CHAPTER 16 – LANDING GEAR

LIST OF ILLUSTRATIONS

PROXIMITY SENSING SYSTEM

BRAKE SYSTEM

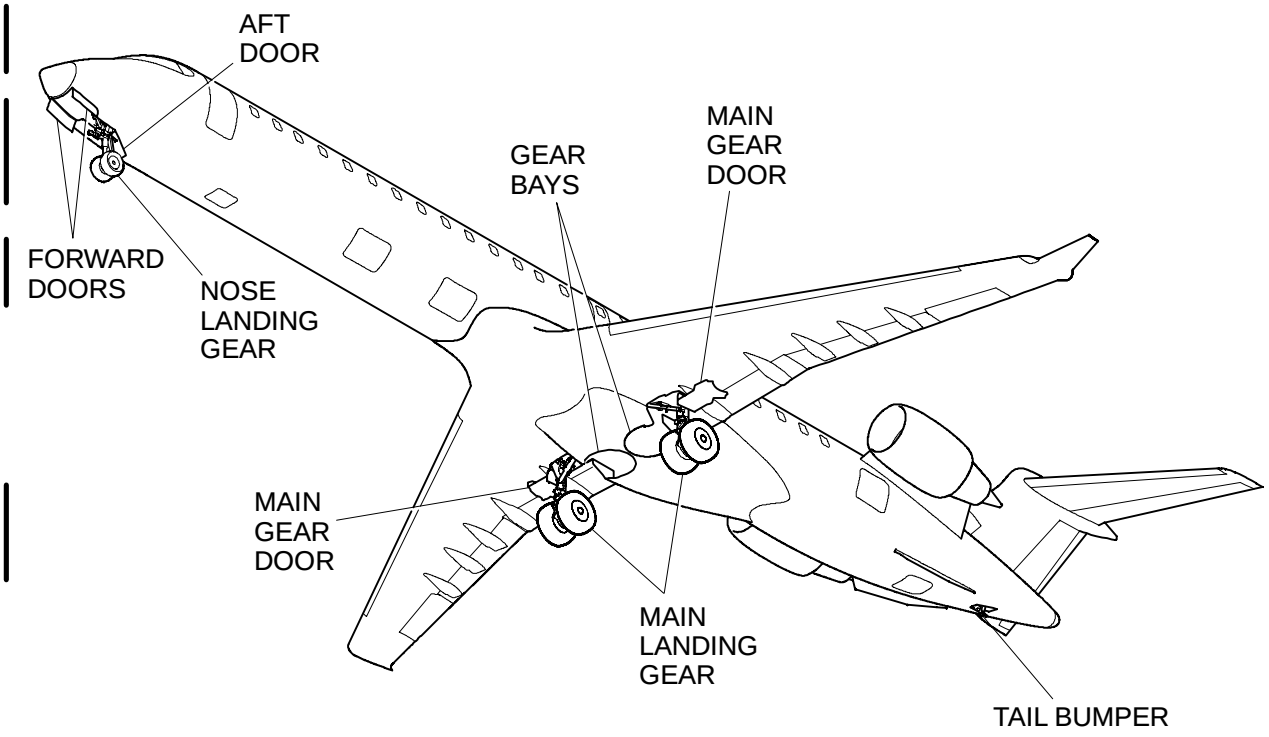
NOSE WHEEL STEERING SYSTEM

1. INTRODUCTION

The landing gear is a retractable tricycle type consisting of two wing root mounted main landing gear assemblies and a forward fuselage mounted steerable nose landing gear assembly. Each gear assembly has two wheels. The main landing gear assemblies retract inboard and the nose landing gear assembly retracts forward. Each landing gear has a shock strut to absorb and dissipate the shock loads encountered when the aircraft lands. The main landing gear are fitted with steel multi-disc brakes.

Landing gear extension and retraction is electrically activated by the landing gear selector lever and controlled by the proximity sensing electronic unit (PSEU). Sensors for the PSEU are mounted on the landing gear and landing gear doors. The PSEU also provides landing gear position indication on the EICAS display. The landing gear is hydraulically actuated by hydraulic system 3, in normal operation. An alternate independent means of extending the landing gear is available should the normal extension system fail.

A tail bumper protects the aircraft tail structure from tail strikes caused by over-rotation of the aircraft on take-off. The tail bumper consists of a shock absorber, a skid assembly and a strike indicator.



Landing Gear Assemblies
Figure 16–10–1

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1. NOSE AND MAIN LANDING GEAR

Normal extension or retraction of the landing gear is initiated by landing gear control handle selection. The retraction or extension signal is sent to the proximity sensing electronic unit (PSEU) which monitors various landing gear proximity sensing inputs and weight-on-wheels inputs. If the correct parameters are met, the PSEU energizes a selector valve to retract or extend the landing gear using hydraulic system No. 3 pressure.

The landing gear control handle is equipped with a solenoid lock which prevents an up selection of the landing gear control handle with the aircraft on the ground. In the event of a solenoid lock malfunction, a downlock release on the landing gear control panel, permits up selection of the landing gear control handle by overriding the solenoid lock.

Retraction and extension of each landing gear is driven by a retract/extend actuator. An auxiliary actuator, powered by hydraulic system No. 2 provides a backup means of extending the main landing gear.

Tension springs assisted by a downlock actuator ensure that the main gear locks in the down position. The lock is released at the start of the retraction cycle. An uplock assembly locks the main gear in the retracted position. An uplock release actuator releases the uplock assembly at the start of the extension cycle.

The nose landing gear locks in both the extended or retracted positions with a spring-loaded, over-centre type locking mechanism. A lock actuator moves the locking mechanism out of the over-center condition at the beginning of each cycle.

