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Airbus
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ATA 32
Landing Gear

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Training Manual

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ATA 32 LANDING GEAR

32–00 LANDING GEAR - GENERAL

INTRODUCTION

The Landing Gear (L/G) System consists of:

- two Main Landing Gears (MLG) and their related Main Landing Gear Doors
- a Nose Landing Gear (NLG) and its related Nose Landing Gear Doors
- two Extension and Retraction Systems for the Landing Gears and their related doors
- Landing Gear Wheels and their related Braking Systems
- a Nose Landing Gear Steering System.
- a Landing Gear Indication and Warning System

The Landing Gear supports the aircraft on the ground. The Main Landing Gears are oleo–pneumatic shock absorbers which absorb taxi and landing loads.

During flight, the Landing Gears retract into the landing gear bays of the aircraft belly. When the L/G is extended or retracted, the related doors close to fit with the aerodynamic contour of the aircraft.

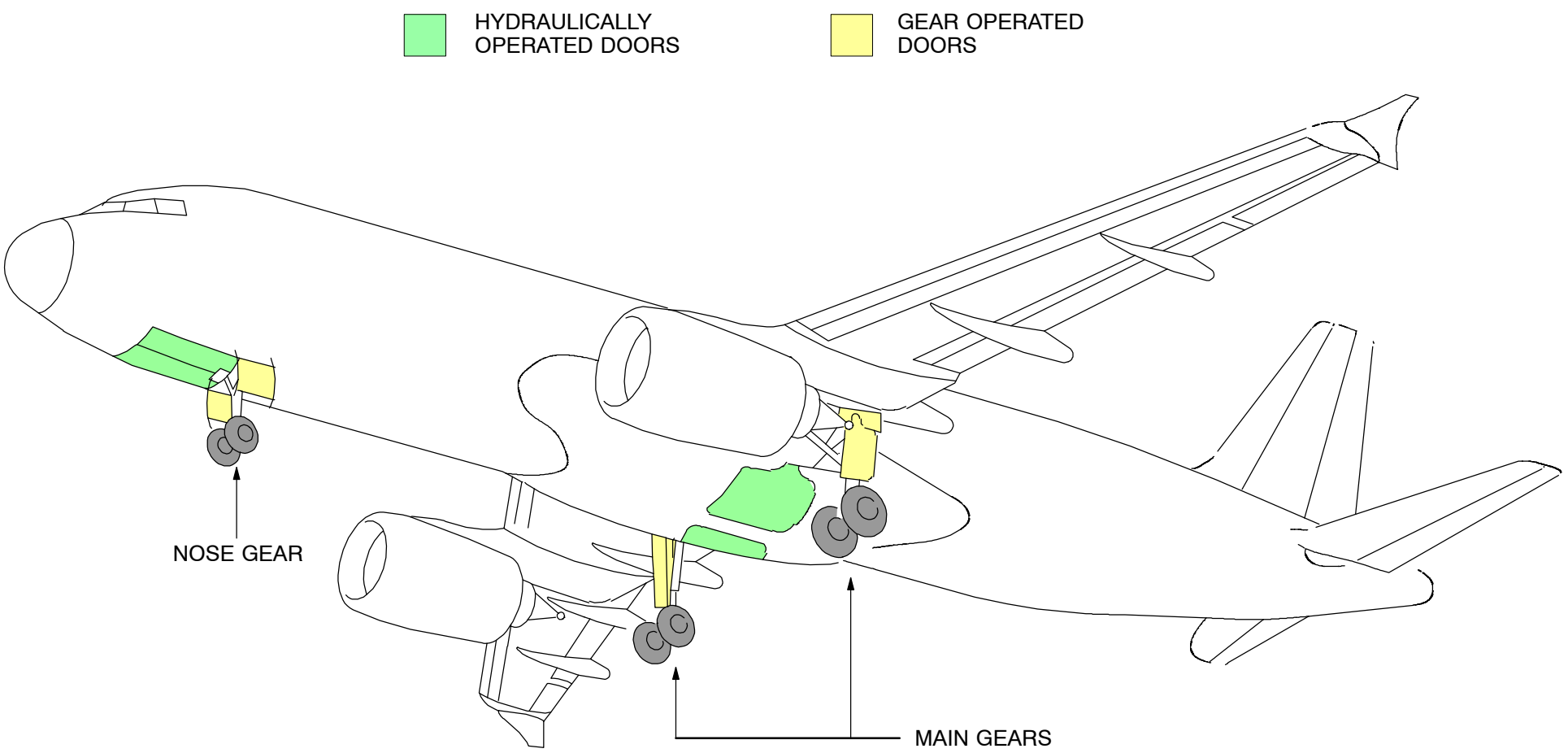


Figure 1 Landing Gears and Doors

SAFETY PRECAUTIONS

CAUTION: BEFORE PERFORMING ANY WORK IN THE AREA OF THE LANDING GEARS, BE SURE THAT ALL THE FOLLOWING SAFETY PRECAUTIONS ARE OBSERVED:

- Wheel Chocks are in position
- the hydraulic system is de-pressurized
- Safety Sleeves and Safety Pins are fitted on the Landing Gear and Landing Gear Doors
- Ground Door Opening Handles are in open position

The graphic below shows the locations of the Landing Gear safety devices

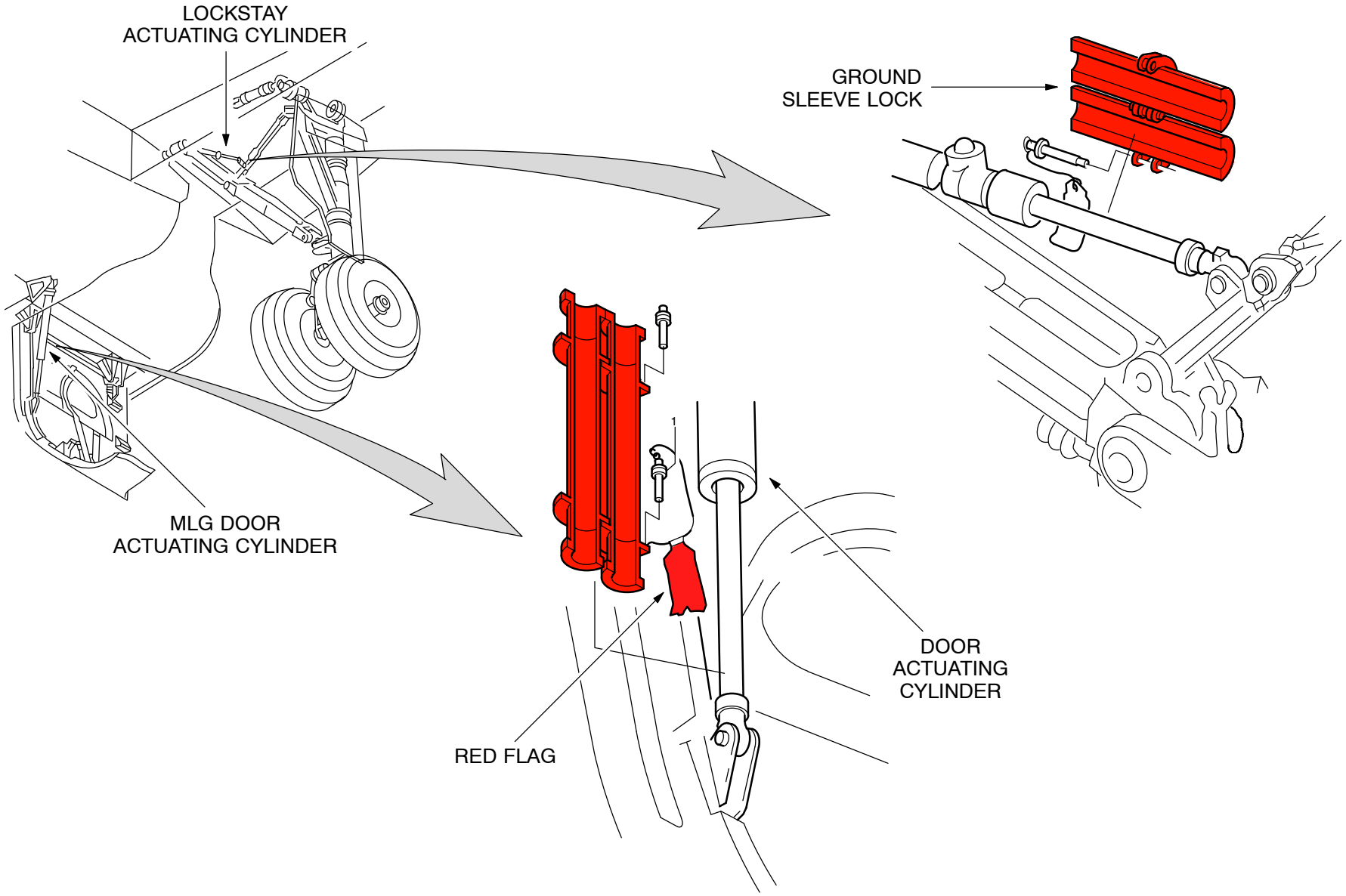


Figure 2 MLG and MLG-Doors Safety Devices

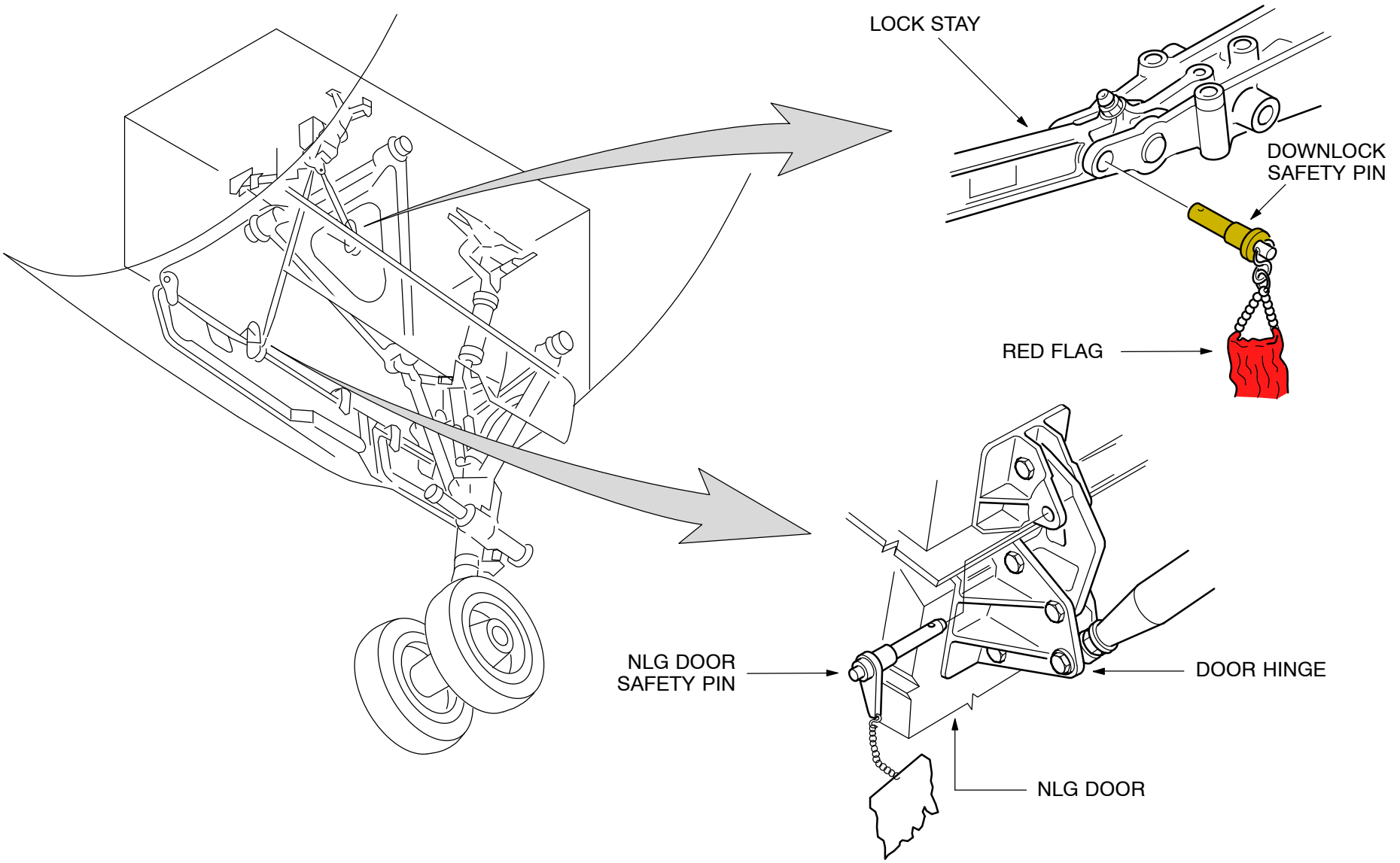


Figure 3 NLG and NLG-Doors Safety Devices

MAIN LANDING GEAR

MLG GROUND SLEEVE LOCK

MLG DOOR
SAFETY SLEEVE

NOSE LANDING GEAR

NLG DOWNLOCK SAFETY PIN

NLG DOOR SAFETY PIN

Figure 4 Safety Devices

LANDING GEAR DOORS GROUND OPENING

Aircraft Status Precaution

- on ground
- wheel chocks in position
- Landing Gear safety devices installed
- A/C electrically grounded
- electrical ground cart available.

Safety Precautions

WARNING: MAKE SURE THAT THE GROUND SAFETY LOCKS ARE IN POSITION ON THE LANDING GEAR.

WARNING: MAKE SURE THAT THE CONTROLS AGREE WITH THE POSITION OF THE ITEMS THEY OPERATE BEFORE YOU PRESSURIZE A HYDRAULIC SYSTEM.

WARNING: PUT SAFETY DEVICES AND WARNING NOTICES IN POSITION BEFORE YOU START A TASK ON OR NEAR COMPONENTS WHICH MAY MOVE. MAKE SURE THAT THE DOORS TRAVEL RANGES ARE CLEAR.

WARNING: FOR YOUR SAFETY, STAY AFT OF THE GEAR LEG WHEN YOU OPERATE THE GROUND OPENING CONTROL OF THE DOORS. CAREFULLY READ THE PLACARD ON THE LEG DOOR BEFORE YOU OPEN THE GEAR DOORS.

Main Doors

The ground opening control handle is located FWD of the respective MLG bay into the hydraulic compartment. This location places the operator in a safe position with a clear view of the door travel. The handle is connected through a push–pull cable to the door by–pass valve on the outboard side of the MLG bay.

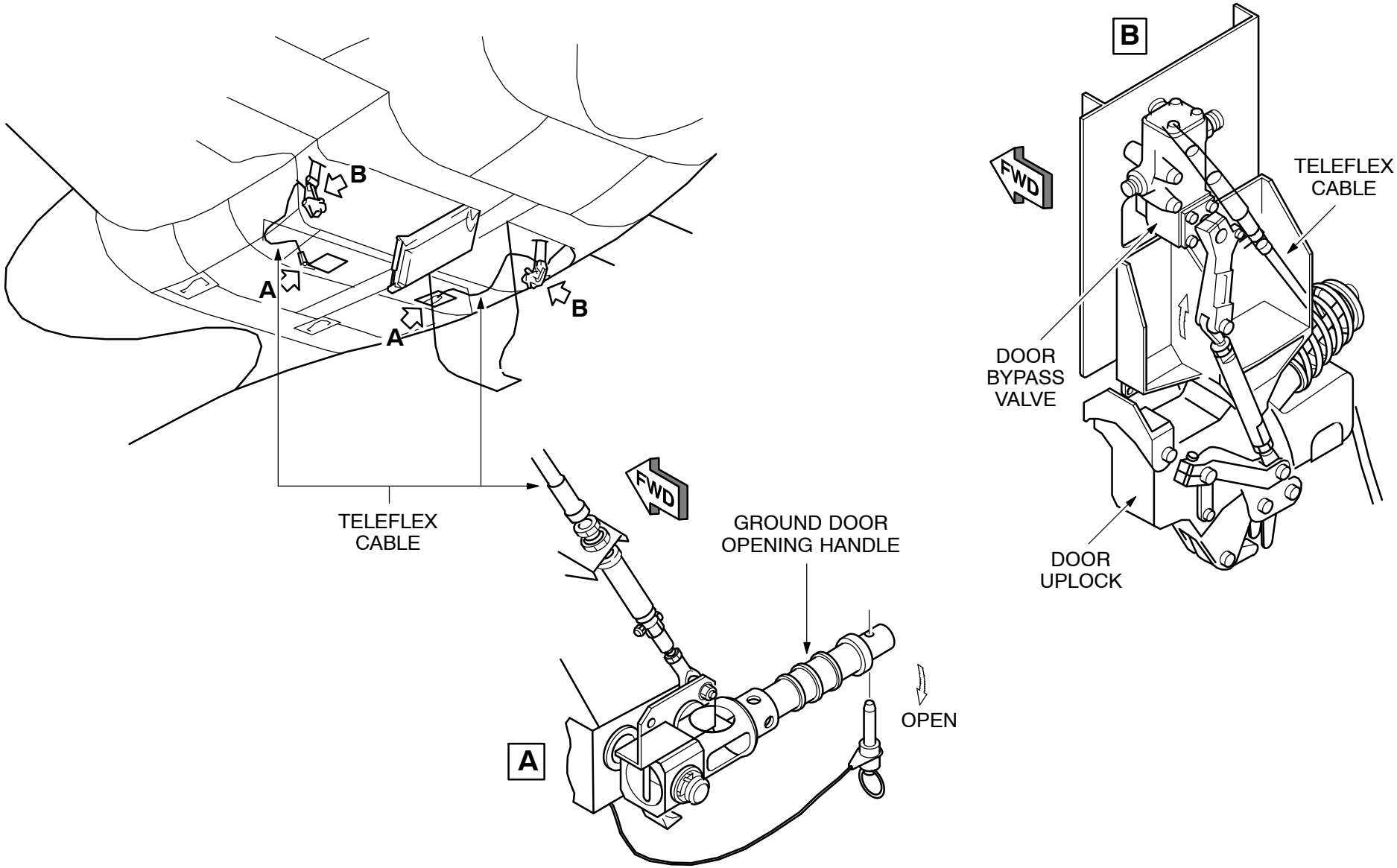


Figure 5 MLG Ground Opening

Nose Doors

The ground opening control handle is located in a housing AFT of the Nose NLG bay. This location places the operator in a safe position with a clear view of the door travel. The handle is connected to a lay shaft on the door by–pass valve and the door uplock on the left hand side wall of the NLG bay.

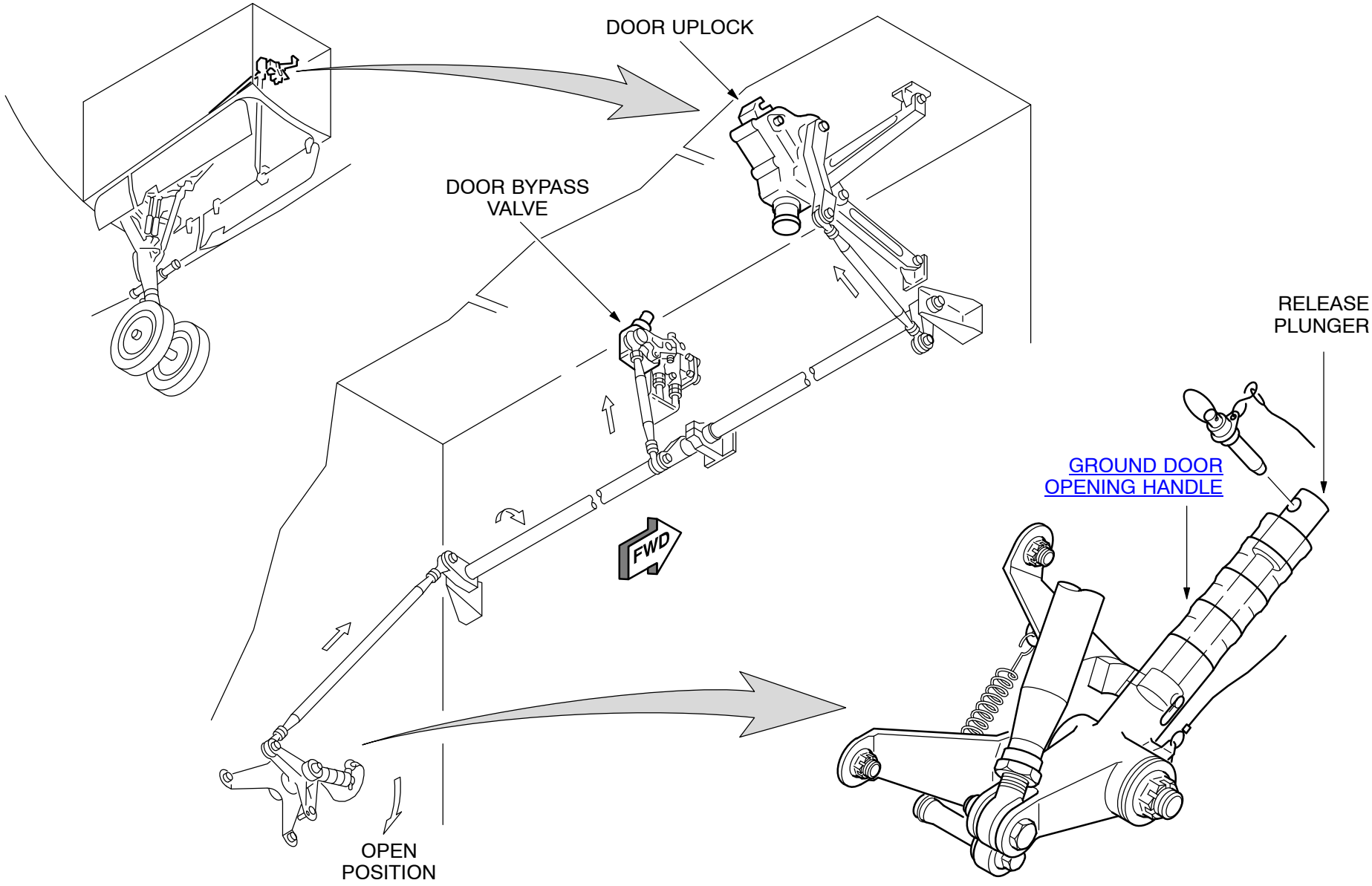


Figure 6 NLG Ground Opening

PANEL DESCRIPTION

1 LANDING GEAR CONTROL LEVER ASSEMBLY

The two position selector lever sends electrical signals to the two LGCIUs.

- **UP:**

  This position selects landing gear retraction.

  An interlock mechanism prevents the movement of the lever when either gear shock absorber is compressed or the nose wheel steering is not centered.

- **DOWN:**

  This position selects landing gear extension

The red arrow light illuminates if the landing gear is not locked down at the following conditions:

- when the aircraft is in the landing configuration associated with MASTER WARNING
- L/G not downlocked and radio height lower then 750ft and both engines N1 lower than 75% (or if engine shutdown N1 of the remaining engine lower than 97%)
- L/G not downlocked and radio height lower then 750ft and flaps at“ 3“ or “FULL“
- L/G not downlocked and flaps at “FULL“ and both radio altimeters failed

2 AUTO/BRK LANDING GEAR PANEL (PANEL 402VU)

LDG Gear Position Lights

UNLK:

Illuminates red if the gear is not locked in selected position.

A green the triangle illuminates if the gear is locked down.

NOTE: LDG GEAR indicator lights remain available as long as LGCIU 1 is electrically supplied, even in case of LGCIU 1 FAULT.

Autobrake Arm P/BSW

MAX, MED, LO Pushbutton switch: controls the arming of the required deceleration rate.

- **MAX:** Normally selected for take off.

  In the event of an aborted T/O, the maximum pressure is sent to the brakes as soon as ground spoiler deployment order is present.

- **MED:** Normally selected for landing.

  Progressive pressure is sent to the brakes 2 seconds after ground spoiler deployment in order to provide a $3m/s^2$ deceleration.

- **LO:** Normally selected for landing.

  Progressive pressure is sent to the brakes 4 seconds after ground spoiler deployment in order to provide a $1.7m/s^2$ deceleration.

ON: Illuminates blue to indicate positive arming.

DECEL: Illuminates green when actual aircraft deceleration corresponds to 80% of the selected rate.

OFF: The corresponding autobrake mode is deactivated.

BRK Fan P/B Switch

ON: Illuminates white when the brake fans run and the L/H MLG is downlocked.

OFF: The brake fans stop.

HOT: Illuminates amber with associated ECAM caution when brake temperature becomes high.

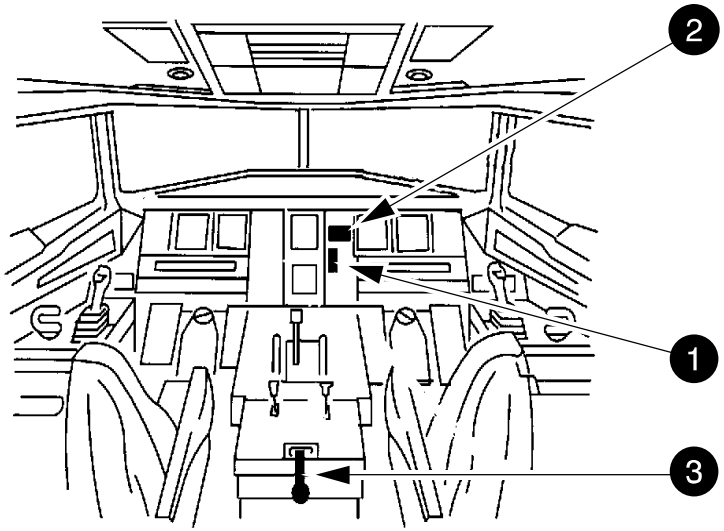
A/SKID & N/W Steering Switch

ON: Green hydraulic pressure is available. Anti-skid and Nose Wheel Steering is available.

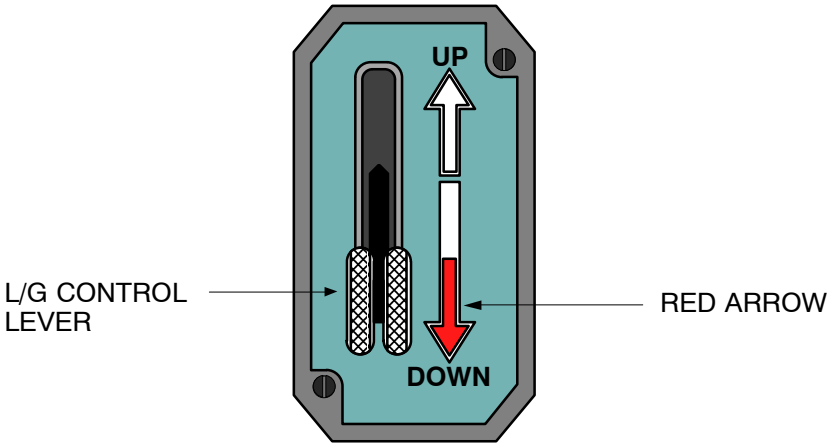
OFF: Anti-skid and Nose Wheel Steering are deactivated.

3 FREE FALL EXTENSION HANDLE

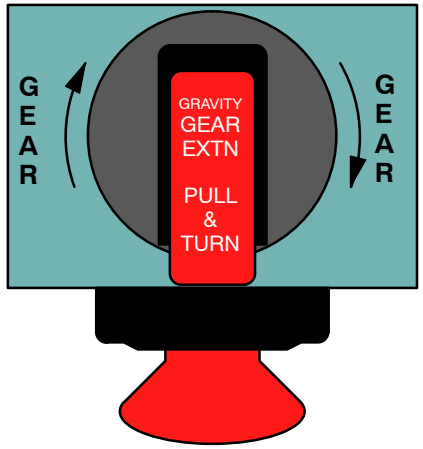
For Landing Gear gravity extension the handle must be extended. than rotated three turns clockwise.



1 L/G Control Lever Assembly



3 Free Fall Extension Handle



2 Panel 402 VU

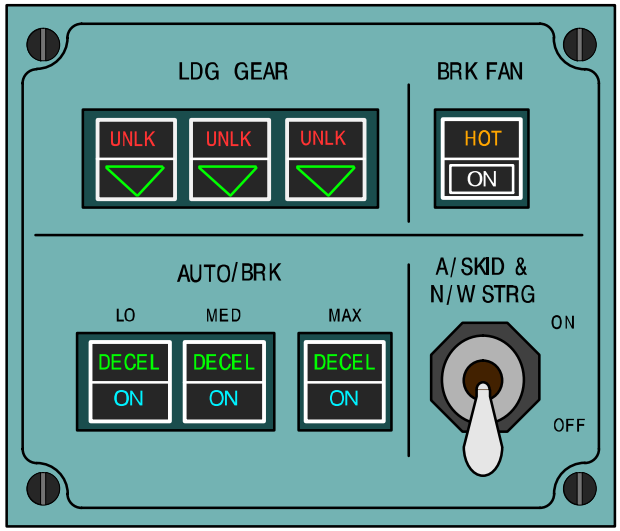


Figure 7 Controls & Indicators

4 PARKING BRAKE CONTROL HANDLE

Pull and turn the handle clockwise to apply the parking brake. The PARK BRK indication is displayed on the ECAM memo page.

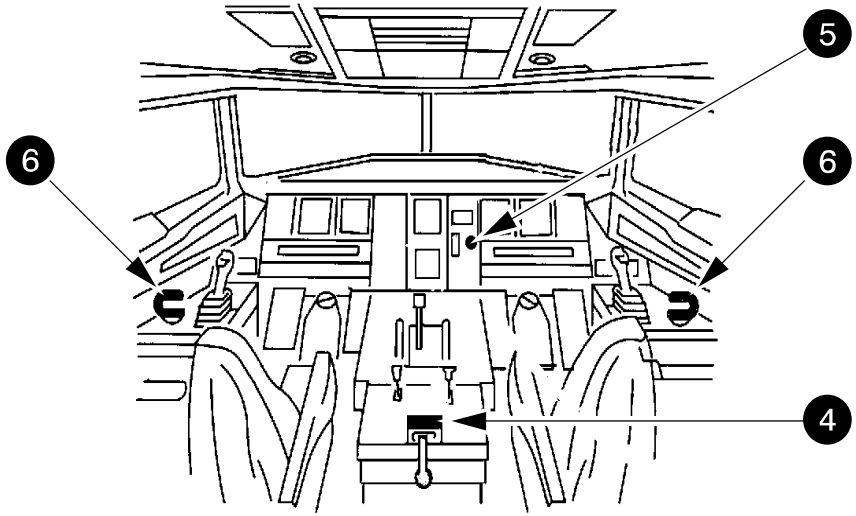
NOTE: Activation of the parking brake deactivates all other braking modes.

5 BRAKES AND ACCU PRESSURE INDICATOR

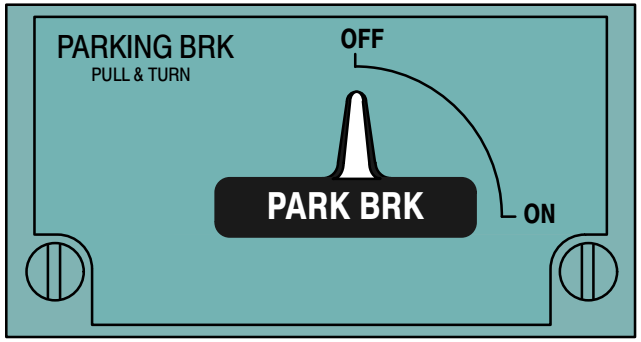
- **ACCU PRESS**:
  Indicates the pressure in the yellow brake accumulator
- **BRAKES**:
  Indicates the yellow pressure delivered to the left and right brakes measured upstream of the alternate servo valves.

6 NOSE WHEEL STEERING HANDWHEELS

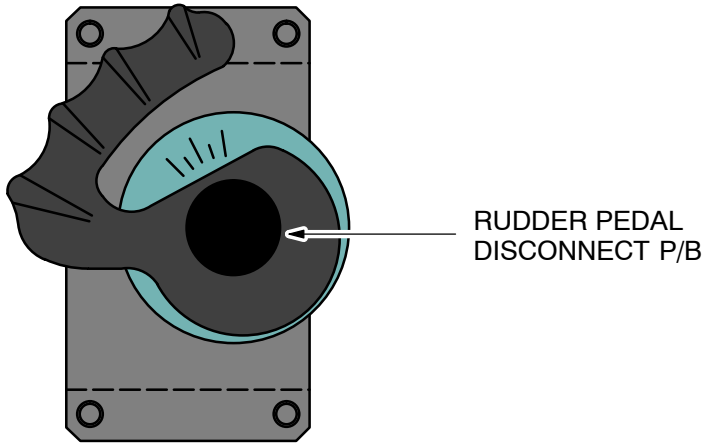
The steering handwheels can steer the nose wheel up to 75° in either direction. Pressing the disconnect pushbutton on either handwheel removes control of nose wheel steering from the rudder pedals until the button is released.



4 Parking Brake Control Handle



6 Nose Wheel Steering Handwheel



5 Brakes & Accu Pressure Indicator

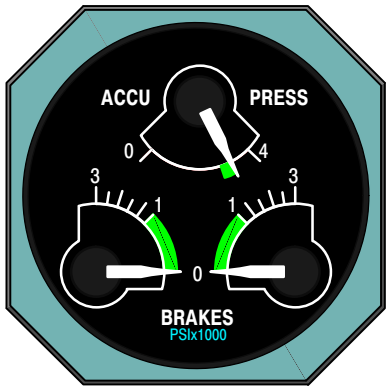


Figure 8 Controls and Indicators

ECAM INDICATION

ECAM Wheel Page

The ECAM Wheel Page can be selected from the ECAM control panel or appears automatically when:

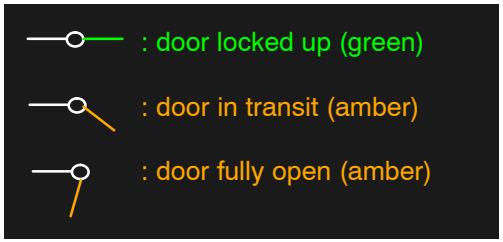
- The first engine starts until the first engine gets to T/O power
- The L/G is selected DOWN or at 800 ft radio altitude (whichever is the first to occur) until the second engine shutdown.

1 Landing Gear Position Indication

The L/G positions are indicated by two triangles for each gear. Each triangle is controlled by one LGCIU, the triangle of the active LGCIU is shown in front.

- The triangle illuminates green if the LGCIU detects a L/G downlocked
- The triangle illuminates red if the LGCIU detects a L/G in transit
- No visible triangle indicates the LGCIU detects L/G uplocked
- Amber crosses indicates the LGCIU failed

2 Landing Gear Door Position Indication



3 L/G CTL

This legend appears amber along with an ECAM caution if the gear lever and the L/G position do not agree.

4 UPLOCK

This legend appears along with an ECAM caution if the L/G uplock is engaged when the L/G is down locked.

