation of the switch while the autopilot is engaged causes the autopilot to disengage.
- It is divided into two segments, which have to be actuated together to provide command.



CONTROL PEDESTAL AFT PANEL

EICAS INDICATION

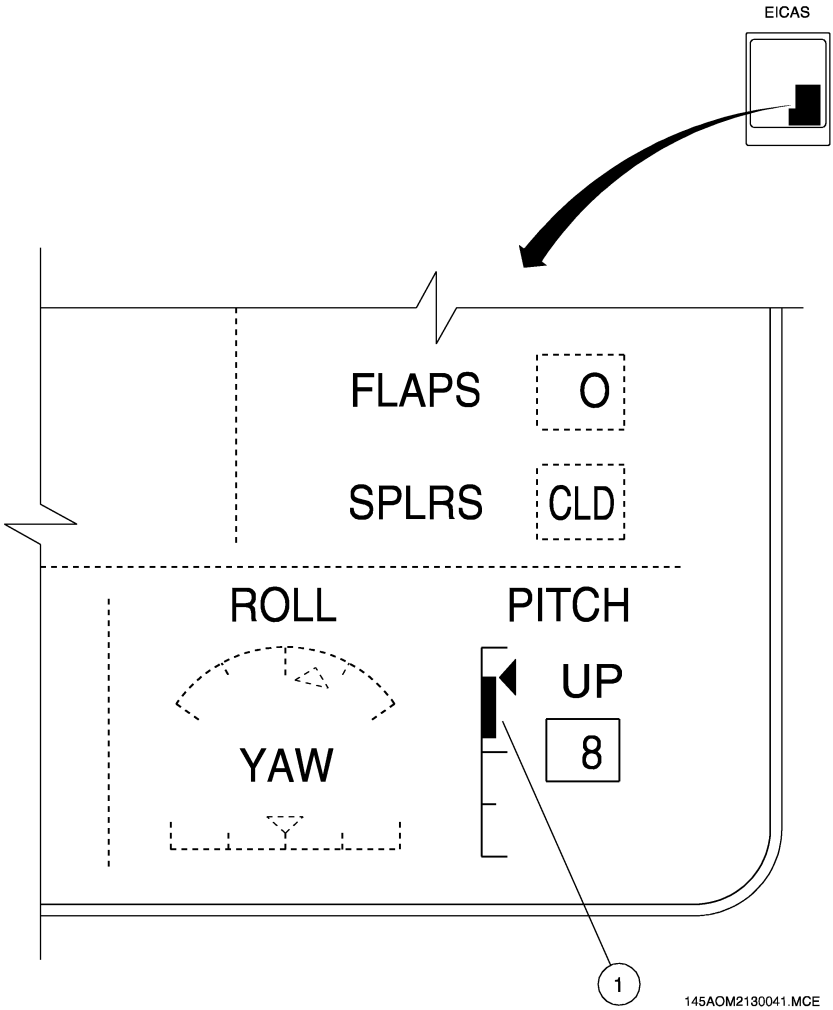
1 - PITCH TRIM INDICATION

- A green pointer moving on a white vertical scale represents the amount of pitch compensation.
- Trim position is indicated digitally in a white box.
- The letters UP or DN are presented above the box to indicate that the airplane is trimmed up or down.
- Scale ranges from 4° nose down (bottom of scale) to 10° nose up (top of scale). Every thick mark on the scale represents 3.5° of pitch.
- A green band is provided on the analog scale from 4° to 8° nose up to indicate the allowable takeoff position range for the horizontal stabilizer.

NOTE: Due to the system's resolution, it's possible to have the digits, box and pointer turning amber, in spite of the fact that the pitch trim indication is displayed at 4º or 8º. The trim setting color displayed on the EICAS depends on the horizontal stabilizer surface position. For the unit 8 displayed on the EICAS the surface position can be between 7.7° and 8.7° going upward and between 8.3° and 7.3° going downward. The color change would occur when the surface position is 8.1°. For this reason, when setting pitch trim to 8, first select 7. Then, increase slowly and stop trimming immediately when the value 8 is displayed. For the unit 4 displayed on the EICAS, the surface position can be between 3.7° and 4.7° going upward and between 4.3° and 3.3° going downward. The color change would occur when the surface position is 3.9°. For this reason, when setting pitch trim to 4, first select 5. Then, decrease slowly and stop trimming immediately when the value 4 is displayed. This procedure prevents to set the trim at the top or bottom of the green band in order to avoid the possibility of encountering takeoff config warnings.

- In the event of a pitch trim miscomparison, the pointer, digital value, and the direction indication are removed from display.
- If the pitch trim is out of the green band and the airplane is on the ground, the pointer and digital indications will turn amber.

– If the airplane is on the ground, any thrust lever angle is above 60° and pitch trim is outside the green band, the digits, box, and pointer turn red, the aural warning TAKEOFF TRIM sounds and the EICAS warning message NO TAKEOFF CONFIG is displayed.



EICAS INDICATIONS

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ROLL CONTROL

Roll control is provided by hydraulically-actuated ailerons controlled by either control wheel.

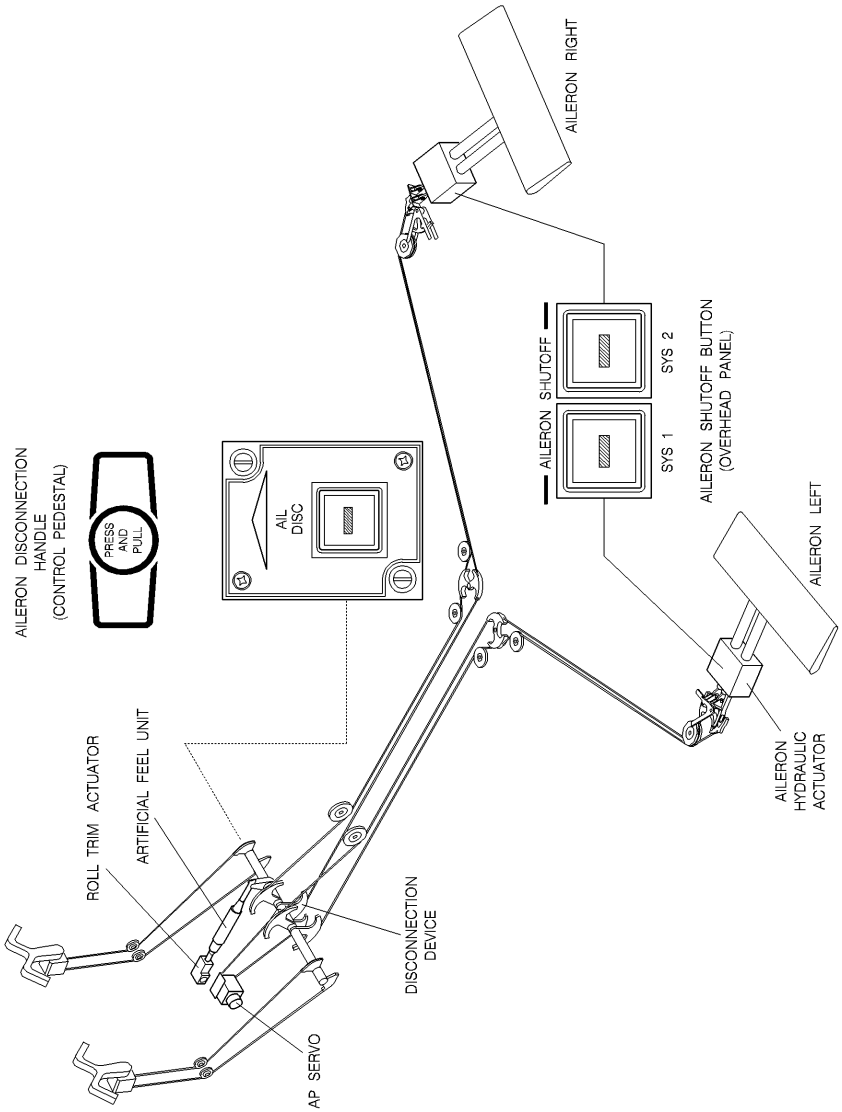
AILERON CONTROL SYSTEM

The ailerons are positioned by the pilot´s control wheels, which are linked together by a torque tube and cables to supply mechanical input to two separate hydraulic actuators.

Each aileron actuator is supplied by both hydraulic systems. Either hydraulic system is capable of providing full power control. If necessary, each hydraulic system supply can be shut off, by means of a button installed on the overhead panel. In case of loss of both hydraulic systems, rotation of the pilot´s control wheels mechanically positions the ailerons.

In case of jamming of either aileron, both panels may be disconnected through a handle located on the control pedestal. This procedure will release the free aileron from its jammed counterpart allowing the free panel to be commanded. When disconnected, an amber light illuminates on the control stand. Controls cannot be reconnected during flight, requiring maintenance action.

An autopilot servo is installed on the left side of the torque tube. The roll trim servo and the artificial feel unit are installed on the right side of the torque tube. In case of system disconnection, the artificial feel unit will actuate on the right aileron only and the autopilot must not be used. The artificial feel unit is provided to give pilots a aerodynamic load feedback imposed on the aileron surface.