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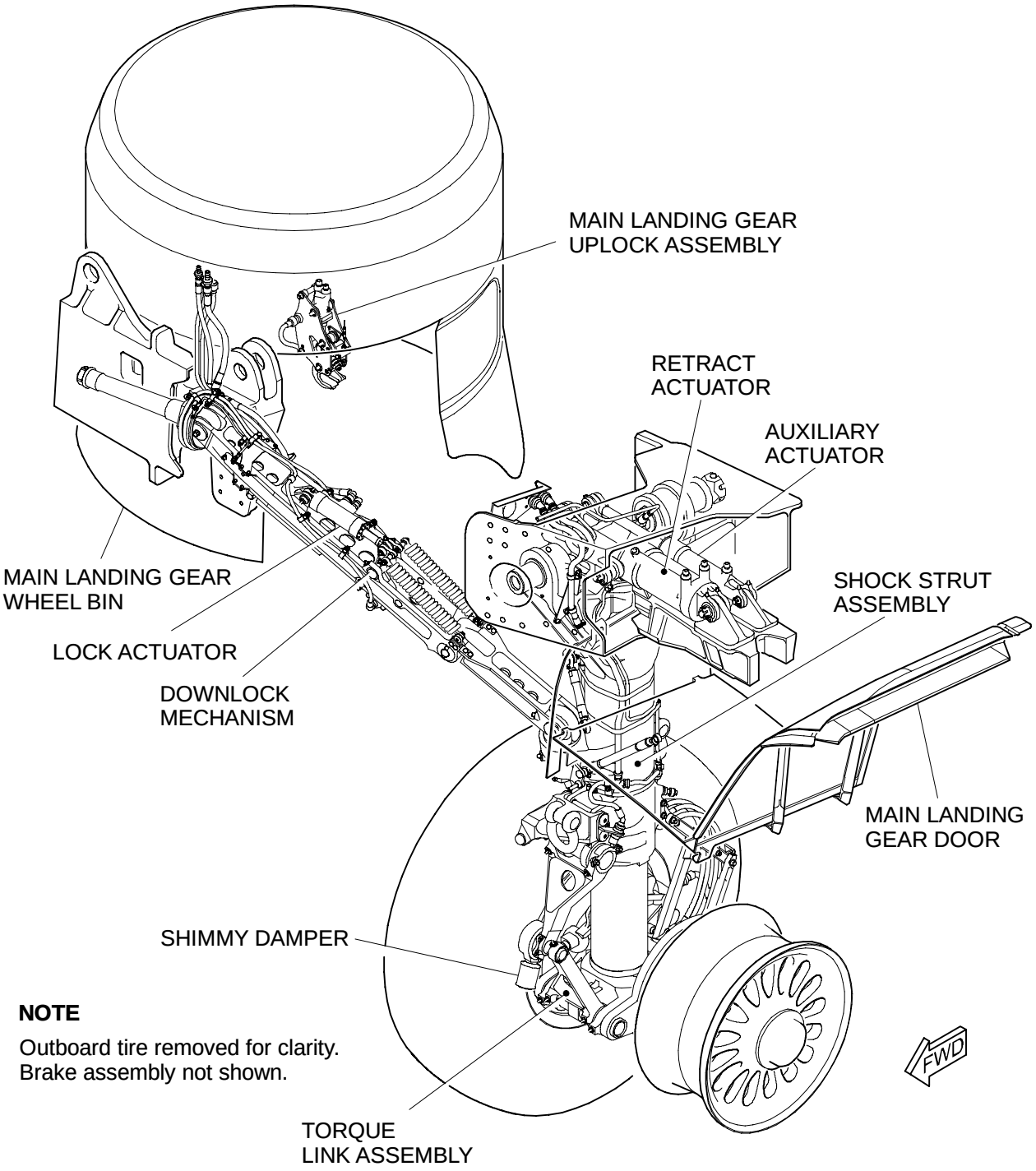
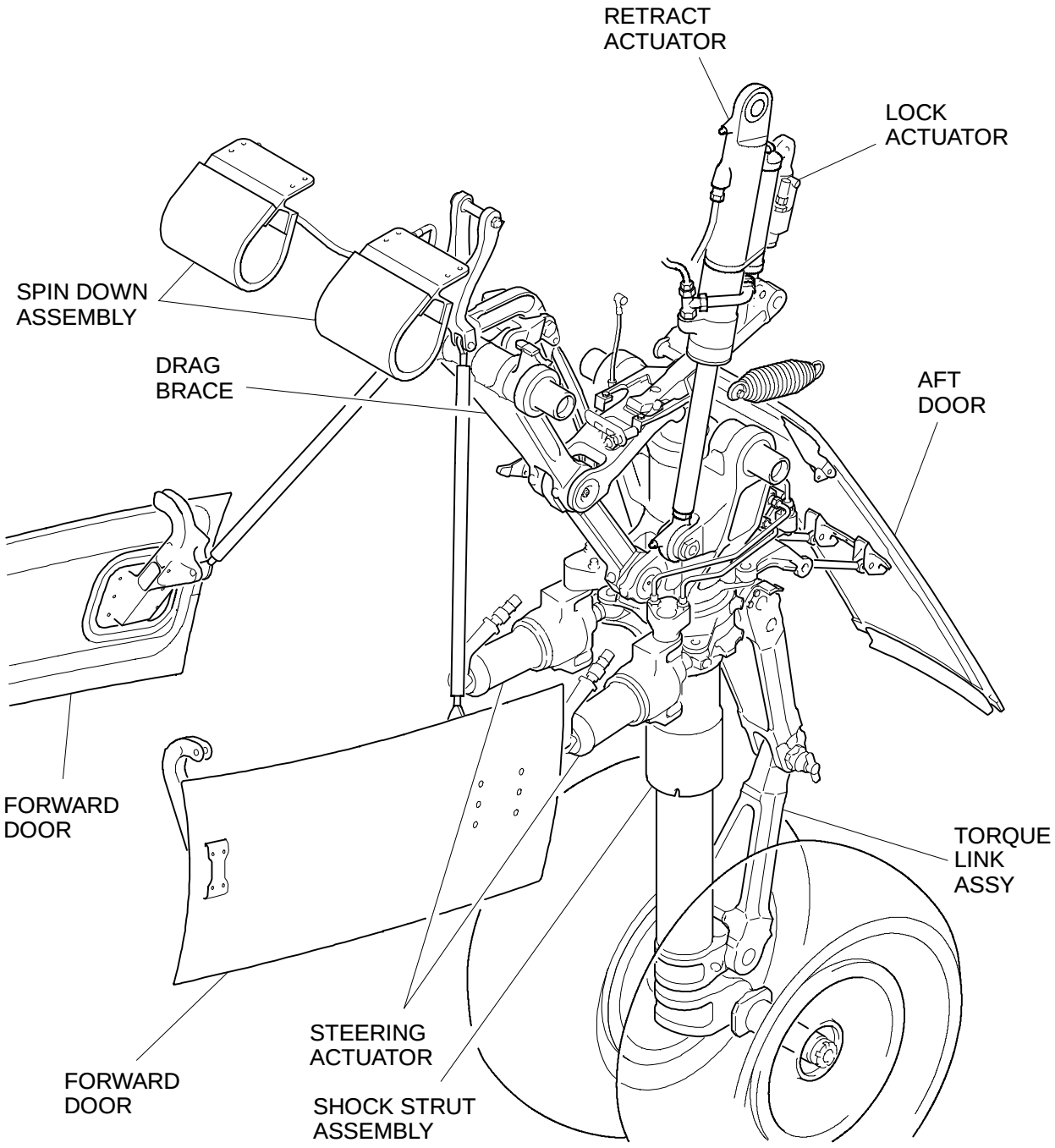


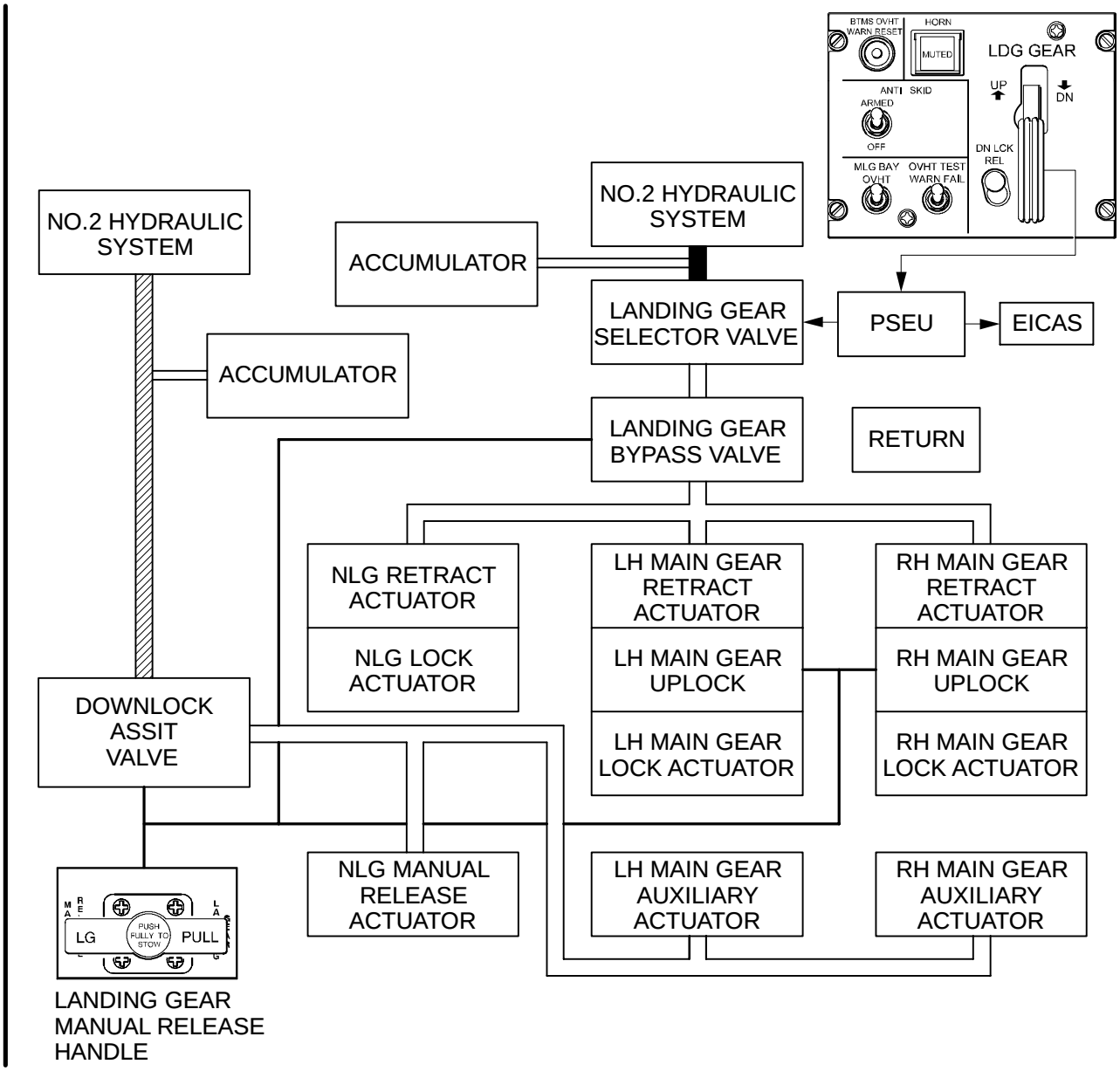
NOTE

Outboard tire removed for clarity.
Brake assembly not shown.