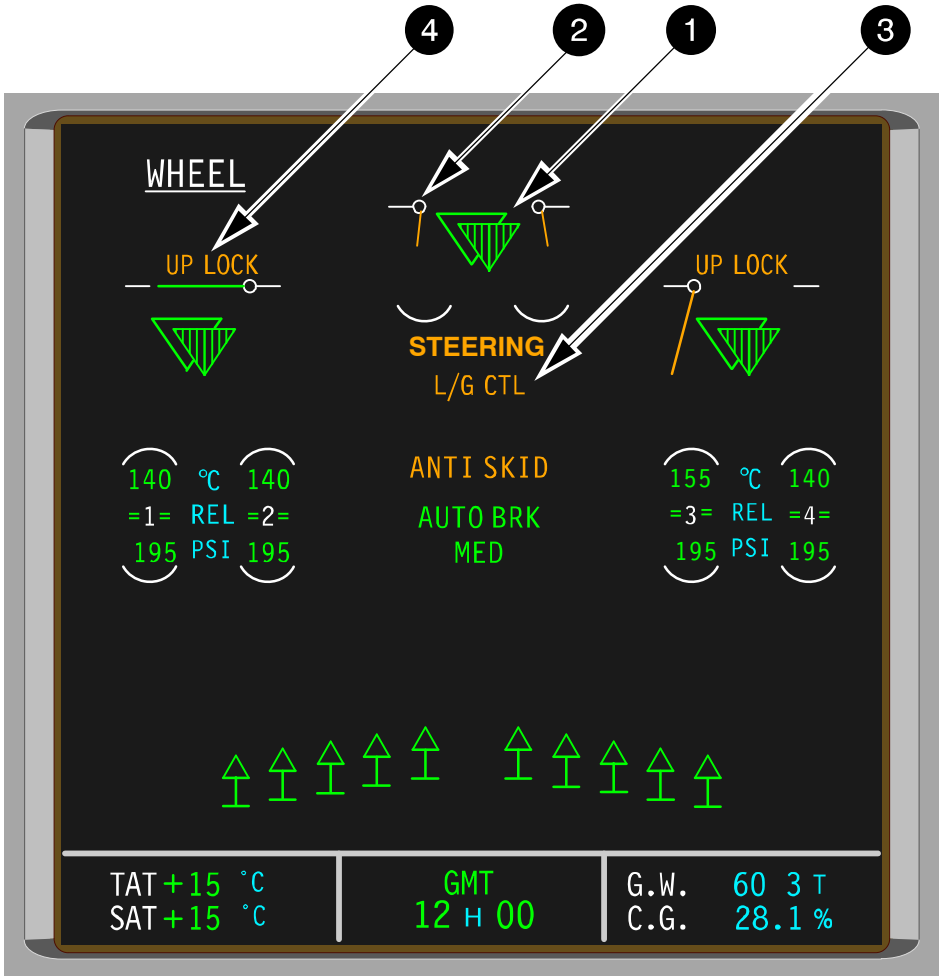


Figure 9 ECAM Wheel Page 1/2

5 A/SKID

Appears amber associated with ECAM caution in case of total BSCU failure or when the A/SKID & N/W STRG switch is in OFF position, or if the BSCU detects an ANTI-SKID failure.

6 Brake Temperature Indication

The temperature normally appears in green. The green arc appears on the hottest wheel when one brake temperature exceeds 100°C. The green arc becomes amber, and ECAM caution appears, when the corresponding brake temperature exceeds 300° C, or 260° C on A321.

7 Wheel Number

This wheel number (white) identifies wheels of the main L/G.

8 ALTN BRK Indication

This legend appears in green if the braking system is in alternate mode.

9 AUTO BRK Indication

The AUTO BRK Indication appears in green when auto brake is armed. It is flashing green for 10 seconds after auto brake disengagement. It appears in amber, along with ECAM caution in case of system failure.
LO, MED or MAX indicates the selected rate (green).

10 Release Indication

The green lines temporarily appear in flight after L/G extension to indicate a valid anti-skid function. They reappear after touch down, along with REL (blue), when the anti-skid is active.

11 STEERING Indication

The STEERING indication appears amber associated with ECAM caution in case of a total BSCU failure, A/SKID & N/W STRG switch in OFF, or steering failure detected by the BSCU.

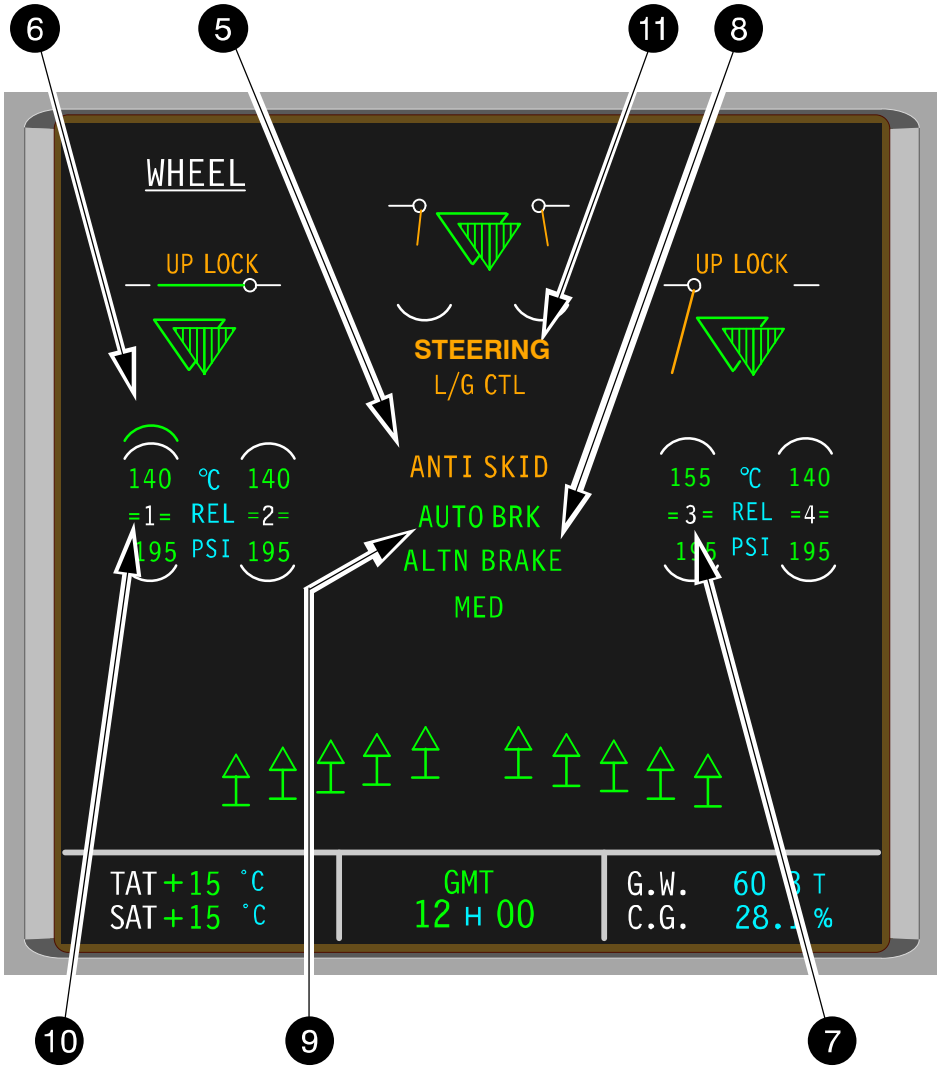


Figure 10 ECAM Wheel Page 2/2

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32–10 MAIN GEAR AND DOORS

INTRODUCTION

Purpose

The MLGs (**M**ain **L**anding **G**ears) support the aircraft on the ground and absorb loads during taxiing, take off and landing by means of a Shock Absorber and a Torque-Link Damper. They are installed in the wing between the rear spar and gear rib 5 at zones 730 and 740.

Each MLG leg has twin wheels with a multi–disc brake unit attached. The MLGs retract into bays on the underside of the aircraft. The bays are closed by the MLG doors. Extension and retraction is achieved hydraulically by a Retraction Actuator.

The Side Stay Assembly serves for side stability and together with the Lock Stay as a locking device while the MLG is extended.

General

The MLGs includes the following parts:

- a MLG Shock Absorber
- a Side Stay Assembly which includes a Lock Stay
- a Retraction Actuator
- a Torque-Link Damper
- Electrical and Hydraulic Dressings

MLG Doors

Each MLG has three doors:

- a Fixed Fairing Door that is attached to the MLG leg
- a Hinged Door that is attached to the underside of the wing
- a Main Door that is hydraulically operated and closes the section of the fuselage after the MLG has retracted or extended.

Indication

Proximity sensors on the MLG and the MLG doors give position data to the LGCIU (**L**anding **G**ear **C**ontrol and **I**nterface **U**nit).

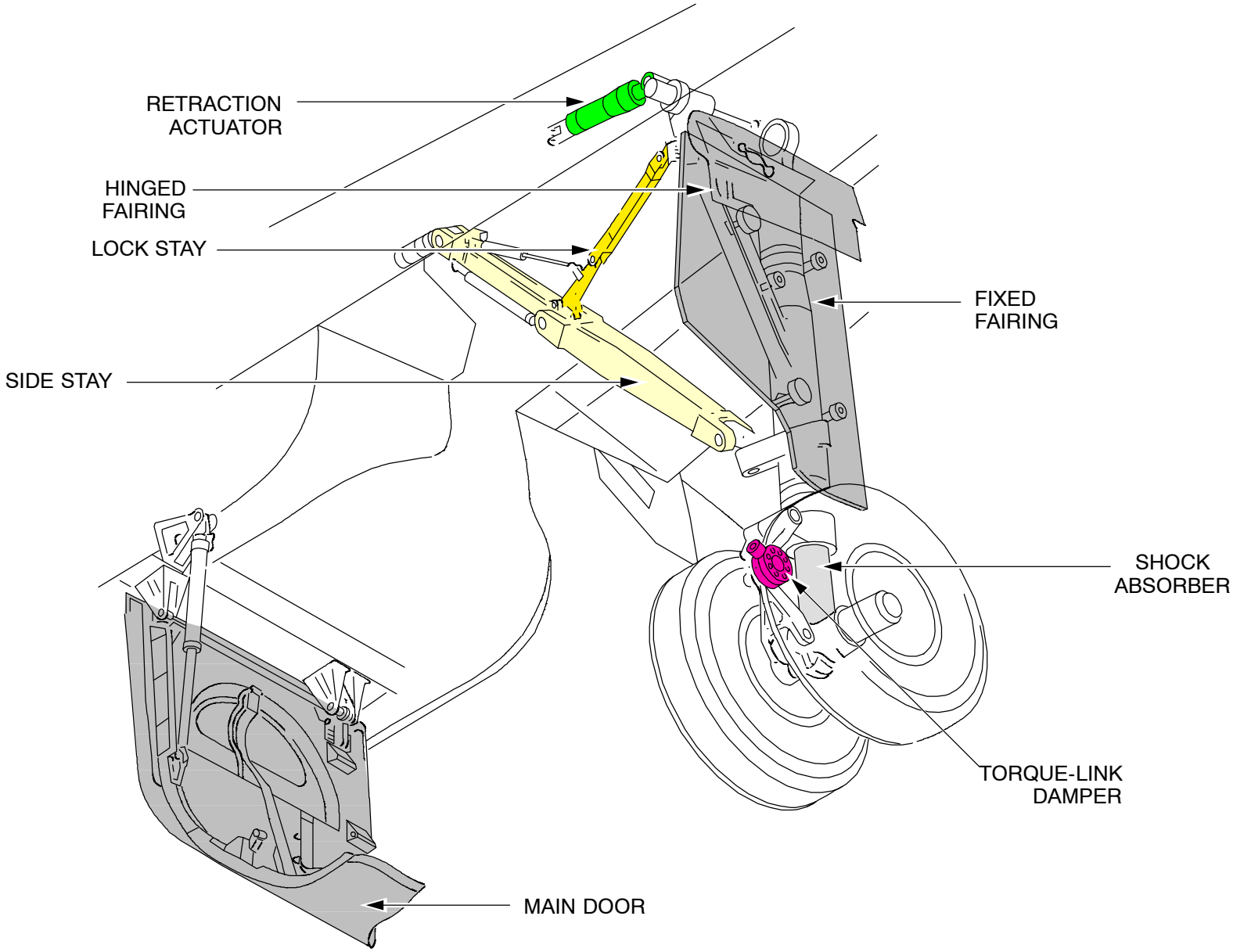


Figure 11 Main Landing Gear and Doors

32–11 MAIN GEAR

MAIN LANDING GEAR DESCRIPTION

Main Landing Gear Leg

Each MLG leg has two primary structural components, which are the main fitting and the sliding tube. Each of these components is a one–piece assembly and contains the shock absorber.

An axle, which is a part of the sliding tube, can contain a wheel–speed tachometer, a brake–cooling fan and/or a tire–pressure sensor for each wheel.

Torque Links

The upper torque–link and the lower torque–link align the axle. They attach to the lugs at the front of the main fitting and the sliding tube.

There is a torque–link damper at the interface of the upper and lower torque–links. The torque–link damper absorbs the vibrations that can occur during landing.

Side–Stay Assembly

A two–piece side–stay assembly connects the MLG leg main–fitting and the wing structure. It prevents the movement of the landing–gear leg sideways. The side–stay assembly is locked in the down position by a two–piece lock–stay assembly.

Retraction Actuator

A retraction actuating cylinder connects the wing structure and the landing–gear forward hinge–point.

The retraction actuating cylinder retracts the MLG leg (sideways) into the fuselage.

Inflation Valve

The main fitting and the sliding tube each have an inflation valve. The valves are used to fill the shock absorber with hydraulic fluid and nitrogen.

Dressing

Located between the main fitting and the sliding tube, there is a slave link.

It holds the electrical cables and the hydraulic pipes, to make sure they do not catch on the wheels.

A spare–seal activating–valve is on the main fitting. This operates if there is a hydraulic leak through the gland seals. It is only used until the gland seals can be examined/replaced.

The hydraulic pipes and the electrical harness are in rigid and flexible conduits. The conduit routing gives protection from runway debris, birdstrikes and flailing tire treads, as well as maximum separation of the two systems.

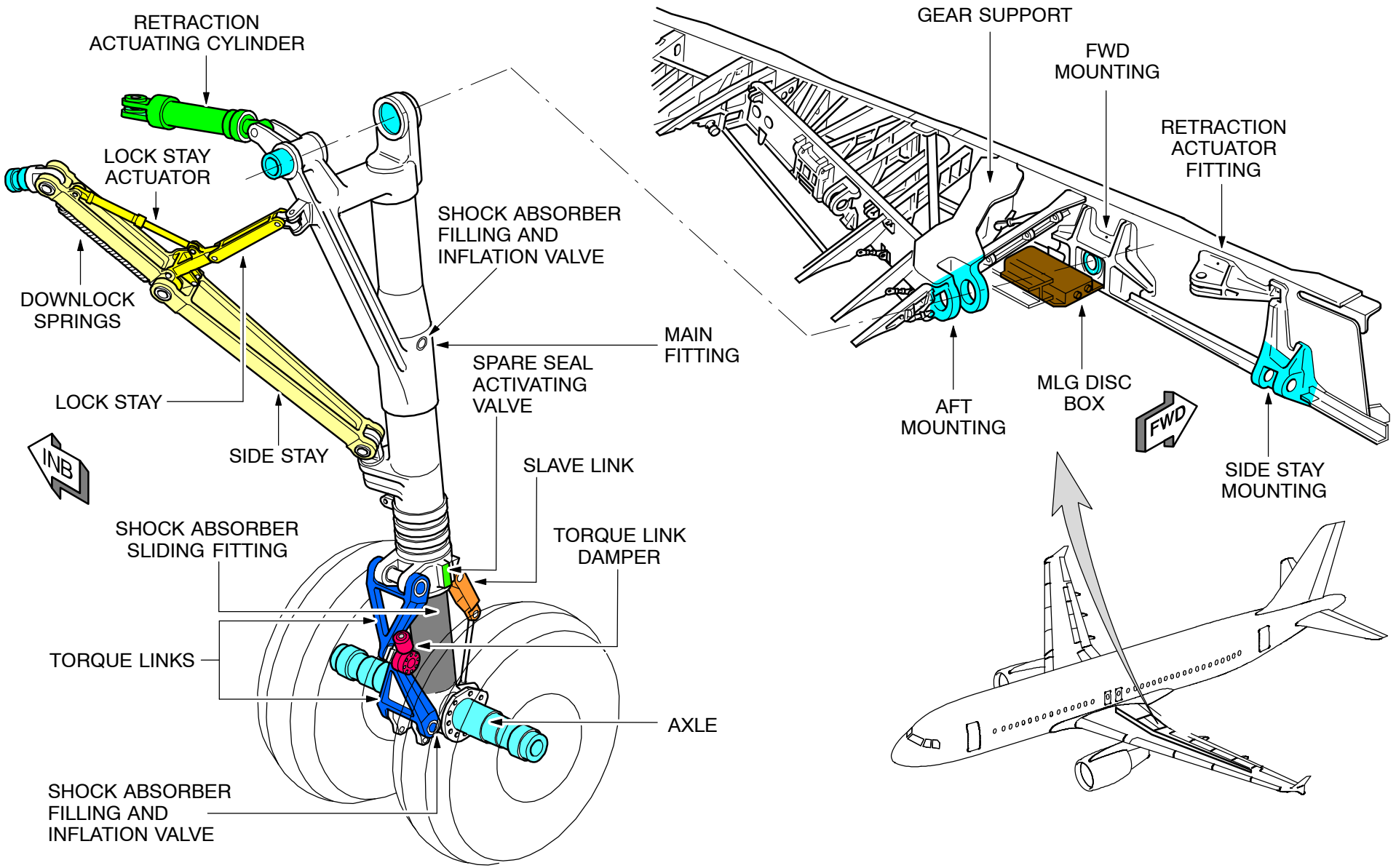


Figure 12 Main Landing Gear

SHOCK ABSORBER

The Shock Absorber is a telescopic oleo–pneumatic unit which includes the sliding tube. It is in the main fitting to transmit the landing, take–off and taxiing loads to the wing.

Function

When the shock absorber compresses, the load transmits to the hydraulic fluid and nitrogen gas. The recoil stroke is slow, which makes sure that the aircraft does not become airborne again.

The Shock Absorber is a two stage unit and contains four chambers:

- a 1st stage gas chamber contains an LP gas pressure and some hydraulic fluid
- a recoil chamber that contains hydraulic fluid
- a compression chamber that contains hydraulic fluid
- a 2nd stage gas chamber that contains a HP gas pressure

Primary control of the shock absorber recoil is:

- the fluid flow from the recoil chamber into the gas chamber
- the fluid flow from the gas chamber into the compression chamber.

The damping tube, which contains the first stage orifice, attaches to the head of the 2nd stage cylinder and has a fluid connection. The movement of the damping tube through the orifice block decreases the fluid flow in the 1st stage damping. This increases the damping effect. A floating piston in the 2nd stage cylinder separates the hydraulic fluid of the compression chamber and the gas of the 2nd stage chamber. During a compression stroke, the floating piston does not move down until the gas pressures of the 1st and the 2nd stage chambers are equal.

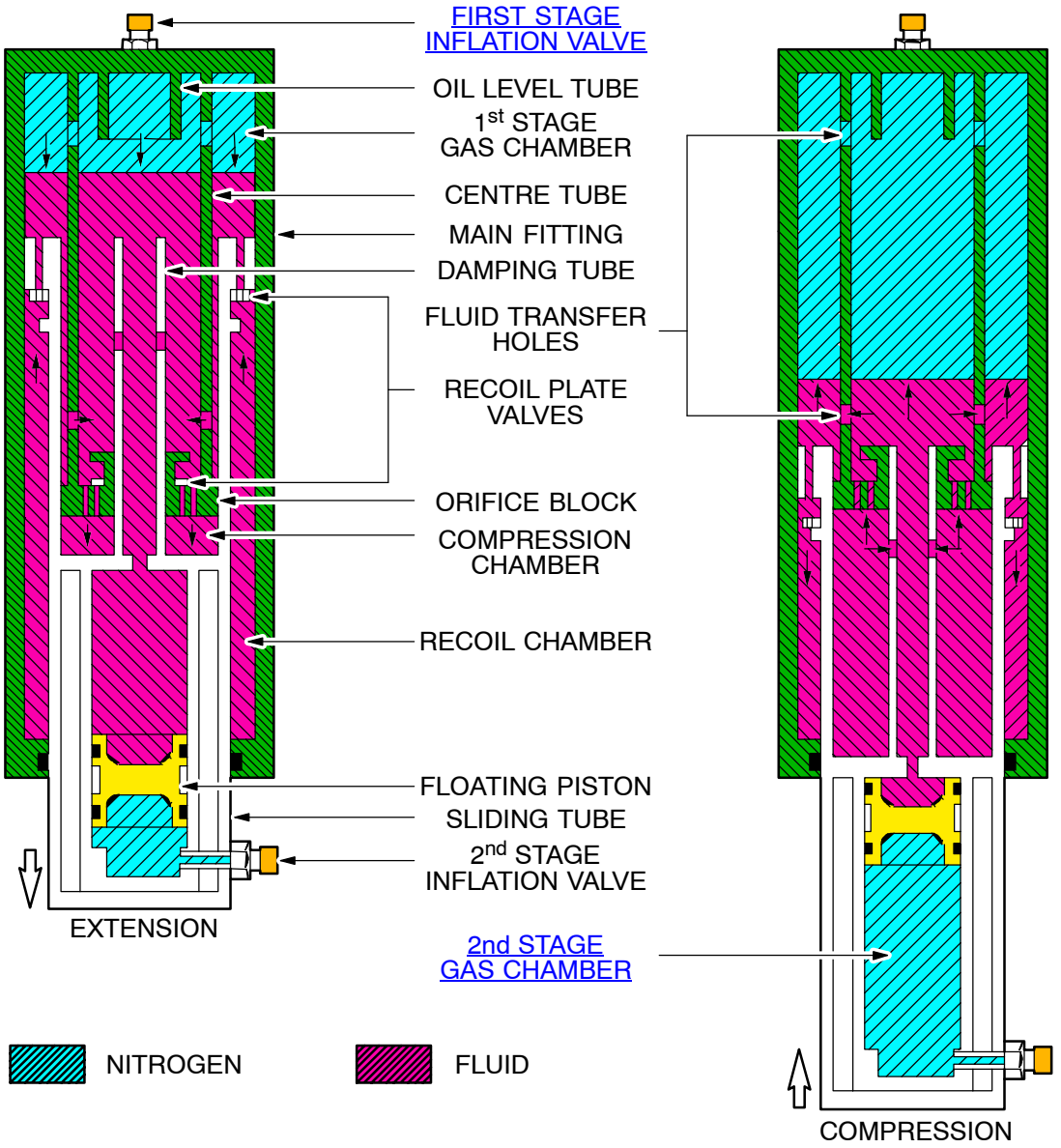


Figure 13 MLG Shock Absorber Schematic

SHOCK ABSORBER COMPONENT DESCRIPTION

Upper Diaphragm and Tube Sub–Assembly

The Upper Diaphragm and Tube Sub–Assembly is connected to the Main Fitting by a Lateral Retaining Pin.

The pin includes the 1st Stage Inflating Valve which fills the shock absorber with hydraulic fluid or nitrogen gas. An oil–level tube towers through the diaphragm into the gas chamber. This gives the correct level of fluid in the shock absorber during the maintenance procedures.

The tube of the diaphragm and tube sub–assembly goes into the open top of the sliding tube. The top part of the tube has four holes in the area of the gas chamber. These holes permit fast separation of the fluid and the gas when the MLG leg goes from the retracted to the extended position.

A diaphragm with a baffle, is at the bottom of the diaphragm and tube sub–assembly.

The baffle causes the diffusion of the fluid that goes through it, to decrease the quantity of absorbed gas.

The diaphragm has a compression–orifice–plate that lets full flow during the compression, but decreases the flow during the recoil.

A damping tube, on the lower diaphragm, moves through the baffle. It has a set of four radially–aligned holes that give the two–stage damping effect of the shock absorber.

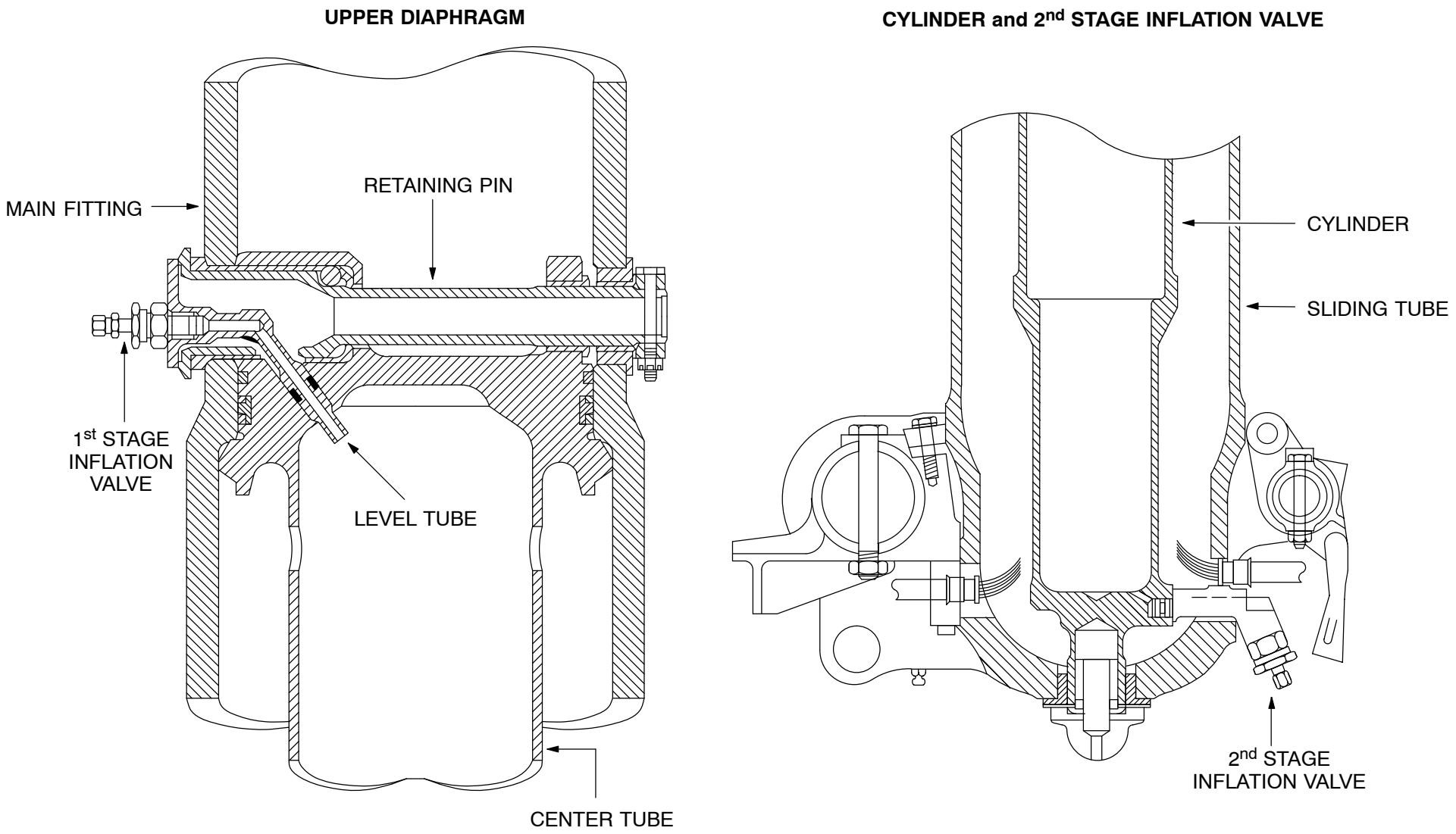


Figure 14 Diaphragm and Cylinder

UPPER BEARING

The sliding tube connects to the main fitting by a bearing and a bearing housing. A recoil valve assembly (on the bearing housing) has a recoil–orifice–plate and recoil chamber to control the flow of fluid.

An annular travel–stop inside the sliding tube is attached by the dowels which hold the bearing housing. The travel–stop touches the center tube flange when the unit is fully extended, and holds the sliding tube.

Gland–Housing Assembly

A gland–housing assembly, at the bottom end of the main–fitting barrel, seals the joint between the barrel and the sliding tube.

This assembly contains a:

- Gland Housing, that holds the Top (Spare) Gland Seals and the Bottom (Main) Gland Seals
- Bearing, that keeps the Sliding Tube correctly aligned
- Wiper Ring, that keeps the unwanted material out of the shock absorber.

Three threaded pins attach the gland housing and the bearing to the barrel of the main fitting. The threaded pins have greasers to lubricate the bearing.

You can remove the shock absorber from the main fitting while it is on the aircraft. You must remove the lateral retaining pin and the main–gland lower–bearing assembly first.

ATTENTION: To get the sufficient ground clearance, it is necessary to increase the jacked height of the aircraft.

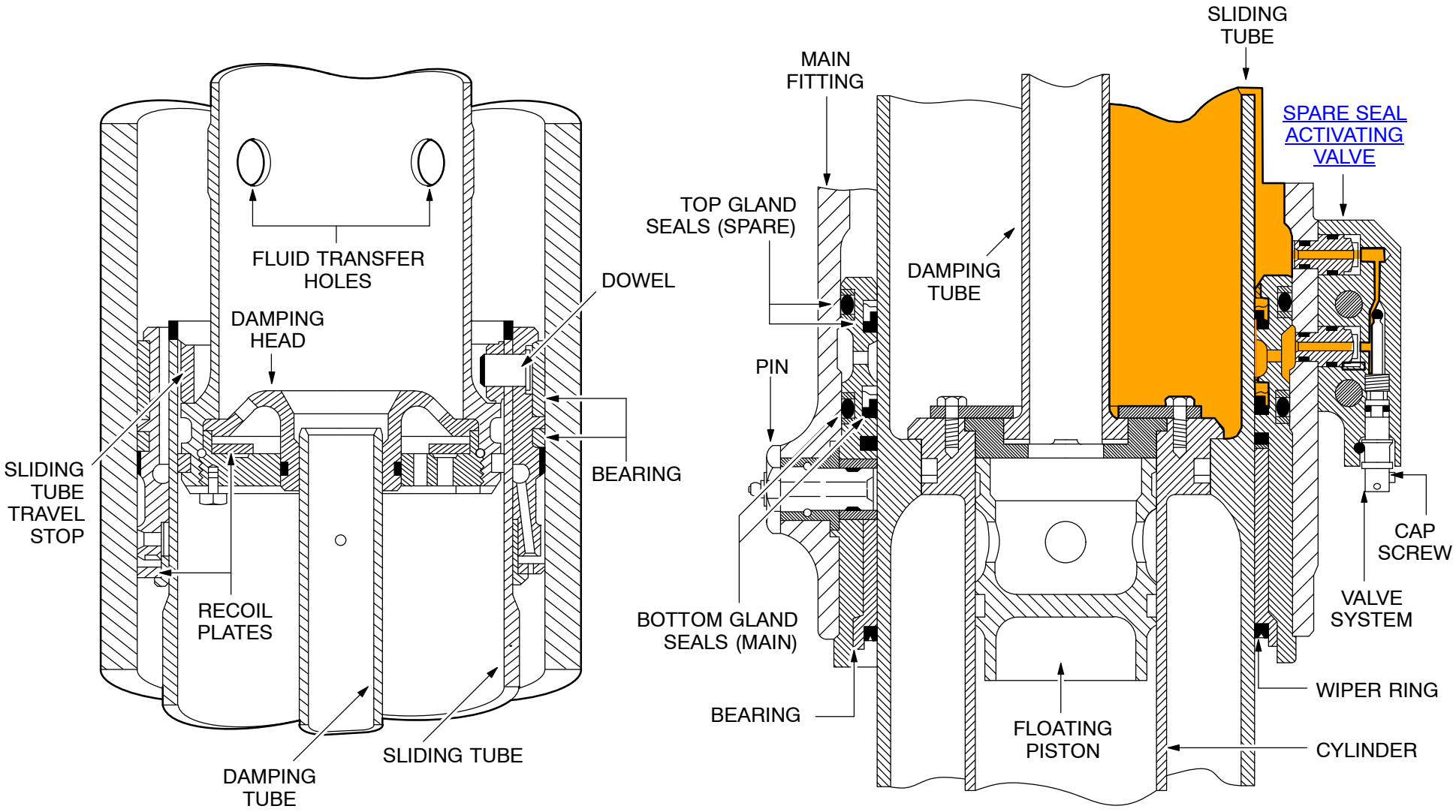


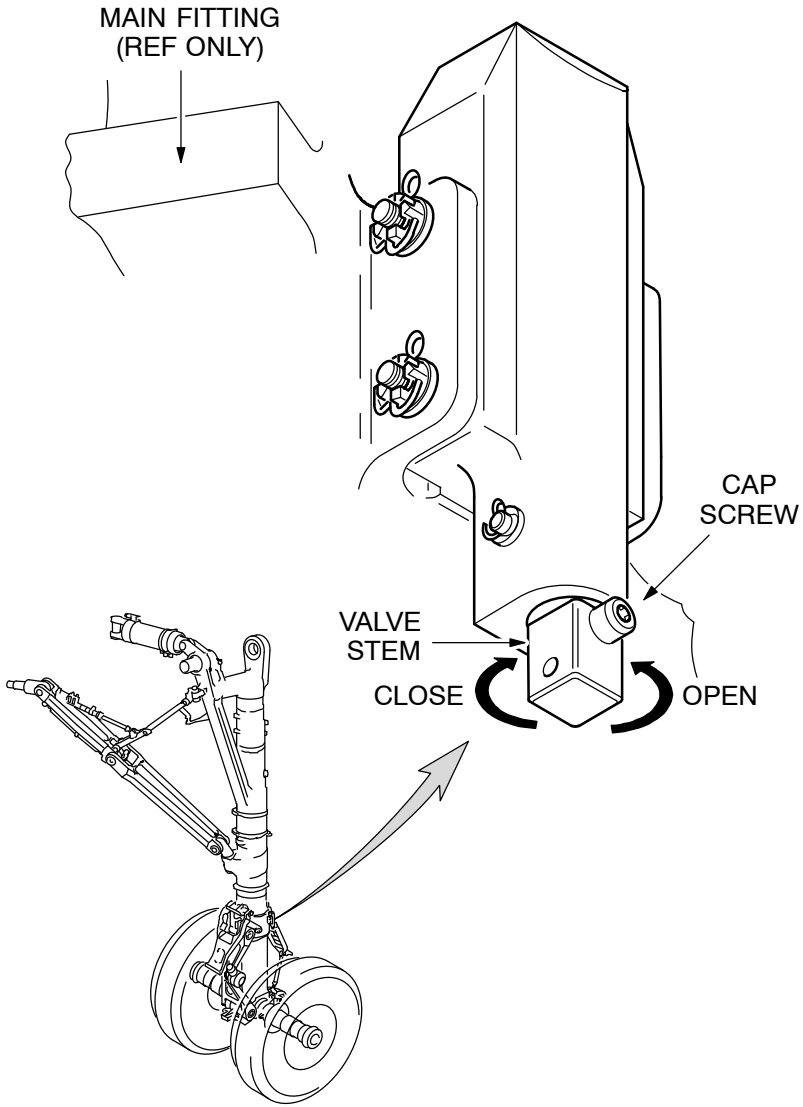
Figure 15 UPR Bearing and Gland Housing Assembly

SPARE SEAL ACTIVATING VALVE

Each main fitting has a spare–seal activating–valve. This valve can isolate the bottom gland seals if a leak occurs.

The activating valve is on the barrel of the main fitting, adjacent to the gland–housing assembly. When the activating valve closes, it isolates the bottom set of seals (from the fluid pressure).

The spare seal operates when you remove the cap screw and turn the threaded valve–stem in. This puts the ball valve on its seat, which isolates the bottom gland seals and causes the top gland seals to seal the joint.