AILERON SCHEMATIC

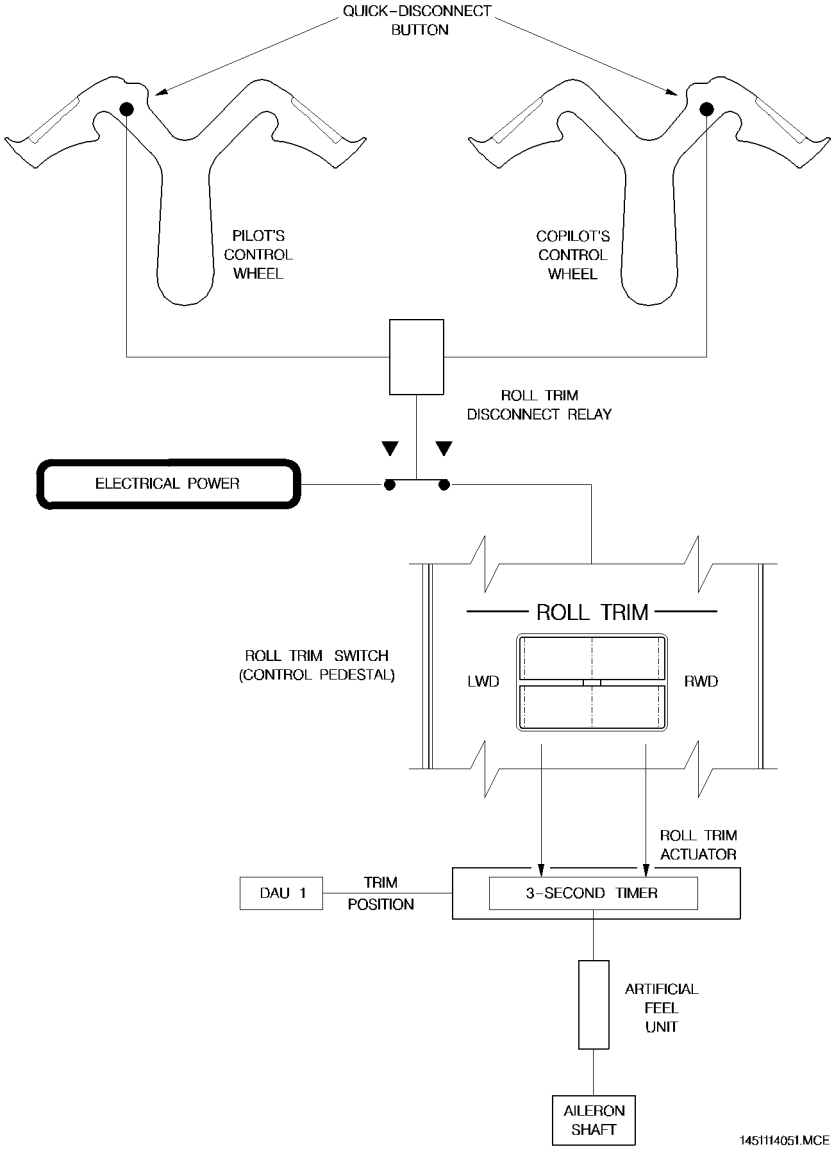
ROLL TRIM SYSTEM

Roll trim is performed by relocating the aileron's neutral position. It is provided through an electromechanical actuator linked to the artificial feel unit and commanded through a switch on the control pedestal aft panel. If the aileron trim switches are activated with the autopilot engaged, the aileron neutral point is repositioned. When the autopilot is disengaged, the ailerons move to the repositioned aileron neutral point.

A continuous command of the roll trim switch is limited to 3 seconds, even if the trim switch is pressed longer than 3 seconds. As a result, when manually actuating the trim, it is necessary to release the switch after a 3-second actuation, then actuate it again to continue the trim command. This feature intends to minimize the effects of an inadvertent trim command failure.

When using the roll trim switch, it is necessary to command both segments simultaneously since, if just one segment is commanded, the control unit will not provide any command for the actuator.

A quick-disconnect button installed on the control wheels allows, while kept pressed, to disconnect the roll trim.



ROLL TRIM SCHEMATIC

EICAS MESSAGES

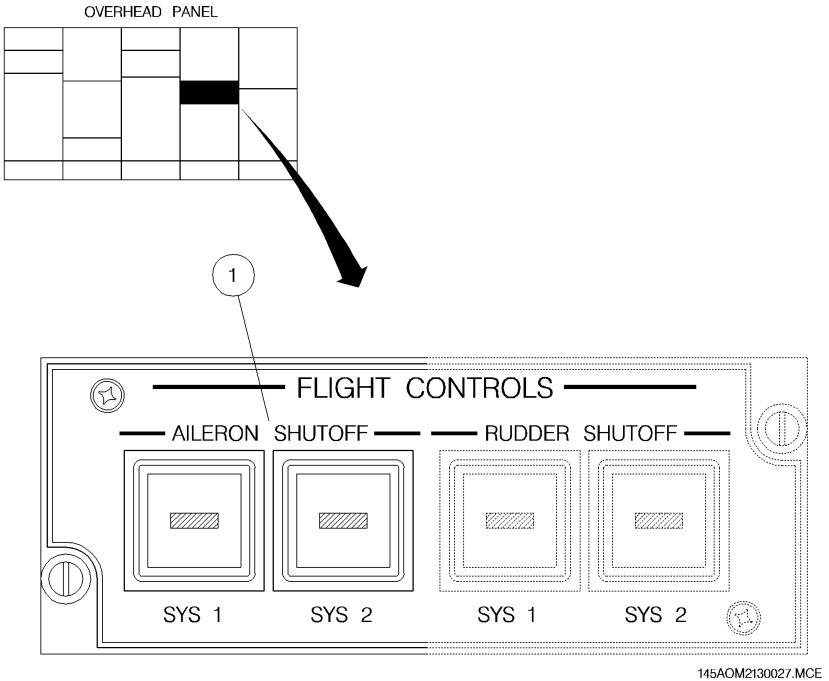
TYPE	MESSAGE	MEANING
CAUTION	AIL SYS 1 (2) INOP	Aileron actuation through hydraulic power is inoperative.

CONTROLS AND INDICATORS

FLIGHT CONTROLS PANEL

1 - AILERON SHUTOFF BUTTON

- Enables (pressed) or disables (released) the supply of hydraulic power from the associated system to the aileron units.
- A striped bar illuminates in the button to indicate that it is released.



FLIGHT CONTROLS PANEL

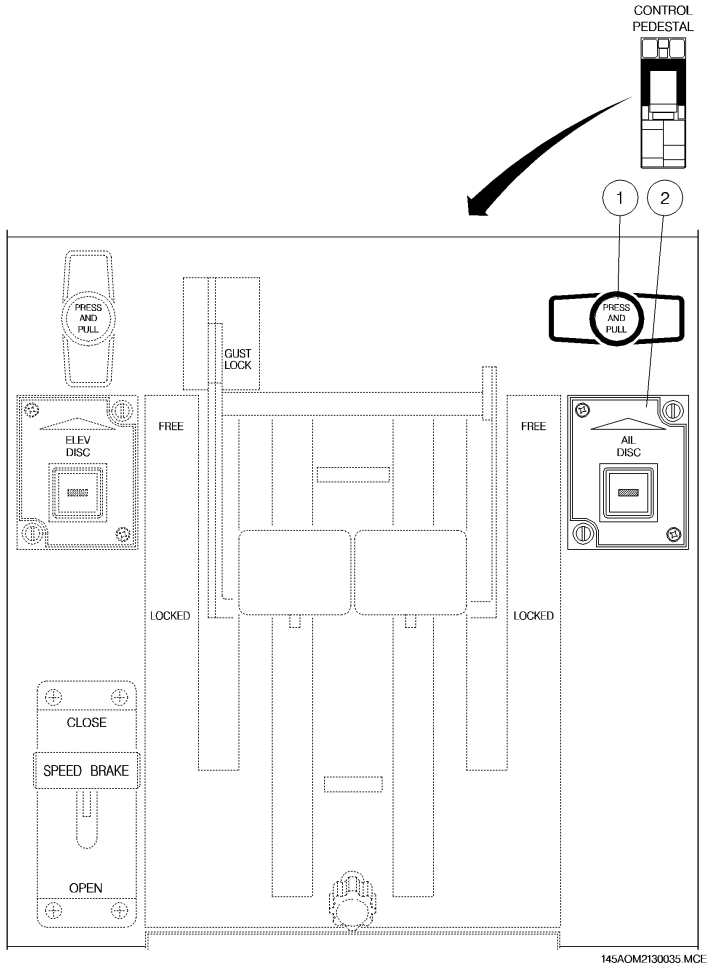
CONTROL STAND

1 - AILERON DISCONNECTION HANDLE

- When pulled, disconnects pilot's from copilot's controls.
- To pull the handle, the safety lock button must be pressed.

2 - AILERON DISCONNECTION LIGHT

- When the striped bar is illuminated, indicates that the aileron disconnection mechanism is actuated.

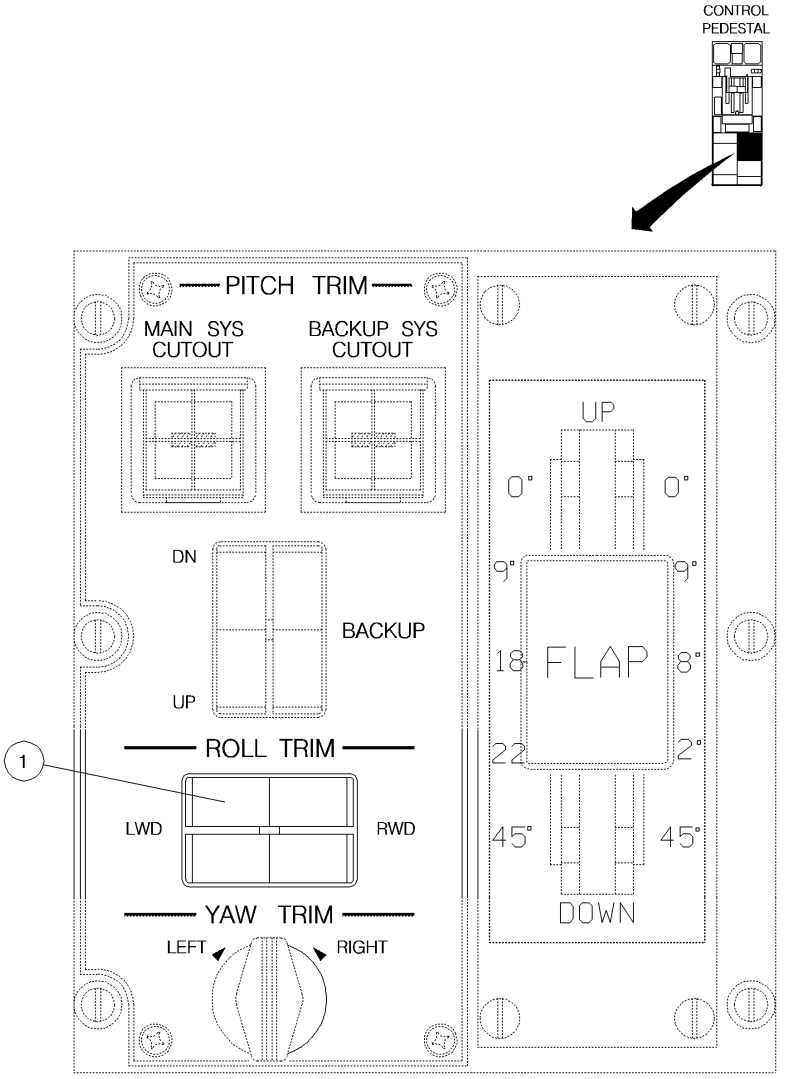


CONTROL STAND

CONTROL PEDESTAL AFT PANEL

1 - ROLL TRIM SWITCH (spring-loaded to neutral)

– Pressed left or right actuates the roll trim to roll left or right.