Main Landing Gear
Figure 16–20–1



Nose Landing Gear
Figure 16-20-2



Landing Gear Retraction and Extension – Schematic
Figure 16–20–3

For landing gear retraction:

Once the aircraft is airborne, with no weight-on-wheels signal, the PSEU commands and monitors the following events:

- The landing gear control handle solenoid downlock is released to permit UP selection of the landing gear control handle.
- The landing gear selector valve energizes the nose and main landing gear retract/extend actuators, releases the downlocks and retracts the landing gear. Hydraulic pressure from the landing gear up line is routed to activate the brake control valves to stop main wheel rotation. The tire spin-down assembly in the nose landing gear bay stops nose wheel rotation.
- Uplocks are engaged to secure the landing gears in the retracted position.

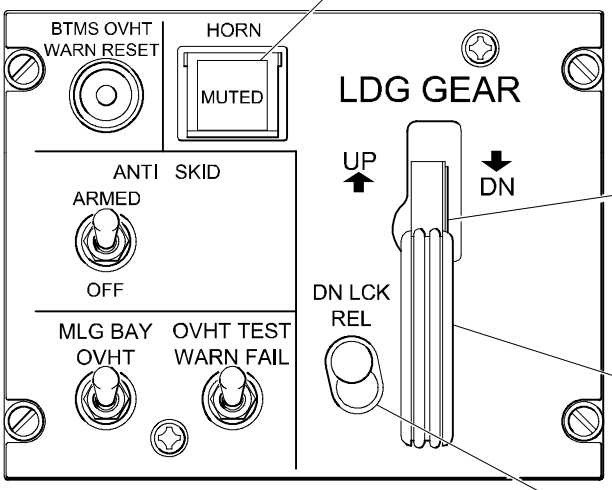
For landing gear extension:

The PSEU commands and monitors the following events:

- The landing gear control handle is manually selected to the DN position.
- The landing gear selector valve energizes the nose and main landing gear retract/extend actuators, releases the uplocks and extends the landing gear.
- Downlocks are engaged to secure the landing gear in the extended position.

To prevent the landing gear from retracting when the aircraft is on the ground, ground lock pins are inserted by the ground crew.

HORN
Used to mute landing gear warning horn.
- MUTE (white) light indicates that landing gear warning horn has been muted.

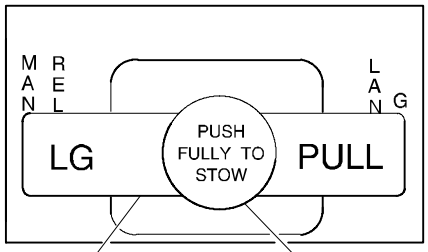


Landing Gear Lever Down Lock
Prevents inadvertent landing gear up selection when on ground.
When airborne, a weight-off-wheels signal from the PSEU disengages the lock to permit a gear up selection.

Landing Gear Lever
Used to retract and extend landing gear.

Landing Gear Control Panel
Centre Instrument Panel

DN LCK REL
Used to manually release the landing gear lever down lock.



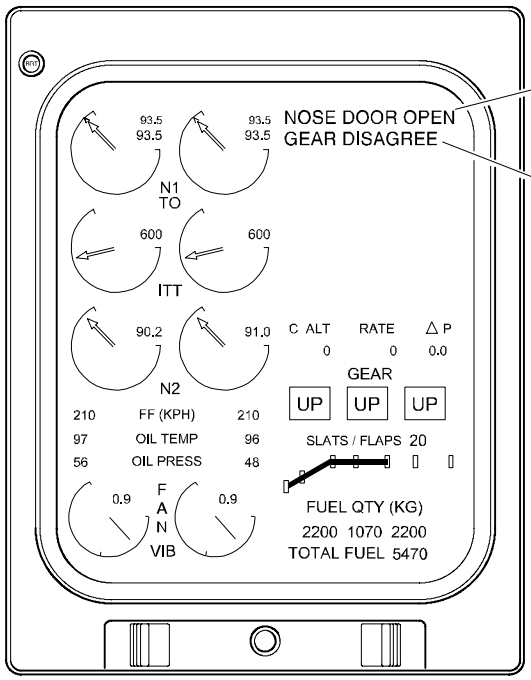
Landing Gear Manual Release
Used to manually lower the landing gear.
- Pull and hold handle in the fully extended position until EICAS indicates the nose and main landing gear are down and locked.

NOTE

Considerable force is required to operate the landing gear manual release system.

PUSH FULLY TO STOW
Used to reset the manual release system.
- Hold handle, press button and then slowly return handle to the stowed position.

Landing Gear Controls
Figure 16–20–4



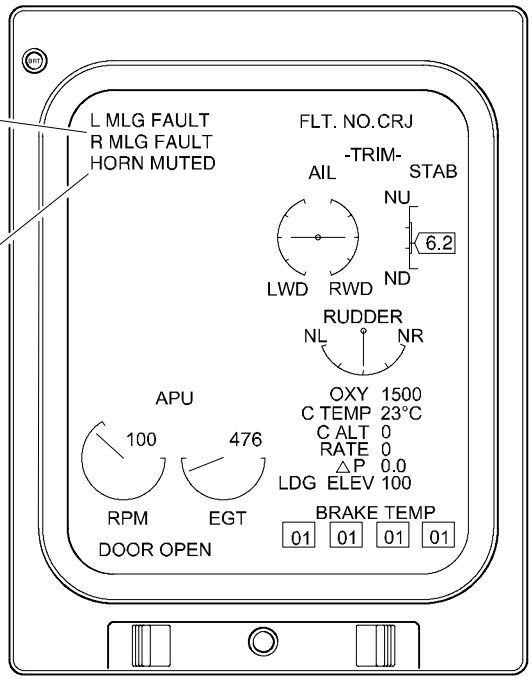
Primary Page

NOSE DOOR OPEN warning (red)
Indicates that either nose landing gear door is not closed after gear is up.

GEAR DISAGREE warning (red)
Indicates that landing gear position does not agree with landing gear control handle position.

L or R MLG FAULT status (white)
Indicates that left or right actuator shuttle valve or the pressure switch have failed in the closed position (for MLG downlocked)
OR
Left or right actuator pressure switch has failed in open position (for MLG uplocked).

HORN MUTED status (white)
Indicates that landing gear warning horn has been manually muted.



Status Page

Landing Gear EICAS Indications <1001>
Figure 16-20-5

A. Alternate Landing Gear Extension

If a failure occurs in the landing gear control system or in hydraulic system No. 3, the landing gear can still be extended by pulling the landing gear manual release handle.

When the manual release handle is pulled, the main landing gear uplocks are released by mechanical means, and at the same time a bypass valve dumps hydraulic system No. 3 pressure from the normal extension and retraction hydraulic circuits. This will permit the landing gear to partially extend under its own weight. The manual release handle also positions a downlock assist valve to direct hydraulic system No. 2 pressure to the main landing gear auxiliary actuators and to the nose gear uplock manual release actuator.

The main landing gear is assisted to the down-and-locked position by the main gear auxiliary actuators and the nose landing gear is assisted to the down-and-locked position by airflow and two tension springs.

B. Wheels and Tires

Each wheel has a pressure relief plug (overpressure valve) and an inflation valve. Refer to the Aircraft Maintenance Manual for tire pressure adjustment.

Four heat sensitive fusible plugs are installed in each main wheel to release excessive air pressure caused by heat build-up. The fusible plugs protect the main wheel against tire burst that could occur under heavy braking activity.

C. Landing Gear Doors

The landing gear doors are mechanically linked to the landing gear. The doors close when the gear retracts and open when the gear extends.