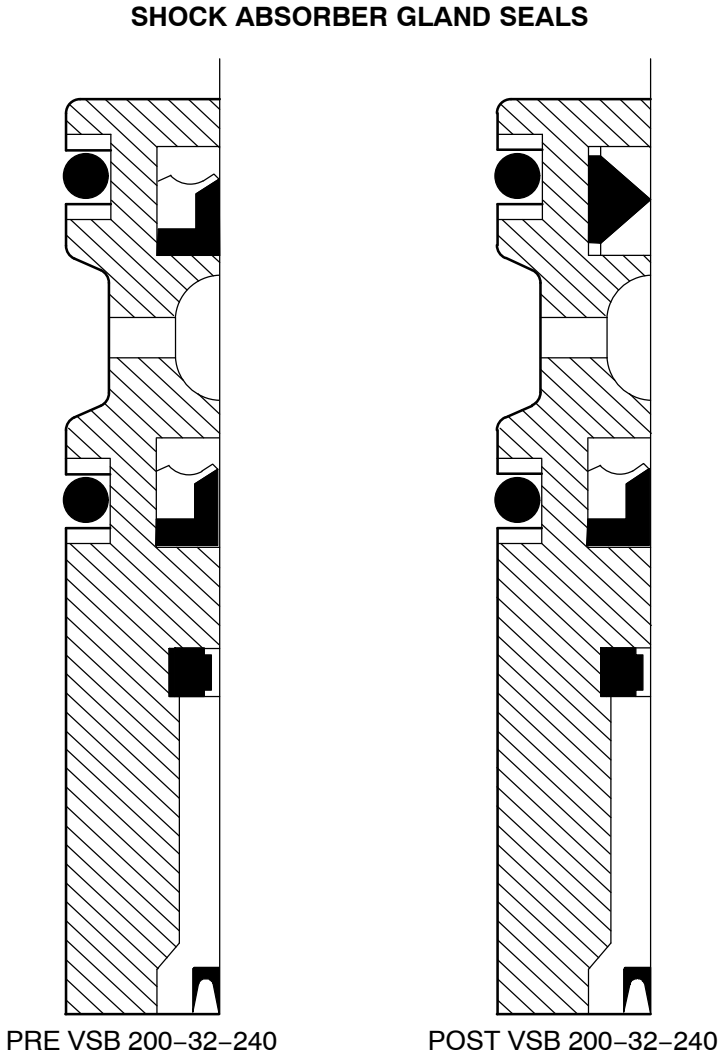


Figure 16 Spare Seal Activating Valve

TORQUE-LINK DAMPER SYSTEM FUNCTION

The torque–link damper is a spring–centered, two–way hydraulic unit, which has its own (pressurized) hydraulic reservoir. Its function is to decrease the landing vibrations through the torque links.

The torque–link damper has a damper body with a reservoir at the top and a check valve at the bottom. A bleed screw and a bleed plug are installed in the top of the reservoir. The torque–link damper is on the bottom of the upper torque–link and operates through the apex bolt from the lower torque link.

The hydraulic fluid contents of the damper are shown by the extension of the reservoir when it is pressurized. When the contents are correct, the markings “FULL“ and “REFILL“ are in view. If the contents are not correct, only “REFILL“ is in view.

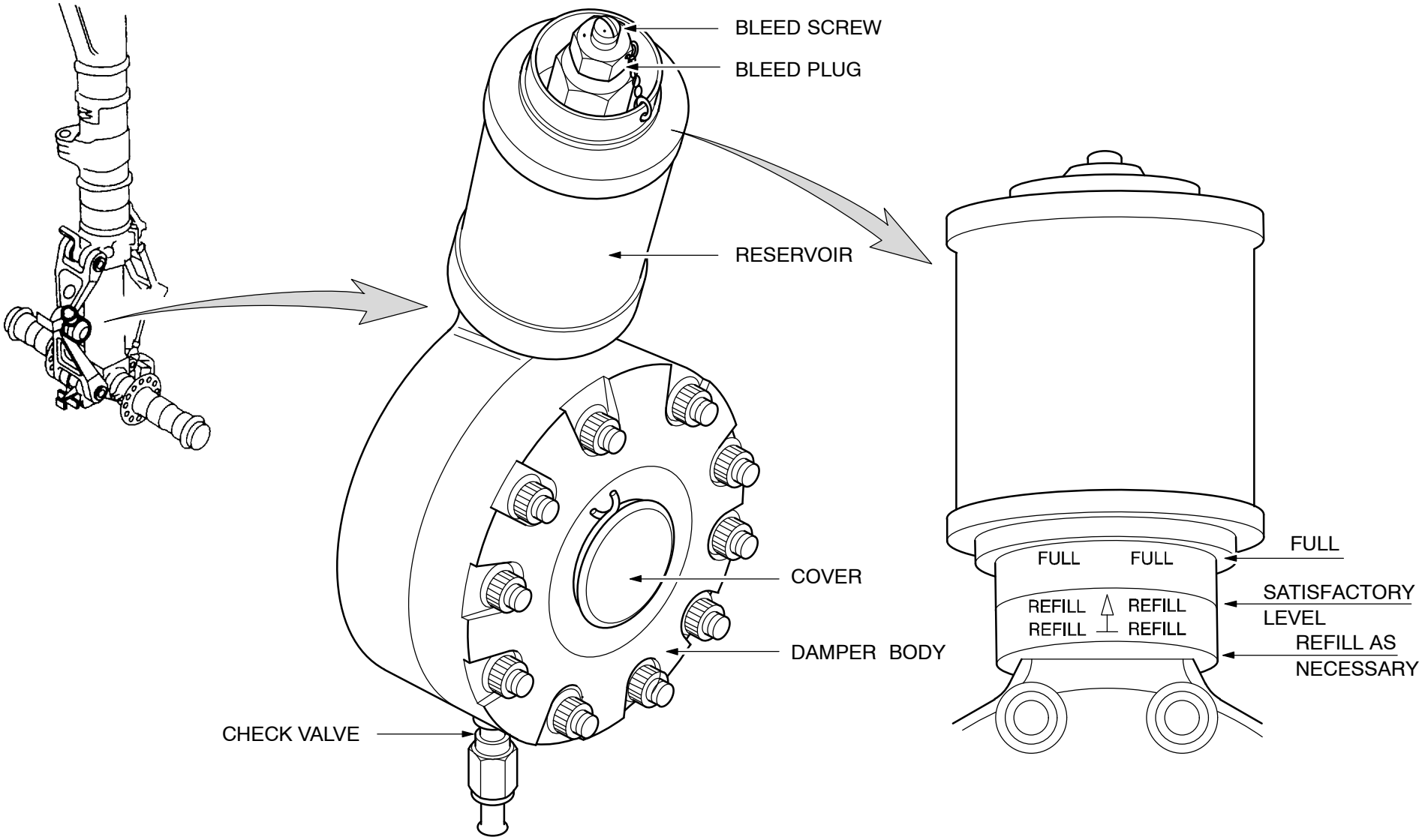


Figure 17 MLG Torque Link Damper

DRESSINGS COMPONENT DESCRIPTION

General

The MLG dressings are the hydraulic lines and the electrical wiring (and the parts that attach, hold and prevent damage to them). The routing of the dressings gives maximum separation for the systems and protection from possible damage.

Between the main fitting and the sliding tube there is a slave link located. It holds the electrical cables and the hydraulic pipes, to make sure they do not catch on the wheels.

The dressings are flexible conduits or rigid conduits and pipes. The parts that do not need to move are rigid and the parts that are at joints (such as the wing/gear interface, across the torque and slave links, and the wheel brakes) are flexible.

Hydraulic Dressings

The hydraulic dressings on the MLG complete the hydraulic circuits for:

- the MLG retraction actuator
- the lock–stay actuator
- the normal and alternate braking systems.

The MLG retraction actuator has a pressure and return line that goes from the wing gear interface. The normal and the alternate brakes each have a supply and a return circuit from the wing/gear interface to their related manifolds. The normal brake manifold supplies the hydraulic pressure to one of the two connections at each wheel brake. The alternate brake manifold supplies the other. The supply/return for the lock–stay actuator interfaces next to the side–stay lug attachment.

Electrical Dressings

The electrical dressings on the MLG complete the electrical circuits to these systems/components:

- the proximity switches
- the normal braking system
- the alternate braking systems
- the brake temperature–monitoring system
- the brake cooling system
- the TPIS (tire pressure indicating system) if installed

Electrical Harness

The 1M and 2M electrical harness have cables which supply the electrical connection to the:

- braking and anti–skid systems
- brake cooling system
- tire pressure indicating system (if installed)
- position and warning systems
- indicating and warning systems

The disconnection point for the 1M harness is at the MLG disconnection box. For the 2M harness, the disconnection point is outboard of the gear rib 5.

Proximity Sensors

The proximity sensors and targets attach to the MLG in specified locations. They send position/status data to the Landing Gear Control and Interface Units (LGCIUs). These units use the data to:

- control the retraction and extension sequences of the landing gear
- supply the indication/failure data of the MLG to the indication and warning systems in the cockpit

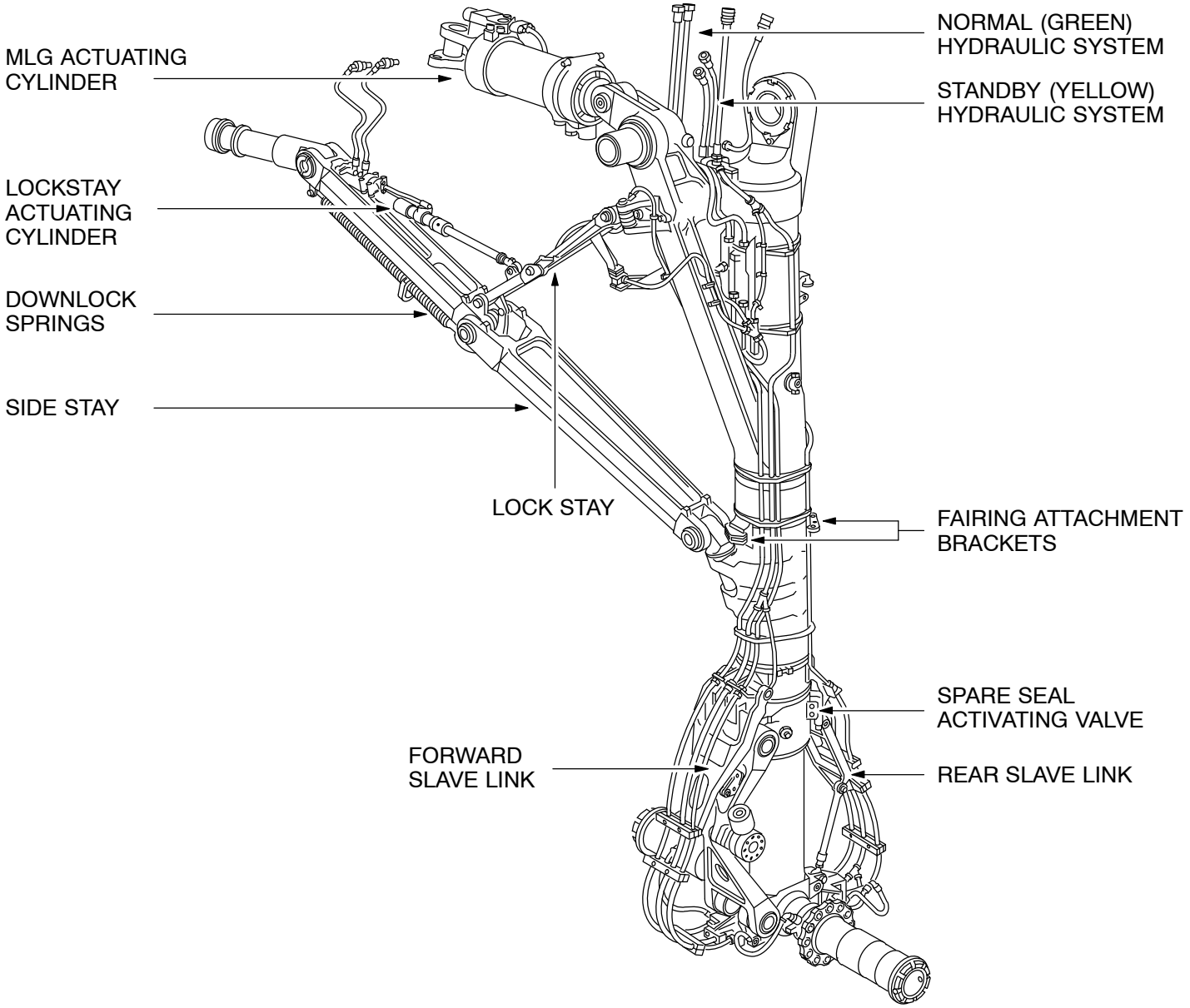


Figure 18 MLG Leg and Dressing

SIDE STAY ASSEMBLY

The side stay assembly is between the rear spar of the wing and the main fitting of the MLG leg. A cardan joint connects the side stay assembly at each position. These joints let each connection point turn around two axes.

The primary components of the side stay assembly are:

- a basic side stay
- a lock stay
- a lock–stay actuator
- two hydraulic hoses (from the Green hydraulic system to the lock–stay actuator)
- two lock springs
- the proximity sensors and their related targets

Basic Side Stay

The basic side stay has two links with a central pivot pin. The upper link is an 'H' section member that has bushed lugs. These attach to the lock–stay actuator, the lock springs and the lock stay. The lower link is also 'H' section, that has forked ends. The cardan joint connects the side–stay to the wing structure and the main fitting.

Lock Stay

The lock stay gives the mechanical downlock for the main landing gear. It has two 'H' section links that move around a central pin. The forked ends attach the lock stay to the basic side stay and to the main fitting.

The lower link of the lock stay has bushed lugs for the connection of the downlock actuator. The two pairs of lugs extend from the end of the lower link that connects to, and operates the lock springs. The upper link of the lock stay continues below the center pivot to give an over–center stop. This constellation serves as a geometric lock if there is a failure of the downlock actuator internal stop. Two proximity sensors and their related targets are on the brackets. Other brackets on the upper link hold the electrical harness that connect to these proximity sensors.

Lock Springs

A pair of tension springs are in the bottom channel of the upper side stay. They attach between the upper end of the basic side stay and the lugs of the lock stay. The lock springs have an eye–end fitting at each end with a plain bush. The bushes turn on the attachment pins at each end. During the extension cycle the lock springs move the lock stay to an over–center position and keep it in position.

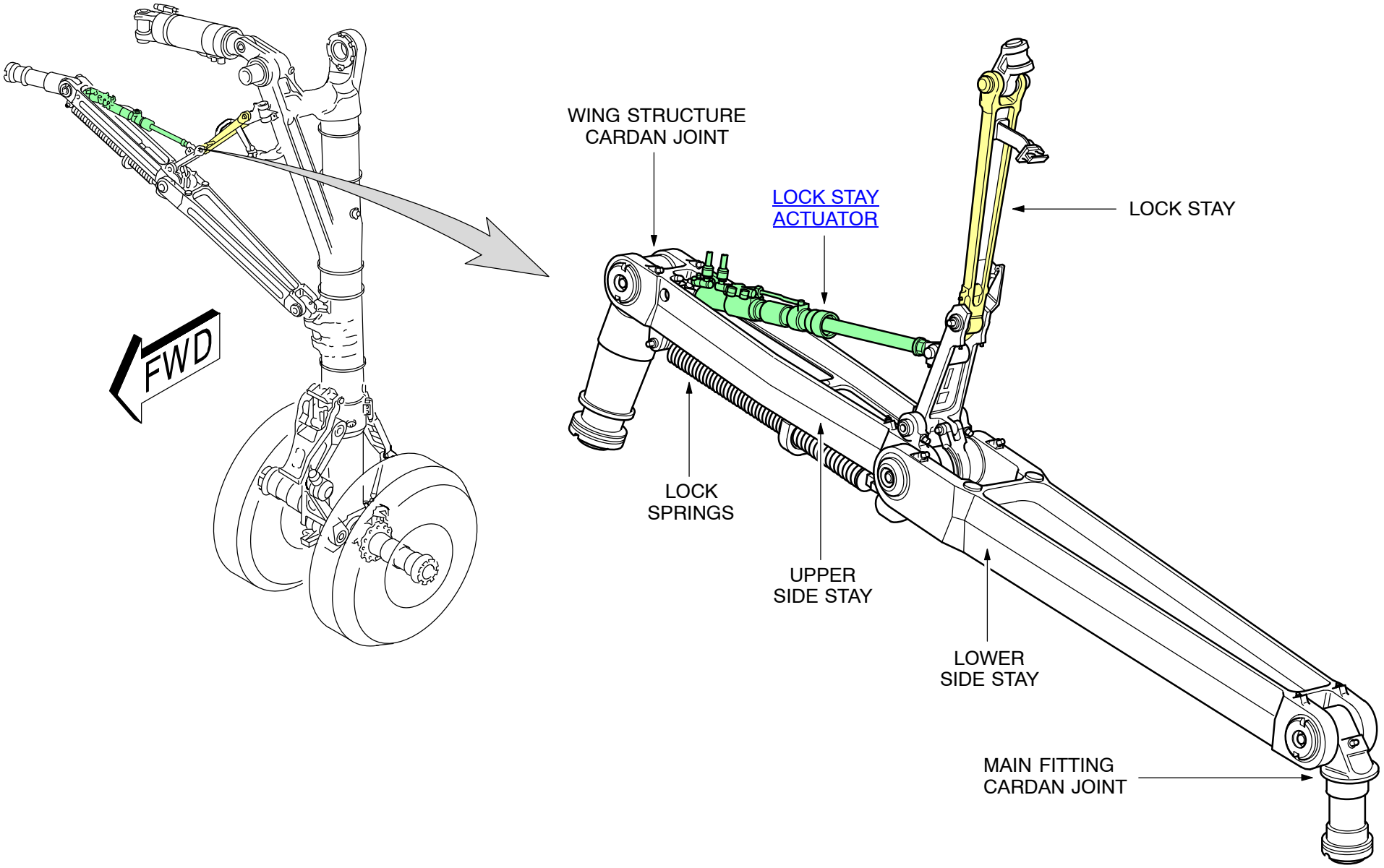


Figure 19 MLG Side Stay

32–12 MAIN GEAR DOORS

DESCRIPTION

General

Three doors close each Main Landing Gear bay. These are:

- a hydraulically operated Main Door
- a mechanically operated Hinged Fairing Door
- a gear operated Fixed Fairing on the MLG leg

The MLG doors are made from CFRP (**C**arbon–**F**ibre **R**einforced–**P**lastic) with a NOMEX honeycomb core. Each door has flexible seals at its structure interface which protect the CFRP/metal interfaces from damage by the airflow.

When the MLG retracts, all the doors close. When the MLG extends, the hydraulically operated doors close and the mechanically operated doors stay open.

A door opening mechanism permits opening of the hydraulically operated doors on the ground for access to the MLG bay. A ground door–opening handle operates a bypass valve in the doors hydraulic circuit and releases the door uplock. A ground lock–sleeve can be installed on each door actuator, to keep it open.

Main Door

Each main door has:

- a related MLG Door Actuating Cylinder
- Access Steps
- Door Ramps
- Position Proximity Sensors

Each main door has hinges at the keel beam and closes outboard to an uplock in the fuselage. The main body of the door actuating cylinder attaches to a fitting on the keel beam. Steps on the internal surface of the door give access to the MLG bay, without other support equipment. Two fixed ramps and (not on all A320s) one adjustable ramp, are installed on the inside of the main door. These ramps make sure that the main gear does not get caught on the door during a free–fall extension.

The MLG door actuating–cylinder operates the main door during the extension and retraction sequence. The door opens in sequence, before movement of the main gear. The door closes only when the main gear is locked in the fully extended or retracted position. An uplock roller assembly, installed on the main door, engages with the MLG door uplock. The uplock roller assembly and the MLG door uplock keep the door in the closed position.

Proximity Sensors

Proximity sensors and targets are used to show the position of the main door. The proximity sensors are installed on the center–fuselage keel–structure. The targets are installed on the main door, on a bracket at the door hinge line.

During the operation of the door, the positions of the proximity sensors change in relation to their targets. The sensors send a signal to the LGCIUs (**L**anding **G**ear **C**ontrol and **I**nterface **U**nits). This signal shows when the door is FULLY OPEN or NOT FULLY OPEN.

This data is used to:

- control the retraction and extension sequences of the landing gear
- supply indication/failure data of the MLG doors, to the indication and warning system in the flight compartment

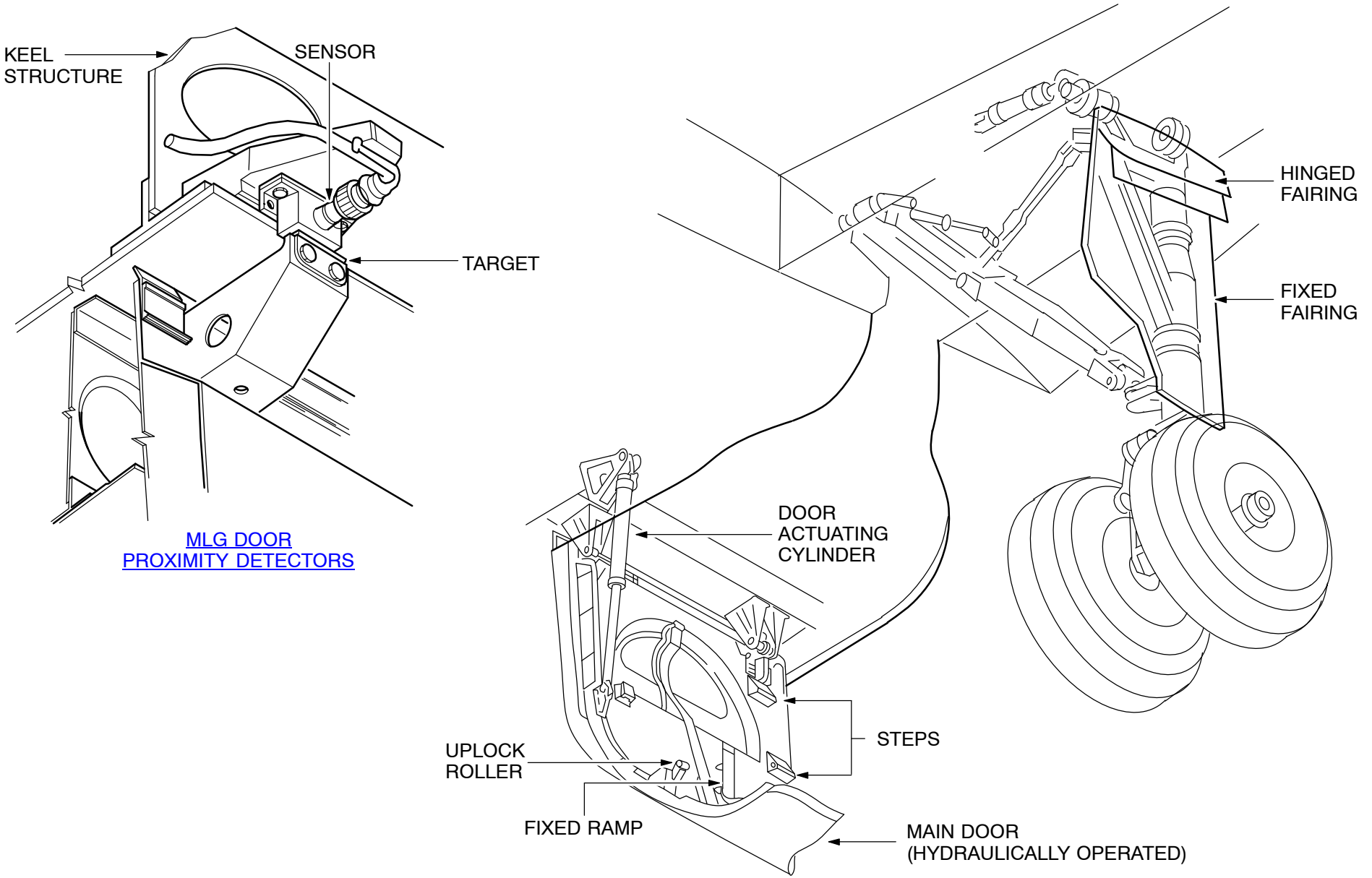


Figure 20 MLG Door and Fairing

FAIRING

Hinged Fairing

The hinged fairing is installed on a hinge on the lower wing surface, and an adjustable rod connects it to the MLG leg. When the main gear operates, the adjustable rod causes the hinged fairing to move with the landing gear leg.

Fixed Fairing

The fixed fairing is attached to the outboard side of the landing–gear main fitting, by two types of attachment assembly:

- two adjustable studs, installed on the front of the main fitting
- three adjustable rod ends, one installed on the front of the main fitting, and two installed on the rear

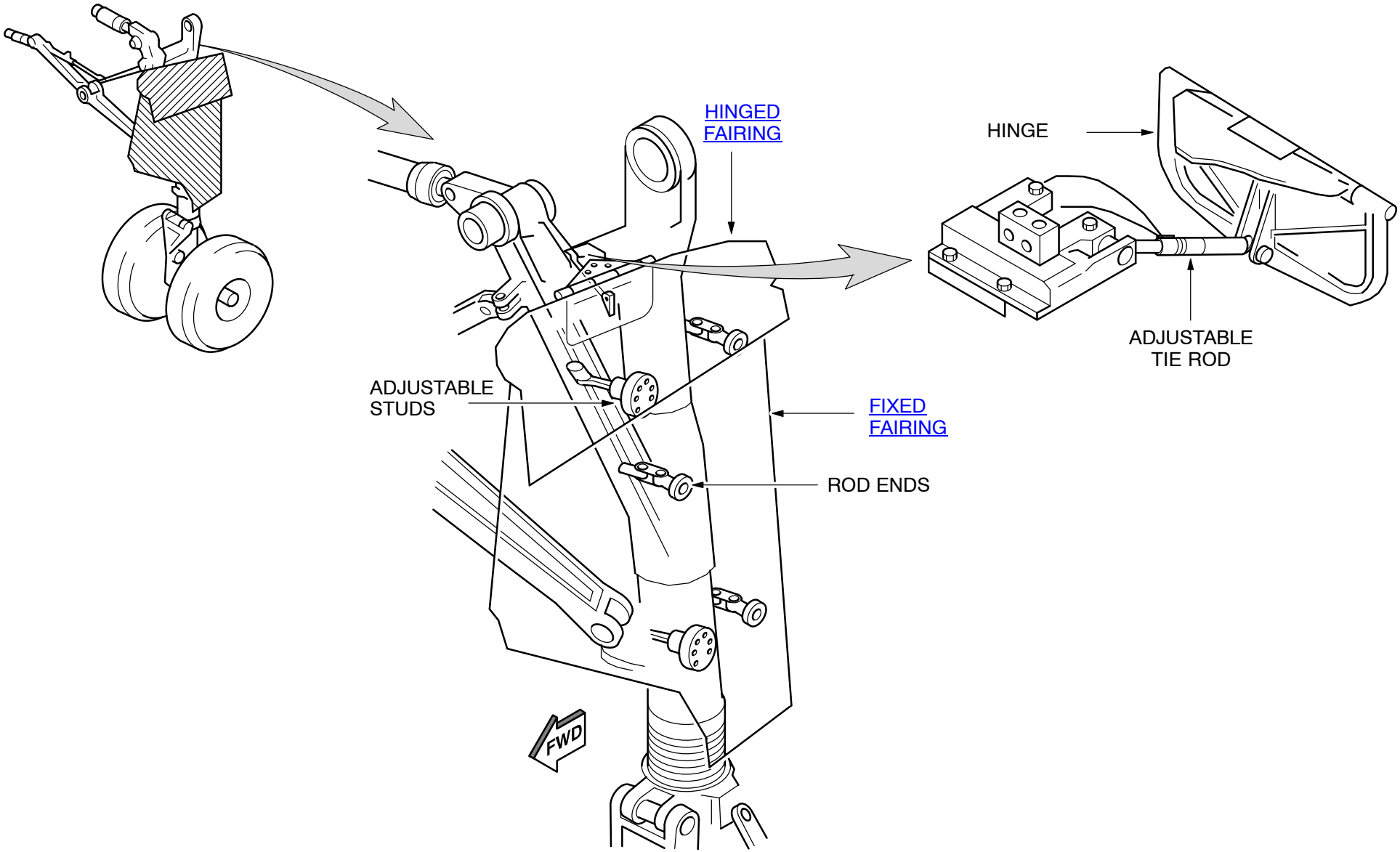


Figure 21 MLG Fairings

SYSTEM FUNCTION

MLG DOOR OPENING ON GROUND

Ground Door Opening Mechanism

Each main door has a Ground Door Opening Mechanism to open the door for maintenance. The mechanism consists of the following components:

- a Ground Door Opening Handle
- a Bypass Valve
- a Release Mechanism in the door uplock

Access to the ground door opening handle is gained through panel 195BB (196BB) in the center fuselage. The handle connects, through a push–pull cable to a lay–shaft on the door bypass valve outboard of the MLG bay.

NOTE: Any movement of the Ground Door Opening Handle is only possible if the Locking Pin is removed and the Release Plunger is pressed.

MAINTENANCE PRACTICES

Ground Door Opening for Maintenance

Operating of the ground door opening handle pulls a tele–flex cable which causes the bypass valve to isolate the door close hydraulic supply from the door actuating cylinder and couples the two chambers of the MLG door actuating cylinder. At the same time, the hook of the door uplock is released and the main door opens by gravity.

Ground Door Closing for Maintenance

NOTE: Setting of the ground door opening handle back to the closed position is only possible if the green hydraulic system is pressurized because a locking plunger in the bypass valve prevents movement of the handle as long as the hydraulic system is not pressurized.

Setting of the ground door opening handle to the closed position operates the bypass valve via the tele–flex cable and isolates the hydraulic actuator chambers and supplies hydraulic pressure. At the same time the door uplock is brought back to its initial position. The main door actuator moves the main door to the closed position and the uplock closes.

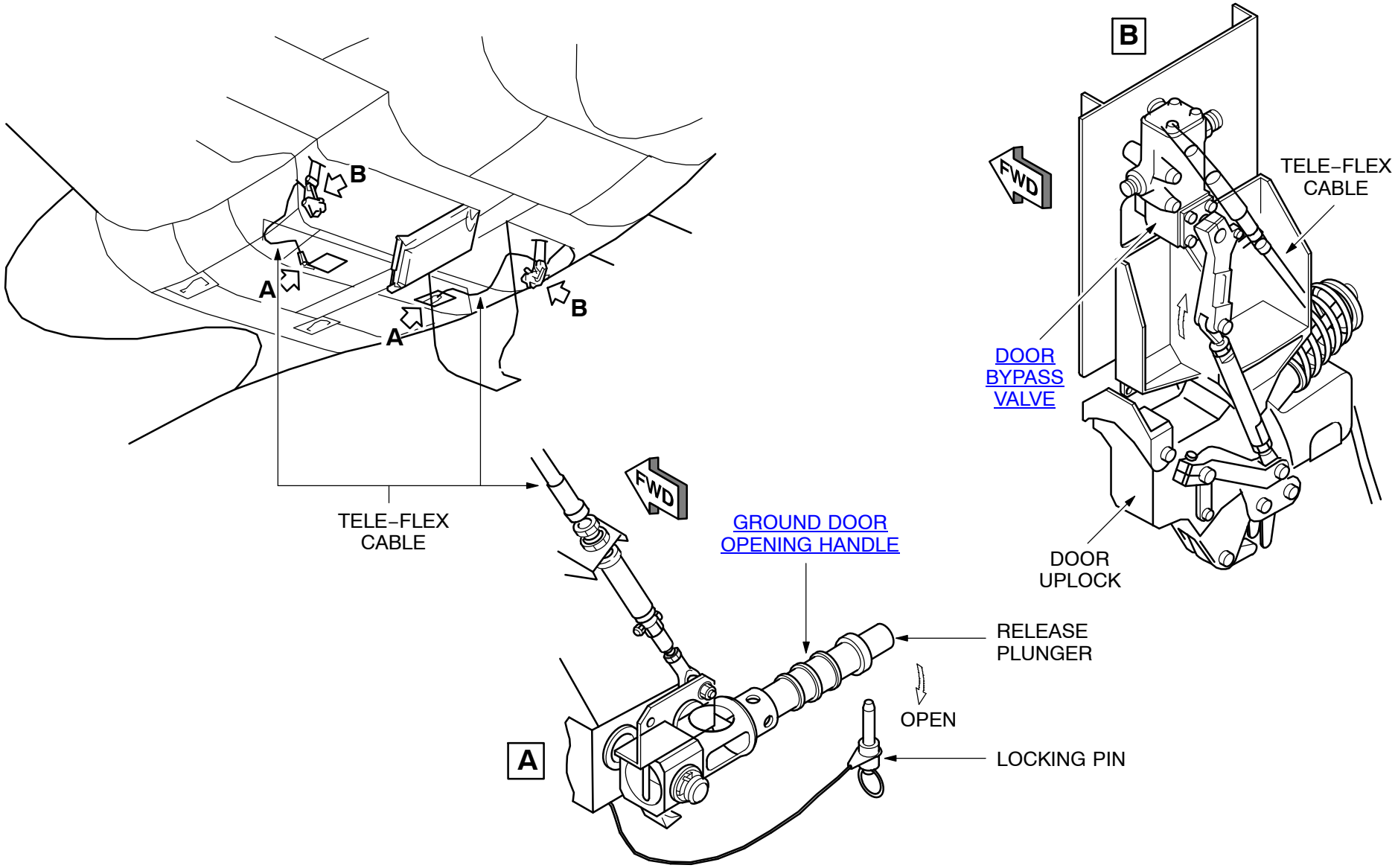


Figure 22 MLG Ground Opening Mechanism

32–20 NOSE GEAR AND DOORS

GENERAL DESCRIPTION

Nose Gear

The Nose Gear is attached on the aircraft structure between FR19 and FR20

It includes a:

- Leg Assembly with a Shock Absorber,
- Wheel Steering Assembly,
- Drag Strut Assembly and a Lock-Stay which locks the gear in the down position,
- Gear Actuating Cylinder.

Nose Gear Doors

The Nose Gear Doors consists of:

- two Main Door Assemblies,
- two Aft Door Assemblies secured to the gear by rods,
- one Leg Door Assembly attached to the rear of the shock strut, which closes the nose gear well after retraction of the nose gear.

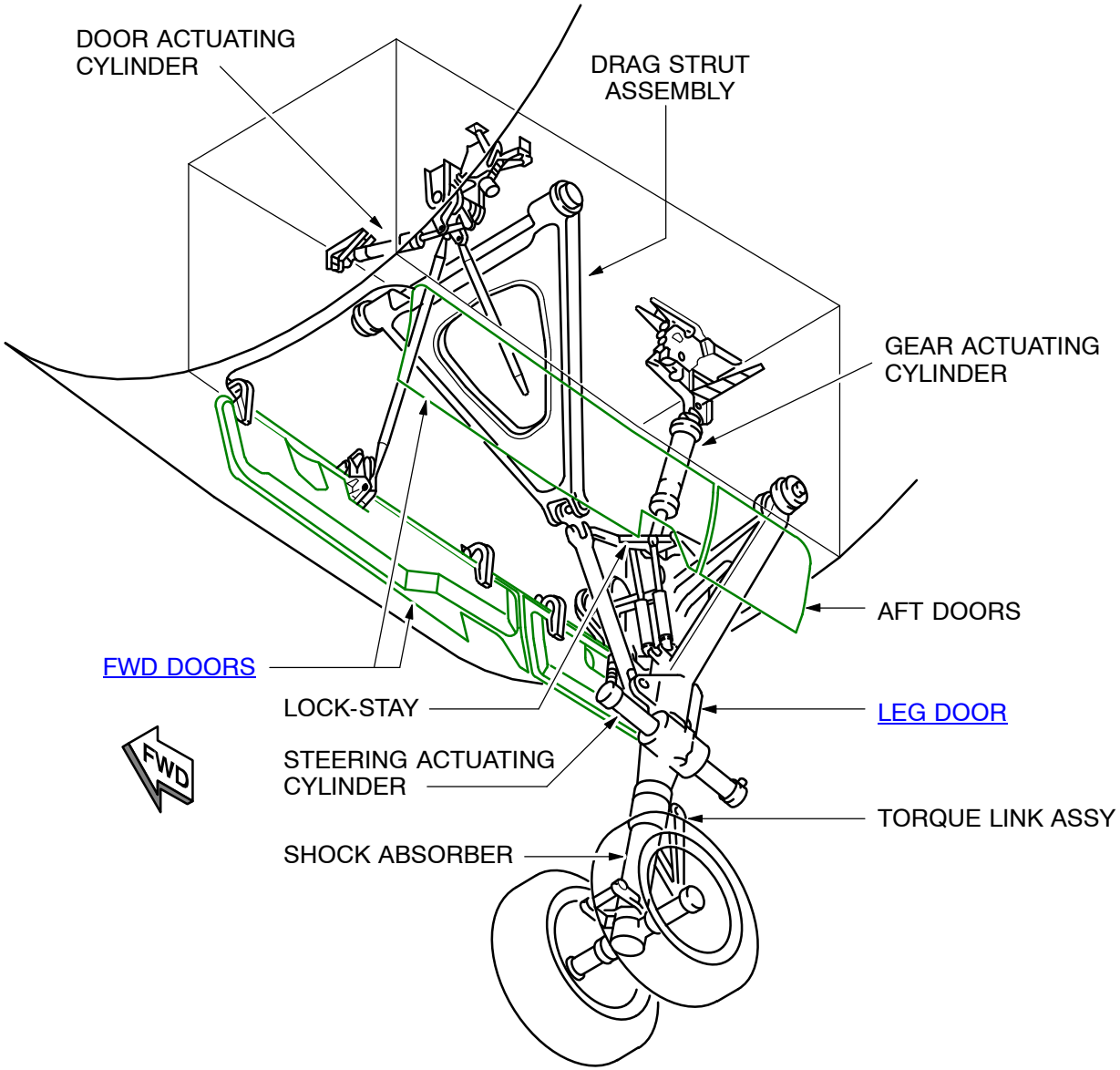


Figure 23 Nose Gear and Doors

32–21 NOSE GEAR

COMPONENT DESCRIPTION

The nose gear is of the direct acting type with an integral shock absorber. It retracts forward into the fuselage and is assisted by the aerodynamic forces in the downlocking direction during gear extension.