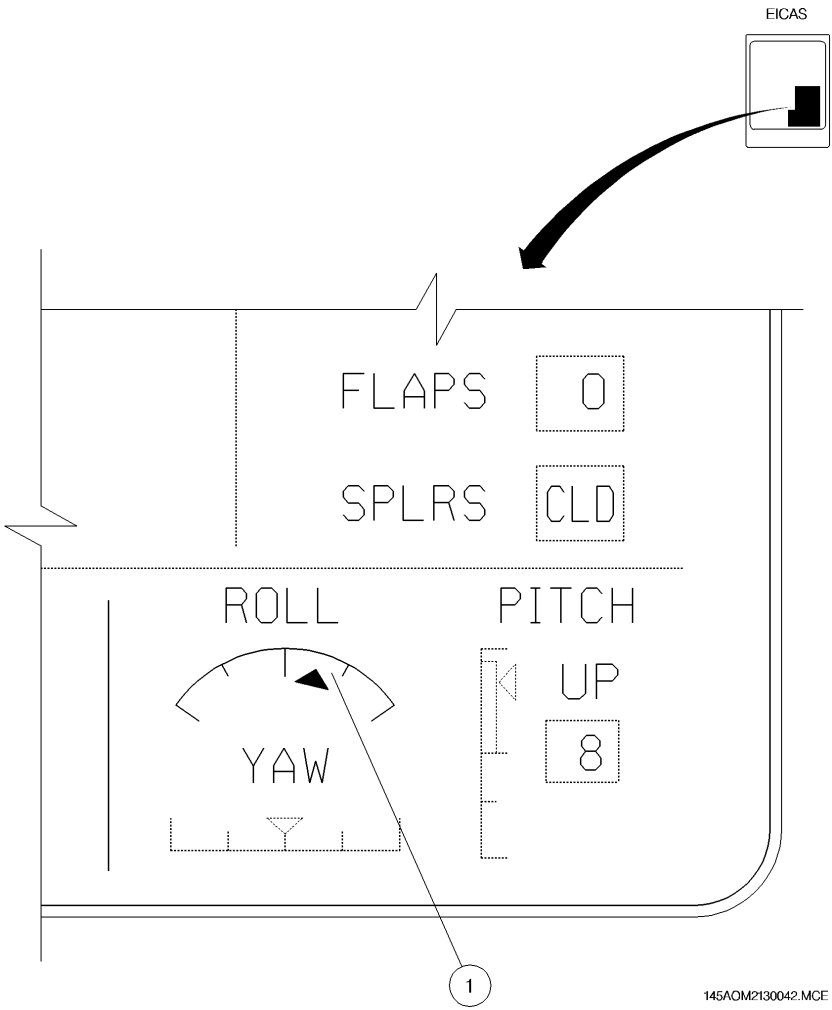


CONTROL PEDESTAL AFT PANEL

EICAS INDICATIONS

1- ROLL TRIM POSITION

- Indicated by a green pointer moving on a white semicircle scale.
- Center of the scale is zero trimming.
- Each mark represents 50% of trimming range for the associated side.



EICAS INDICATIONS

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YAW CONTROL

Yaw control is provided through hydraulically-powered rudders, which may also be mechanically commanded. A yaw trim system assists in moving and holding the rudder in the desired position.

RUDDER CONTROL SYSTEM

Directional control about the yaw axis is provided by two in-tandem rudders. Forward rudder is driven by the control system, while the aft rudder is linked to the forward rudder and deflected as a function of forward rudder deflection. Either set of rudder pedals will position the rudder through a Power Control Unit (PCU). The mechanical control is fully duplicated, consisting of cables running from the pedals in the cockpit to the rear fuselage, where the PCU is commanded to position the forward rudder. The rudder can also be commanded through the autopilot.

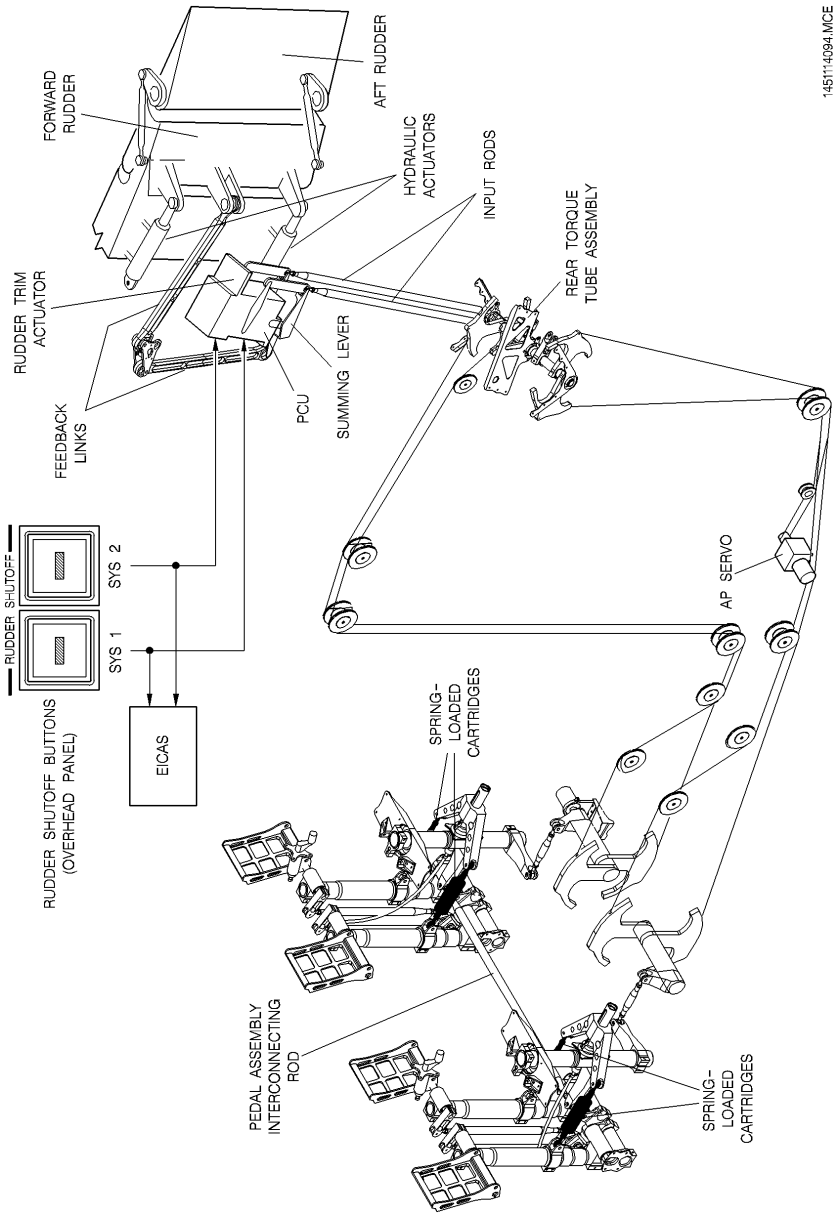
The rudder PCU is a dual hydraulic unit, simultaneously powered by both hydraulic systems. Each PCU hydraulic circuit controls the hydraulic power to one respective rudder actuator. Therefore, the rudder system is divided into Rudder System 1 and Rudder System 2. The PCU also incorporates an artificial feel device that provides the pedals with an artificial feel of the aerodynamic load imposed on the rudder.

Rudder System 1 and/or Rudder System 2 may be either manually or automatically shut off. The manual shut off operation is provided through the Rudder Shutoff Buttons, located on the Overhead Panel. The automatic shut off operation is provided through the speed switch and through the hardover protection function.

When operating under mechanical mode the aerodynamic loads on the rudder are directly transmitted to the pedals and, therefore, to the pilots. Since no rudder hydraulics control is available, artificial feel and trim functions will also not be available. Some characteristics can be observed:

– greater control forces
– sluggish response of rudder to pedals inputs
– backlash of rudder pedals around neutral position when changing the force application from one to the other pedal.

If either or both rudder systems are inoperative, caution messages are presented on the EICAS.



RUDDER SCHEMATIC

AUTOMATIC SHUTOFF THROUGH THE SPEED SWITCH

During normal operation both systems are powered at speeds below 135 KIAS. Above 135 KIAS, Rudder System 1 is automatically shut off.

If the automatic shut off fails to shut off a system above 135 KIAS, a caution message is presented on the EICAS. In this case, it is necessary to manually shut off system 1 or 2, according to the checklist.

If Rudder System 2 hydraulic power supply fails, Rudder System 1 automatically takes over the rudder and an associated caution message is presented on the EICAS.

RUDDER HARDOVER PROTECTION

The rudder hardover protection function automatically selects the mechanical reversion mode as a function of pedal input force, rudder deflection, and airplane engine operation (two or single-engine operation). This feature is applicable in the case of a runaway rudder and a caution message is presented on the EICAS.
The rudder systems are automatically shut off if all conditions below are met simultaneously:

- Rudder deflected above 5°±1°.
- Force above 59 kg (130 lb) on the pedal to counteract rudder deflection.
- Both engines running above 56% N2.

CAUTION: DO NOT RESET THE RUDDER SYSTEMS IF THE MECHANICAL REVERSION MODE WAS RESULTANT OF HARDOVER PROTECTION ACTIVATION.

If mechanical reversion mode was not resultant of hardover protection, a reset function is available on the Overhead Panel, by pressing both Rudder Shutoff Buttons off and on again.

The following remarks are applicable to the rudder hardover protection:

- The signal from the Pedal Spring-Loaded Cartridges to shut off the rudder systems are applicable only if the pilots are applying force to one side with the rudder deflected above 5° ± 1° to the opposite side. If pilot command input and the rudder deflection are in the same direction, the system will not be shut off, regardless of how strong the pilot input.

- During single-engine operation, when the rudder system is more significantly required, the rudder hardover protection is disabled and the RUD HDOV PROTFAIL caution message may be presented on the EICAS.
- If a disagreement between FADECs from the same engine occurs, rudder hardover protection is deactivated and the RUD HDOV PROTFAIL caution message is presented on the EICAS.