1. PROXIMITY SENSING SYSTEM

The proximity sensor system (PSS) includes the proximity sensor electronics unit (PSEU) and associated proximity sensors and proximity switches installed throughout the aircraft. The PSS provides five basic functions:

- Normal landing gear positioning control
  The PSS provides the signals that command the landing gear extend and retract solenoids to change the position of the landing gear.

- Landing gear position indication
  The PSS monitors landing gear position and provides indication of the position status of the landing gear.

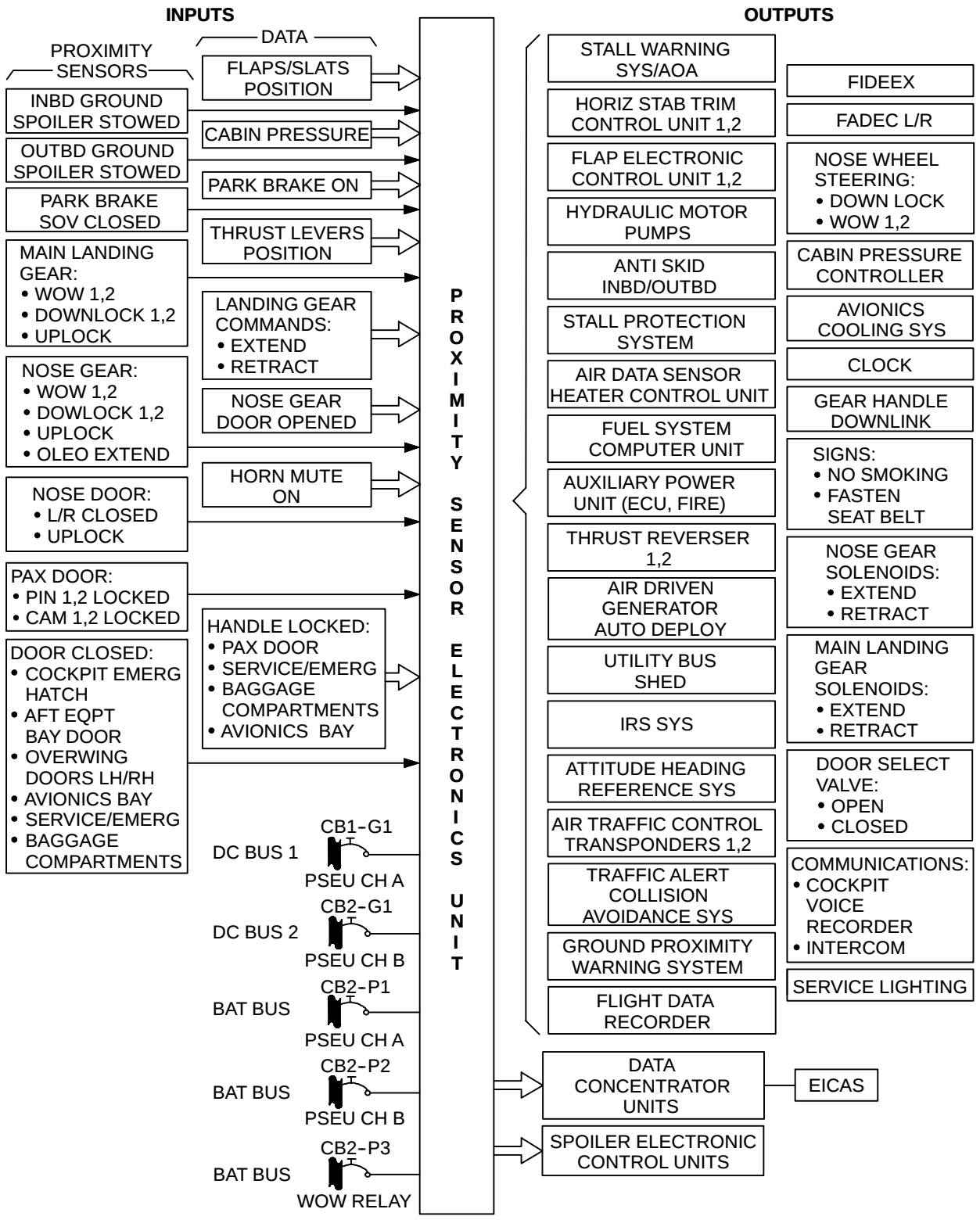
- Weight-on-wheels indication
  The PSS monitors landing gear strut compression and provides indication of air or ground status of the aircraft.

- Fuselage door indication
  The PSS monitors fuselage door position, latches and lock status and provides indication of the status of the doors (refer to Chapter 6).

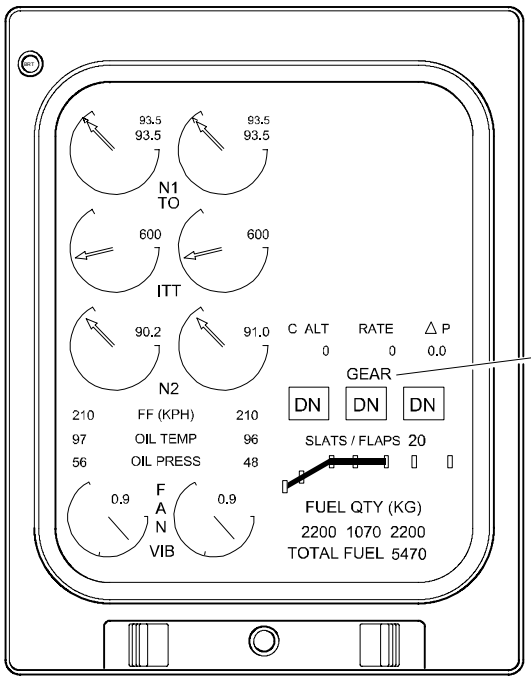
- Thrust reverser indication
  The PSS monitors and reports to EICAS the stowed/unstowed status of the left and right thrust reversers (refer to Chapter 20).

The PSEU, after processing sensor inputs, generates outputs that are used to control landing gear position, report status and provide control data for other systems.

Continuous and periodic tests are performed by the PSEU to monitor specific aircraft systems health and status. Landing gear position and status are displayed on the engine indication and crew alerting system (EICAS) primary page. The landing gear position indication is removed 30 seconds after the landing gear is in the up and locked position with the flaps at 0 degrees.



Proximity Sensing System – Schematic <1025>
Figure 16–30–1

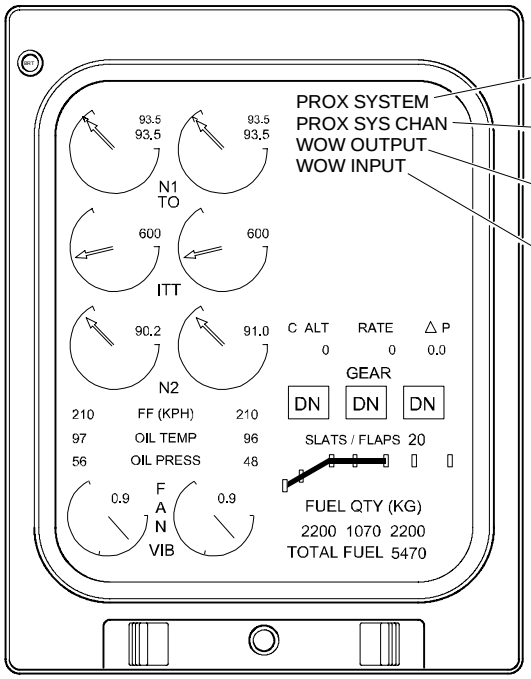


Primary Page

Landing Gear Position Indicator

- UP (white) – Indicates that respective landing gear is in the up and locked position.
- DN (green) – Indicates that respective landing gear is in the down and locked position.
- (amber) – Indicates that respective landing gear is in transition.
- (red) – Indicates that respective landing gear is not safe.
- – – (amber dashes) – Indicates that respective landing gear is in unknown position.

Landing Gear Position Indicator <1001>
Figure 16–30–2



PROX SYSTEM caution (amber)
Indicates loss of both PSEU channels.

PROX SYS CHAN caution (amber)
Indicates loss of one PSEU channel or input/output of a critical system.

WOW OUTPUT caution (amber)
Indicates that WOW output failed or disagrees with another critical output.