The sliding tube assembly, which includes the wheel axle, is inclined 9 degrees forward in order to simplify design. This design made it possible to put the wheel axle 50 mm to the rear of the shock strut centerline. Thus the wheels return freely to the center position. The sliding tube is made of steel and is connected to the rotating tube by torque links.

The shock strut is made of aluminum alloy and is connected by two trunnions to the structure. A rotating tube made of steel is installed inside the shock strut. A pinion gear installed on the tube is engaged with a rack which is connected to the steering actuating cylinder.

The shock absorber includes two centering cams which engage with each other after take–off of the aircraft. This causes the wheels returning to the center position before gear retraction.

DRAG STRUT AND LOCK–STAY ASSEMBLY

The folding drag strut assembly with a lock–stay locks the gear leg in the extended position. At the top of the assembly is a fore–stay, made of aluminum, and at the bottom a tubular arm made of steel. The fore–stay and the tubular arm are connected by a universal joint. This assembly provides primary bracing. Secondary bracing is provided by the lock–stay assembly.

The lock–stay assembly includes two parts connected by a spherical bearing:

- the upper link made of forged aluminum alloy, which hinges on the leg
- the lower link made of forged steel.

The fore–stay of the primary bracing assembly is attached to the aircraft by two trunnions in the same way as the gear leg. Some hinge points include spherical bearings to permit movement in case of deformation.

A hydraulic cylinder on the nose gear lock–stay locks and unlocks both brace assemblies in normal operation. If the hydraulic pressure is not available, two traction springs pull and hold the leg in the extended locked position in Free Fall Extension mode. One spring is sufficient to operate the lock–stay mechanism.

NOSE GEAR UPLOCK

The nose gear uplock assembly holds the gear in the retracted position. The uplock roller is installed on the upper hinge pin of the drag strut universal joint.

NOSE GEAR ACTUATING CYLINDER

A double–acting actuating cylinder with a spherical bearing at each end operates the nose gear. The cylinder body is attached to the rear wall of the nose gear well. The cylinder sliding rod is attached to the gear leg. The actuating cylinder contains devices for metering the hydraulic fluid. These allows slow down movement of the gear at the end of retraction and during the complete extension cycle.

NLG TIRES

The radial type tires or conventional type tires are installed on the gear. The dimensions of these tires are 30 x 8.8 –15 and 30 x 8.8 R15.

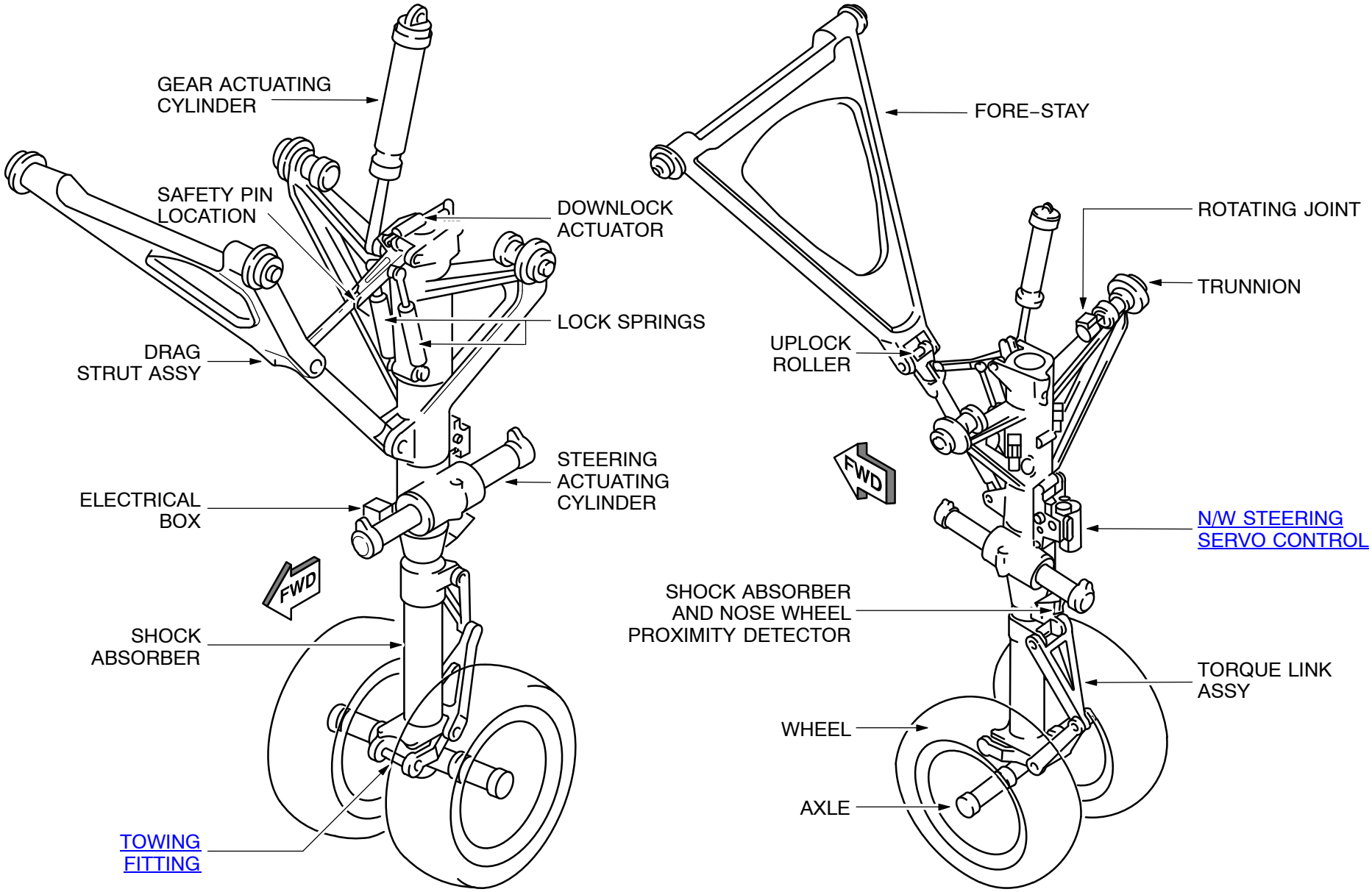


Figure 24 Nose Gear Components

SHOCK ABSORBER

General

The shock absorber is of the single chamber type without a separator piston and is double acting. It is possible to remove the shock absorber without drainage of the hydraulic fluid (removal of retaining ring at upper part of leg).

Shock Absorber Main Data

- total travel: 430 mm
- filling pressure: 19 bars
- threshold load: 1350 daN
- volume of fluid: 6.2 liters

A placard bonded to the leg shows the filling curves. These curves show whether the shock absorber is at the correct pressure for the standout length of the sliding rod.

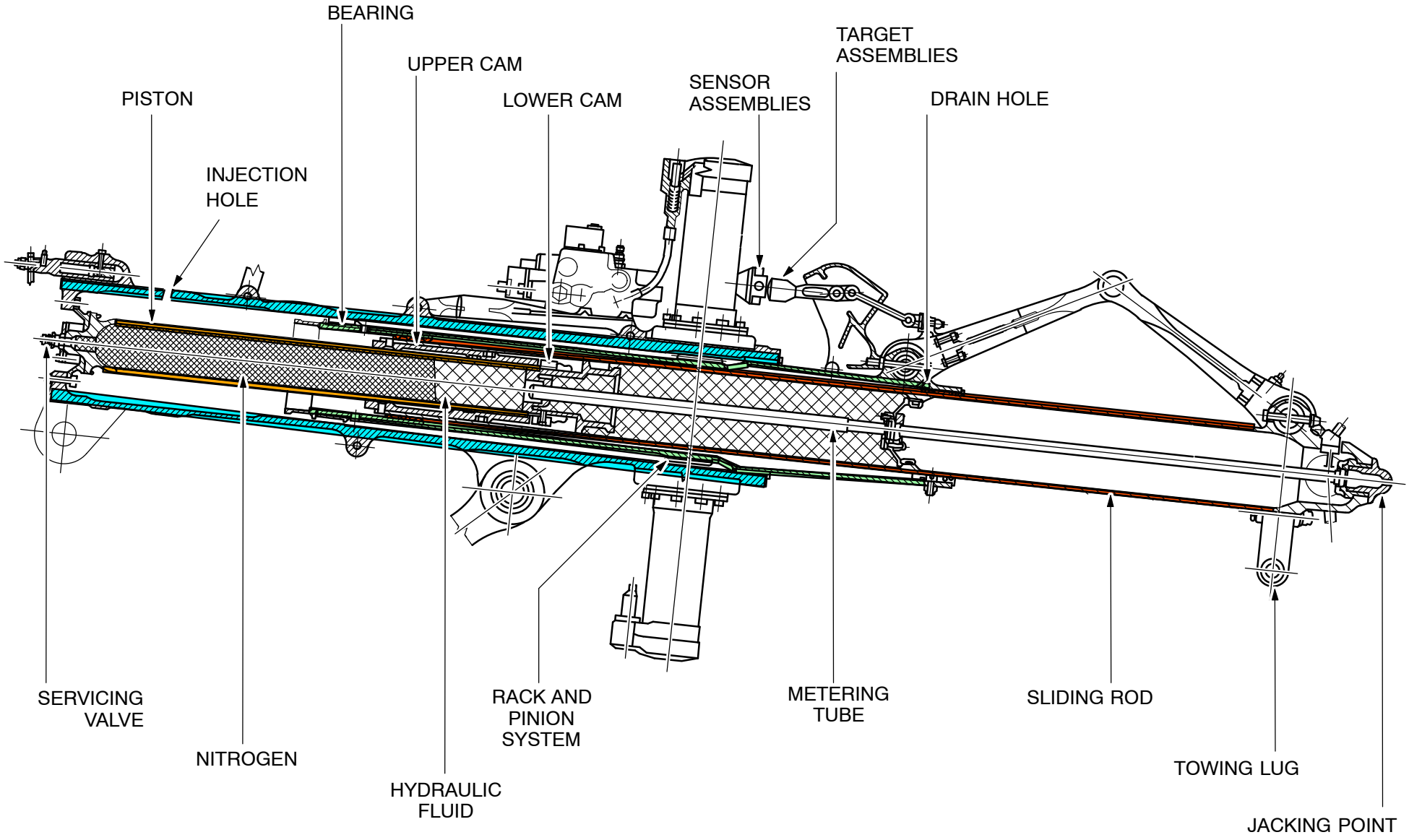


Figure 25 NLG Shock Absorber

DESIGN AND CONSTRUCTION

The shock absorber is filled with hydraulic fluid and nitrogen through a single standard servicing valve at the upper part of the leg.

A hole is included in the leg to show possible leaks from the dynamic seal of the shock absorber. The dynamic seal is located at the top part of the shock absorber (between the plunger tube and the sliding rod). The dynamic seal is therefore in a protected area which is not subjected to side loads during ground maneuvers.

The shock absorber includes 2 centering cams, one is part of the plunger tube and the other is part of the sliding tube. When the shock absorber is fully extended the pressure of the nitrogen causes the cams to engage. The wheels then return automatically to the center position.

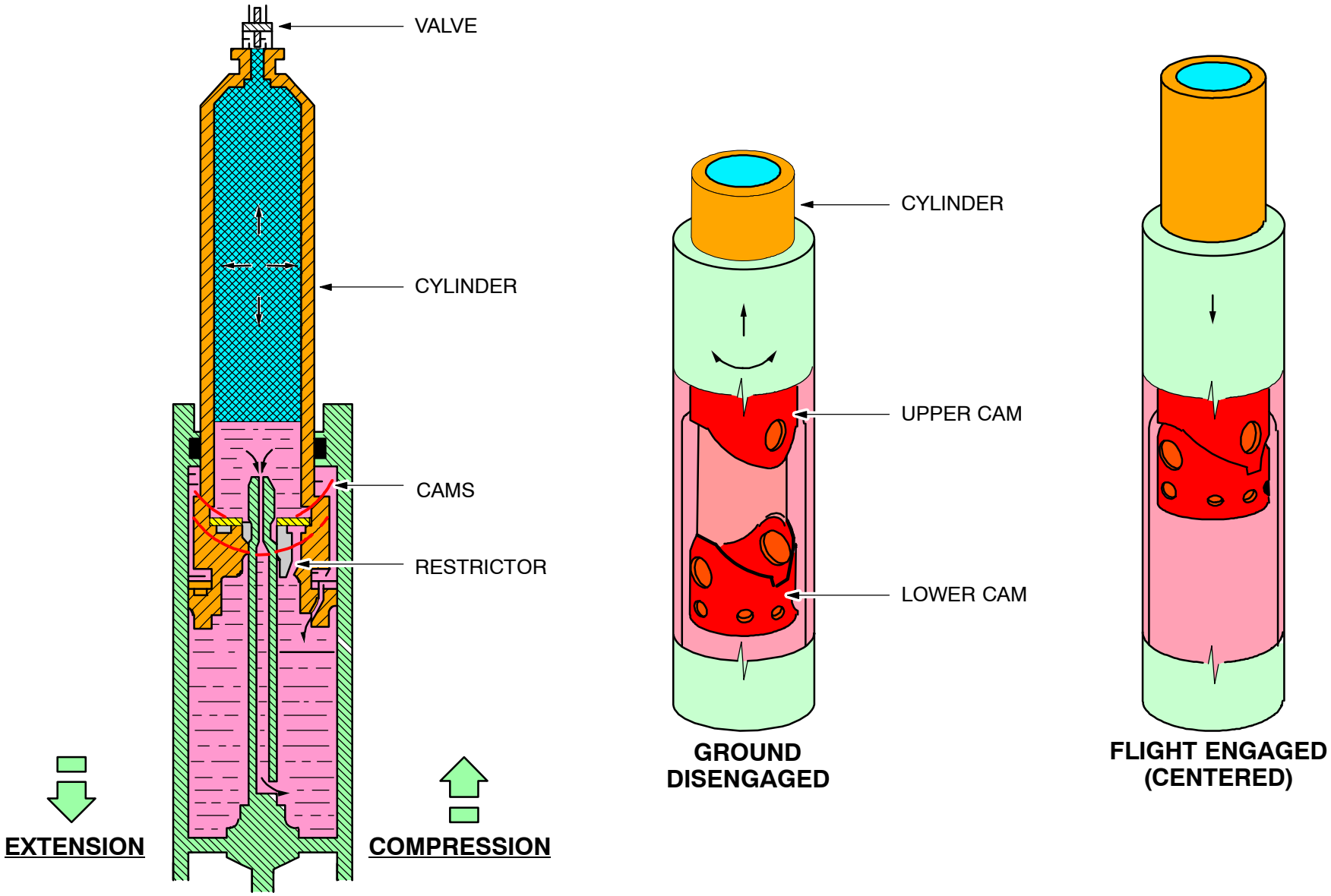


Figure 26 NLG Shock Absorber Details

LOCK-STAY ASSEMBLY DESCRIPTION

Construction

The Lockstay Assembly controls the alignment of the folding drag strut. The stable position of the Lockstay Assembly is over-centered (approx. 13 mm) to give added safety in the downlocked position.

If rupture of the internal stop in the lockstay occurs, movement of the lockstay is limited by the internal stop of the lockstay downlock actuator.

The lockstay downlock actuator includes a fluid metering device which slows down alignment of the struts at the end of extension of the gear. This decreases loads caused by downlocking of the gear. If failure of the lockstay hydraulic cylinder occurs, two springs assist downlocking. Each spring puts a load of 43 daN on the lockstay.

Ground Safety

On the ground, a Safety Pin prevents accidental release of the gear. It locks the two arms of the lockstay. It is only possible to put the pin into the two arms if the lockstay is in the locked position.

Indicating

Indicating of down and locked position is given by two Proximity Detectors. Each Proximity Detector is installed on two separate brackets.

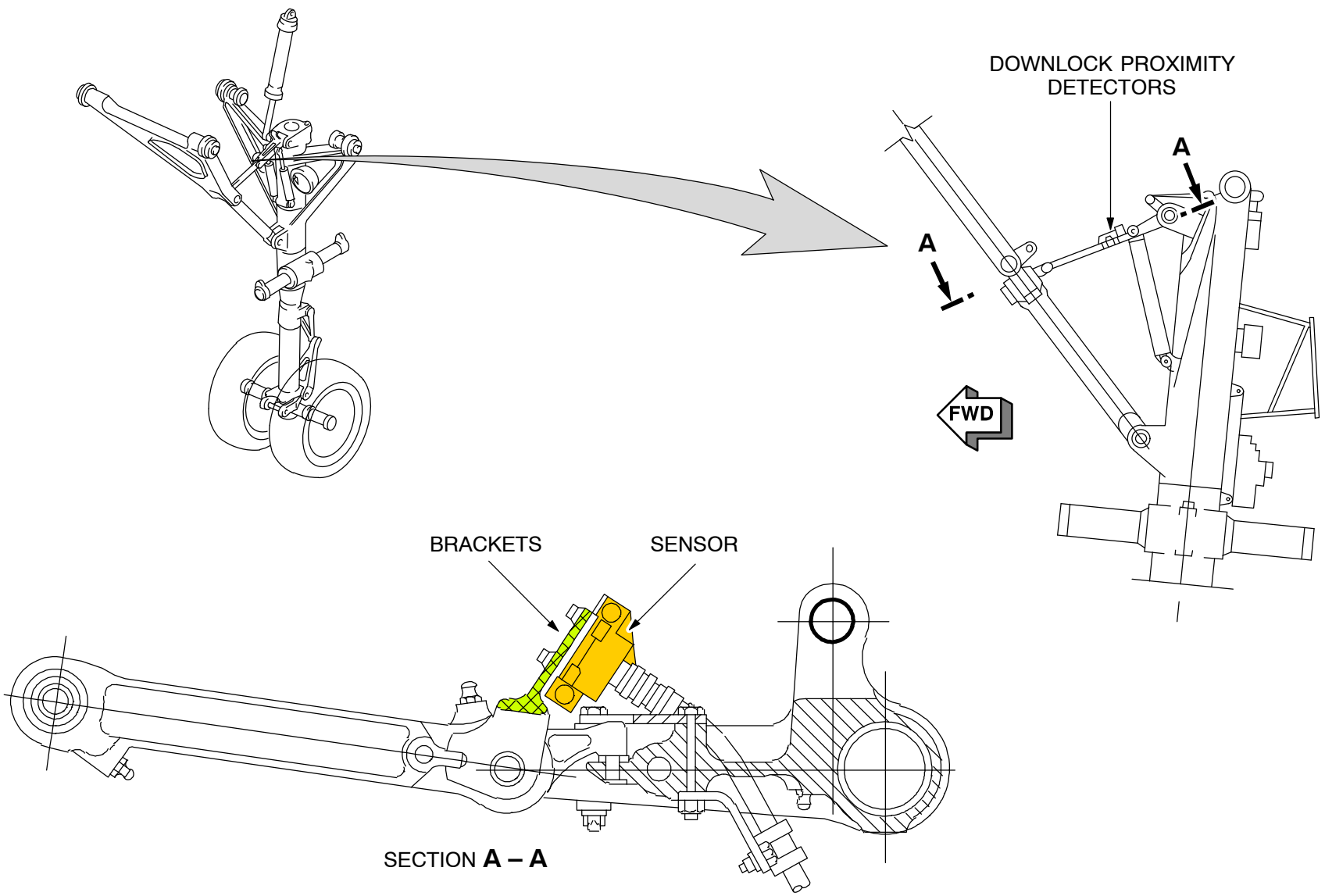


Figure 27 NLG Lock–Stay Assembly

32–22 NOSE GEAR DOORS

DESCRIPTION

General

The doors of the nose landing gear include:

- two Forward Doors operated by a hydraulic actuating cylinder
- two Aft Doors connected by a rod to the gear and a leg door attached to the rear part of the gear leg
- one Leg Door closes the nose gear well when the gear is retracted.

Main Doors

The two main doors are connected mechanically to the aircraft by a linkage which has two control rods connected to the same bellcrank. This bellcrank is installed at the roof of the landing gear well and is operated by one double acting actuating cylinder (opening and closing of the doors).

An uplock assembly latches the doors in the closed position. A bypass valve manually controlled by a lever releases the uplock latch on the ground. After the latch is released, the doors open under the effect of gravity. The doors are closed by the hydraulic system after the lever is put in the normal position.

Proximity detectors provide a signal when the doors are in the open position. The doors must be in this position to permit the gear to operate. Each door is equipped with two proximity detectors installed on separate brackets.

Aft Doors

The two aft doors are symmetrical and are attached by two points on the aircraft structure. They are also connected by an adjustable rod to the gear leg. The doors close the aft part of the nose gear well when the gear is retracted. When the gear is extended, the doors remain open.

Leg Door

This door is attached at three points to the rear part of the gear leg. When the gear is retracted it closes the area through which the drag strut passes when the gear is extended. The Leg Door includes two rollers. The main doors touch these rollers when the door closes after the gear retraction.

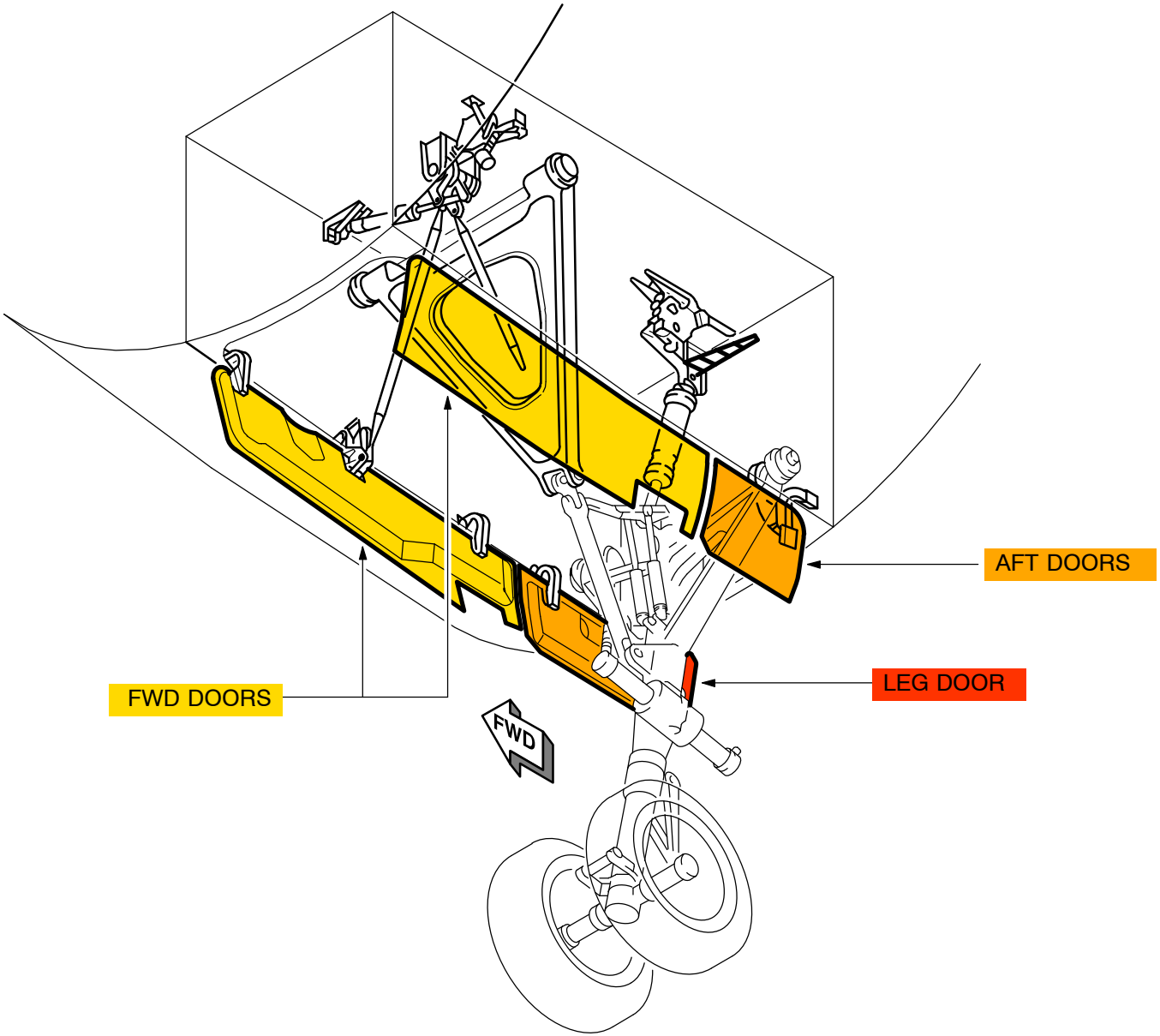


Figure 28 Nose Gear Doors

32–30 EXTENSION AND RETRACTION

INTRODUCTION

General

The extension and retraction system extends and retracts the L/G (**L**anding **G**ear).

The system is divided into two sub–systems:

- the Normal Extension and Retraction System
- the Free Fall Extension System.

The Landing Gear normal extension and retraction system is electrically controlled and hydraulically operated, to extend and retract the MLG (**M**ain **L**anding **G**ear) and doors and the NLG (**N**ose **L**anding **G**ear) and doors.

The system is divided into the following parts:

- Electrical System
- Hydraulic System
- Mechanical Components

Electrical Control System

The Electrical Control System consists of the following components:

- a Landing Gear Control Lever
- two LGCIUs (**L**anding **G**ear **C**ontrol and **I**nterface **U**nits)
- a Gear Electro–Hydraulic Selector Valve
- a Door Electro–Hydraulic Selector Valve
- a Landing Gear Electro–Hydraulic Safety Valve
- 32 Proximity Sensors and their related targets
- a set of Indicator Lights

The electrical control system has two sub–systems, System 1 and System 2 which operate independently of each other. Each sub–system has:

- a LGCIU
- 16 Proximity Sensors and their related targets
- isolated electrical supplies

Normal Extension and Retraction

The normal extension and retraction system is used to extend and retract the landing gear. The system is electrically controlled and hydraulically operated. Hydraulic supply is from the Green hydraulic power system.

The LGCIU controls the sequence of operations.

The L/G control lever operates the extension and retraction of the landing gear. The two control and position sensing systems each have a LGCIU, proximity sensors and targets.

Free Fall Extension

If the normal extension and retraction system is not serviceable, you can operate the free–fall extension system. It extends the NLG and the MLGs by gravity. The system is mechanically operated by cables, rods, and levers, used to make the necessary extend selections.

The free–fall extension control–handle operates the L/G mechanically and is on the rear of the center pedestal. When you operate the free–fall extension control–handle, it releases the uplock on:

- the Main Landing Gear Doors
- the Nose Landing Gear Doors
- the Main Landing Gears
- the Nose Landing Gear.

A mechanically operated valve isolates the hydraulic supply. To prevent cavitation and hydraulic locks, other mechanically operated valves let fluid move in the hydraulic components of the normal extension and retraction system.

When the uplock releases, gravity extends the L/G doors and the L/G. springs pull the downlock links of the L/G into the locked position and the L/G doors stay open.

When you put the free–fall extension control handle to the NORMAL position and set the L/G control handle to DOWN, the main doors close and the system is set to the normal extension and retraction mode.

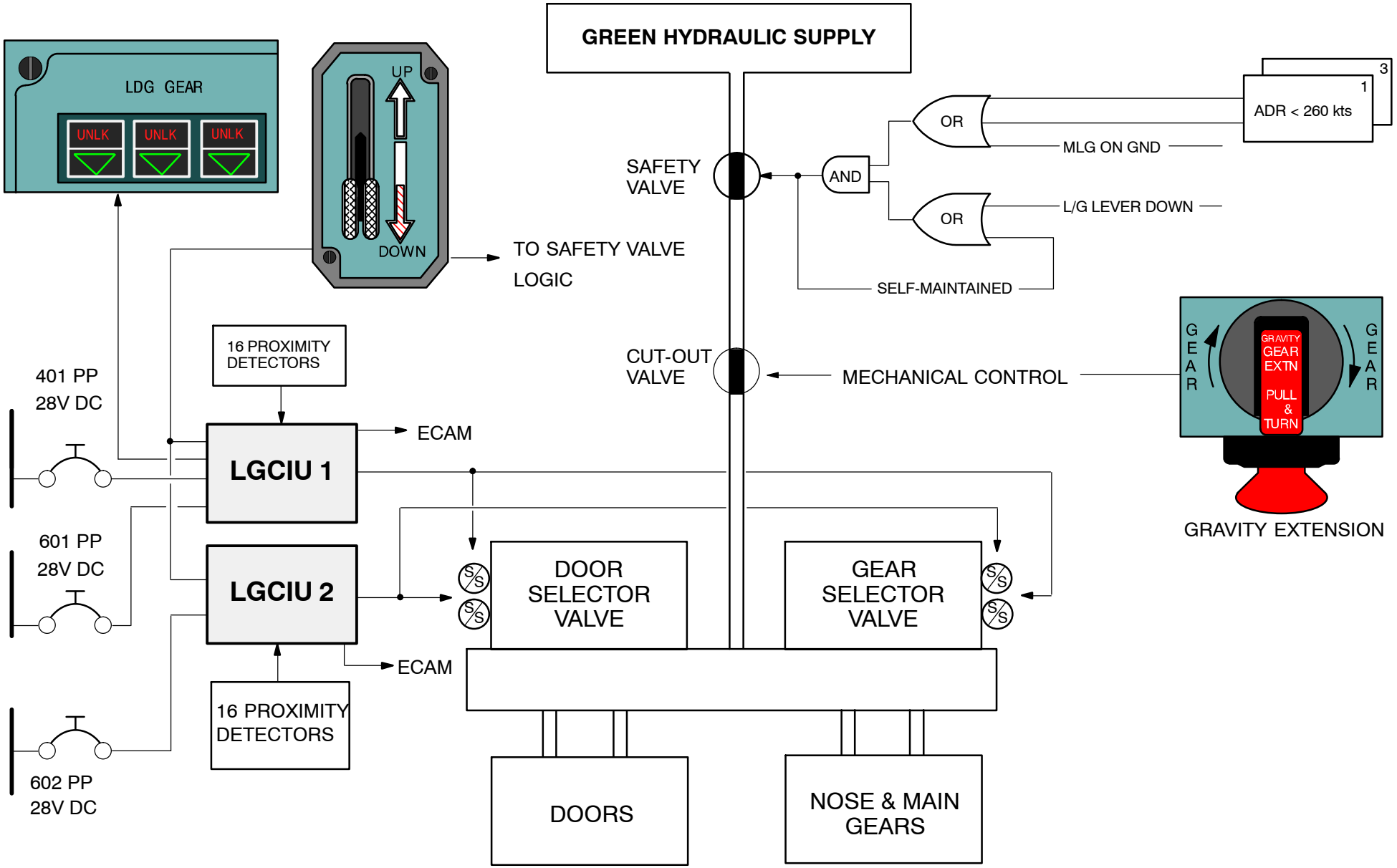


Figure 29 Extension and Retraction Schematic

32–31 NORMAL EXTENSION AND RETRACTION

ELECTRICAL SYSTEM DESCRIPTION

LANDING GEAR CONTROL AND INTERFACE UNIT

The two LGCIUs (which are the same) are identified LGCIU1 and LGCIU2, and can be in either System 1 or System 2. The LGCIU in System 1 independently controls the operation of a circuit for the L/G downlock indicator lights. When a LGCIU is installed in System 2 the independent circuits for the L/G downlock indicator lights are not used.

The LGCIUs are continuously supplied with power, but only one LGCIU controls the extension/retraction sequence at a time. The control changes from one LGCIU to the other after each retraction/extension cycle (when the L/G control lever is moved away from the DOWN position) or when one LGCIU becomes unserviceable.

The LGCIU is a computer which gets position signals from the proximity sensors and the L/G control lever. It uses these position signals to set the L/G door and the L/G selector valves in the correct position. The LGCIU calculates the necessary door and gear configuration signals and compares them with the configuration requested from the L/G control lever. It then sends the necessary signals to operate the selector valves.

The LGCIU has secondary functions to:

- control the operation of the baulk solenoid in the L/G control lever
- supply L/G and door position and system configuration data to other systems
- interface with the CFDS (**C**entralized **F**ault **D**isplay **S**ystem) and the Central Warning System
- monitor the control circuits to find failures and do automatic tests (BITE).

PROXIMITY SENSORS

The proximity sensors are electronic position indicators and are installed on the mechanical components of each L/G. There are two sensors in each position. One sensor sends signals through System 1 and the other sends signals through System 2. The sensors show the configuration of the components listed below:

- each Landing Gear Uplock
- each Landing Gear Downlock
- each Landing Gear Door Uplock
- each Landing Gear Door (open position)

LANDING GEAR CONTROL LEVER

The L/G control lever has two positions, UP to retract the L/G, and DOWN to extend the L/G. Signals are sent to the LGCIUs when a selection is made. The L/G control lever has a baulk device which stops movement of the lever to the UP position, when the aircraft is on the ground. The LGCIU sends a signal to release the baulk device, to let the L/G control lever move (to the UP position).

VALVES

The L/G Isolation Safety Valve, the L/G Selector Valve and the L/G Door Selector Valve are solenoid operated valves in the hydraulic system. Signals from the LGCIUs control the operation of the selector valves.

A signal from the ADIRS (**A**ir **D**ata **I**nertial **R**eference **S**ystem) and the L/G control lever controls the operation of the safety valve.