RUDDER DEFLECTION

AIRPLANES UNDER CTA AND FAA CERTIFICATION

The rudder's main control primary stops, limit rudder deflection at ± 15° on ground or in flight.

AIRPLANES UNDER JAA CERTIFICATION

There are two rudder deflection versions:

- Airplanes with rudder main control primary stops, located on the rear torque tube assembly, that limit the ruder deflection at ± 10° on ground or in flight and;
- Airplanes Post-Mod. S.B. 145-27-0015 or equipped with an equivalent modification factory incorporated, equipped with movable rudder primary stops, which provide two different ranges of rudder deflection:
  - On ground: maximum rudder deflection is ± 15°.
  - In flight: maximum rudder deflection is ± 10°.

  The Movable Rudder Primary Stop System comprises a hydraulic actuation system, which operates according to the air/ground logic and will limit rudder deflection to 10° in the extended position and to 15° in the retracted position.

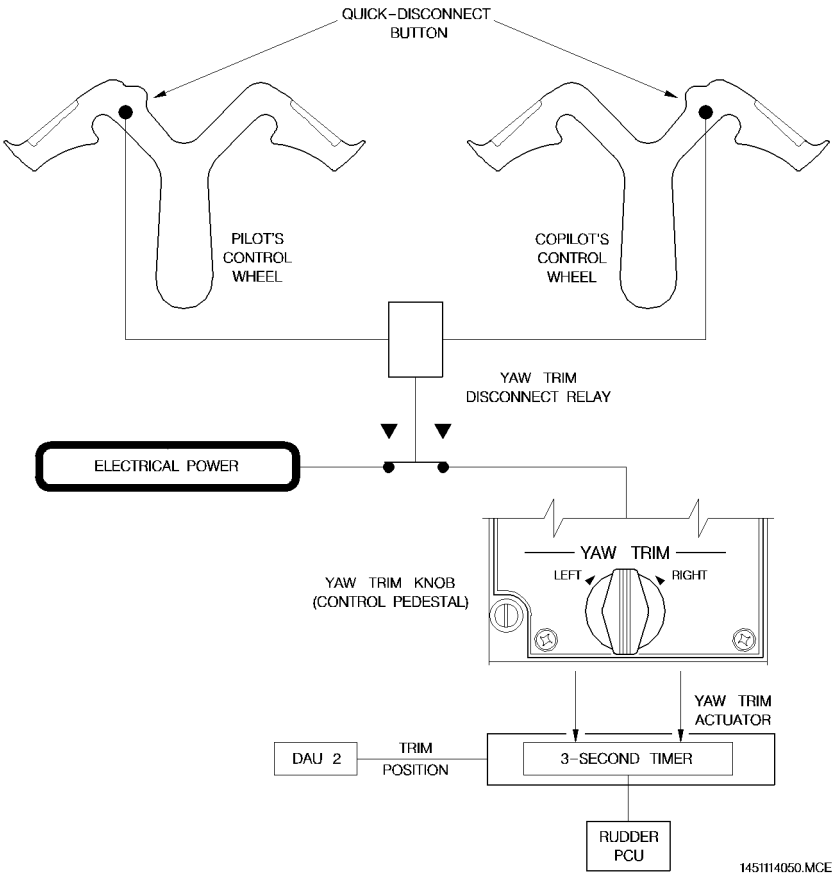
  An amber indication light is provided on the main panel to alert the crew in case of a disagreement between the actuator position and the air/ground condition.

YAW TRIM SYSTEM

Yaw trim is accomplished by an electromechanical actuator, which receives signals from the yaw trim knob.

A continuous command of the yaw trim knob is limited to 3 seconds, even if the trim knob is actuated longer than 3 seconds. As a result, when manually actuating the trim, it is necessary to release the knob after a 3-second actuation, then actuate it again to continue the trim command. This feature intends to minimize the effects of an inadvertent trim command failure.

Yaw trim position is presented on EICAS display.
A quick-disconnect button installed on the control wheels allows, while kept pressed, disconnecting the yaw trim.



YAW TRIM SCHEMATIC

EICAS MESSAGES

TYPE	MESSAGE	MEANING
CAUTION	RUDDER SYS 1 INOP	Rudder System 1 is inoperative. Message is presented under the following conditions: –Below 135 KIAS. –Above 135 KIAS if airspeed of both ADC's is invalid.
	RUDDER SYS 2 INOP	Rudder System 2 is inoperative.
	RUDDER SYS 1–2 INOP	Both Rudder Systems are inoperative.
	RUDDER OVERBOOST	Both rudder systems hydraulic actuators are pressurized above 135 KIAS.
	RUD HDOV PROTFAIL	–Disagreement between both FADECs of a same engine. –Rudder position microswitches indicate rudder to right and left simultaneously.
	RUD STOP DISAGREE (*)	The rudder's movable stop presents disagreement: 15° in flight or 10° on ground.

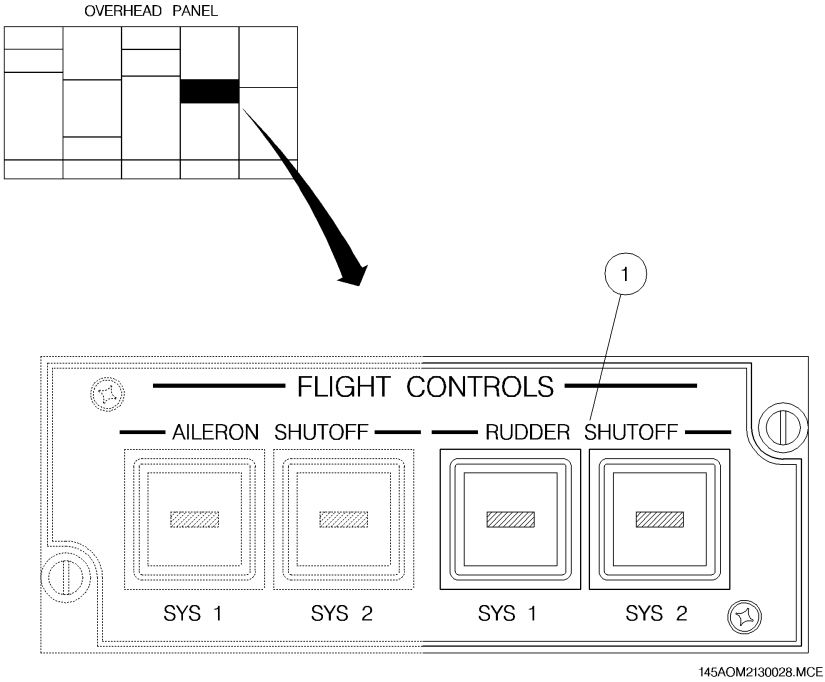
(*) Applicable to airplanes operating under JAA certification and not equipped with rudder movable stops indication light.

CONTROLS AND INDICATORS

FLIGHT CONTROLS PANEL

1 - RUDDER SHUTOFF BUTTON

- Enables (pressed) or disables (released) the associated rudder hydraulic actuator.
- A striped bar illuminates in the button to indicate that it is released.

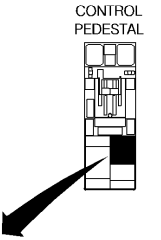


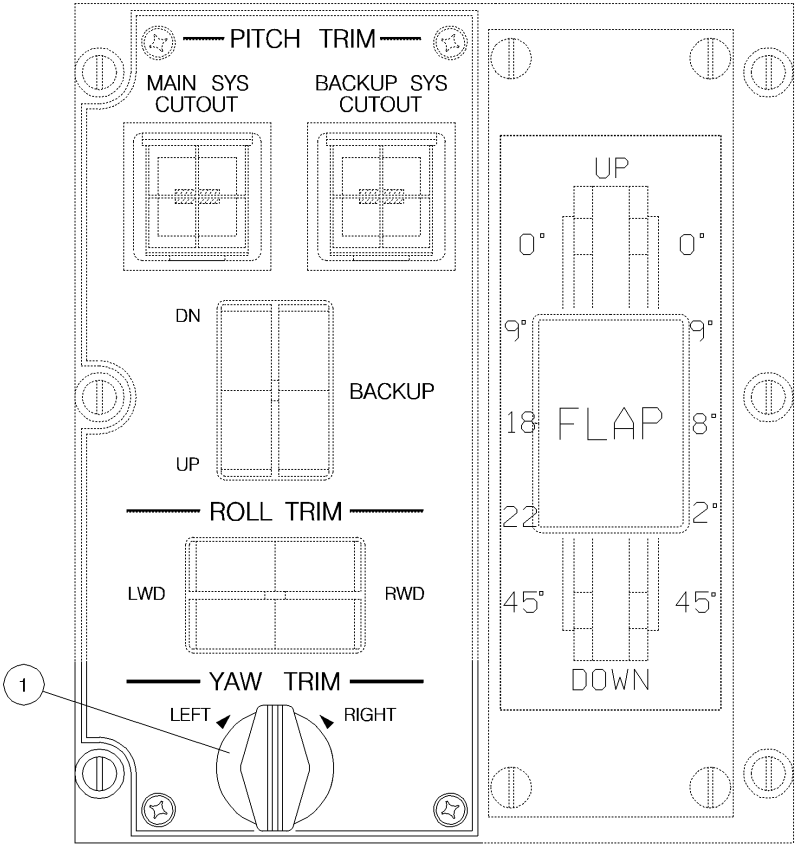
FLIGHT CONTROLS PANEL

CONTROL PEDESTAL AFT PANEL

1 - YAW TRIM KNOB (spring-loaded to neutral)

– Rotated clockwise or counterclockwise actuates the yaw trim, right or left .