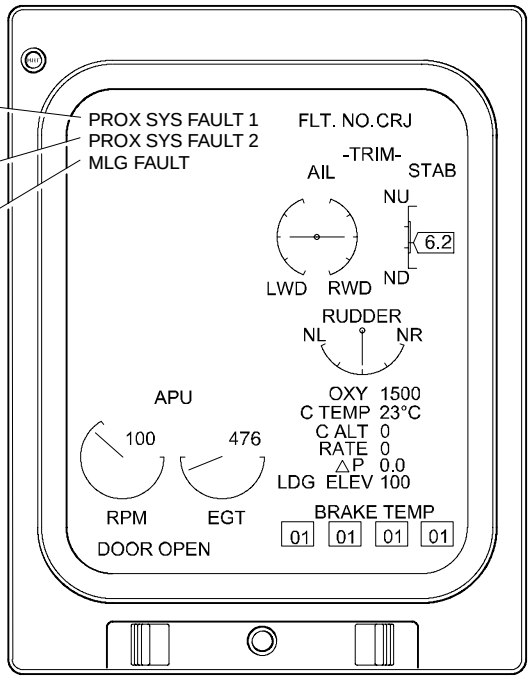
WOW INPUT caution (amber)
Indicates that two or more WOW sensors disagree or have failed.

Primary Page

PROX SYS FAULT 1 status (white)
Indicates a failure of any one PSEU input or output related to a critical aircraft system.

PROX SYS FAULT 2 status (white)
Indicates that any one non-critical sensor or an input or output is failed or unreasonable.

MLG FAULT status (white)
Indicates PSEU has detected a fault in the main landing gear shuttle valve.



Status Page

Proximity Sening System EICAS Indications <1001>
Figure 16-30-3

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Proximity Sensing	Electronics Unit	PSEU CH A	DC BUS 1	1	G1	
		PSEU CH B	DC BUS 2	2	G1	
		PSEU CH A	BATTERY BUS		P1	
		PSEU CH B			P2	
	Weight On Wheels	WOW RELAY			P3	

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1. BRAKE SYSTEM

Each wheel of the main landing gear is equipped with self-adjusting multi-disc brakes. The brakes of the inboard wheels are powered by hydraulic system 3 and the brakes of the outboard wheels are powered by hydraulic system No. 2.

Brake application is initiated by pressing the rudder pedals which are mechanically linked to the associated brake control valves. The brake control valves meter hydraulic pressure, proportional to the pedal pressure, to the four main wheel brake units, through four independent anti-skid control valves and four hydraulic fuses.

If a leak occurs in a brake line, the associated hydraulic fuse will close off the hydraulic line, preventing loss of the entire system fluid.

With the loss of one hydraulic system, the aircraft has 50% symmetric braking capability with full anti-skid control to the working brakes. In the event of a failure of both hydraulic systems 2 and 3, accumulators in each hydraulic system will provide reserve pressure for braking. During landing roll or rejected takeoff, reverse thrust and the ground spoilers will decelerate the aircraft, if the brakes are degraded or fail completely.

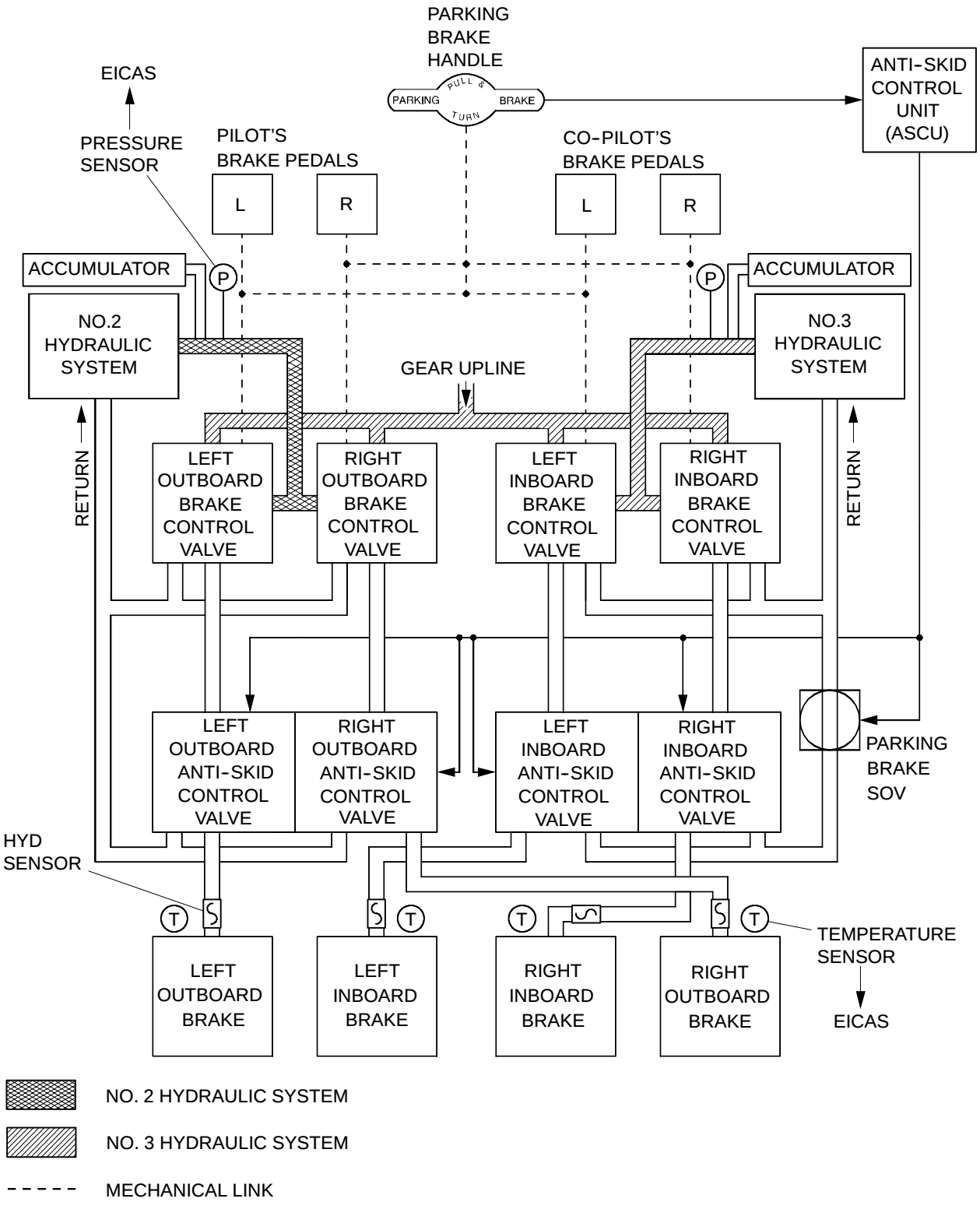
Available inboard and outboard brake pressure is continuously monitored and displayed on EICAS on the hydraulic synoptic page, and any abnormal brake pressure detected is displayed on EICAS in the form of a visual message.

During landing gear retraction, hydraulic pressure is applied to the main wheel brake control valves to stop main wheel spin. A rubber spin-down pad assembly in the nose landing gear wheel well provides resistance to stop the nose wheel from spinning after gear retraction.

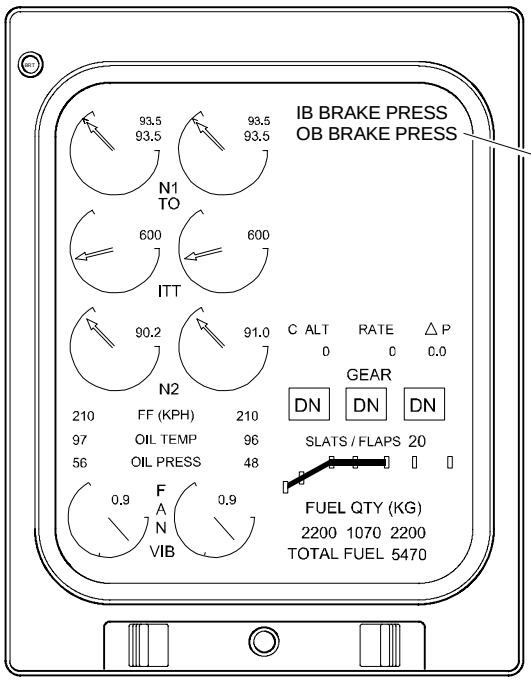
Two brake wear indicator pins installed on each brake assembly provide a visual indication of brake wear.

NOTE

The brake wear indicator pins must be checked with the brakes applied and No. 2 and No. 3 hydraulic systems pressurized.