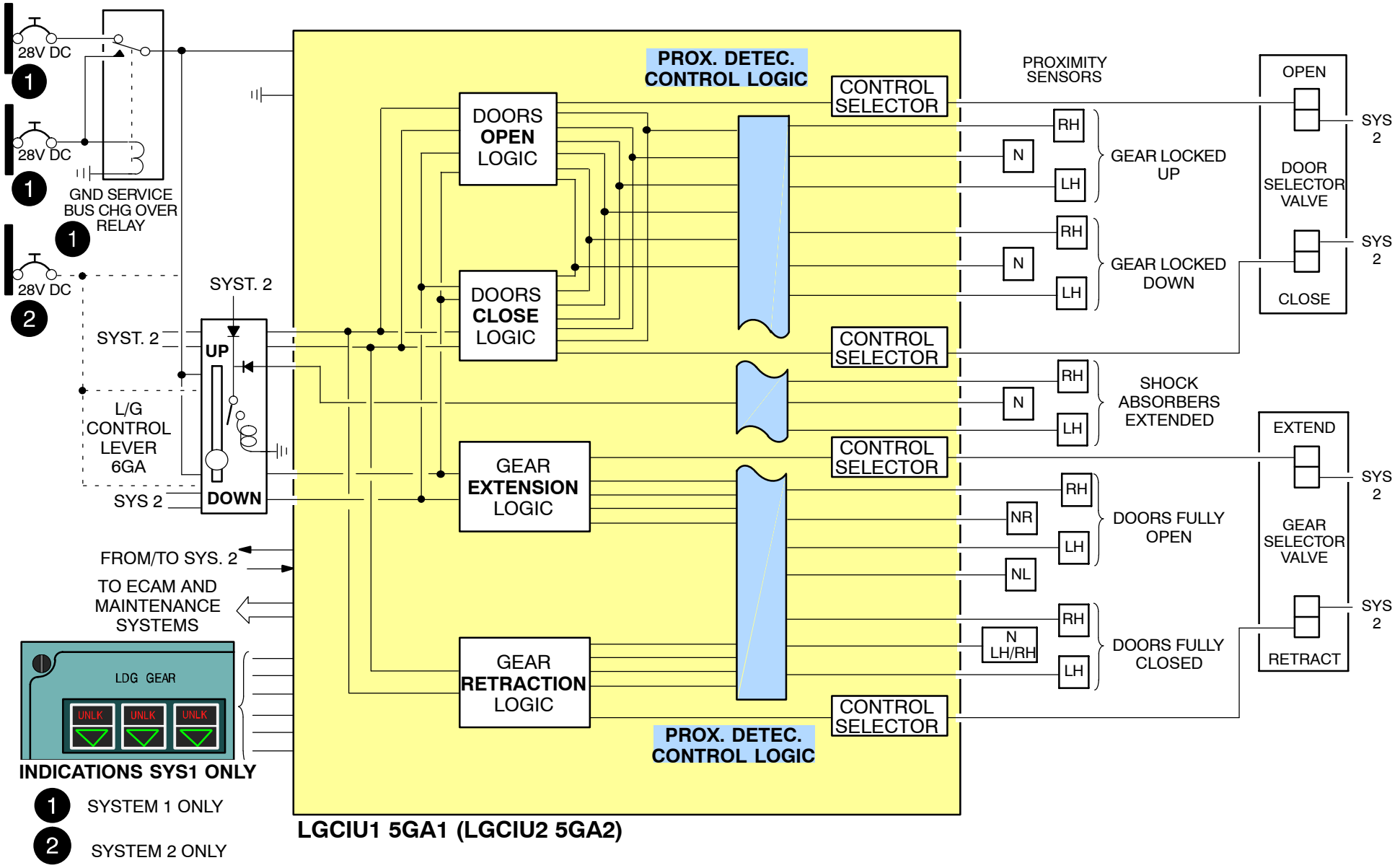


Figure 30 Electrical Block Diagram

PROXIMITY SENSOR AND TARGET

Description

The proximity sensor is an electronic position indicator.

Because of the environmental conditions (pollution, no pressurization) a sensor type without integrated electronics is used.

The main components of the sensor are a stainless steel body, a sensor coil and an electrical connector. The sensor has a related target.

The stainless steel body contains the sensor coil. the coil is connected to the electrical connector.

Each proximity detection circuit contains:

- a proximity sensor
- a sensor target
- a channel of a proximity–sensor electronics card

Operation

The proximity sensor continuously transmits an electrical signal to the proximity–sensor electronics–card within the LGCIU.

As the target moves into or out of the proximity–sensor's actuation area it causes a change in the proximity sensor's electrical property. The electrical signal to the proximity sensor electronics card also changes.

The proximity–sensor electronics–card converts these electrical signal changes into user status signals. The LGCIU control logic modules use these user status signals to control the extension and retraction of the L/G.

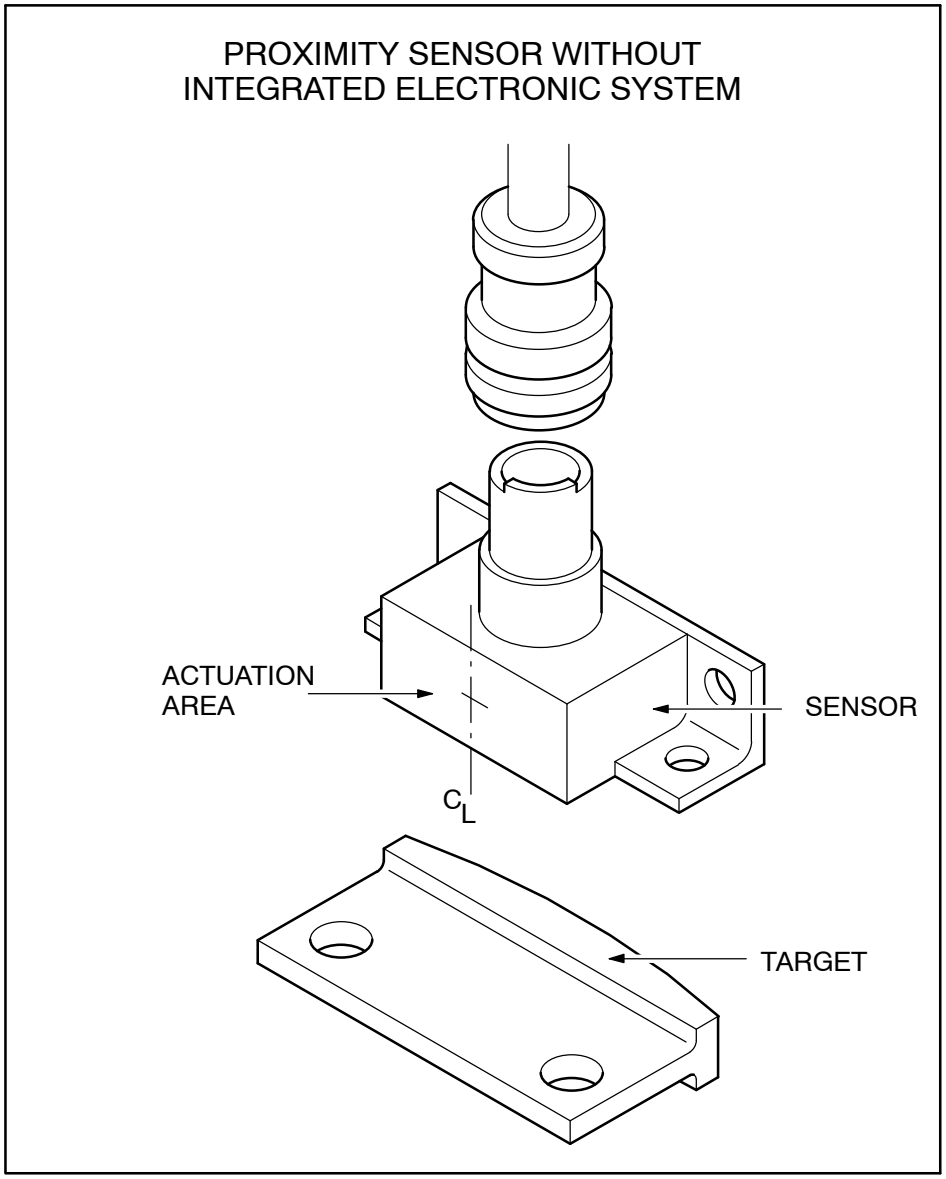


Figure 31 Proximity Sensor and Target

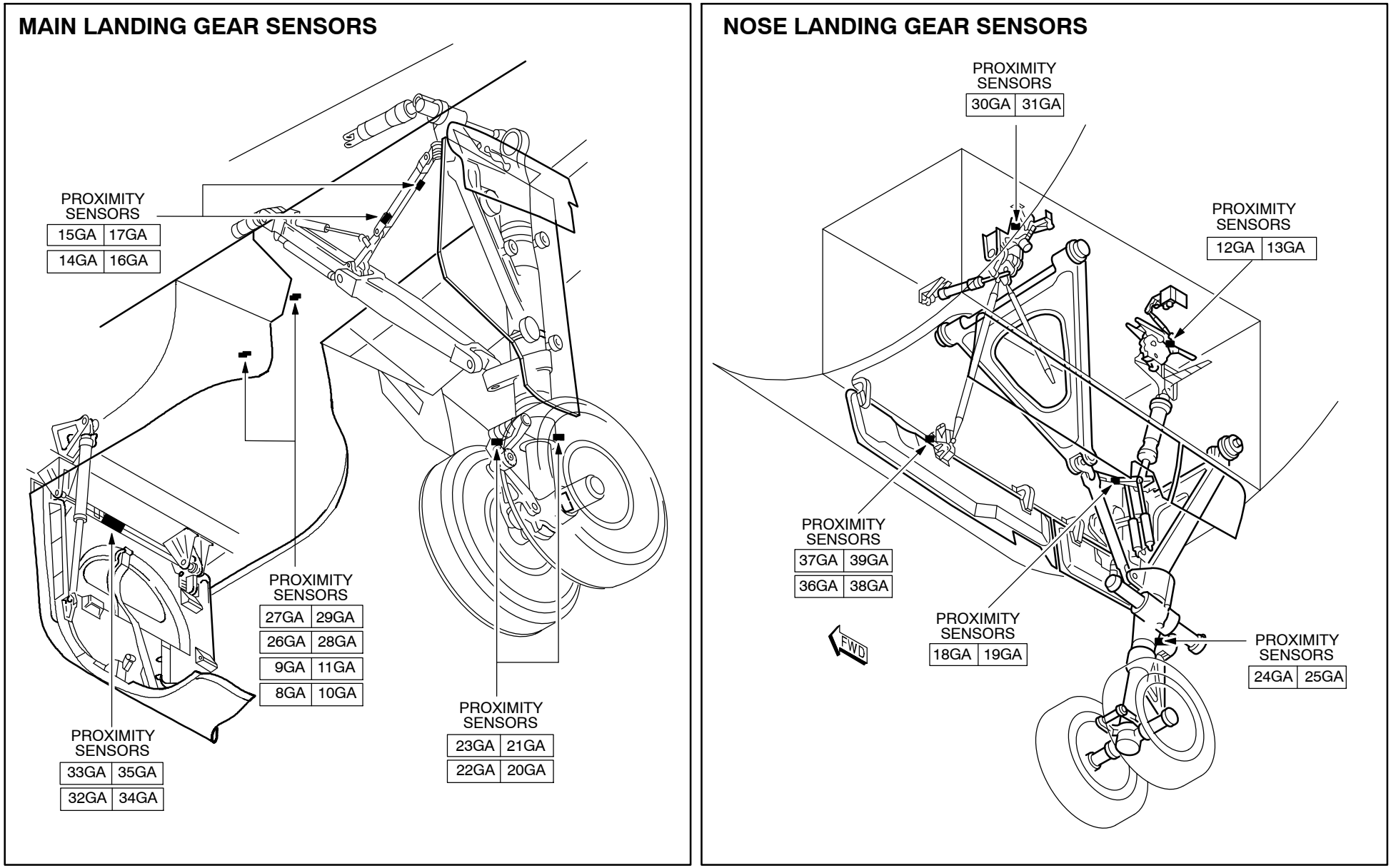


Figure 32 Proximity Sensors Location

HYDRAULIC SYSTEM DESCRIPTION

General

The hydraulic system has:

- Actuators that move the Mechanical L/G Components
- EHSVs (**E**lectro–**H**ydraulic **S**ervo **V**alves) to control the operation of the Actuators
- Mechanically Operated Valves to let the doors to be opened on the ground
- Mechanically Operated Valves to operate the Free Fall Extension System.

Each L/G has these actuators:

- Retraction Actuator
- Downlock Actuator
- Uplock Actuator
- Door Actuator
- Door Uplock Actuator

Valve Description

Pressurized hydraulic fluid is sent to the actuators through the EHSVs to move the related mechanical components. The operation sequence is controlled by the LGCIU.

The following EHSVs are installed in the system:

- a L/G Isolation Safety Valve

  The L/G isolation safety valve is a two–position valve that isolates the L/G hydraulic supply from the green hydraulic system (when its solenoid is de–energized). This stops extension of the L/G when the aircraft speed is more than 264 kt to prevent damage.
- a Selector Valve and Manifold Assembly which includes a L/G Door Selector Valve and a L/G Selector Valve which operate independently.

  The selector valve and manifold assembly 2524GM controls the flow of hydraulic fluid to:
  - the door open and door close lines
  - the L/G extend lines and retract lines

Ground Door Opening

To open the L/G doors (for access on the ground) each L/G bay has a mechanically–operated door–bypass valve.

The door bypass valve allows landing gear door opening on ground for maintenance and prevents movement of the doors for safety if the system is pressurized.

Free Fall Extension

To let the L/G extend by gravity the Free Fall Extension System has mechanically operated cut–out and vent valves to prevent a hydraulic fluid lock in the actuators.

The system also has safety valves and restrictor valves. The safety valves keep hydraulic fluid upstream of the safety valve if a leak occurs downstream. The restrictor valves are installed in the selector valve and manifold assembly to control the rate of fluid flow through the L/G extend lines.

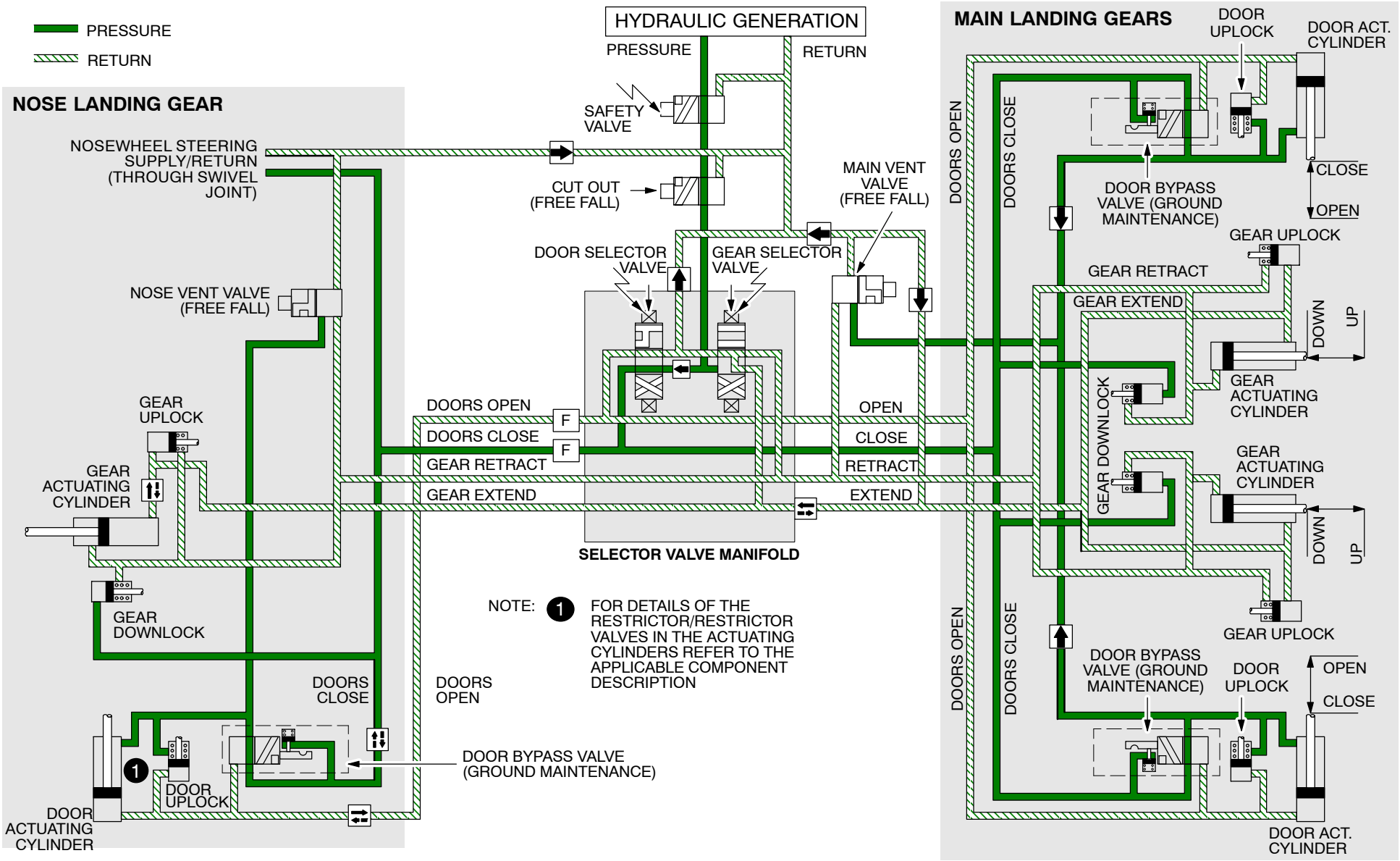


Figure 33 Hydraulic Schematic (L/G down, Doors closed)

OPERATION AND CONTROL

General

The L/G control system is electrically controlled and hydraulically actuated. The Green system supplies the hydraulic pressure. The L/G and doors are related systems and operate in the sequence that follows:

1. door uplock released and doors open
2. L/G locks released and L/G retracts or extends
3. doors close.

The position of the L/G control lever controls the extension and retraction of the L/G. The L/G control lever cannot be moved to the UP position during the following conditions prevented by the baulk mechanism:

- the MLG is not fully extended
- the NLG shock absorber is not fully extended
- the Nose Wheels are not in the center position

Landing Gear Retraction Sequence

With the L/G down and locked, and the doors closed and locked, on selection of UP, the LGCIU will sent the following signals:

- Signal the doors to open
- When all doors fully open:
  - signal the Landing Gear to retract
  - hold the doors open signal to keep the door open line pressurized.
- When all the Landing Gears are up and locked:
  - signal the doors to close
  - maintain the L/G retract signal to keep the L/G up–line pressurized.
- As the last door closes and locks, the operations that follow will occur:
  - the retract signal will be cancelled
  - the selector valve will de–energize
  - the retract lines will de–pressurize

When the calculated airspeed increases to 264 kts, a signal from the Air–Data Intertial–Reference Units (ADIRU) causes the safety valve to close. This isolates the Green hydraulic system from the L/G hydraulic system. When the pressure has decreased sufficiently, a spring in the door selector valve will adjust the valve to center. This causes the door close line to de-pressurize.

Landing Gear Extension Sequence

When the calculated airspeed decreases to 260 kt or less, the ADIRUs will function. This lets a ”valve open” signal to the safety valve when you make a DOWN selection. The safety valve then opens and connects the L/G system to the Green system hydraulic pressure.

With the L/Gs up and locked and the doors closed and locked, on selection of L/G DOWN, the LGCIU will:

- Signal the doors to open
- When all the doors are fully open:
  - signal the L/G to extend
  - hold the door open signal to keep the door open–line pressurized.
- When all the L/Gs are down and locked:
  - signal the doors to close and pressurize the lock–stay actuating cylinder
- As the first door moves from the fully open position:
  - cancel the L/G extend signal.
- Maintain the doors closed signal and the L/G lock–stay actuating–cylinder pressurized

Sequence Control

The sequence control is such that it is not possible to move the L/G unless all the doors are fully open and to close the doors unless all the L/Gs are locked in their selected position.

With the L/Gs locked up and the doors locked closed, the doors will not be commanded to open if a door becomes unlocked. This is only if the control lever is selected to the UP position.

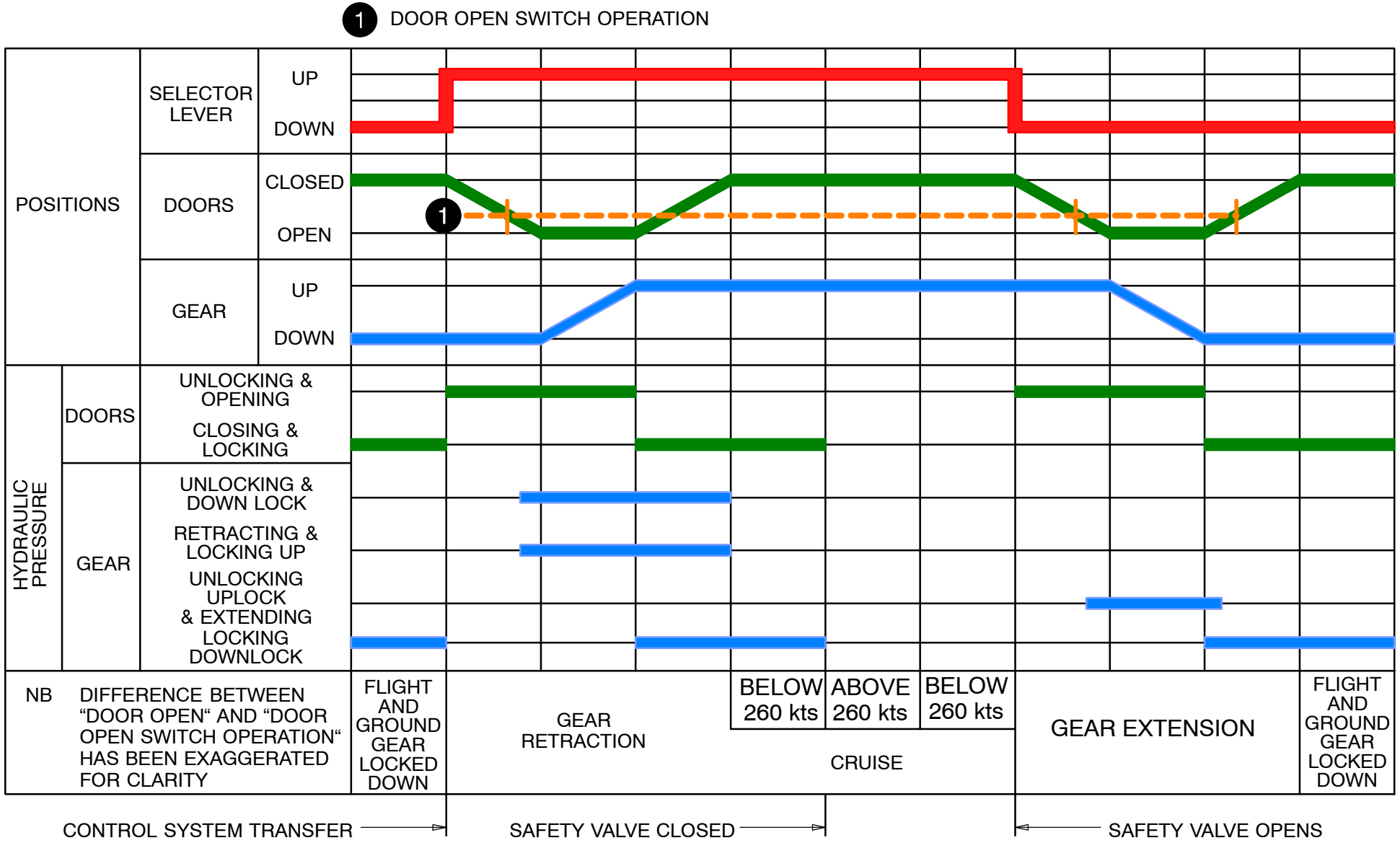


Figure 34 L/G System - Sequence of Operation

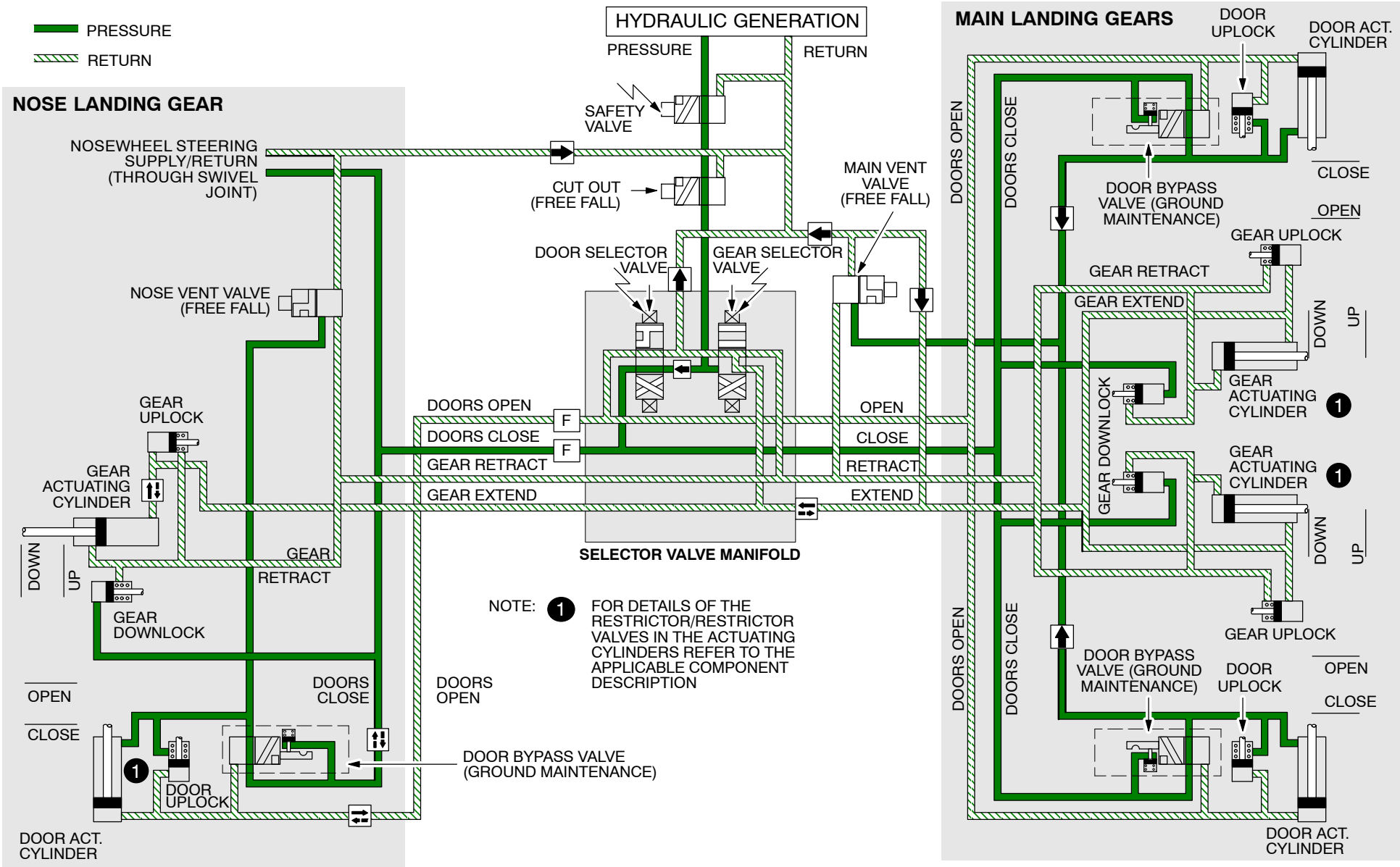


Figure 35 L/G Down (Doors Closed)

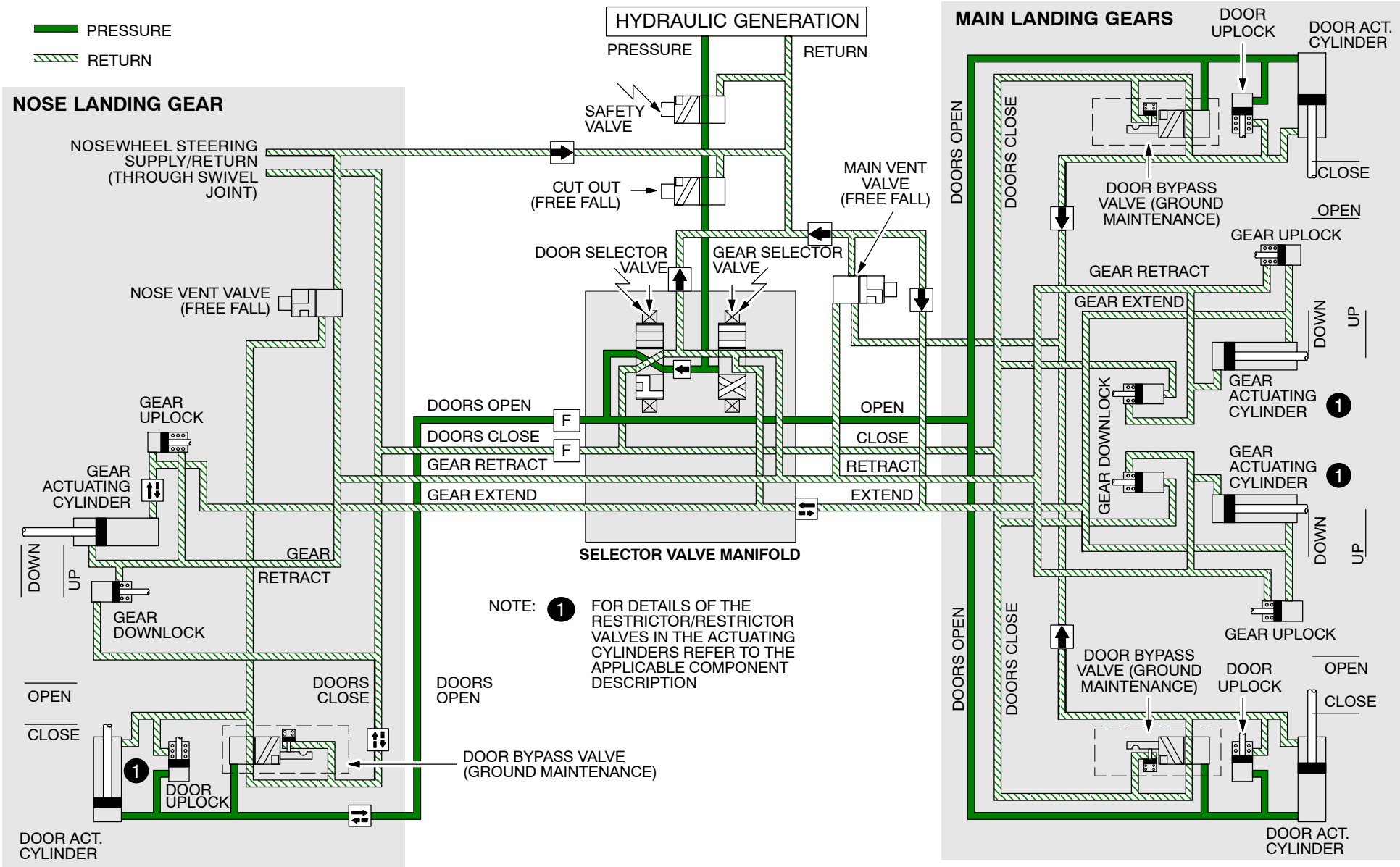


Figure 36 L/G UP selected (Doors move to open)

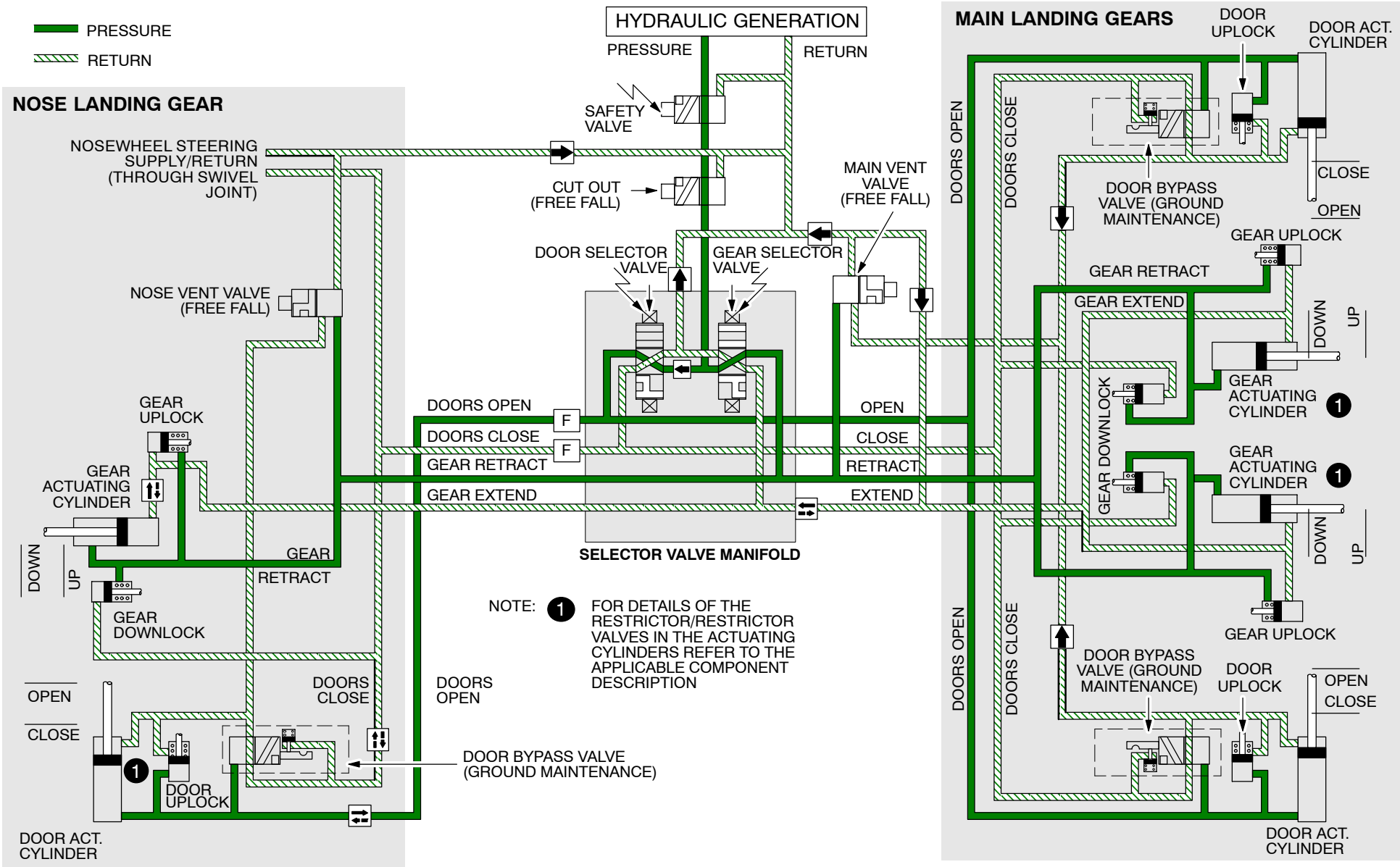


Figure 37 L/G UP selected (Gears move to Up)

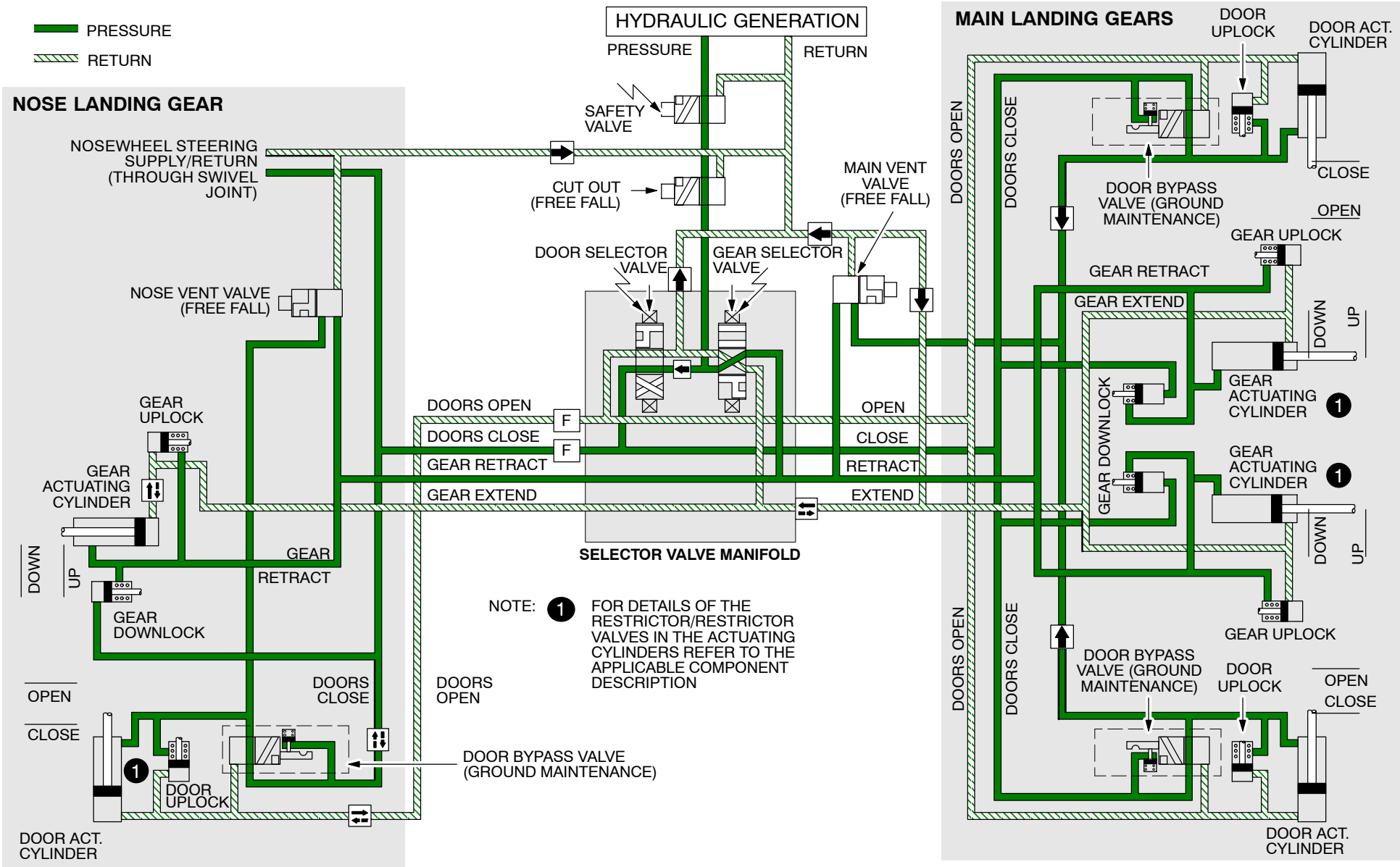


Figure 38 L/G UP selected (Doors move to close)

LANDING GEAR AND DOORS COMPONENT DESCRIPTION

LANDING GEAR CONTROL LEVER

The L/G control lever is installed on the First Officers side of the center instrument panel to control the L/G extension and retraction (normal extension and retraction mode). The front face of the unit has a control lever and two arrows identified 'UP' and 'DOWN'.