145AOM230030.MCE

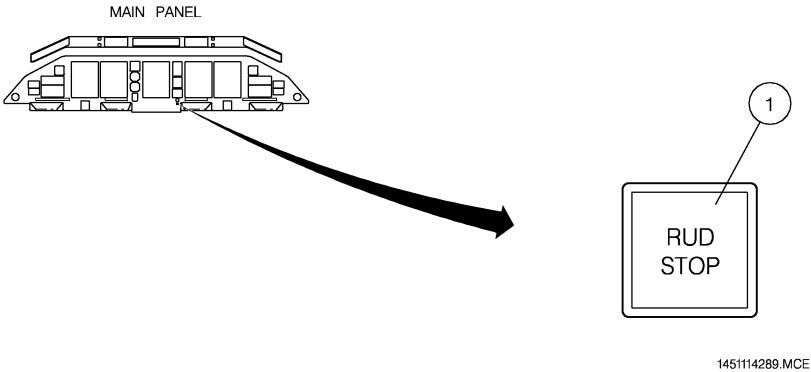
CONTROL PEDESTAL AFT PANEL

MAIN PANEL

1 - MOVABLE RUDDER STOPS INDICATION LIGHT (APPLICABBLE TO AIRPLANES OPERATING UNDER JAA CERTIFICATION)

- Color: amber
- Illuminates to indicate an incorrect position of at least one hydraulic actuator of the movable rudder stops system, as follows:
  - Airplane in flight with movable rudder stops at 15° position.
  - Airplane on ground with movable rudder stops at 10°position.
- A time delay of 5 seconds is provided to prevent fault indication during transient.

NOTE: For some airplanes, the indication light will be replaced by the EICAS message RUD STOP DISAGREE.

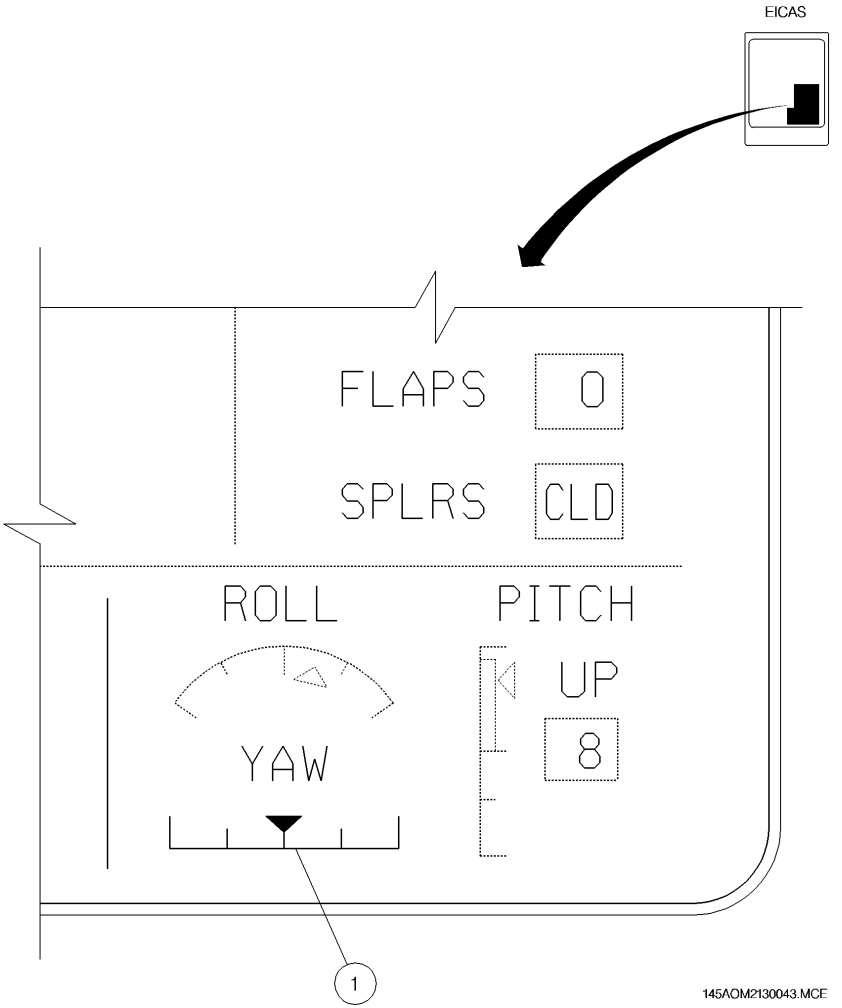


MAIN PANEL

EICAS INDICATIONS

1- YAW TRIM POSITION

- Indicated by a green pointer moving on a horizontal scale.
- Center of the scale is zero trimming.
- Each mark represents 50% of trimming range for the associated side.



EICAS INDICATIONS

GUST LOCK SYSTEM

A gust lock system is provided to lock the elevator to avoid damage to elevator components in the case the aircraft is subject to strong gusts on the ground. The aileron and rudder surfaces do not need to be mechanically locked since their actuation systems naturally damp any undesired movement.

There are two different gust lock systems:

- Mechanical Gust Lock System
- Electromechanical Gust Lock System

MECHANICAL GUST LOCK SYSTEM

The gust lock system is mechanically-actuated and can be identified by a yellow lever on the control pedestal with the inscription GUST LOCK. The mechanical gust lock actuates on the torque tube which is attached to the control column.

To lock the elevator, the control column must be pushed and held fully forward and the gust lock lever moved backwards from the FREE to LOCKED position. Aside locking the elevators, it also restricts both thrust levers to a minimum thrust above IDLE position.
To unlock the system, push the control column forward while the safety lock device is lifted and the lever is moved forward from the LOCKED to FREE position.

ELECTROMECHANICAL GUST LOCK SYSTEM

The electromechanical gust lock can be identified by a yellow and black striped safety lock device on the control pedestal with the inscription ELEC GUST LOCK, and by two indication lights on the glareshield panel.

The electromechanical gust lock acts directly on the elevator panels, preventing them from moving. Basically, the system is composed of locking pins driven by an electromechanical actuator, which is commanded by the gust lock lever. Gust lock system operation (locking and unlocking) is possible on the ground only. Once airborne, the system is deenergized to prevent gust lock lever movement and inadvertent actuation.

The gust lock indication lights located on the glareshield panel illuminate to indicate the unlocking cycle or when a failure in the system occurs or when it is pressed for test. For airplanes Post-Mod. SB 145-27-0101 or equipped with an equivalent modification factory incorporated, when the TLA is higher than 59° and the gust lock system is still locked, the lights will illuminate indicating that an unlocking cycle has initiated.

When the gust lock lever is at locked position, the thrust levers are prevented from moving beyond the thrust setting needed for ground maneuvering. However, the gust lock lever was designed to allow extra travel for one of the thrust levers. Airplanes Post-Mod. SB 145-27-0115 or equipped with an equivalent modification factory incorporated are provided with a movable cylinder installed on the lever that allows the pilot to choose the thrust lever to have extra travel to be used during taxi.

The system is fed by DC Bus 2 and has a dedicated circuit breaker, located on the overhead circuit breaker panel.

LOCKING OPERATION

To lock the elevator proceed as follows:

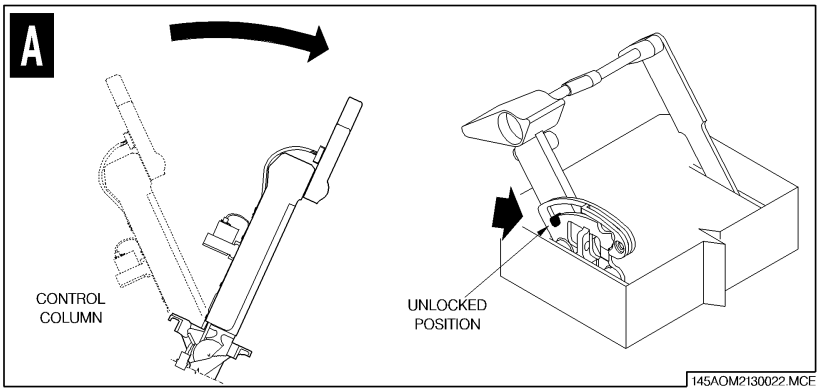
A. Pull the control column backwards to any position from neutral to full nose up.

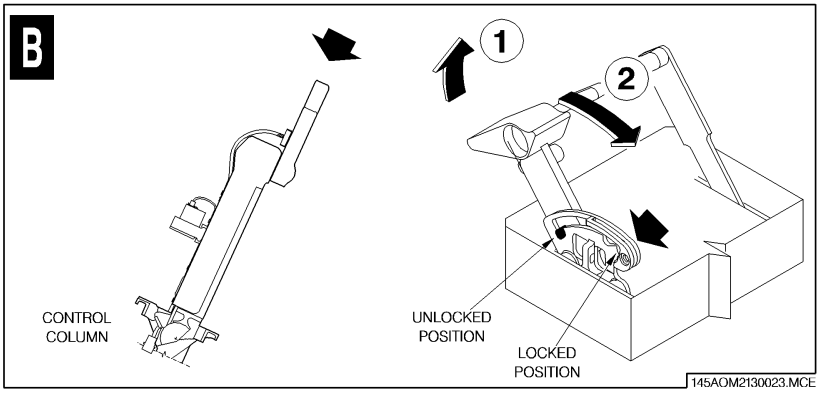
B. Lift the safety lock device (1) and move the gust lock lever from the unlocked (FREE) to the locked position (2).

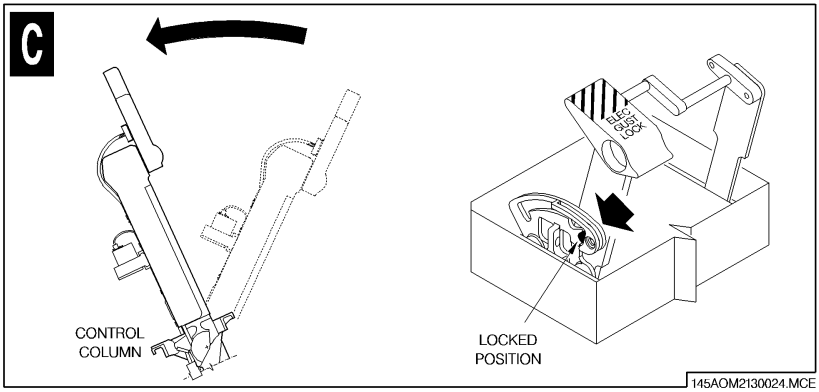
C. Push the control column fully forward until the control column movement is restricted. Locking is completed.

NOTE: During the locking operation, indication lights remain off.