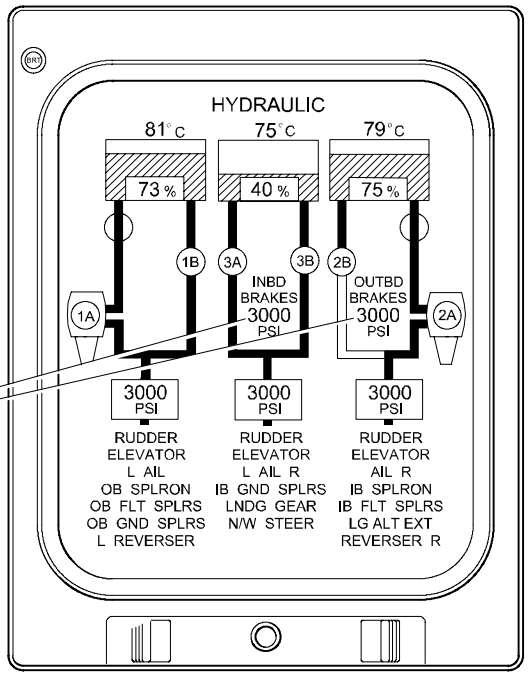


Brake System – Schematic
Figure 16–40–1



Primary Page

IB or OB BRAKE PRESS caution (amber)
Indicates that brake pressure of the respective system is less than 1800 psi and DC bus 2 is powered.



Hydraulic Page

Brake Pressure Readout
Displays brake pressure of respective system (in 100 psi increments).

- Green – Between 1800 psi and 3200 psi
- White – Greater than 3200 psi
- Amber – 1800 psi or less
- Amber dashes – Invalid data

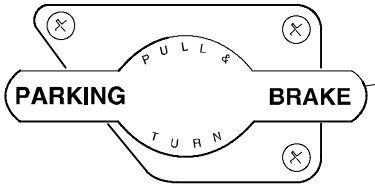
Brake System EICAS Indications <1001>
Figure 16–40–2

A. Parking Brake

Inboard brake control valves and the parking shutoff valve are used to provide braking when the aircraft is parked. Pulling the parking brake handle while fully depressing both rudder pedals and turning the handle 90 degrees in either direction, locks both brake control valves in the applied position.

When the hydraulic systems are shut down, hydraulic pressure slowly leaks away via the anti-skid return lines. The parking brake shutoff valve closes when the parking brake is applied, ensuring that hydraulic system 3 accumulator pressure is maintained on the inboard brakes for a prolonged period of time.

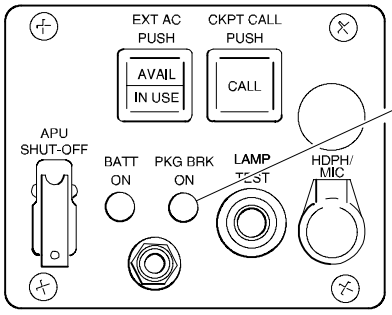
Parking brake configuration and operational condition are continuously monitored and any detected fault is displayed on EICAS in the form of a visual and/or aural message.



Parking Brake Handle
Centre Pedestal

PARKING BRAKE
Used to set parking brake.
To engage parking brake:
- While fully depressing both rudder pedals on the pilot's or copilot's side, pull parking brake handle and rotate it 90 degrees to the locked position.

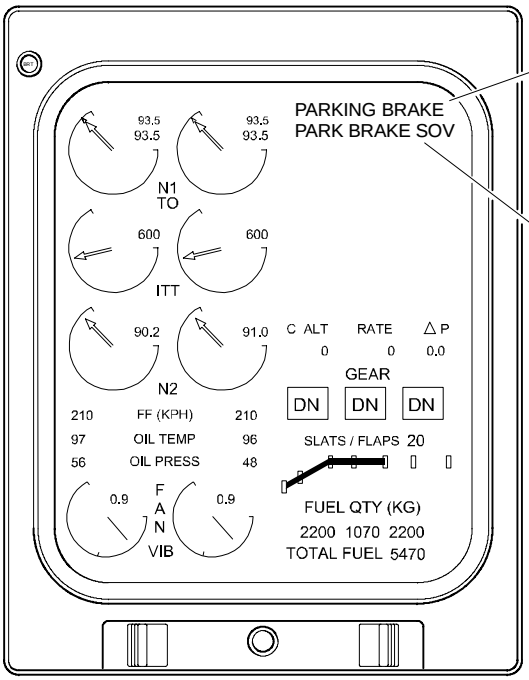
To disengage parking brake:
- While fully depressing both rudder pedals on the pilot's or copilot's side, rotate the parking brake handle to the unlocked position and push it in.



External Service Panel
Right Forward Fuselage

PKG BRK ON Light
Indicates that the parking brake is set.

Parking Brake Controls <1205>
Figure 16–40–3

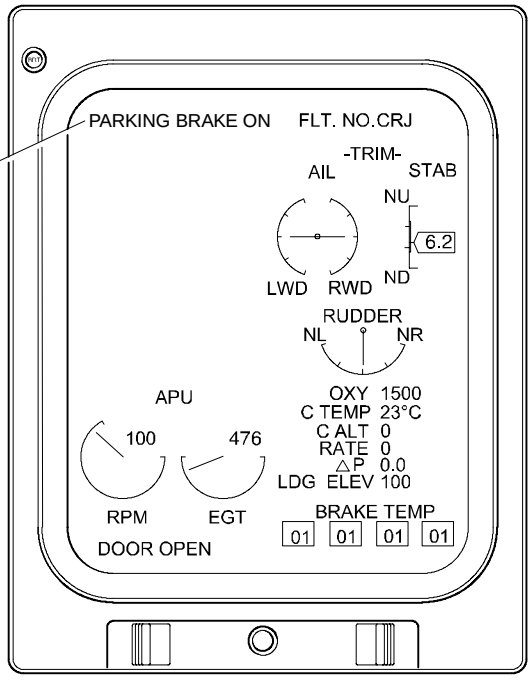


Primary Page

PARKING BRAKE warning (red)
Indicates that the parking brake is set with the airplane configured for takeoff or in the air.

BRAKES

PARK BRAKE SOV caution (amber)
Indicates that the parking brake shutoff valve has failed open with inboard brake pressure greater than 800 psi and the parking brake set.



Status Page

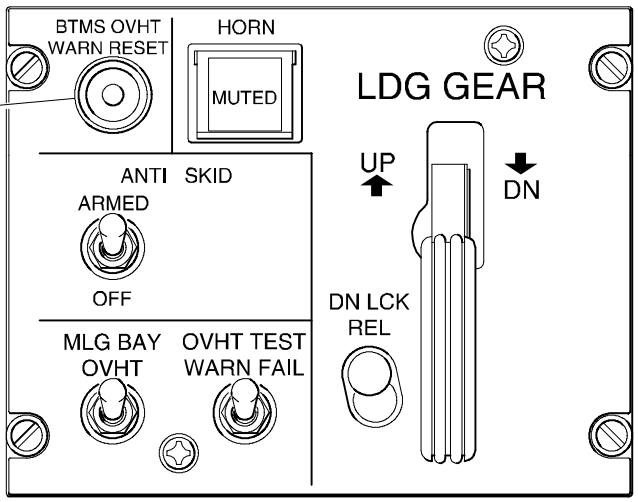
PARKING BRAKE ON advisory (green)
Indicates that the parking brake is set with the airplane on the ground, both engines not at take-off power and inboard brake pressure greater than 800 psi.

Parking Brake EICAS Indications <1001>
Figure 16-40-4

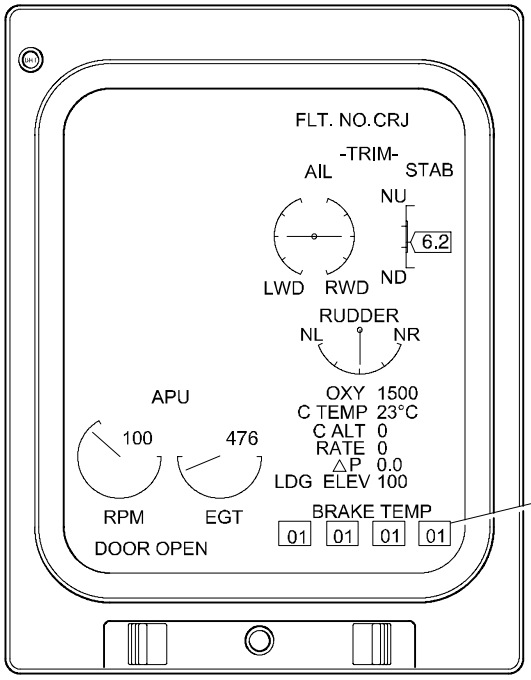
B. Brake Temperature Monitoring System

The brake temperature monitoring system (BTMS) provides an indication to the crew of the main wheel brake temperatures. Individual brake temperatures are displayed as a color coded numerical readout on the status page of the EICAS secondary display. The brake temperature readout will be displayed when the landing gear and slats/flaps position indications are being displayed on EICAS primary page. A BTMS overheat warning reset switch, on the landing gear control panel, is used to reset the system when the brake overheat condition no longer exists.