The control lever has a knurled wheel on the end of an arm. The arm moves in a slot in the face of the unit. Internal locks in the unit keep the arm in the fully UP or the fully DOWN position. The arm moves switches inside the unit, which supply electrical signals to the LGCIUs.

A solenoid–operated baulk mechanism prevents an UP selection if the L/G shock absorbers are not fully extended. The LGCIU's supply 28V DC to energize the baulk solenoid and release the mechanism, when the shock absorbers are fully extended.

Internal white lighting shows through the UP and DOWN legends and the outline of the two arrows.

To operate the L/G control lever, you pull it away from the face of the unit. Then move it to the UP or DOWN position. The lower part of the DOWN arrow shows red when the aircraft is in a landing configuration (but the L/G is not locked down).

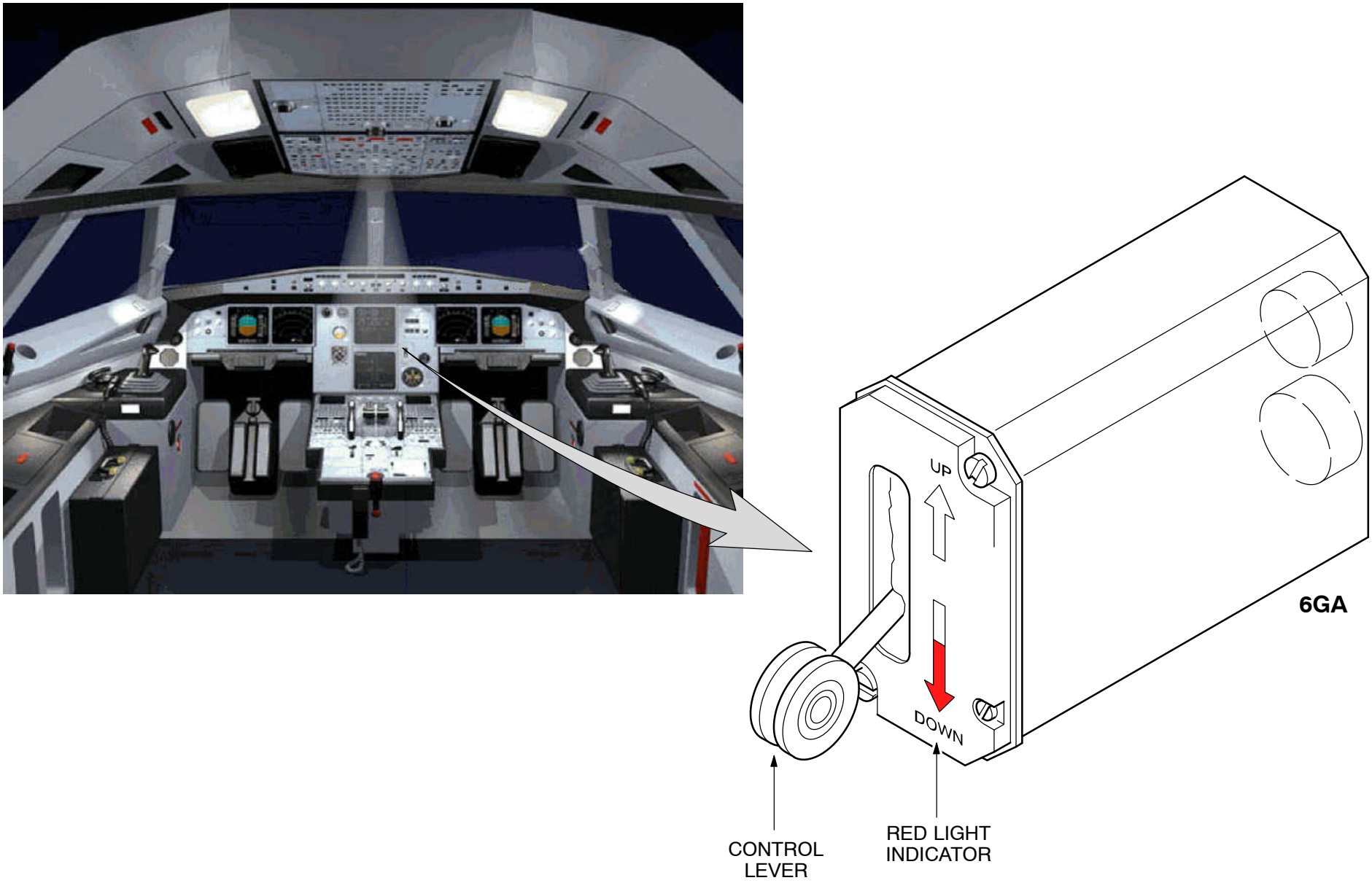


Figure 39 Landing Gear Control Lever

ISOLATION SAFETY VALVE

The primary components of the valve are a:

- Valve Body
- Solenoid and Electrical Connector
- Pilot Valve

The safety valve is installed on a manifold in the RH MLG bay.

The pilot valve is a spool valve that is connected to the main valve body by two screws.

The safety valve body has three ports that are identified A, B and C. The valve body has holes to connect the ports and faces to install the solenoid and connector.

The safety valve is an electrically–operated, two–position valve that isolates the Green hydraulic supply to the L/G system. When the computed airspeed is more than 264 kts the safety valve closes (solenoid de–energized). The safety valve opens (solenoid energized) when the computed airspeed is less than 260 kts and the L/G control–lever is selected DOWN.

A signal from LGCIU 1 keeps the safety valve open during maintenance.

The LGCIU sends this signal when the LH and RH MLGs are compressed or, when ground power is connected to the aircraft.

The safety valve gets its electrical supply from the essential busbar (401PP), during maintenance it can be supplied from the ground service busbar (601PP).

With the solenoid is energized the pressure inlet A is connected to the supply outlet C and the return outlet B is closed. This connects the Green hydraulic system to the L/G system.

With the solenoid de–energized the pressure inlet A is closed and the supply outlet C is connected to the return outlet B. This isolates the Green hydraulic system from the L/G system.

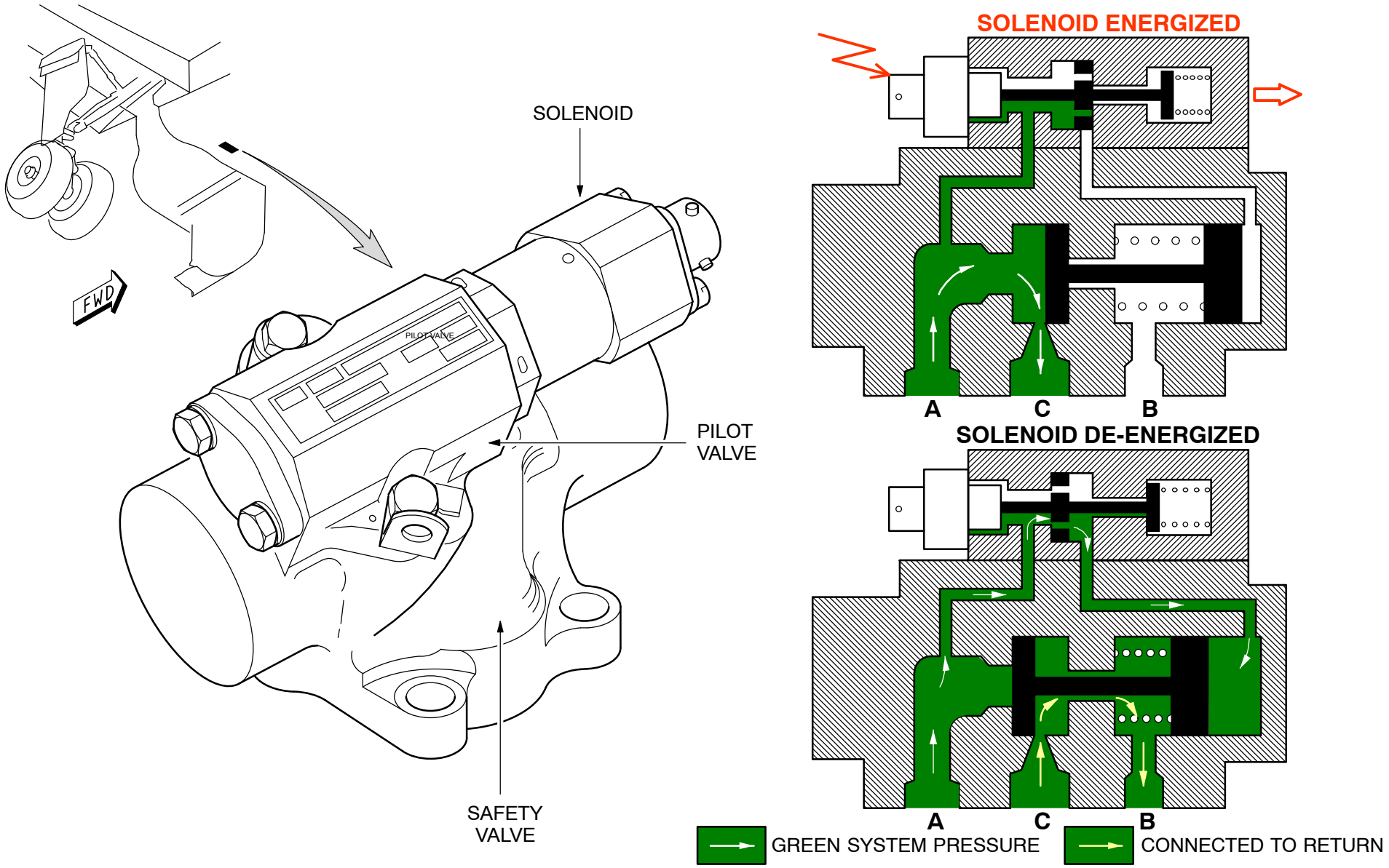


Figure 40 Safety Valve Operation

SELECTOR–VALVE MANIFOLD–ASSEMBLY

The selector valve manifold assembly is an electrically–operated hydraulic unit that controls the flow of hydraulic fluid to and from the L/G hydraulic components.

The primary components of the unit are:

- a manifold 2524GM which contains a restrictor valve 2538GM, and a check valve 2537GM
- two selector valves 41GA and 40GA. The selector valve 41GA controls the operation of the L/G doors and the selector valve 40GA controls the operation of the L/G.

The two selector valves are mounted on the manifold block. Each valve has two operating solenoids, each with two coil windings, one for each of the L/G control sub–systems.

When electrical or hydraulic power is not available the solenoids are de–energized and the spool is centralized by spring tension.

Manifold Block

The manifold has drills which connect to external ports and hydraulic connectors. Other drills connect specified ports together. The manifold has two faces on which the selector valves are installed. The faces have fluid ports which connect to the selector valve ports (annuli).

To centralize the spool, hydraulic pressure is supplied to the pressure port and passes through annuli 3 and the pilot valve to both end caps. Clearances between the spool lands and the main valve annuli 2 and 4 connects the service ports to the return port.

When the door solenoid 'A' is energized, the ball valve moves away from its seat to close the pilot valve orifice. Hydraulic fluid is then sent through annuli 5 to return. Because the pressures in the end caps are different, the spool moves to the right to open annuli 4. Ports 'D' and 'L' are connected to the pressure supply directly across the open spool. The return from the service ports 'C' and 'K' goes through annuli 2 and annuli 1 to the return gallery. The return gallery connects to annuli 5 and the pressure return line. When the door solenoid 'A' is de–energized and hydraulic pressure is available the ball valve is moved on to its seat to close the valve. This stops the flow of return fluid and hydraulic fluid is sent through the pilot valve to the end cap. The spring tension and fluid pressure return the spool to the central position. Both of the solenoids operate in the same way.

Restrictor Valve

The restrictor valve decreases the fluid pressure to reduce the MLG extension speed. When the MLG is retracted the restrictor valve lets the return fluid flow fully.

Check Valve

The check valve maintains the supply pressure to the door actuator when the L/G is in operation.

An arrow on the body shows the direction in which the fluid flows.

Selector valve

The selector valve is a three–position electrically–operated valve and has:

- two solenoids A and B
- two pilot valves
- a spool valve which contains a spool, a sleeve and two springs

Each solenoid, A and B, has two coil windings. Each coil winding is independently connected to two electrical connectors identified SYSTEM 1 and SYSTEM 2. Usually only one circuit is used, but either circuit operates the solenoids if the other is not available.

When energized, each solenoid moves a plunger which operates a spool–type pilot valve. The pilot valve opens or closes a hole that connects to one end of the spool valve.

The spool valve has a sleeve in which a spool moves. Two springs keep the spool in the center position of the sleeve when there is no pressure in the valve.

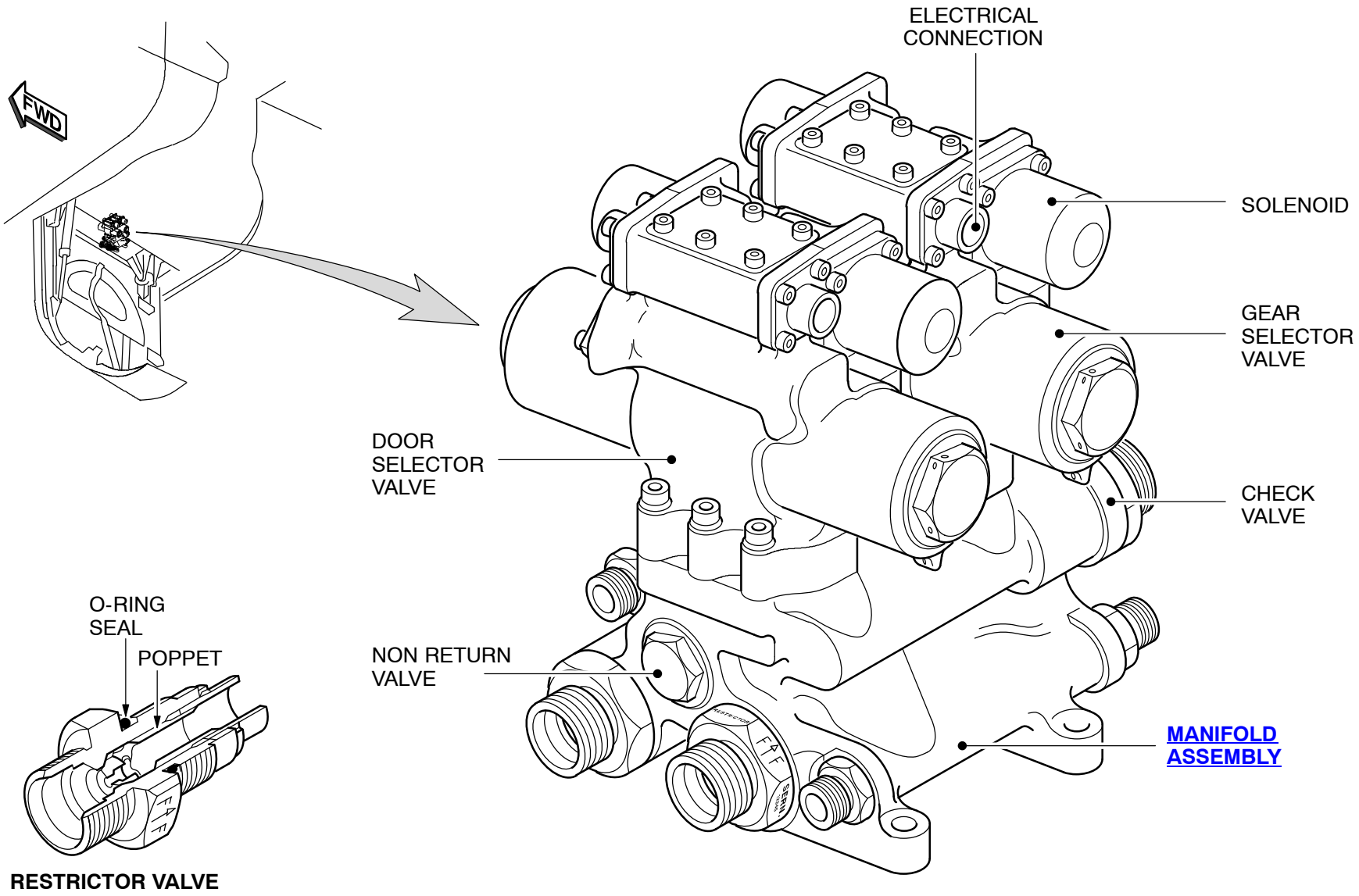


Figure 41 Selector Valve Manifold Assembly

DOOR CLOSING/OPENING SAFETY VALVE

The safety valve is installed in the open and close lines between the NLG door–actuator and the L/G door selector–valves. The safety valve closes the line if there is a hydraulic leak.

The safety valve will only operate at a flow rate equal to or greater than 11 ltr/min.

Valve Body

The valve has a body with two hydraulic ports B and C. The body is machined and holds the slide valve and valve seat.

The slide valve has drilled ports to let the hydraulic fluid move through the valve. The wire installed on the spring pin goes through the jet to prevent it from being blocked.

The spring pushes against the spring seat to keep the valve in the open position.

The valve seat is installed at the lower end of the valve body and is held in position by a screwed ring sealed by packing rings.

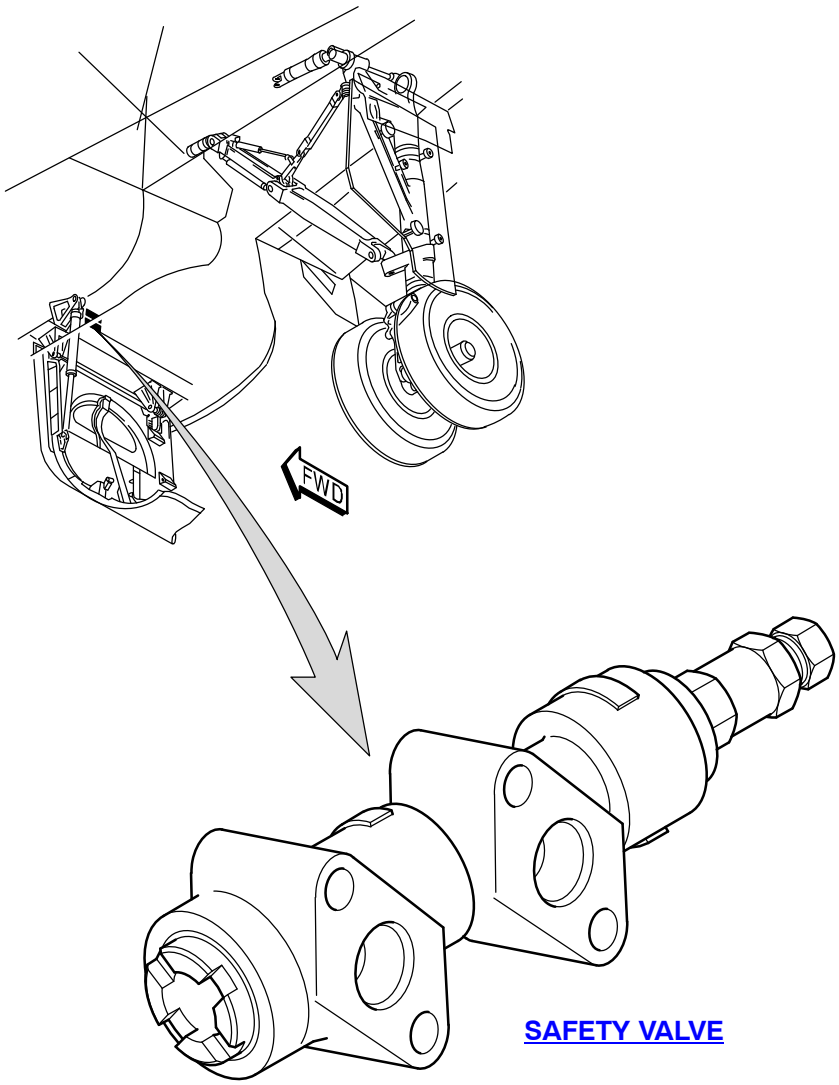
Hydraulic Fluid

In normal operation, the hydraulic fluid goes into port B, passes through the slot in the slide valve and goes out through port C. When a leak occurs downstream of the safety valve (with a flow rate greater than 11 ltr/minute) the slot in the slide valve stops the increase of flow. This causes the valve to begin to close. At the same time the spring is compressed and cavitation is formed in chamber A, which slows the movement of the slide valve.

The hydraulic fluid passes through the small hole in the slide valve and fills chamber A. When the chamber A is full the effect of the cavitation is removed and the valve closes. The speed at which chamber A fills controls the speed at which the valve will operate.

When the NLG door–actuator is operated it momentarily increases the hydraulic flow rate and causes cavitation in chamber A. When this happens, the spring returns the slide valve to the open position. The safety valve will stay in the closed position even when the supply pressure decreases to that of the Green system reservoir.

To reset the safety valve it is necessary to de–pressurize the Green system reservoir or to open the bleed screw installed on the end of the safety valve.



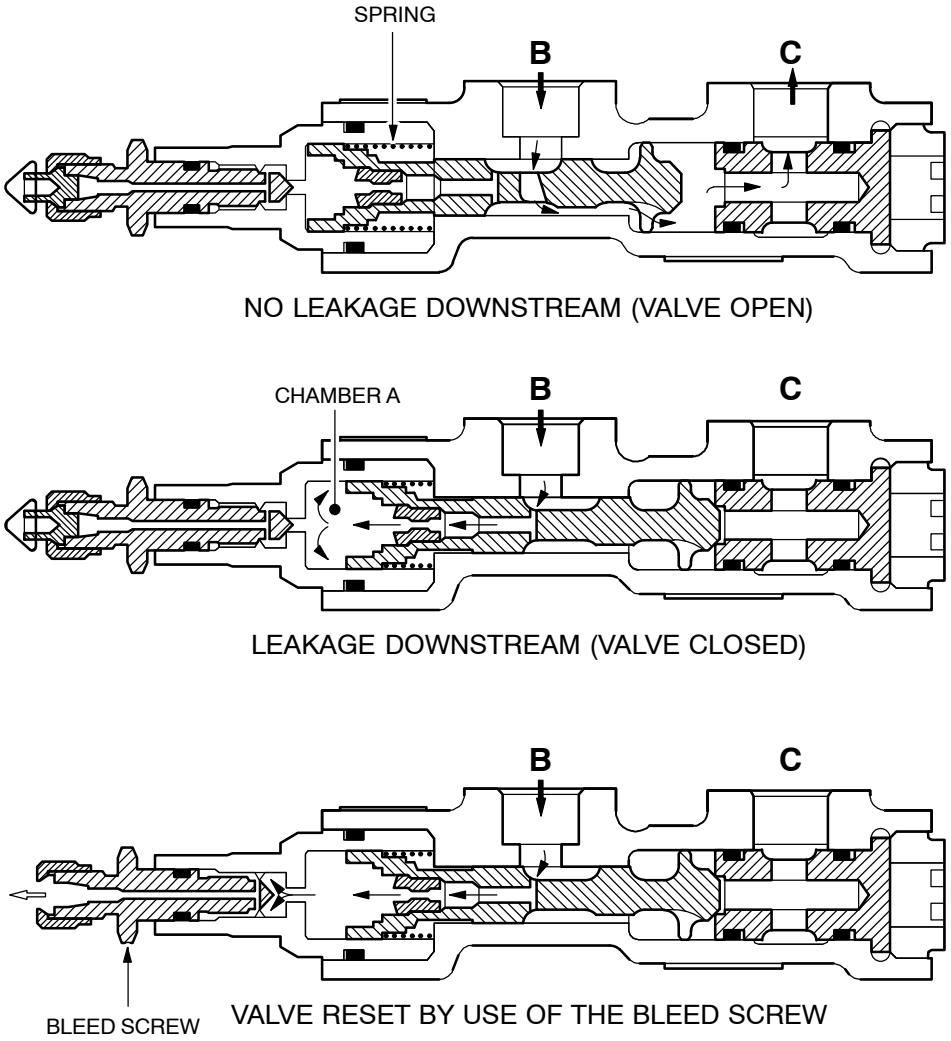


Figure 42 NLG Doors Safety Valve

MLG ACTUATING CYLINDER DESCRIPTION AND COMPONENTS

Description

The MLG actuating cylinder is installed on the main fitting at the piston rod end. Two lugs attach the body of the actuating cylinder to the wing rear spar. The actuator is operated hydraulically and has rate control devices. The primary components of the unit are a cylinder, a piston rod and two valve housings.

The cylinder contains the piston rod and a sealed piston head. Each valve housing contains a restrictor and a restrictor valve. The restrictor decreases the flow of fluid in each direction and the restrictor valve decreases the flow of fluid out of the cylinder.

Actuating Cylinder

The body of the actuating cylinder has a housing bolted to each end that are connected by an external pipe. Each housing contains a restrictor and a restrictor valve. These components control the speed at which the actuating cylinder operates and the end of travel damping, which occurs in each direction of travel. To give protection against the high fluid pressures (caused during end of travel damping) the walls of the actuating cylinder are thicker at the piston rod end.

Piston Rod

The piston rod moves in the cylinder assembly and has a plug at the internal end, an integral eye–end (with a spherical bearing) at the external end and a vent valve.

If pressurized fluid gets into the piston rod, the vent valve blows out and prevents an increase in pressure in the piston rod. To prevent corrosion a small quantity of hydraulic fluid is put into the piston rod during assembly.

With hydraulic pressure supplied to the full area side of the piston, the piston rod extends and retracts the MLG. Pressure to the annular side of the piston, retracts the piston rod and extends the MLG. The piston rod range of travel is controlled by the side stay during the MLG extension cycle and the uplock during the MLG retraction cycle.

Restrictor Valve

The restrictor valve is closed by hydraulic fluid flow when the L/G is operated. This decreases the flow of fluid and controls the speed of the piston rod. Near the end of the piston rod travel the piston closes a control orifice. This causes the remaining fluid to return through the closed restrictor valve to the hydraulic system return and an increase in pressure (on the return side of the piston) which damps the end of the piston rod travel. The shape of the piston causes a smooth increase in the damping effect.

MLG ACTUATING CYLINDER OPERATION

Retraction Sequence

When the piston rod is in the extended position, the piston covers the control orifice of the restrictor valve at the piston rod end. The increased internal diameter of the cylinder prevents the orifice of the one–way restrictor being totally covered.

When a selection is made to retract the piston rod, port A is open to the hydraulic system pressure and port B to the hydraulic system return. The hydraulic fluid enters port A and pressure is transmitted directly to the valve housing at the piston rod end. The fluid cannot go through the control orifice, so the valve of the one–way restrictor is moved to permit full fluid flow. The initial piston movement is slow because the control orifice of the restrictor valve is closed by the piston. Once the piston has moved past the control orifice of the restrictor valve, the flow is increased and the piston accelerates.

Damping

At the other end of the retraction actuator, the hydraulic system return fluid goes through the piston end valve housing to port B. The fluid is forced through the control orifice of the restrictor valve and the orifice of the one–way restrictor valve, which is moved to decrease the fluid flow. As the piston covers the control orifice, the fluid flow by this path is reduced and finally stopped. Fluid which returns through the one–way restrictor, causes a pressure build–up in the piston end of the actuator. This decelerates the piston movement and dampens the end of travel stroke.

Extension

Both restrictor valve sub–assemblies on the retraction actuator are similar in operation. This means that the extension of the actuator is opposite to the retraction.

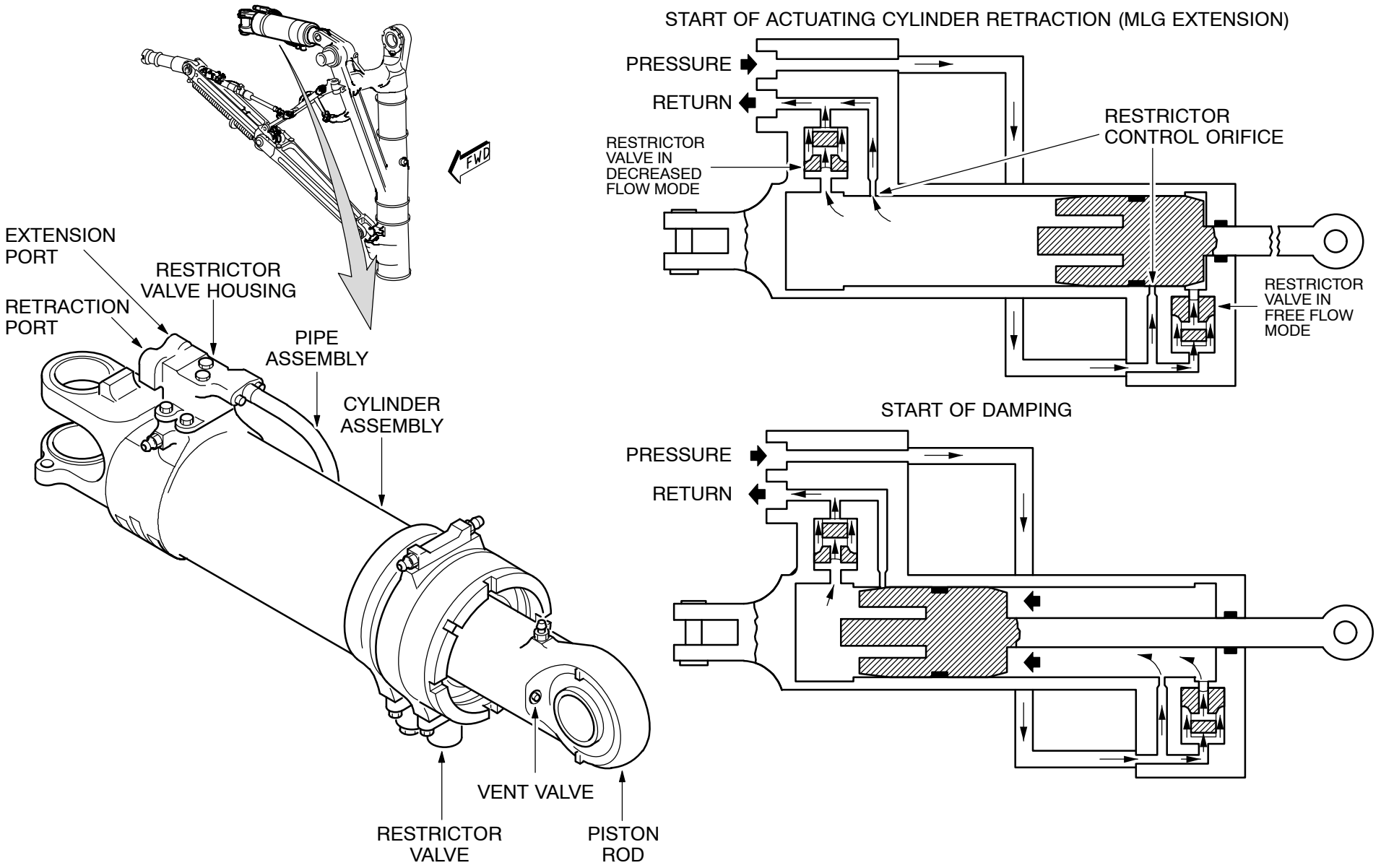


Figure 43 MLG Actuating Cylinder

NLG ACTUATING CYLINDER DESCRIPTION AND COMPONENTS

Description

The NLG actuating–cylinder is a two–acting type. The body has a valve housing at each end, each of which contains a restrictor. The actuating cylinder assembly contains the following components:

- Piston Rod Assembly
- Cylinder Assembly
- Rod Extension and Retraction Body
- Hydraulic External Fittings

Piston–Rod Assembly

The piston–rod assembly has a rod which moves in a spherical bearing and a piston with a seal. The piston is connected to the rod by a lock–washer and a nut, which are locked by a bolt and a nut. The piston has a ring which prevents any sideways movement of the piston on the rod. The piston movement is kept within specified limits by a seal, and preformed packing and back–up rings.

Cylinder Assembly

The cylinder assembly includes a:

- Cylinder
- Spherical Bearing
- Retaining Ring
- Plate

The cylinder has a spherical bearing at one end that connects the cylinder to the aircraft structure. The bearing, with a seal and scraper, is held in the opposite end of the cylinder by a ring and plate. The exterior of the cylinder contains ports for the hydraulic connections.

Extension Body

The extension body is installed on the upper end of the actuating cylinder. The body has three hydraulic unions and contains two internal annuli. One of these annuli is connected to the actuator–supply port. The other annuli contains the restrictor. Two annuli in the body, aligned with two annuli in the cylinder, provide the hydraulic connection between the components.

Retraction Body

The body assembly contains a hydraulic union and an annuli. The annuli contains a restrictor. An annuli in the body, in line with an annuli in the cylinder, provides the hydraulic connection between the components.

External Hydraulic Fittings

The actuating–cylinder extension–body has connections for the extension and retraction hydraulic–fluid supply–hoses. The extension and retraction bodies are connected together by a hydraulic pipe. This pipe is attached to the cylinder assembly.

NLG ACTUATING CYLINDER OPERATION

Retraction

To retract the NLG, pressurized hydraulic fluid goes through the restrictor into the annular side of the actuating–cylinder. This causes the piston rod to retract to move the NLG. The hydraulic fluid on the other side of the piston goes to the hydraulic system return through the main return orifice and the restrictor. As the piston gets near to the end of its travel, it closes the return orifice in the actuating cylinder. This decreases the flow of hydraulic fluid to the hydraulic system return, which damps the end of piston–rod travel.