TO LOCK:


A
CONTROL COLUMN
UNLOCKED POSITION
145AOM2130022.MCE


B
1
2
CONTROL COLUMN
UNLOCKED POSITION
LOCKED POSITION
145AOM2130023.MCE


C
CONTROL COLUMN
LOCKED POSITION
145AOM2130024.MCE

UNLOCKING OPERATION

To unlock the elevator proceed as follows:

A. Lift the safety lock device (1) and move the gust lock lever to its intermediate detented position (2).

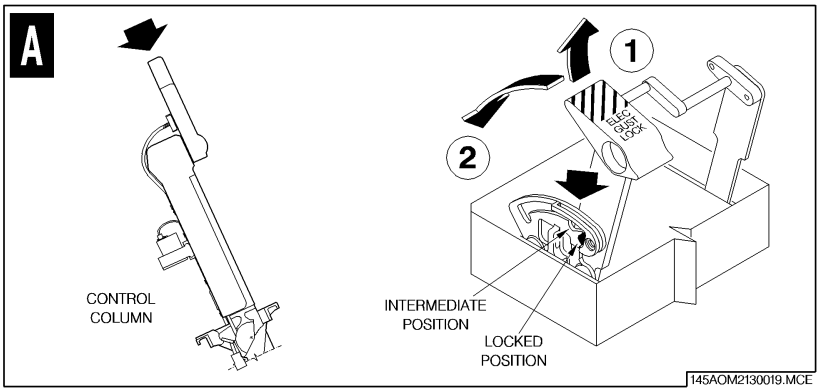
B. At this position, the locking pins are commanded to open and the elevators will be unlocked after approximately 8 seconds. The indication lights will illuminate during the unlocking cycle, remaining off after that.

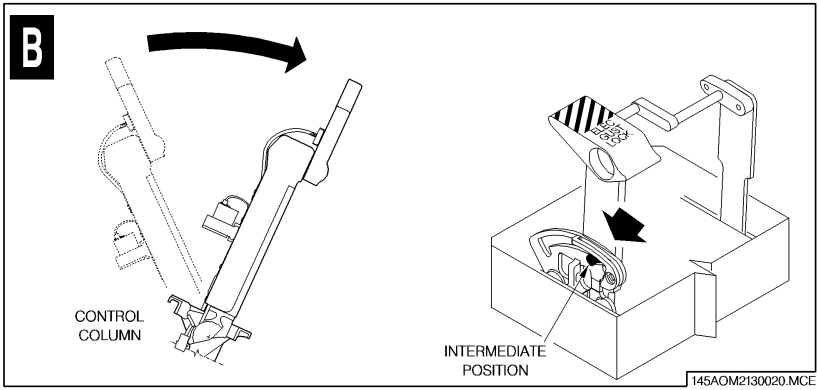
   After the indication lights go off, pull the control column backwards to any position from neutral to full nose up.

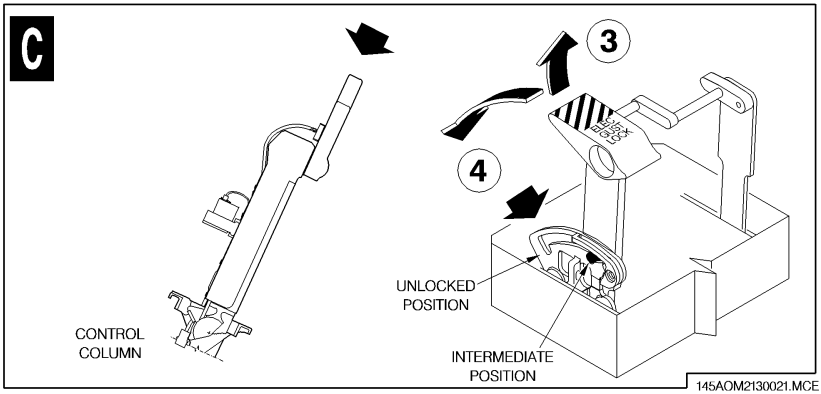
C. Lift the safety lock device (3) and pull the gust lock lever from the intermediate position to its full forward inflight resting position (4), completing the unlocking cycle.

NOTE: Gust lock lever command from the intermediate to the unlocked (FREE) position is not possible prior to pulling column rearward.

TO UNLOCK:


A
CONTROL
COLUMN
1
2
INTERMEDIATE
POSITION
LOCKED
POSITION
145AOM2130019.MCE


B
CONTROL
COLUMN
INTERMEDIATE
POSITION
145AOM2130020.MCE

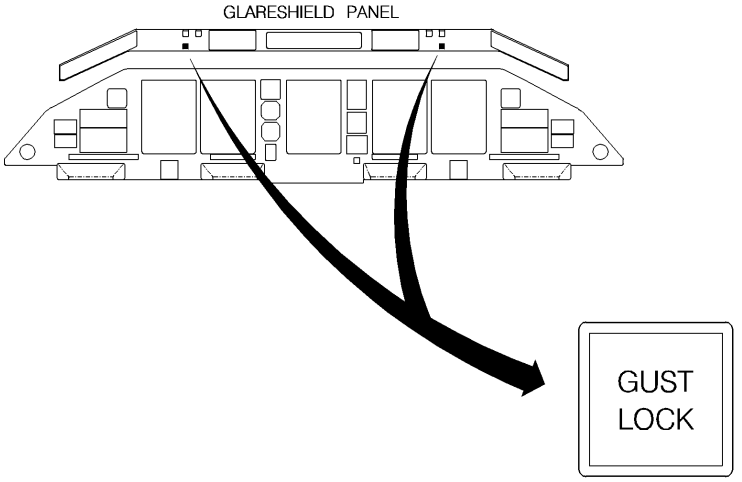

C
CONTROL
COLUMN
3
4
UNLOCKED
POSITION
INTERMEDIATE
POSITION
145AOM2130021.MCE

CONTROLS AND INDICATORS

GLARESHIELD PANEL

GUST LOCK INDICATION LIGHTS (*)

- Color: amber
- Illuminates during the unlocking cycle to indicate that the locking pins were commanded to unlock the elevator surfaces.
- Illuminates in case of failure.
- Illuminates when it is pressed.



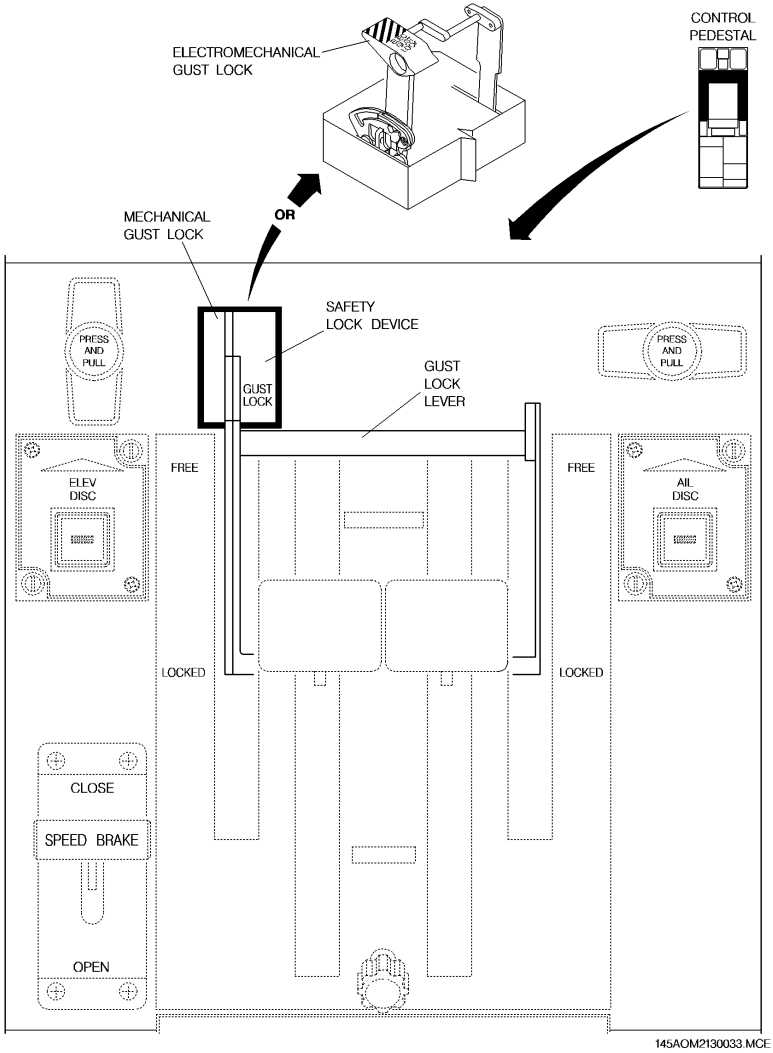
145AOM2130025.MCE

(*) Applicable only to airplanes equipped with electromechanical gust lock system.

CONTROL STAND

GUST LOCK LEVER

- Actuated backward, locks both elevator and thrust control levers.
- The safety lock has to be lifted to move the lever.



CONTROL STAND

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FLAP SYSTEM

The flaps are electrically operated, consisting of two double-slotted flap panels installed to each wing.

FLAP SYSTEM OPERATION

The Flap Selector Lever provides five detent settings at 0°, 9°, 18°, 22° and 45° positions. Intermediate positions cannot be selected. When any position is selected, the selector lever signals to the Flap Electronic Control Unit (FECU) to move the flap panels. The FECU also monitors system failures and flap position, sending signals to the EICAS and other related systems.