BTMS OVHT WARN RESET
Used to reset BTMS. The BTMS can only be reset if the brake overheat condition or the brake temperature difference has discontinued.



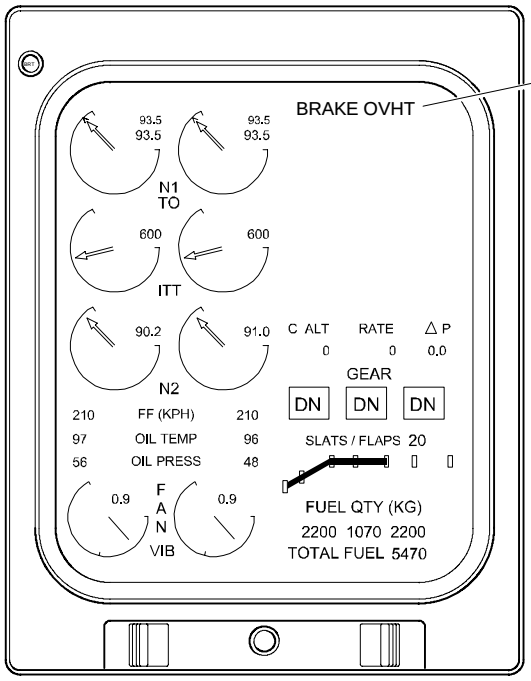
Landing Gear Control Panel
Center Pedestal



Status Page

Brake Temperature Readout
Indicates temperature value of respective brake.
- Green - 06 and less (≤220 °C)
- White - 07 to 14 (between 221 and 492 °C)
- Red - Overheat warning or more than 14 (≥493 °C)

BTMS Controls
Figure 16–40–5



Primary Page

BRAKE OVHT warning (red)
Indicates an overheat condition at any one of the brakes.

BRAKES

BTMS EICAS Indications <1001>
Figure 16–40–6

C. Anti-Skid System

The anti-skid system controls hydraulic pressure to the four main wheel brakes to provide anti-skid protection. The anti-skid system consists of a dual channel (inboard wheel control and outboard wheel control) anti-skid control unit (ASCU), four wheel speed transducers and two dual anti-skid control valves. The anti-skid system performs the following functions:

- Individual wheel anti-skid control: Prevents skids from developing.
- Touchdown protection: Prevents landing with locked wheels in the event that the pilot(s) are depressing the brake pedals during touchdown.
- Locked wheel protection: Allows a wheel to recover from a deep skid.

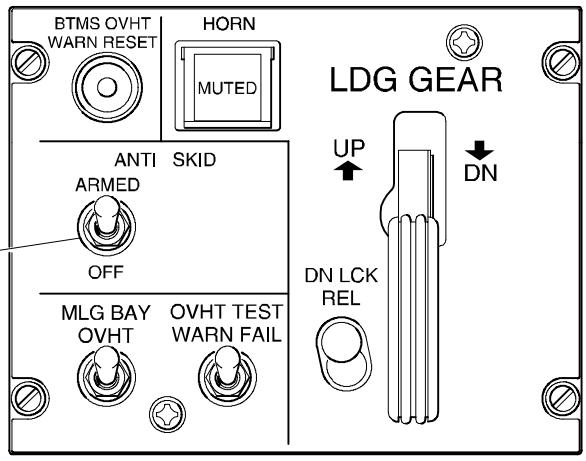
Selecting the anti-skid switch, on the landing gear control panel, to the ARMED position enables the ASCU (provided the parking brake is not engaged and both main landing gear are down and locked). In the event of a failure that causes loss of braking, manual braking is restored by selecting the anti-skid system off.

By monitoring each wheel speed individually, the ASCU can detect tire skidding. The ASCU independently reduces the braking pressure at the skidding wheel by modulating the pressure outputs of the appropriate anti-skid control valve. This modulation is controlled by the individual wheel speed and deceleration monitored through the wheel speed transducers.

In the air, with no weight-on-wheels signal, the anti-skid control valves dump pressure to prevent wheel lock-up on touchdown. The system becomes operational once a 35 knots wheel spin-up signal is present or a weight-on-wheels signal is present after a 5 second delay.

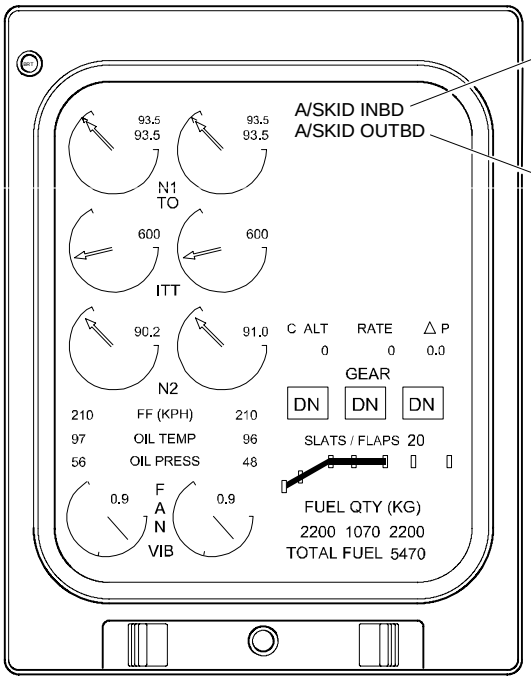
The ASCU continuously monitors the anti-skid system and any detected faults are displayed on the EICAS in the form of a visual message.

ANTI-SKID
Used to arm anti-skid system. System is activated with wheel spin-up (35 kt).



Landing Gear Control Panel
Center Pedestal

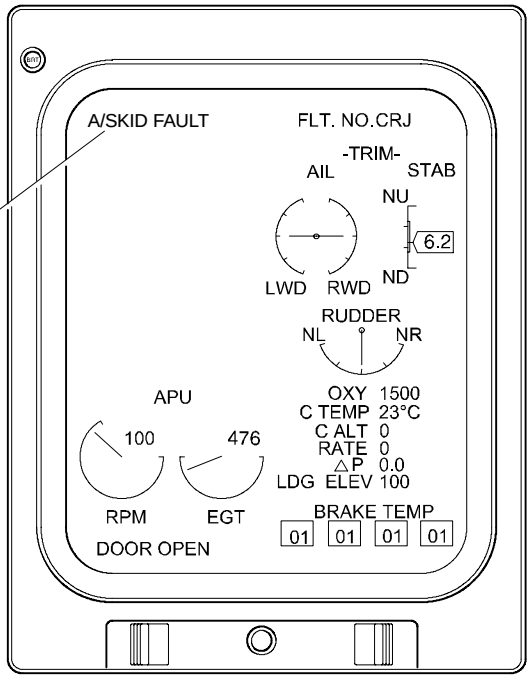
Anti−Skid System Controls
Figure 16−40−7



A/SKID INBD caution (amber)
Indicates that the inboard channel of the anti-skid system has failed, parking brake shut-off valve failed closed or loss of ASCU output.

A/SKID OUTBD caution (amber)
Indicates that the outboard channel of the anti-skid system has failed or loss of ASCU output.

Primary Page



A/SKID FAULT status (White)
Indicates loss of redundancy of ASCU, loss of weight-on-wheels input, spin down fail or loss of internal communication.

Status Page

Anti-Skid System EICAS Indications <1001>
Figure 16-40-8

D. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Brakes	Pressure	BRAKE PRESS APPL	DC BUS 1	1	E13	
		BRAKE PRESS IND	DC BUS 2	2	G3	
	Anti-Skid	ANTI SKID			G4	
		ANTI SKID	DC BUS 1	1	G4	

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1. NOSE WHEEL STEERING SYSTEM

The nose wheel steering system is controlled by a steering control unit and powered by hydraulic system No. 3. The nosewheel steering arming switch is located on the pilots left side panel. Selecting the switch to the ARMED position activates the steering system control unit.