Extension

During the extension of the NLG, the aerodynamic loads, and the weight of the NLG, cause the NLG to extend. The restrictor on the annular side of the piston decreases the return flow of the fluid from the actuating–cylinder. This causes a damping–pressure on the annular side of the piston and thus controls the rate of NLG extension.

A restrictor valve (2691GM) in the L/G Hydraulic System keeps a limit on the damping–pressure. To do this, the valve decreases the flow of pressurized fluid to the extend side of the actuating–cylinder.

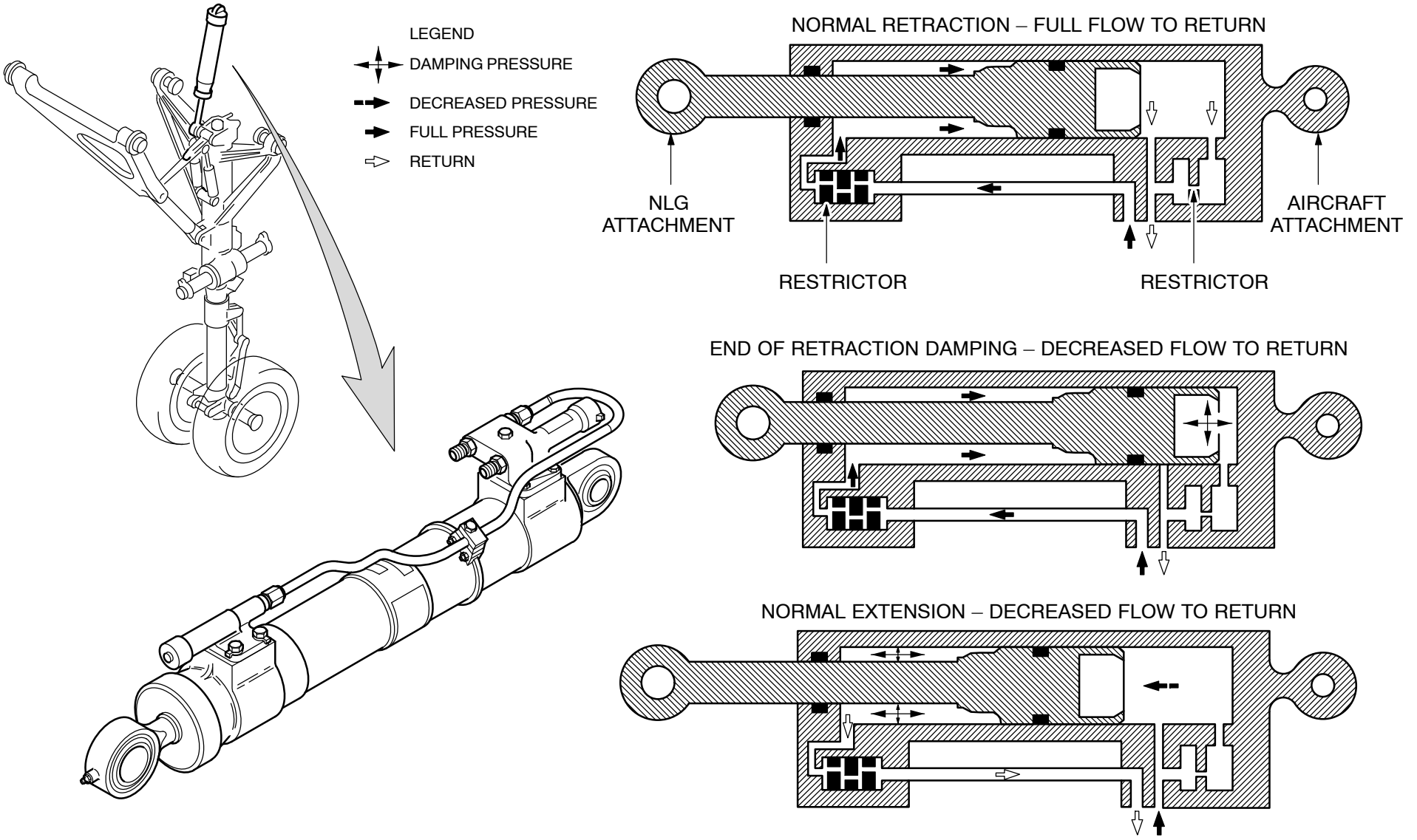


Figure 44 NLG Actuating Cylinder

MLG DOOR ACTUATING CYLINDER DESCRIPTION AND COMPONENTS

Description

The door actuator is a hydraulic actuator with rate control devices. The piston and piston rod are contained in a cylinder. A damping piston, on each side of the piston, goes into a damping bore at the end of the extend and retract strokes.

The door–actuating cylinder attaches to the center–fuselage keel–structure at the fixed end, and to the hinged door at the piston end.

Actuating Cylinder

The actuating cylinder has a cylinder assembly, a restrictor housing and a piston. The cylinder assembly has a cylinder closed at one end by a fixed end fitting. At the other end it is closed by a gland housing and a piston. The fixed end fitting and the gland housing are internally machined to form damping chambers. The piston is shaped to fit inside the damping chambers, at the end of the assembly.

Damping Chamber

The damping chamber in the fixed end fitting has two diametrically opposite damping holes and two diametrically opposite axial feed slots. The gland housing has two damping holes that are axially displaced to provide progressive damping.

The restrictor housing is installed on the fixed end fitting. It has two port connectors that contain restrictors to control fluid flow. A service line connects port B on the restrictor housing to the gland housing. The actuating cylinders range of travel is controlled by the door stops and the door uplock when the door closes and an internal stop (the piston head touches the internal face of the gland housing) when the door opens.

MLG DOOR ACTUATING CYLINDER OPERATION

Doors Closed

When main gear doors 'closed' is selected, hydraulic fluid from port B passes through the restrictor and the damping holes. The hydraulic pressure is applied to the piston flange and the annular face of the piston. The piston retracts slowly (due to the restricted fluid flow) until it opens the second damping hole which increases the piston speed. The speed increases until the piston is free of the damping chamber.

Doors Open

When main gear doors 'open' is selected, hydraulic fluid from port A passes through a restrictor and the axial feed slots. At the same time the hydraulic fluid passes through the damping holes. The piston then extends slowly due to the restricted fluid flow. Piston speed increases until the piston goes into the gland–housing damping chamber.

Damping

The end of stroke damping occurs in the two directions. The damping effect occurs when the piston head goes into the damping chamber, which causes the removed fluid to pass through the damping holes. On extension, the damping effect increases when one damping hole is closed by the piston.

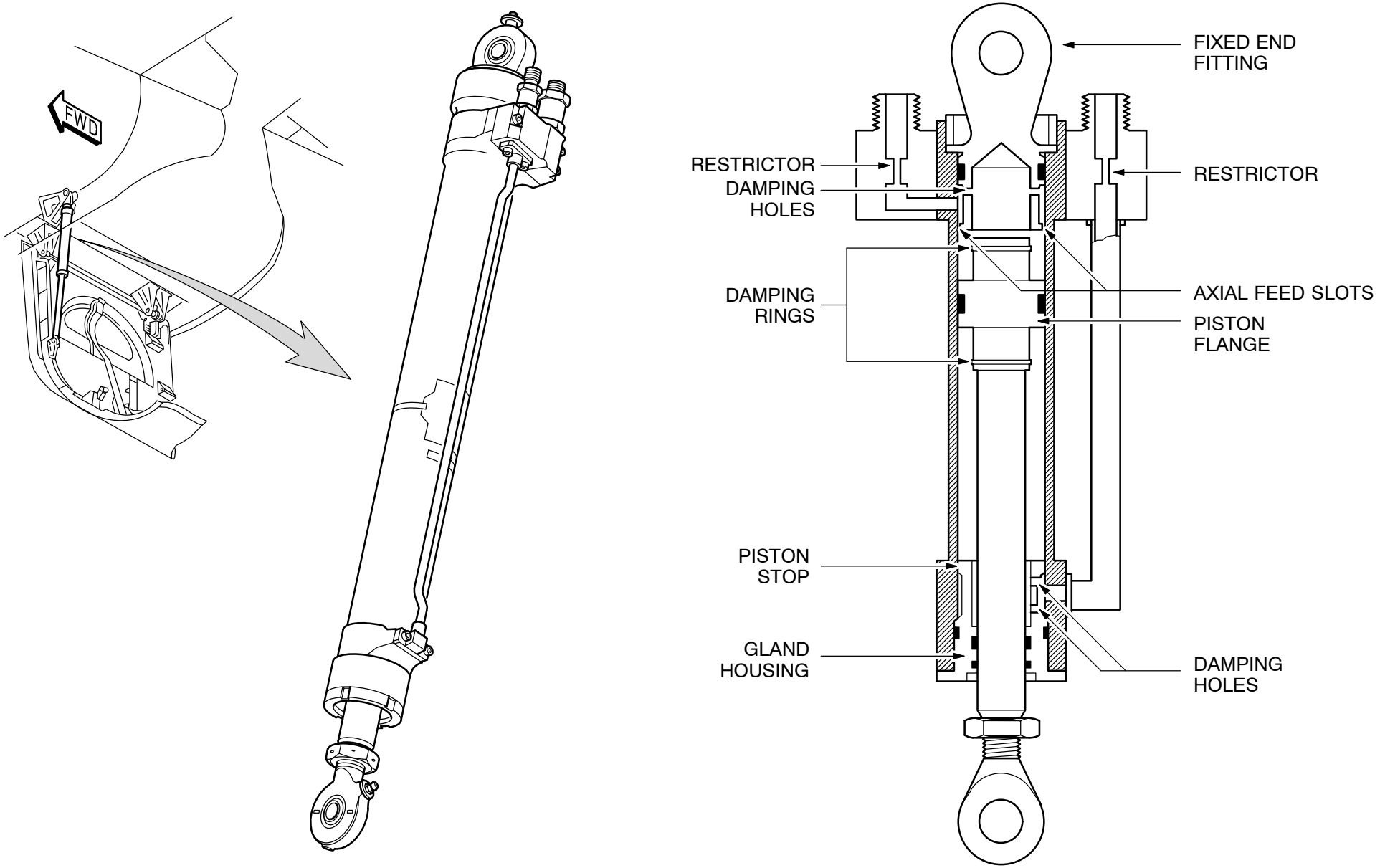


Figure 45 MLG Door Actuating Cylinder

NLG DOOR ACTUATING CYLINDER DESCRIPTION AND COMPONENTS

Description

The door actuator is a hydraulic actuator with rate control devices. The piston and the piston rod are contained in a cylinder. The shape of the internal bore, the position of the return orifices, and the restrictor valve, control the damping.

Actuating Cylinder

The NLG door actuating–cylinder is a two–acting type. A valve–housing on the body of the actuating–cylinder contains a check–valve. The movable part of the check–valve has a slot in the face that touches the valve seat.

The actuating–cylinder connects the door control–rod bellcrank at the piston–rod end and the roof of the landing gear bay at the fixed end.

Restrictor

An in–line restrictor is installed in the line to the annular side of the actuating cylinder. It controls the speed at which the piston–rod operates. The actuating cylinders range–of–travel is controlled by the NLG door uplock as the NLG doors close and an internal stop as the NLG doors open.

NLG DOOR ACTUATING CYLINDER OPERATION

Doors Close

With the NLG doors set to CLOSE, the pressurized hydraulic fluid goes into the annular side of the actuating–cylinder. The piston–rod retracts and closes the NLG doors. On the other side of the piston, the hydraulic fluid goes to return through the main return orifice and the slot in the closed check–valve. Near the end of the piston–rod travel, the piston closes the main return orifice. This causes a large decrease in the flow of fluid to return, which damps the end of the piston–rod travel.

Doors Open

With the NLG doors set to OPEN, the aerodynamic loads help the doors to open. The restrictor decreases the return flow of fluid from the actuating-cylinder. This causes a damping–pressure on the annular side of the piston to control the speed at which the NLG doors open. The restrictor–valve (2535GM) keeps a limit on the damping–pressure. To do this, the valve decreases the flow of pressurized fluid to the extend side of the actuating–cylinder.

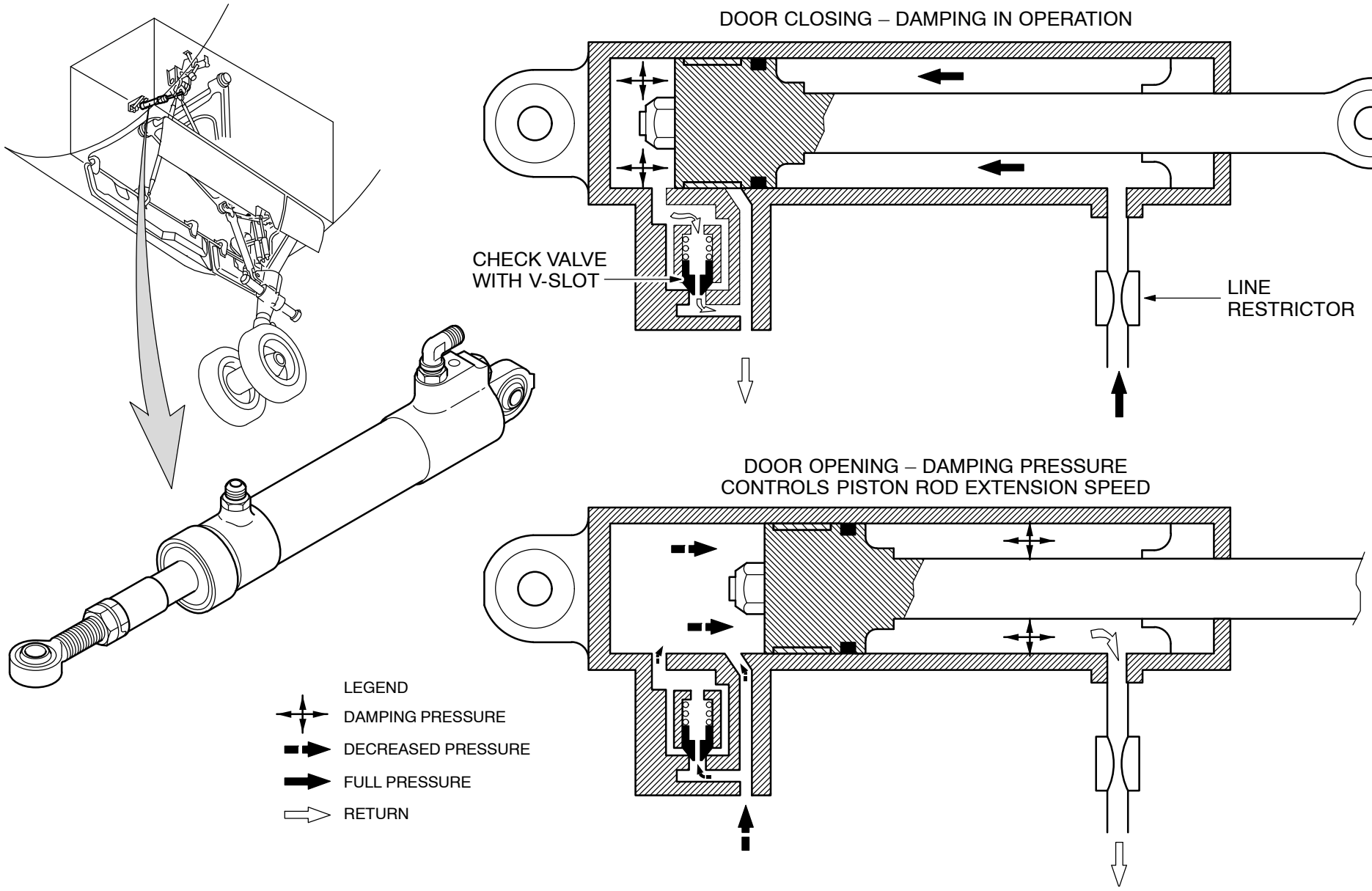


Figure 46 NLG Door Actuating Cylinder

GEAR AND DOOR UPLOCKS COMPONENT DESCRIPTION

The MLG/NLG Gear and Door Uplocks are mechanical devices which automatically locks the MLGs and NLG in the retracted position. They are closed mechanically and opened hydraulically in the normal extension and retraction mode and can be opened mechanically in the free fall extension mode.

The primary components of the uplocks are:

- Casing
- Hydraulic Actuator
- two Proximity Sensors with their related Targets
- Locking Mechanism
- Free–Fall Mechanical–Release Mechanism
- Ground Door Opening Release Mechanism (only Door Uplocks)

MLG UPLOCK DESCRIPTION AND COMPONENTS

Casing

The casing has two halves, which are connected by bolts. The hydraulic actuator has a piston, and is connected to the casing. A spring keeps the piston retracted when there is no hydraulic pressure. The actuator has two hydraulic ports, A and B. The casing has two rigging hole positons:

One position is for checking of the mechanism for the Free Fall Extension System. The other one locks the uplock in the closed position and is for a rigging check of the proximity sensors.

Proximity Sensors

The proximity sensors are attached to the casing and the targets to the latch assembly. They continuously supply an independent electrical signal to show the uplock configuration (uplock closed=target near or uplock open=target far).

Locking Mechanism

The primary components of the locking mechanism are a latch assembly and a hook. The latch assembly has a bearing and two targets. The bearing turns on a pin at its center, as do the latch assembly and the hook. Tension springs connect the latch assembly to the hook. The hook has a cam which touches the bearing.

Free–Fall Mechanical–Release Mechanism

It has a release lever which is connected to a splined drive shaft. This drive shaft connects to the Free Fall Extension System. The uplock is connected to the airframe by a rod end and two support lugs.

MLG UPLOCK OPERATION

Gear Extend

To move the L/G to the extended position, the L/G selector–valve is energized. Hydraulic pressure is then applied through port A. This extends the piston and compresses the actuator spring. The piston strikes the latch assembly, which pivots to release the bearing from the hook cam. The hook opens due to the tension springs and L/G pin forces, and contacts the stop bolt. When the L/G has fully extended, the two hydraulic ports are opened to system return and the actuator spring releases the piston.

Gear Retract

To lock the L/G in the retracted position, the L/G selector–valve is energized. Hydraulic pressure is applied through port B, to make sure that the piston is fully released. The L/G retracts and the L/G pin strikes the upper hook jaw. This causes the hook to pivot and the bearing to move across the hook cam face. When the hook contacts the stop bolt, the tension springs pull the latch assembly over the hook cam, this locks the L/G in position.

Proximity Sensors

During the operation of the locking mechanism, the target to proximity sensor relationship changes. This positional change causes an uplock 'locked' or 'unlocked' signal to be supplied to the LGCIUs.

Hydraulic Failure

When hydraulic pressure is not available, the uplock is released by mechanical operation of the release lever (free–fall system). When the free–fall extension–handle is rotated, the splined shaft rotates. Rotation of the splined shaft causes the release lever to release the bearing from the hook cam. The hook opens due to the tension springs and L/G pin–forces.

The reset of the extension handle, resets the release lever (free–fall system), which returns the uplock to its 'normal' open position.

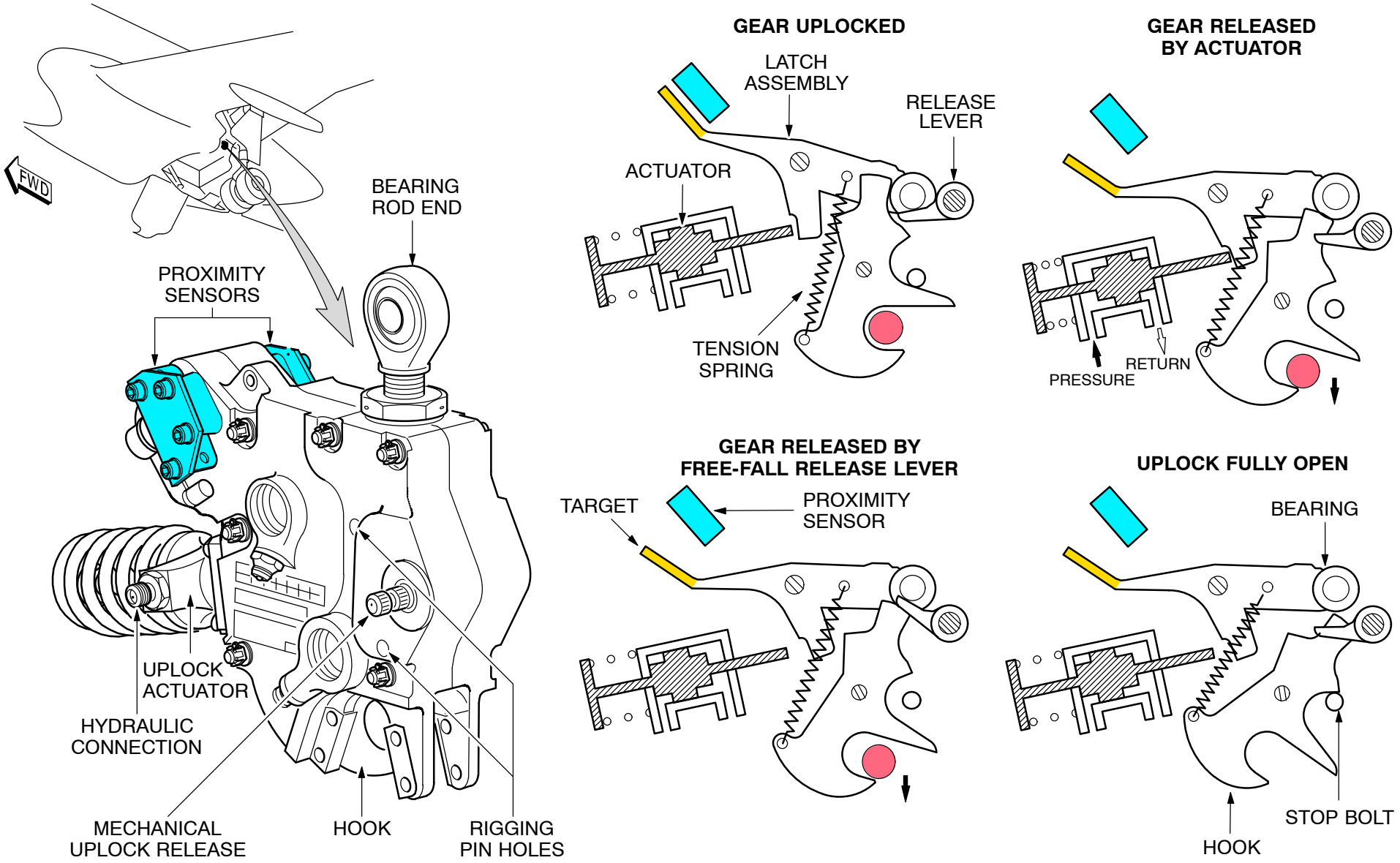


Figure 47 MLG Uplock

NLG UPLOCK DESCRIPTION AND COMPONENTS

Casing

The casing has two halves which are connected with bolts. The hydraulic actuator has a piston, and is connected to the casing. A spring keeps the piston retracted, when there is no hydraulic pressure. The actuator has two hydraulic ports A and B.

Two internal attachment lugs are used to install the uplock to the airframe. A rigging pin hole is provided for initial installation and subsequent adjustment of the free fall system.

Proximity Sensors

Two proximity sensors are attached to the casing and the targets are attached to the lock lever. They continuously supply an independent electrical signal to show the uplock configuration (uplock closed=target near or uplock open=target far).

Lock Mechanism

The primary components of the lock mechanism are a lock lever and a hook. The lock lever has two bearings and two targets. Each bearing turns on a pin at its center. The lock lever and the hook also turn on pins at their centers. Springs tension the lock lever and the hook. The hook has a cam which touches the lower bearing on the lock lever.

Free–Fall Mechanical–Release Mechanism

The mechanical release mechanism has a release cam attached to a splined drive shaft. This shaft connects to the Free–Fall Extension System.

NLG UPLOCK OPERATION

Gear Extend

To move the L/G to the extended position, the L/G selector–valve is energized. Hydraulic fluid goes through port 'A' which extends the piston and compresses the actuator spring. The piston strikes the lock lever, which pivots and releases from the hook cam. The hook opens due to return spring and L/G pin forces. The two hydraulic ports are opened to system return, and the actuator spring releases the piston. When the L/G has fully extended, the hydraulic ports open (to system return) which causes the actuator spring to retract the piston.

Gear Retract

To lock the L/G in the retracted position, the L/G selector–valve is energized. Hydraulic pressure is applied through port 'B', to make sure that the piston is fully retracted.

The L/G retracts and when the L/G pin strikes the upper hook jaw, it causes the hook to pivot to the closed position. The lock lever return spring causes the lock lever to pivot and engage the hook cam. This locks the hook in the closed position.

During the operation of the lock mechanism, the target to proximity sensor position changes. This positional change causes an uplock 'locked' or 'unlocked' signal to be supplied to the LGCIUs.

When hydraulic fluid pressure is not available, the uplock is released by the mechanical operation of the free–fall release–cam. When the free–fall extension–handle is rotated, it rotates the cam shaft. Rotation of the cam shaft causes the release cam to disengage the lock lever from the hook cam.

The hook pivots open due to the return spring and land gear pin forces.

The reset of the extension handle, resets the release cam, which returns the uplock to its 'normal' open position.

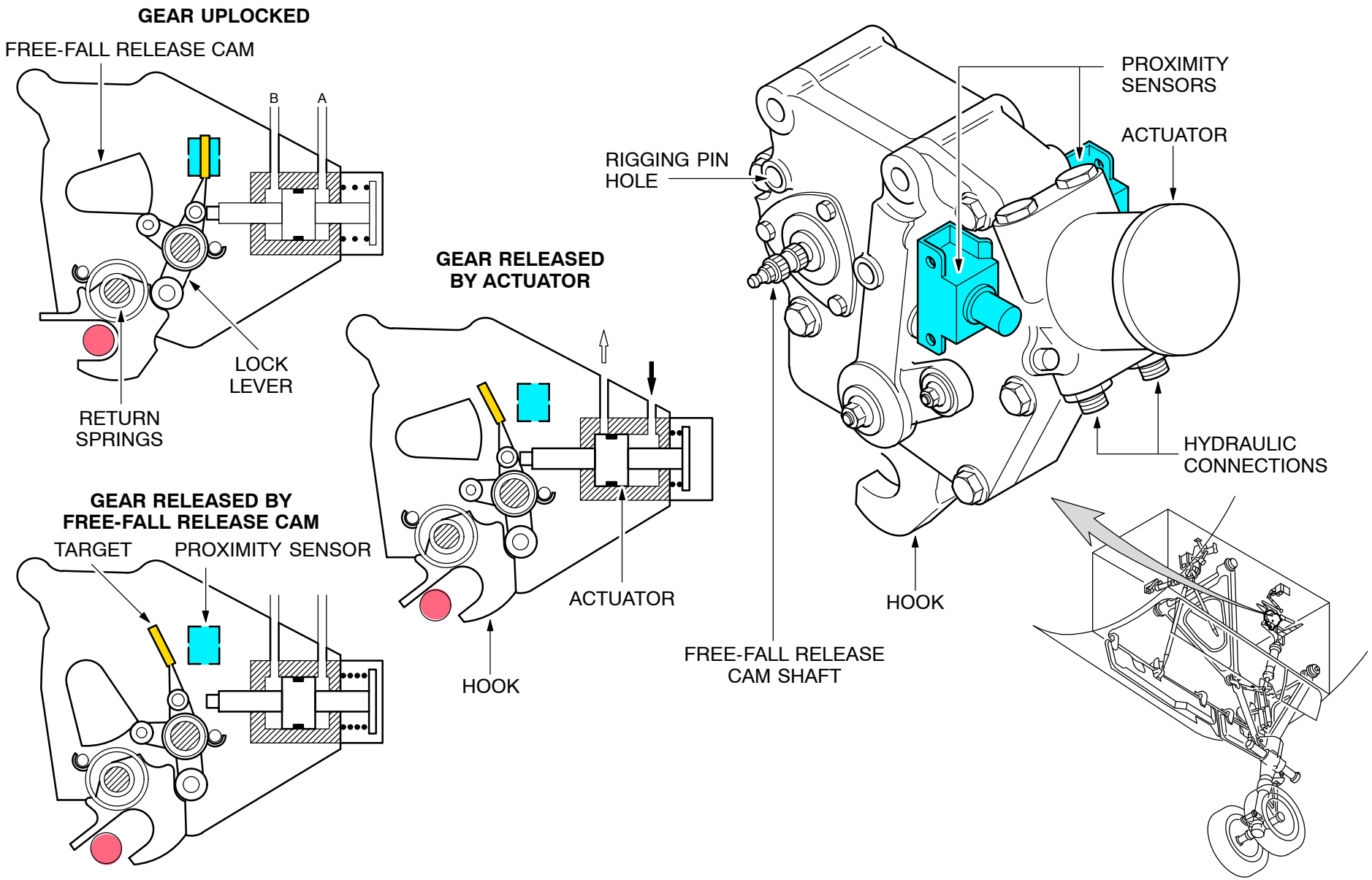


Figure 48 NLG Uplock

MLG DOOR UPLOCK DESCRIPTION AND COMPONENTS

Casing

The casing has two halves which are connected by bolts. The hydraulic actuator has a piston, and is attached to the casing. A spring keeps the piston retracted when there is no hydraulic pressure. The actuator has two hydraulic ports A and B. The casing has three holes for rigging pins which are used to lock the uplock in the closed position to do a rigging check of the proximity sensors, to permit a rigging check of the mechanism for the Free–Fall Extension System and to permit a position rigging check of the mechanism for the Ground Door–Opening System.

Locking Mechanism

Primary components of the locking mechanism are a latch assembly and a hook. The latch assembly has a roller and two (proximity) targets. Tension springs connect the latch assembly and the hook to the casing. The hook has a cam which touches the roller.

Release Mechanism

Each mechanical release mechanism has a release lever connected to a splined drive shaft. One connects to the Free Fall Extension System and the other to the Ground Door–Opening System.

Proximity Sensors

The proximity sensors are installed on the casing, and the targets are installed on the latch lever. They continuously supply an independent electrical signal to show the uplock configuration (uplock closed = 'target near' or uplock open = 'target far').

In the open condition, the bearing on the latch assembly is against the top face of the hook cam. The tension springs hold the latch assembly and hook in this position. The targets are not near the proximity sensors.

MLG DOOR UPLOCK OPERATION

Doors Open

To open the L/G doors, the L/G door selector–valve is energized. Hydraulic pressure is applied through port A, which extends the piston and compresses the actuator spring. The piston strikes the latch assembly, which pivots to disengage the roller from the hook cam. The hook opens, due to the tension springs and door pin forces, and contacts the stop bolt. When the MLG doors are fully open, the two hydraulic ports open to system return and the actuator spring releases the piston.

Doors Close

To close and lock the L/G doors, the L/G door selector–valve is energized. Hydraulic pressure is applied through port B, to make sure that the piston is fully released. The door closes and the door pin strikes the upper hook jaw. This causes the hook to pivot and the roller to move across the hook cam face. When the hook contacts the stop bolt, the tension springs pull the latch assembly over the hook cam, and locks the L/G door in position.

Proximity Sensors

During the operation of the locking mechanism, the target to proximity sensor position changes. This positional change causes an uplock 'locked' or 'unlocked' signal to be supplied to the LGCIUs.

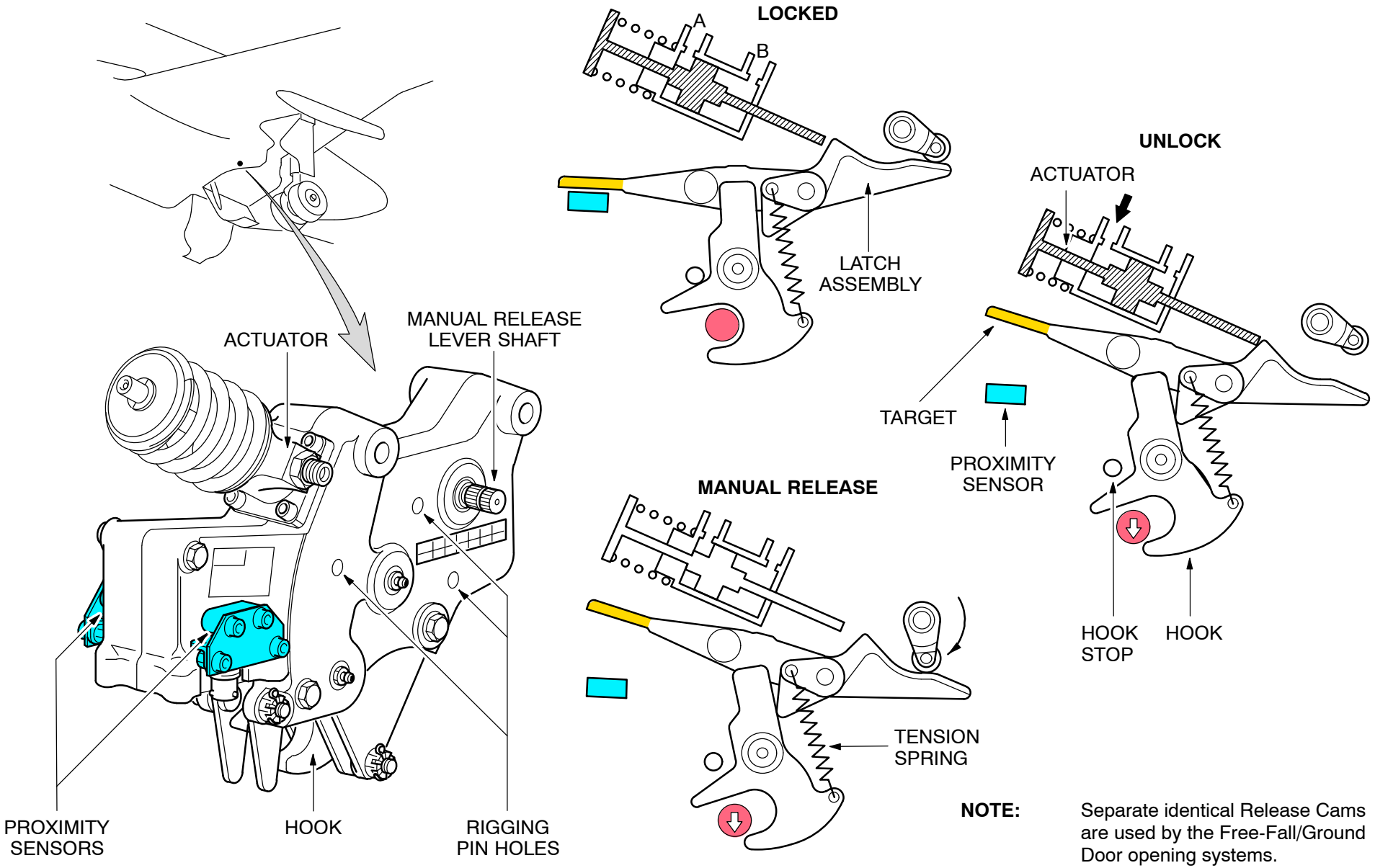
Mechanical Release

When hydraulic fluid pressure is not available, the door uplock is released by mechanical operation of the manual release lever (free–fall system). When the free–fall extension handle is rotated, it rotates the splined shaft. Rotation of the splined shaft causes the release lever to disengage the roller from the hook cam. The hook opens due to the tension springs and door pin forces.

The reset of the manual release lever returns the door uplock to its 'normal' open condition.

Ground Door Opening

The ground–door opening–system uses a separate cam but operates identically to the free–fall system.



NOTE: Separate identical Release Cams are used by the Free-Fall/Ground Door opening systems.

Figure 49 MLG Door Uplock

NLG DOOR UPLOCK DESCRIPTION AND COMPONENTS

Casing

The casing has two halves which are connected by bolts. The hydraulic actuator contains a piston and is connected to the casing. A spring keeps the piston retracted, when there is no hydraulic pressure. The actuator has two ports A and B. Rigging pin holes are provided for initial installation and subsequent adjustment of the free fall system, the ground door opening system and the proximity sensors.

Proximity Sensors

The proximity sensors are installed on the casing, and the targets are installed on the lock lever. They continuously supply an independent electrical signal to show the uplock position (uplock closed = 'target near' or uplock open = 'target far').