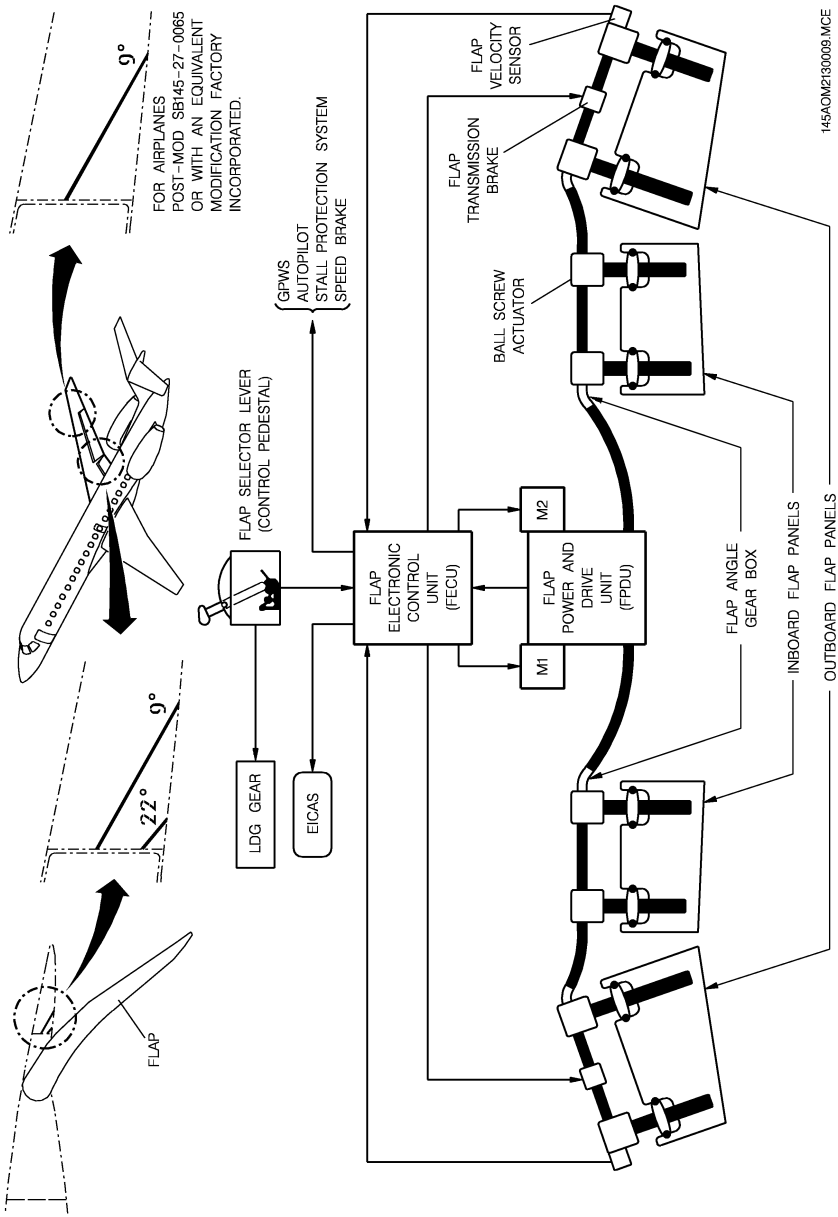
Flap Power and Drive Unit (FPDU) drive the flap panels. The FPDU is a gearbox with two electric motors connected to that unit. Each motor is controlled by the FECU through one independent channel. Both motors drive all the flap actuators through flexible shafts. If a motor, or its associated FECU control channel, or associated velocity sensor or transmission brake fail, the affected channel is disengaged and its associated motor actuation is interrupted. The remaining motor can drive all flap panels at half speed. An EICAS message is presented to indicate that flaps are being moved at a lower speed. If both motors or control channels fail, an EICAS message is presented to indicate that the system is inoperative.

Flap actuators are torque-limited to safeguard structure against excessive loading should flaps or actuators jam. Velocity sensors installed at the end of the flexible shafts detect panels asymmetry. In such cases, the system is disabled.

On the ground a protection circuit prevents flap movement when the airplane is energized and a disagreement is detected between flap position and flap selector lever. To override such protection, it is necessary to lift up and release the flap selector lever.

Two switches on the Flap Selector Lever send signals to the Landing Gear Warning System to alert pilots any time the airplane is in a landing configuration and the gear legs are not locked down.

Flap position is shown on the EICAS display. There are also flap marks on the wing trailing edge, indicating 9° and 22°, which becomes visible when flap moves to those positions.



FLAP SCHEMATIC

EICAS MESSAGES

TYPE	MESSAGE	MEANING
CAUTION	FLAP FAIL	Both flap channels are inoperative.
ADVISORY	FLAP LOW SPEED	One flap channel is inoperative.

FLAP AURAL WARNING (TAKEOFF FLAPS)

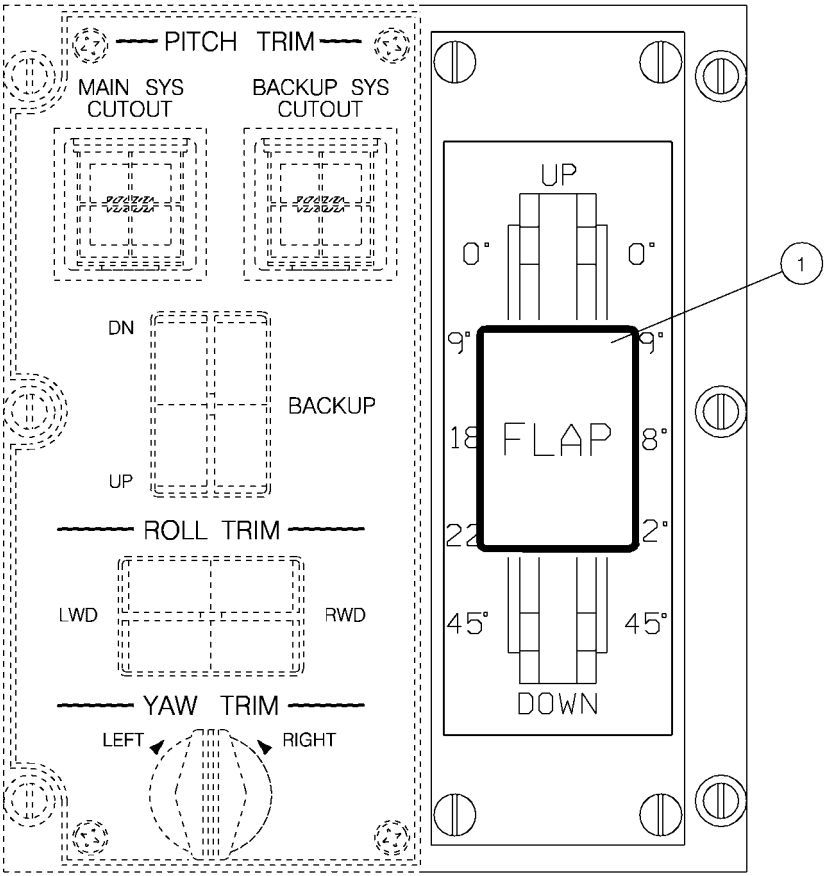
If the airplane is on the ground, any thrust lever angle is above 60° and the flaps are not in the appropriate takeoff position, the digits, box, and pointer turn red, the aural warning TAKEOFF FLAPS sounds and the EICAS warning message NO TAKEOFF CONFIG is displayed.

CONTROLS AND INDICATORS

CONTROL PEDESTAL AFT PANEL

1 - FLAP SELECTOR LEVER

- Moved to the detent positions, selects each discrete flap position.
- To move the lever it is necessary to pull it up.
- Intermediate positions are not enabled.

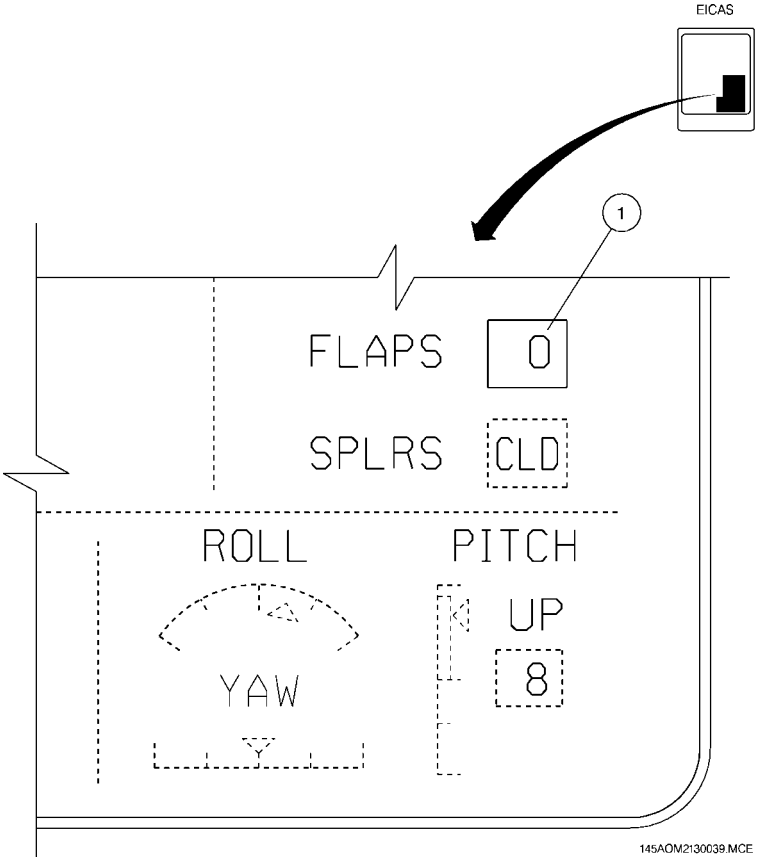


CONTROL PEDESTAL AFT PANEL

EICAS INDICATIONS

1- FLAPS POSITION

- Ranges from 0° to 45°, with discrete indication on 0°, 9°, 18°, 22° and 45°.
- Colors:
  - Box: white.
  - Digits: - green (except 0, which is white).
    - changes to a green dash when flaps are in transit.
- In-transit flap position is replaced by the actual flap position if flap fails.
- If data is invalid, digits are replaced by amber dashes and box becomes amber.



EICAS INDICATIONS

SPOILER SYSTEM

Spoiler system consists of speed brake and ground spoiler subsystems. Speed brakes allow increased descent rate and assist in decelerating the airplane. Ground spoilers destroy lift, thus providing better braking effectiveness.

Spoilers are electrically commanded and hydraulically actuated. A Spoiler Control Unit is responsible for permitting the spoiler panels to open or not. Four spoiler panels are provided, two per wing surface. The outboard spoilers provide both speed brake and ground spoiler functions, while the inboard spoilers provide only a ground spoiler function. The actuation of either subsystem is fully independent.

GROUND SPOILER

The Spoiler Control Unit (SCU) automatically performs ground spoiler opening, without pilots' interference. The SCU enables the ground spoilers to open whenever the following conditions are met:

– Airplane on the ground.
– Main landing gear wheels running above 25 kt.
– Both engines thrust lever angles set to below 30° or both engines N2 below 56%.

If any of those conditions is not met, the ground spoilers will not open. A status indication is presented on the EICAS to indicate that the spoilers are open or closed. If a failure is detected, a caution message is presented on the EICAS.