The steering control unit controls the nose wheel position based on inputs from either the steering tiller on the pilot's side console or the rudder pedals. The steering tiller turns the nose wheel up to 80 degrees either side of center, and is intended for low speed taxiing. Steering with the rudder pedals is limited to 8 degrees either side of center and is intended for high speed taxi and take-off and landing rolls.

After take-off, the steering control unit generates a straight ahead command, which centers the nose wheel prior to landing gear retraction. A centering cam on the nose wheel strut maintains the nose wheel center position when hydraulic power is shut down.

Powered steering using the steering tiller is available when the steering switch on the pilot's side panel is armed and a nose weight-on-wheels signal is present.

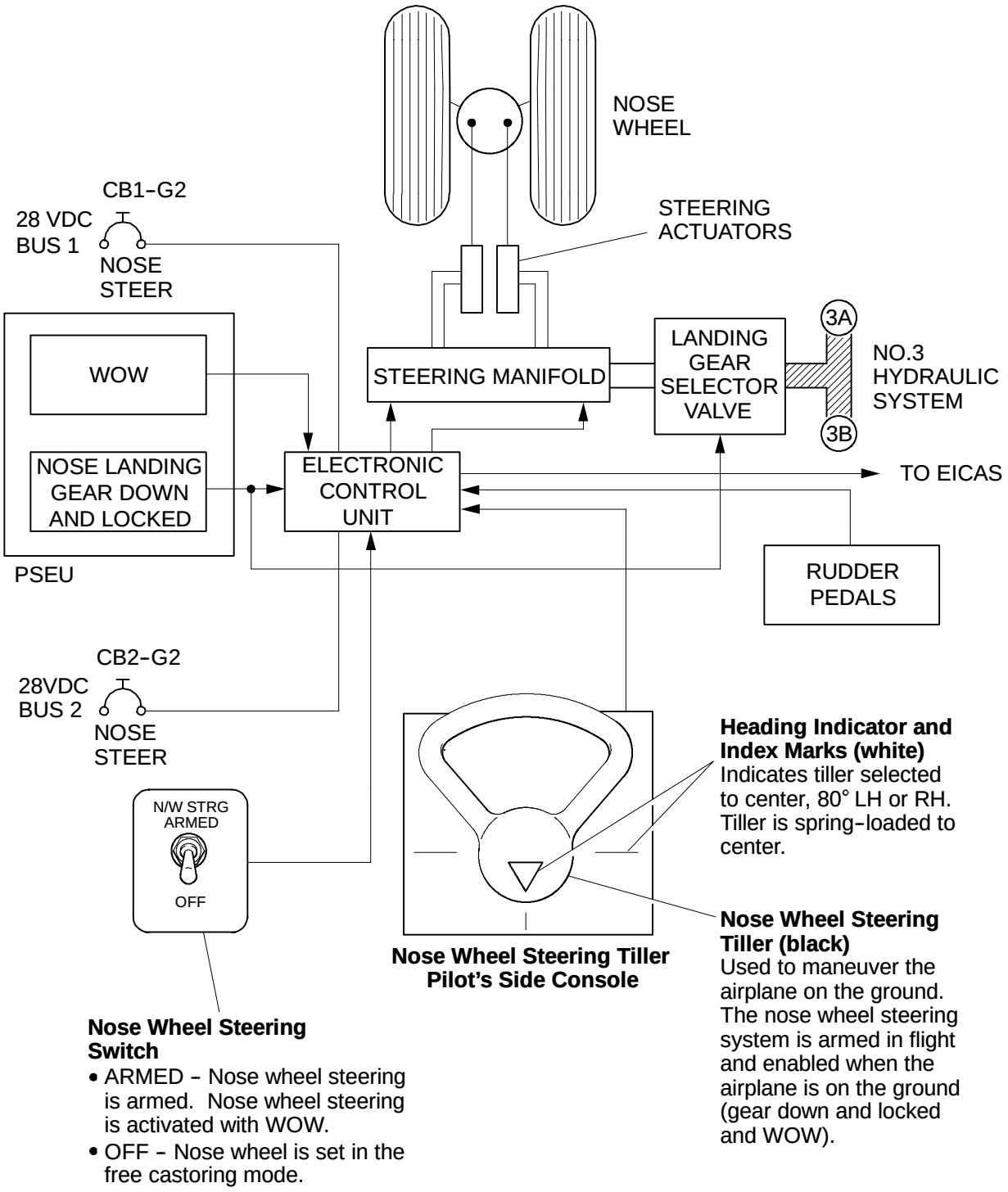
If a failure is detected by the steering control unit, the system reverts to free castoring mode. The pilot then maintains ground directional control through rudder control and differential braking.

In the event of failure of hydraulic system No. 3, the nose wheel is centered mechanically by the centering cams. Rudder, differential braking and differential thrust will be used for directional control.

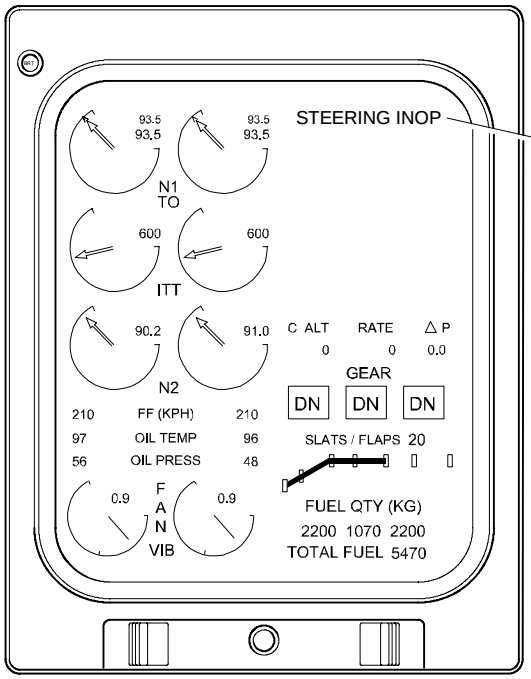
The steering control unit continuously monitors the nose wheel steering system, and any detected faults are annunciated on EICAS in the form of a visual messages. Fault detection will result in steering system shutdown which will revert the system to free castoring mode.

NOTE

Prior to landing, the "STEERING INOP" caution message may come on if the nose wheel steering tiller is moved more than 2 degrees.



Nose Wheel Steering System – Schematic
Figure 16–50–1



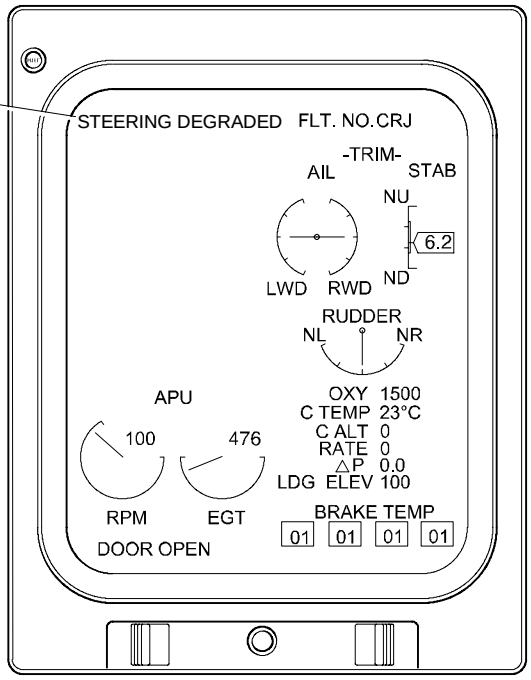
STEERING INOP caution (amber)
Indicates that the steering control unit has detected a fault.

Primary Page

STEERING DEGRADED status (white)
Indicates possible intermittent loss of steering due to nose wheel bouncing.

NOTE

Aft CG and / or light weight are possible conditions for this message to come on.



Status Page

Nose Wheel Steering EICAS Indications <1001>
Figure 16-50-2

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Nose Wheel Steering	Control Unit	NOSE STEER	DC BUS 1	1	G2	
		NOSE STEER	DC BUS 2	2	G2	