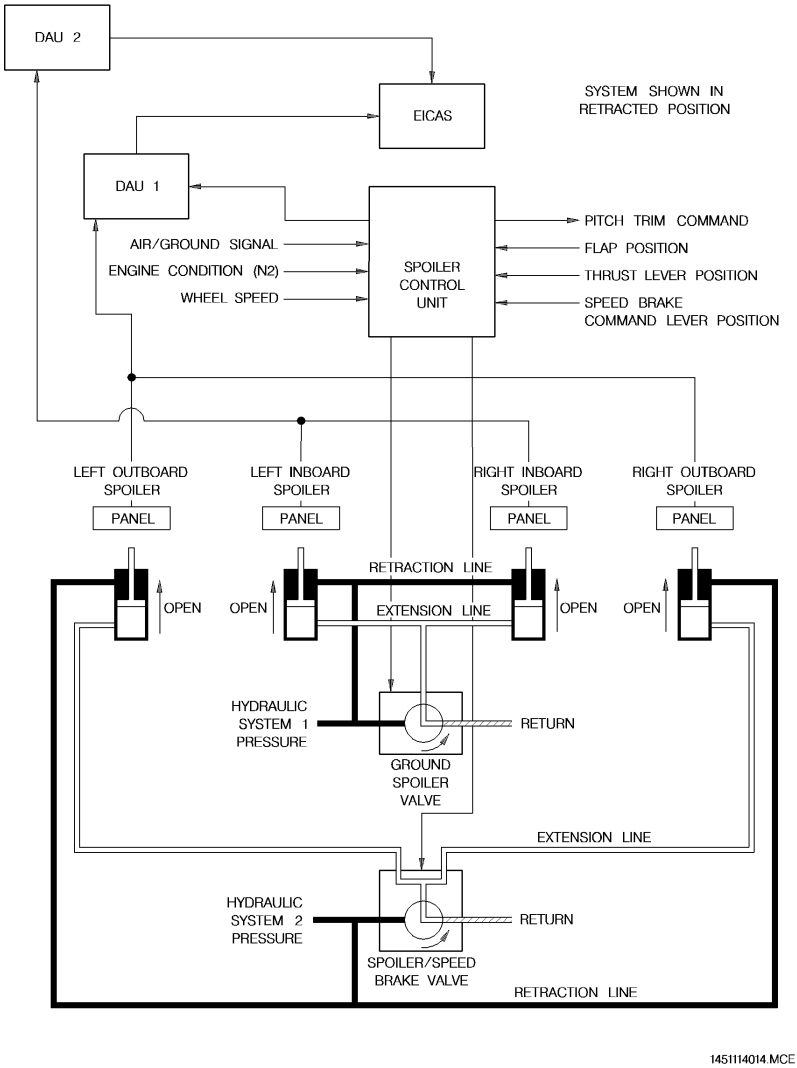
SPEED BRAKE

When speed brake is commanded with autopilot engaged, the auto pitch trim is provided through the autopilot; when the autopilot is not engaged the Spoiler Control Unit provides the auto pitch trim command.

The speed brakes will open when the speed brake lever is set to open and the following conditions are met:

– Thrust lever angle of both engines set to below 50°.
– Flaps at 0° or 9°.

If the speed brake lever is commanded to the OPEN position and any of the speed brake open condition is not met, the speed brake panels are kept closed and a caution message is presented on the EICAS. If the speed brake panels are open and any of the speed brake open condition is not met, the speed brake panels automatically close and an EICAS message is presented. In both cases, the speed brake lever must be moved to the CLOSE position to remove the EICAS message.



SPOILER SYSTEM SCHEMATIC

EICAS MESSAGES

TYPE	MESSAGE	MEANING
CAUTION	SPOILER FAIL	Any spoiler panel open inadvertently, failed to open or any failure in the input signals.
	SPBK LVR DISAGREE	Speed Brake Lever commanded to OPEN but opening logic is not satisfied.

SPOILER AURAL WARNING (TAKEOFF SPOILERS)

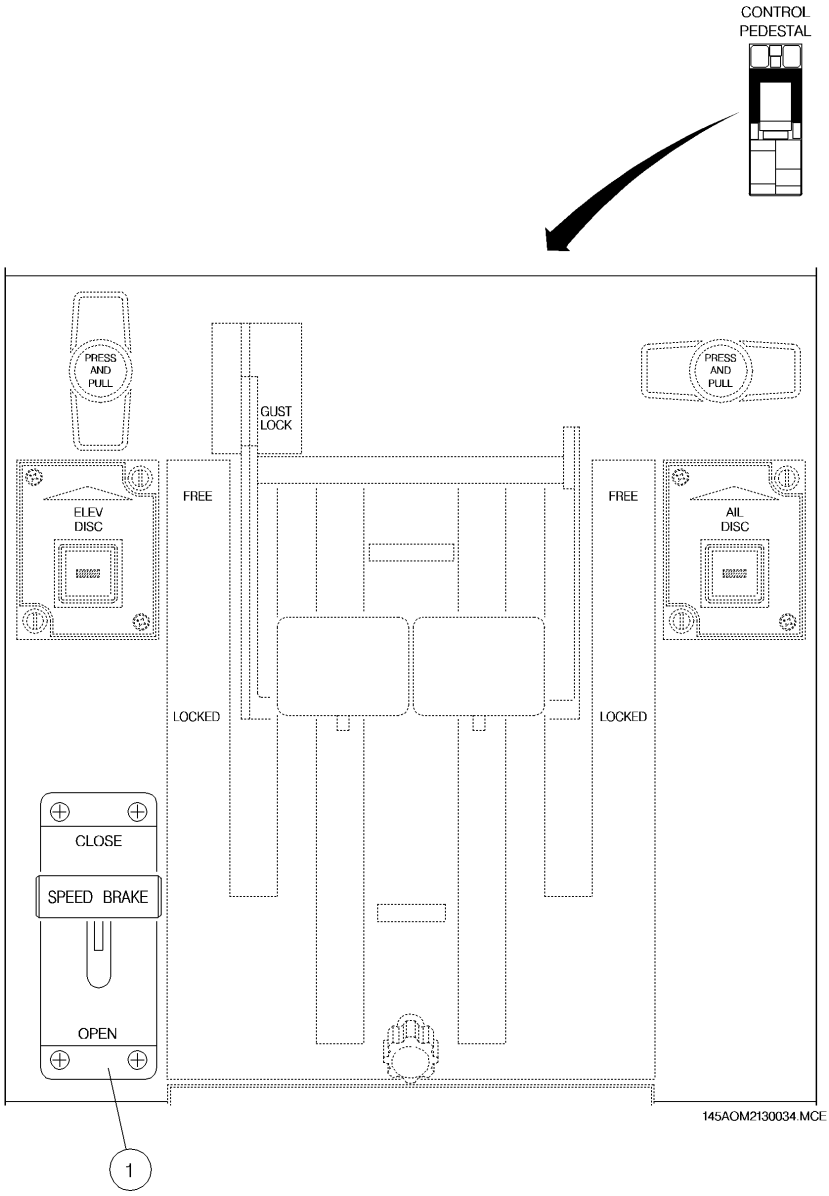
If the airplane is on the ground, any thrust lever angle is above 60° and any spoiler/speed brake panel is deployed, the digits, box, and pointer turn red, the aural warning TAKEOFF SPOILERS sounds and the EICAS warning message NO TAKEOFF CONFIG is displayed.

CONTROLS AND INDICATORS

CONTROL STAND

1 - SPEED BRAKE LEVER

– Actuated to the OPEN position commands outboard spoiler panels to open, provided enabling conditions are met.

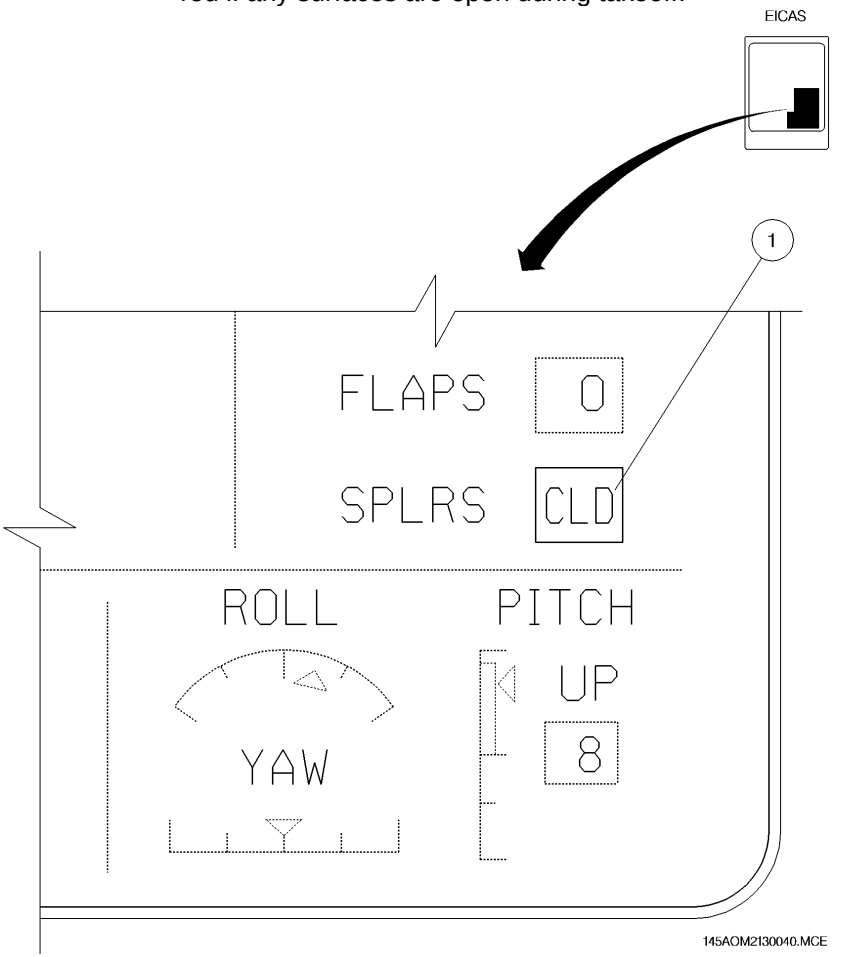


CONTROL STAND

EICAS INDICATIONS

1- SPOILERS INDICATION

- Displays OPN when any of the surfaces are open, or CLD when all of the surfaces are closed.
- Colors:
  - Box: white.
  - CLD: white.
  - OPN: - green in normal condition.
    - red if any surfaces are open during takeoff.



EICAS INDICATIONS