Lock Mechanism

The primary components of the lock mechanism are a lock lever and a hook. The lock lever has two rollers and two targets. Each roller turns on a pin at its center. The lock lever and the hook also turn on pins at their centers. Springs tension the lock lever and the hook. The hook has a cam which touches the lower roller on the lock lever.

Release Mechanism

The mechanical release mechanisms have release cams attached to the splined drive shafts. The shafts connect to the Free Fall Extension System and the Ground Door Opening System.

NLG DOOR UPLOCK OPERATION

Doors Open

To open the L/G doors, the L/G door selector–valve is energized. Hydraulic pressure is supplied through Port A, to extend the piston and compress the actuator spring. The piston strikes the lock lever, which pivots and disengages from the hook cam. The hook opens due to return spring and NLG door pin forces.

Doors Close

To close and lock the L/G doors, the L/G door selector–valve is energized. Hydraulic pressure is supplied through Port B, to make sure that the piston is fully released. The NLG doors close and when the door pin strikes the upper hook jaw, it causes the hook to pivot to the closed position. The lock–lever return–spring causes the lock–lever to pivot and engage the hook cam, which locks the hook in the closed position.

Proximity Sensors

During the operation of the locking mechanism, the target to proximity sensor position changes. This positional change causes an uplock 'locked' or 'unlocked' signal to be supplied to the LGCIUs.

Hydraulic Failure

When the hydraulic system is not available, the door uplock is released by the mechanical operation of the free–fall release–cam. When the free–fall extension–handle is rotated, it rotates the cam shaft. Rotation of the cam shaft causes the release cam to disengage the lock lever from the hook cam. The hook pivots open due to the return spring and door pin forces.

The reset of the free–fall release–cam (free–fall system) resets the uplock to its 'normal' open position.

Ground Door Opening

The ground door opening system uses a separate release cam which operates in the same way as the free–fall release cam.

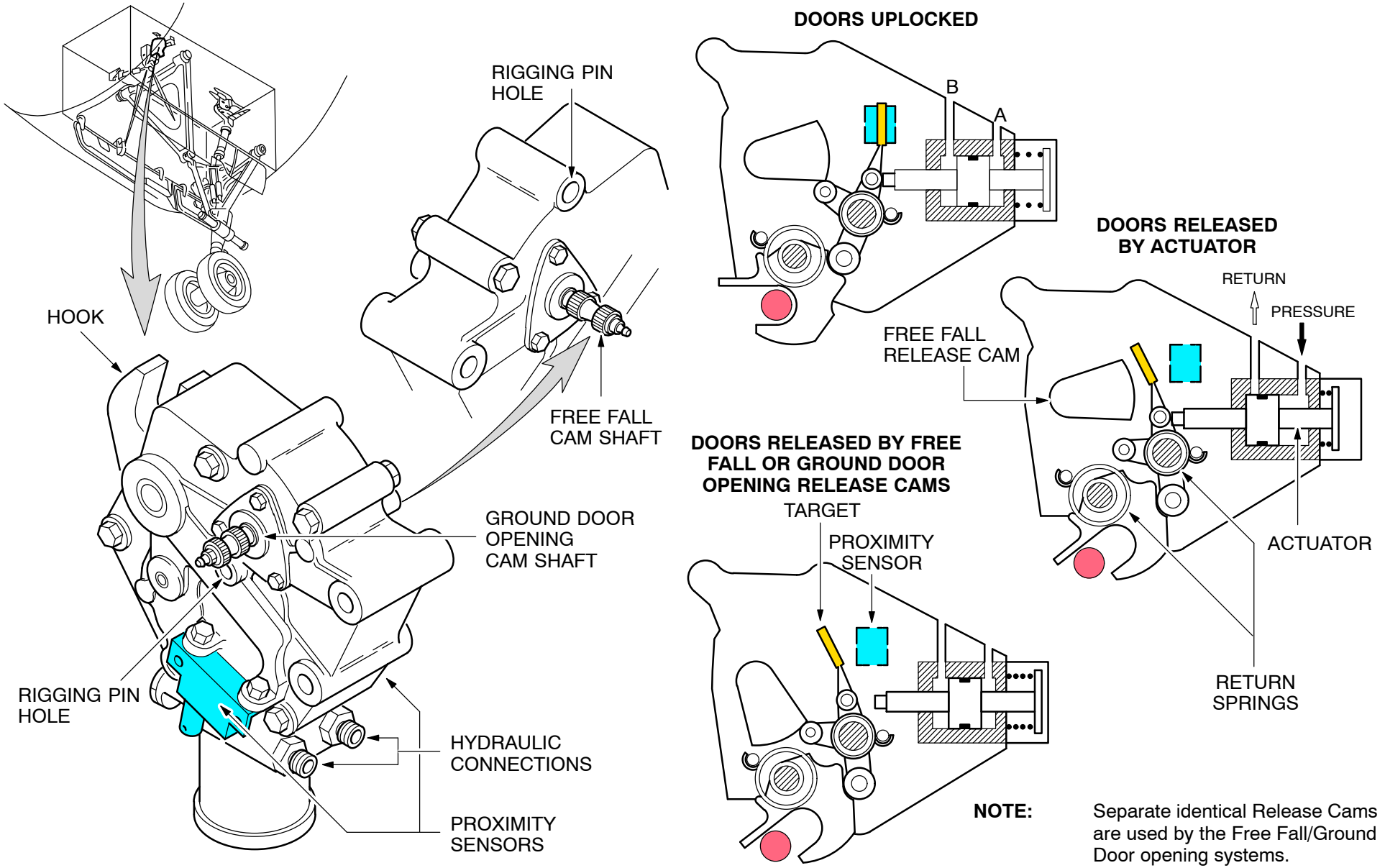


Figure 50 NLG Door Uplock

MLG LOCK-STAY ACTUATOR

The lock–stay actuator is a hydraulic unit with rate control devices. The main components of the actuator are:

The lock–stay, that moves to an over–center position, locks the L/G in the fully extended position.

NLG DOWNLOCK RELEASE ACTUATOR

The lock–stay actuator is a double acting hydraulic actuator. The lock–stay, that moves to an over–center position, locks the NLG in the fully extended position.

NLG OPERATION

When you extend the NLG, the two lock–stay–actuator hydraulic–ports (A and B), are open to return. As the NLG extends, the two lock springs force the lock–stay and drag strut to straighten. The lock–stay is pulled to an over–center position by the lock springs. When the NLG doors start to close, the full area of the lock–stay actuator is pressurized, through port B. This makes sure that the lock–stay is in the over–center position. After the NLG has extended, the pressure remains to keep it in the locked position (if the landing–gear control–lever is in the DOWN position).

NLG Retraction

When you retract the NLG, hydraulic pressure acts on the annular face of the piston, through port A. The actuator then retracts. As the actuator retracts, it breaks the over–center lock, the lock–stay and side stay fold into position against the tension of the lock–springs.

Restrictor Valve

The restrictor valve is installed in the actuator assembly and decreases the speed of operation of the downlock actuator. This causes a decrease in the speed of operation of the lock–stay and the NLG.

Proximity Sensors

During the operation of the lock–stay assembly, the related position of the target and proximity sensor changes. This change causes a NLG ’locked’ or ’unlocked’ signal to be supplied to the LGCIUs.

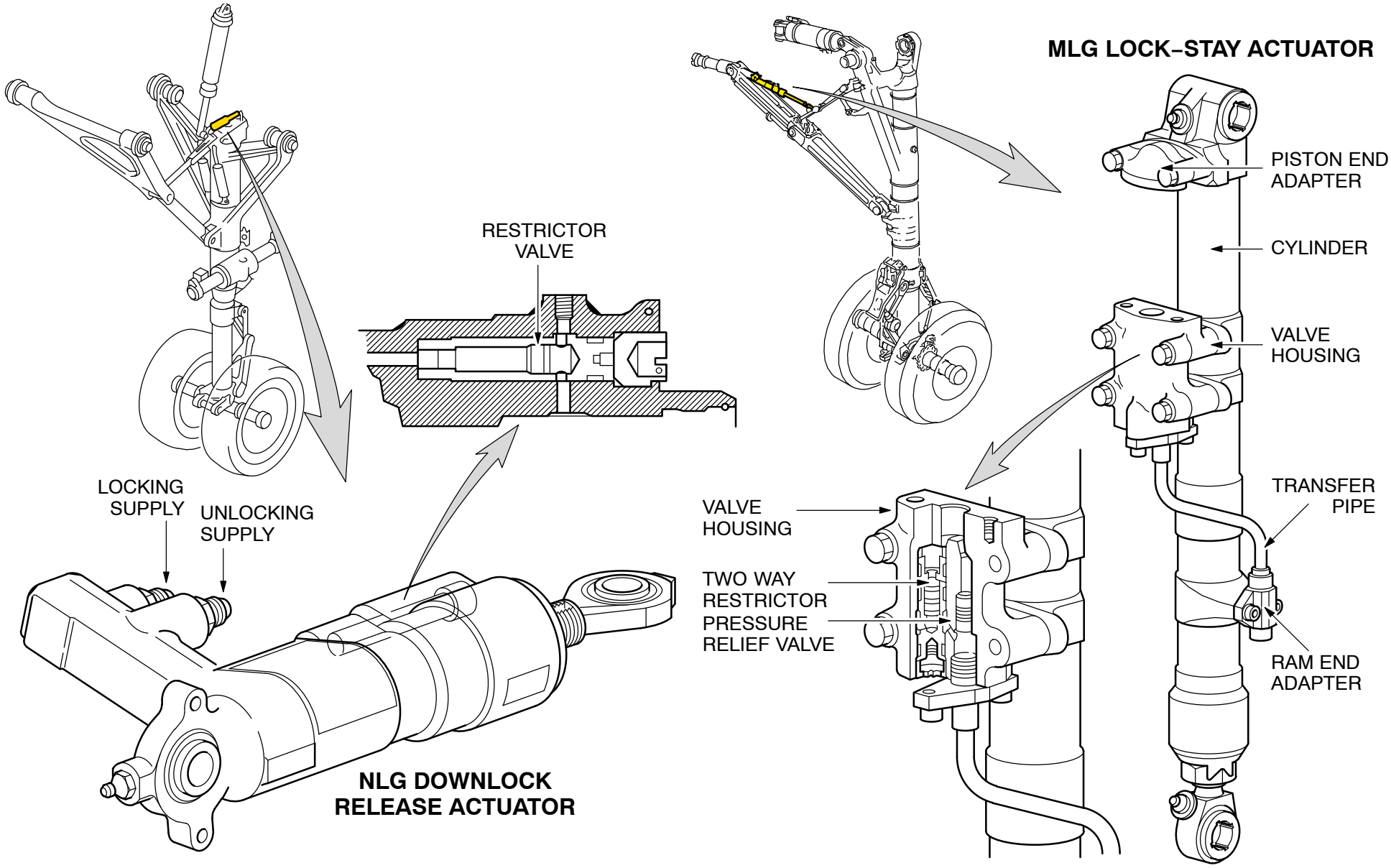


Figure 51 Downlock Release and Lock–Stay Actuator

DOOR GROUND OPENING BY-PASS VALVE

Each by–pass valve has three hydraulic connections marked A, B and C:

- Port A : door open line
- Port B : door close line from the selector valve
- Port C : door close line to the door actuator.

For normal operation, Port A is closed with Port B connected to Port C. For door ground opening, Port B is closed before Port A is connected to Port C.

A locking plunger (baulk) in the by–pass valve stops the movement of the control lever from the OPEN to the CLOSE position. Before selection can be made, a hydraulic pressure greater than 70 bars (1015 psi) must be supplied to port B (doors close line) to retract the locking plunger.

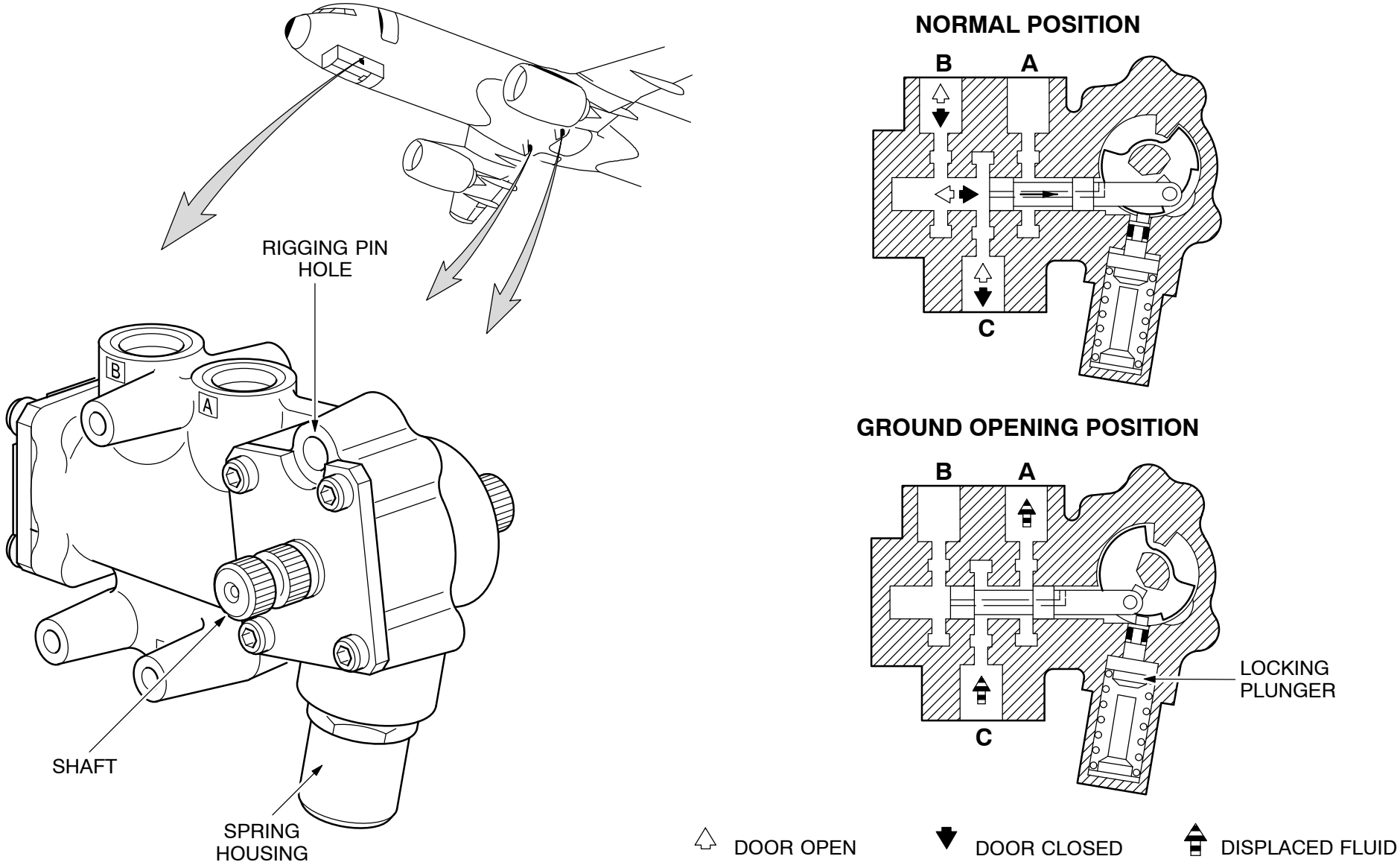


Figure 52 Gear Door GND Opening By-Pass Valve

LANDING GEAR CONTROL AND INTERFACE UNIT

General

There are two identical Landing Gear Control and Interface Units (LGCIUs):

- System No. 1 LGCIU (5GA1), which is located on the rack 93VU
- System No. 2 LGCIU (5GA2), which is located on the rack 94VU

Functions

The function of each LGCIU is to:

- control the operation of the landing gear (L/G) and doors
- find the position and status of the L/G and doors
- supply L/G and door position and status information to other aircraft systems
- process proximity sensor inputs from the Flap disconnect system
- supply data to the Slat and Flap Control Computer (SFCC)
- process proximity sensor and microswitch inputs from the Cargo Door Control System
- provide a control logic circuit for the Cargo–Compartment Door–Systems
- monitor LGCIU system operation and report component/system failures to the Flight Warning Computer (FWC) and Electronic Centralized Aircraft Monitoring System (ECAM)
- store details of failures and to supply this information to the Centralized Fault Display System (CFDS)
- provide BITE and self monitoring functions
- simulate any landing gear configuration for maintenance test and failure investigation tasks

Description

The two LGCIUs are interchangeable, but the aircraft wiring in System No. 1 is different to that of System No. 2. Thus the installed LGCIUs will supply different interfaced aircraft systems with L/G system position information.

Only one LGCIU is in control of the L/G system at a time. The aircraft can operate satisfactorily even if one of the LGCIUs does not operate or is not installed. In this case the serviceable unit must be installed in System No.1 Rack 93VU.

Redundancy

Changeover from one LGCIU channel to the other one occurs:

- at each movement of the L/G control lever away from DOWN position
- in case of active LGCIU failure detection or its peripheries

To permit the automatic changeover, each LGCIU supplies a hardwired status signal to the other one. Independent of this channel change both LGCIUs will continue to supply L/G position and status information to the interfaced aircraft systems. It does not matter which LGCIU is in control of the L/G system.

Construction

Each LGCIU consists of an ARINC 6004 MCU case, that has:

- a Power Supply Unit (PSU)
- an On Board Replaceable Memory Module (OBRM)
- seven Printed Circuits Boards (PCB)
  - 2 Proximity Signal Conditioning cards
  - 1 Output/Control and Indication card
  - 3 Interface cards
  - 1 combined OBRM/Microprocessor card

Two 28 VDC inputs supply each LGCIU. One input is connected to the PSU and one is connected to the Output/Control and indication card and the interface card that remains.

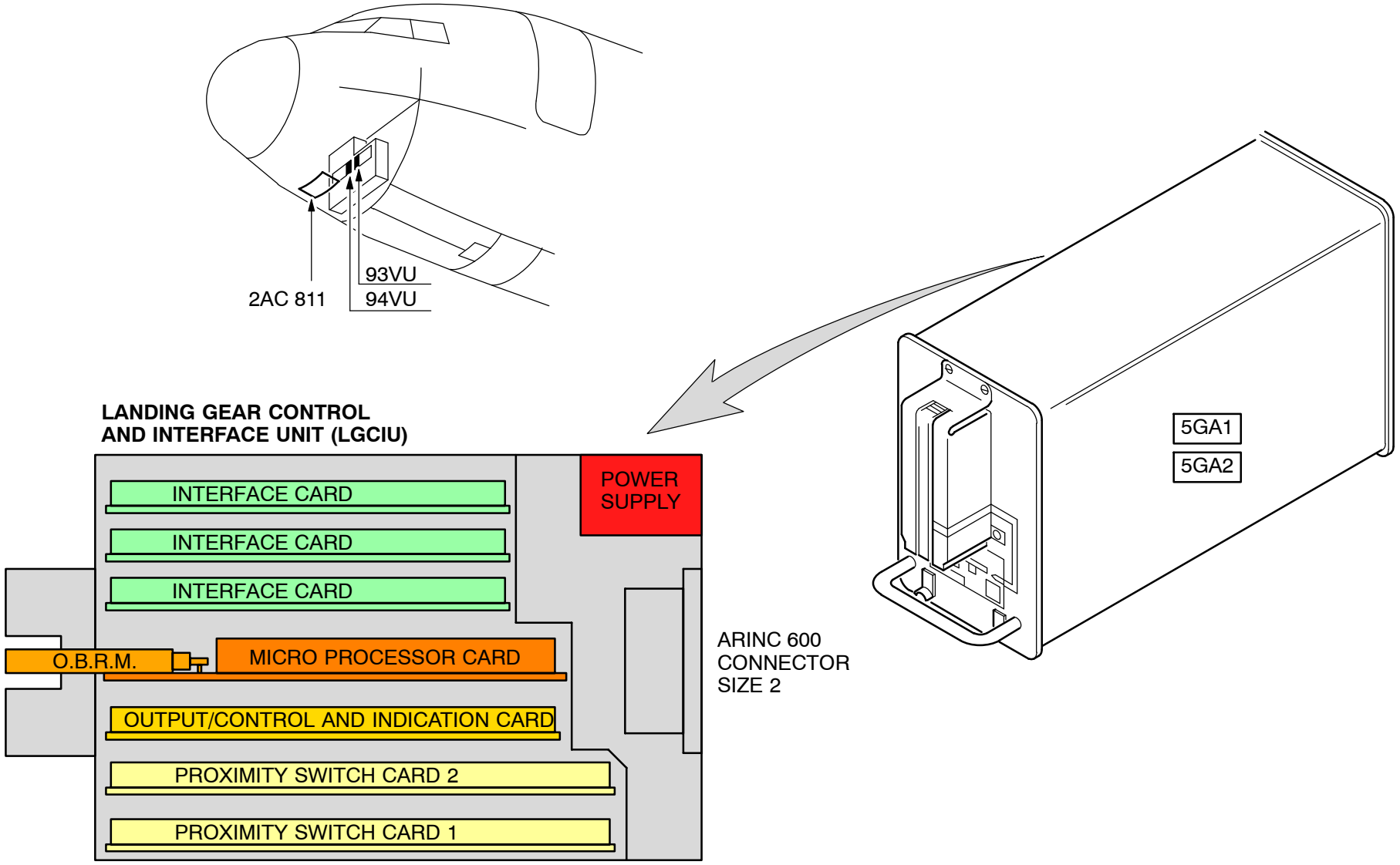


Figure 53 Landing Gear Control and Interface Unit

LGCIU CONTROL SIGNALS

UP Selection

Two UP selection signals that come from the lever, are sent to the LGCIU (**L**anding **G**ear **C**ontrol **I**nterface **U**nit) to initiate the gear retraction sequence.

DOWN Selection

Two DOWN selection signals coming from the lever, are sent to the LGCIU to initiate the gear extension sequence.

Door Uplocks

Three door uplock signals that come from door uplock proximity detectors, are sent to the LGCIU to indicate whether doors are uplocked, or not.

Door Fully Open

There are four door fully open signals, two of which for nose doors. These signals come from the corresponding proximity detectors and are sent to the LGCIUs to indicate whether doors are fully open, or not.

Gear Uplocks

Three gear uplock signals that come from gear uplock proximity detectors, are sent to the LGCIU to indicate whether gears are uplocked, or not.

Gear Downlocks

Three gear down lock signals that come from gear down lock proximity detectors, are sent to the LGCIU to indicate whether gears are down and locked, or not.

Extended or Compressed

Three shock absorber signals, which come from the oleo proximity detectors, are sent to the LGCIU to indicate whether shock absorbers are compressed, or not.

NOTE: The Nose Landing Gear “FLIGHT“ information is given when the gear is extended and the wheels are in centered position.

Door Selector Valve

After analyzing all the input signals, the LGCIU sends two signals to the corresponding solenoid of the door selector valve according to the position of the gears.

Gear Selector Valve

After analyzing all the input signals, the LGCIU sends two signals to the corresponding solenoid of the gear selector valve according to the position of the doors.

L/G Retraction Interlock Solenoid

After analyzing all shock absorber signals, the LGCIU sends a signal to the lever interlock solenoid to prevent gear retraction if any shock absorber is compressed.

LGCIU 2

The control signals for LGCIU 2 are the same. Four signals are used by the LGCIU for system selection:

- two for System No. 1 status
- two for System No. 2 status

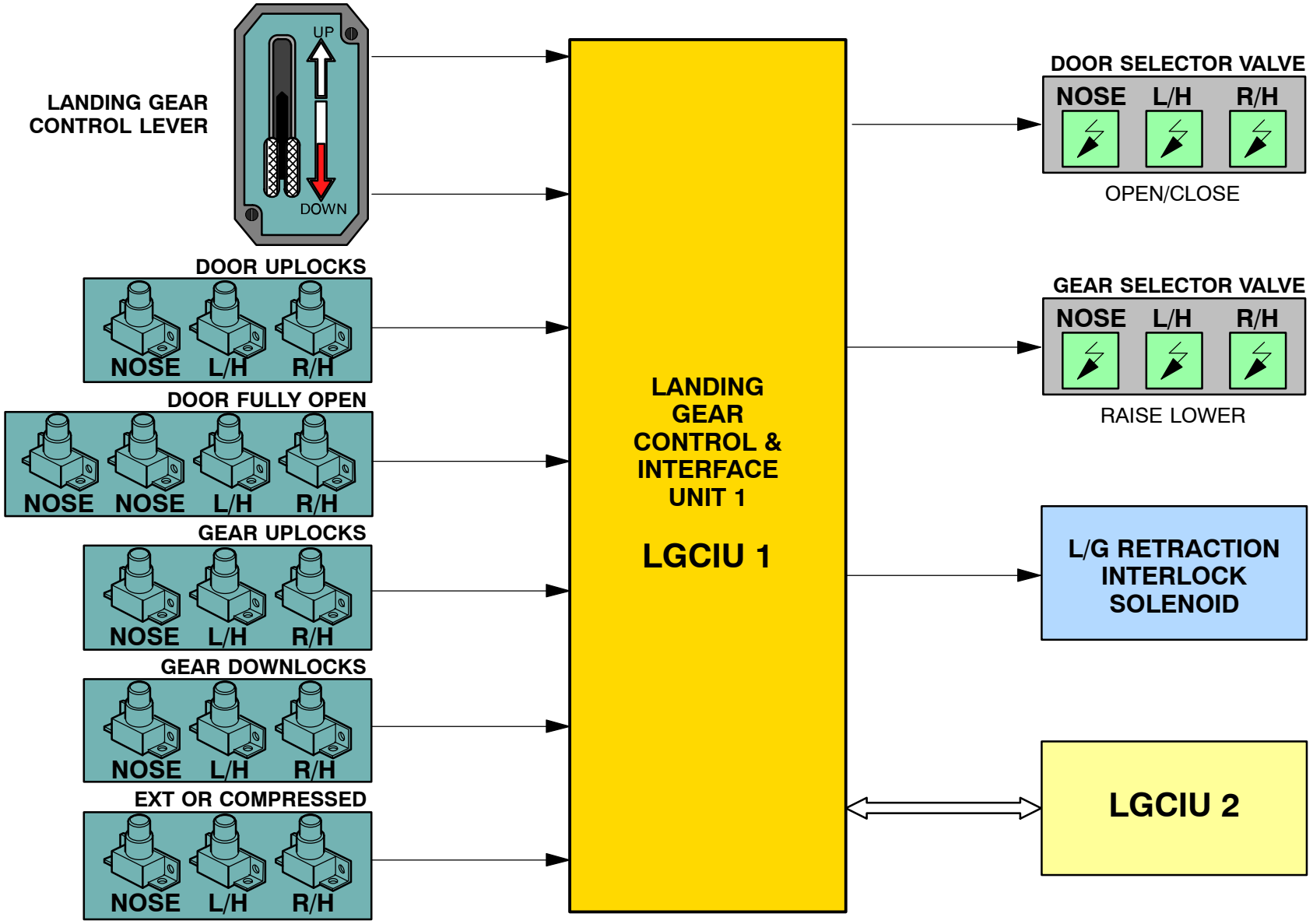


Figure 54 LGCIU Control Signals

32–33 FREE FALL EXTENSION

GENERAL DESCRIPTION AND CONTROLS

A mechanical free–fall system extends the L/G if the normal extension and retraction system is not serviceable.

The free–fall system releases the door and L/G uplocks. A mechanically operated valve isolates the hydraulic supply. Other mechanically operated valves let fluid move in the hydraulic components of the normal extension and retraction system. This prevents cavitation and hydraulic locks.

The L/G doors are opened by the L/G weight and aerodynamic force. Gravity extends the L/G, which is held and locked in the extended position. When the L/G is extended by the free–fall system, the L/G doors stay open.

When the control handle of the free–fall system is reset, the Green hydraulic system is pressurized. The L/G control lever can then be set to the DOWN position to close the L/G doors and set the L/G.

COCKPIT CONTROLS

The free–fall extension–handle is at the rear of the cockpit center pedestal. A system of rods, cables and bellcranks connect the extension handle to the:

- Landing Gear Door Uplocks
- Landing Gear Uplocks
- Vent Valves and a Cut–Out Valve.

When the extension–handle is turned it operates the L/G components in the following sequence:

- the cut–out valve closes to isolate the pressure supply and connect it to return
- the vent valves operate to bypass the normal L/G extension system
- the L/G and the L/G door uplocks release

Shear devices protect the L/G system if either the L/G door or release mechanism jam when the free–fall system is operated.

The free–fall extension system has a mechanical system in the MLG and NLG bays and hydraulic components which have an interface with the green hydraulic system.

MECHANICAL SYSTEM

Main Landing Gear

In the RH MLG bay, the mechanical linkage connects to the:

- Cut–Out Valve
- Main Landing Gear Uplock
- Main Landing Gear Door Uplock

In the LH MLG bay, the mechanical linkage connects to the:

- Main Landing Gear Vent Valve
- Main Landing Gear Uplock
- Main Landing Gear Door Uplock

Nose Landing Gear

In the NLG bay, the mechanical linkage connects to the:

- Vent Valve
- Nose Landing Gear Uplock
- the Nose Landing Gear Door Uplock

HYDRAULIC COMPONENTS

The hydraulic components in the free fall extension system are:

- a Cut–Out Valve
- a Main Landing Gear Vent Valve
- Nose Landing Gear Vent Valve

Cut–out Valve

The cut–out valve isolates the L/G hydraulic system from the Green hydraulic system supply and connects the L/G selector manifold to the hydraulic reservoir return.

Vent Valve

The vent valve lets the hydraulic fluid move between the extension and retraction lines on some components, to prevent cavitation. It also lets any unwanted fluid go back to the reservoir through the third port on the vent valve. The third port on the vent valve connects to the Green hydraulic system return.

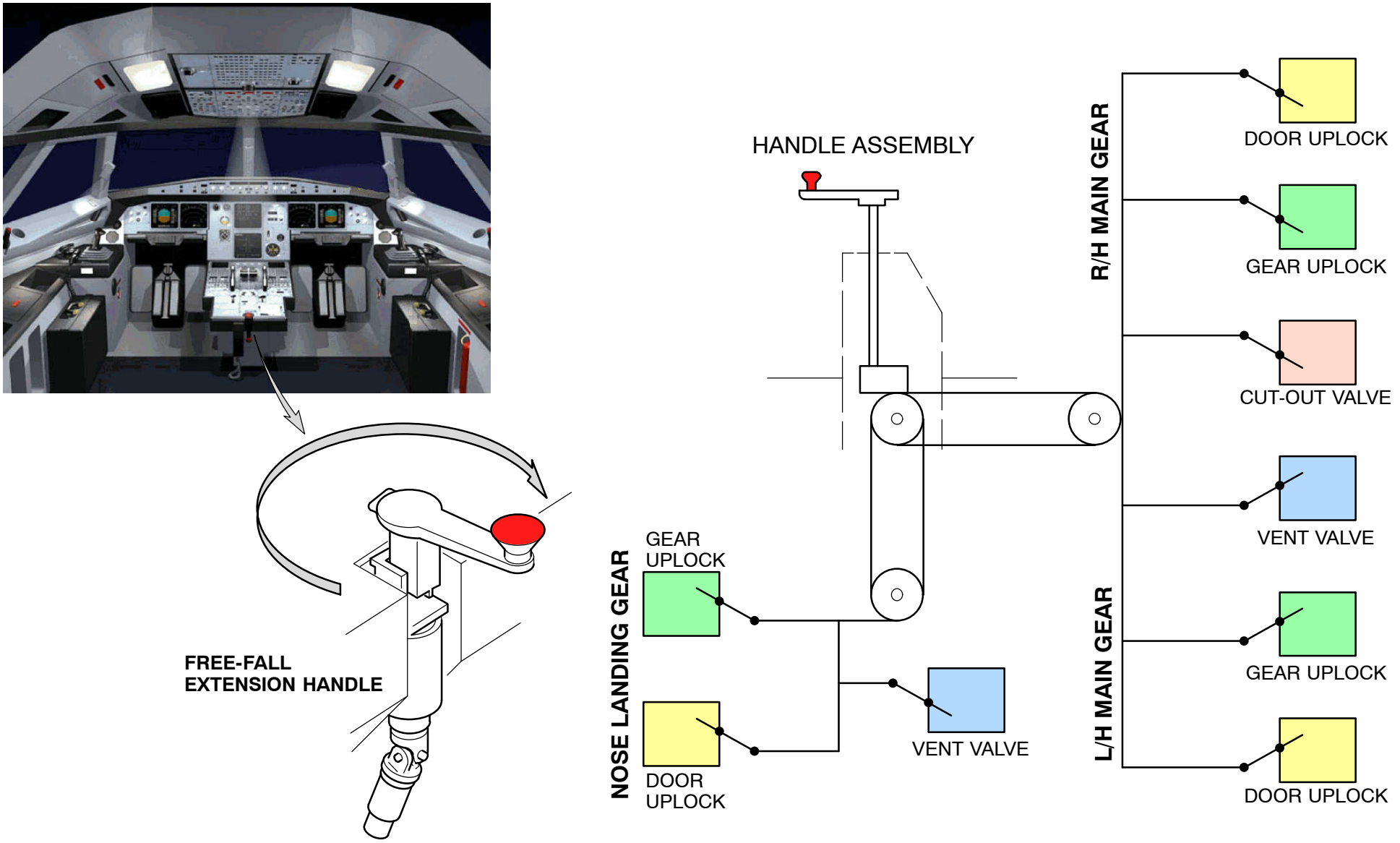


Figure 55 Free-Fall Extension Schematic

FREE FALL EXTENSION SYSTEM OPERATION

Free–Fall Control Handle Assy

The L/G free–fall extension–handle assembly is at the rear of the cockpit center–pedestal. During the normal extension and retraction operations, the handle is folded for storage. When the handle is rotated for three revolutions in a clockwise direction it:

- stops the high–pressure hydraulic supply and connects the L/G system to the reservoir return
- connects the L/G hydraulic–actuator retraction chamber and the L/G door hydraulic–actuator close chamber to the reservoir return
- releases the L/G door uplocks

Operation and Control

A handle assembly on the cockpit center–pedestal controls the L/G free–fall extension. When operated, it starts through a system of cables and mechanical links the following sequence:

- The cut–out valve operates
  - the pressure supply line closes
  - the L/G hydraulic–supply system is connected to return
- The NLG and MLG vent valves open
  - the hydraulic fluid from the door open actuator close chamber and the L/G actuator retraction chamber goes to the reservoir.
- The L/G door uplocks release
  - the L/G doors open
- The NLG and MLG uplocks release
  - the NLG and MLG extends
- The check valve operates
  - the supply of hydraulic fluid to the L/G actuator extension chambers is increased, to prevent cavitation

Reconfiguration

With the aircraft in flight, the L/G system can be put back to its normal extension and retraction mode from a free–fall extension test. The L/G control handle must be set to DOWN and the L/G free–fall extension–handle put to its stowed position. The cut–out valve connects the green hydraulic supply to the landing gear selection manifold and the vent–valves close ports A and B. Hydraulic power is therefore supplied for normal operation.

CAUTION: AFTER LANDING WITH OPERATED FREE-FALL EXTENSION SYSTEM IT IS NECESSARY TO PREVENT UNWANTED OPERATION BY INSTALLING THE SAFETY DEVICES.

Indicating

There is no special indication for the position of the L/G in the free–fall extension mode. The L/G doors will show OPEN when the free–fall extension system is used. The other indications in the cockpit are the same as those for the normal extension and retraction system. These are the:

- Wheel Page on the System Display (SD)
- Landing Gear Downlock Indicator on panel 402VU
- Landing Gear Control Lever Light

If the Wheel Page is not shown on the SD at the start of a free fall extension, it automatically shows after 30 seconds.

When a free fall extension is completed, the Engine Warning Display shows this data:

- L/G DOOR NOT CLOSED
- MAX SPEED 250 KTS

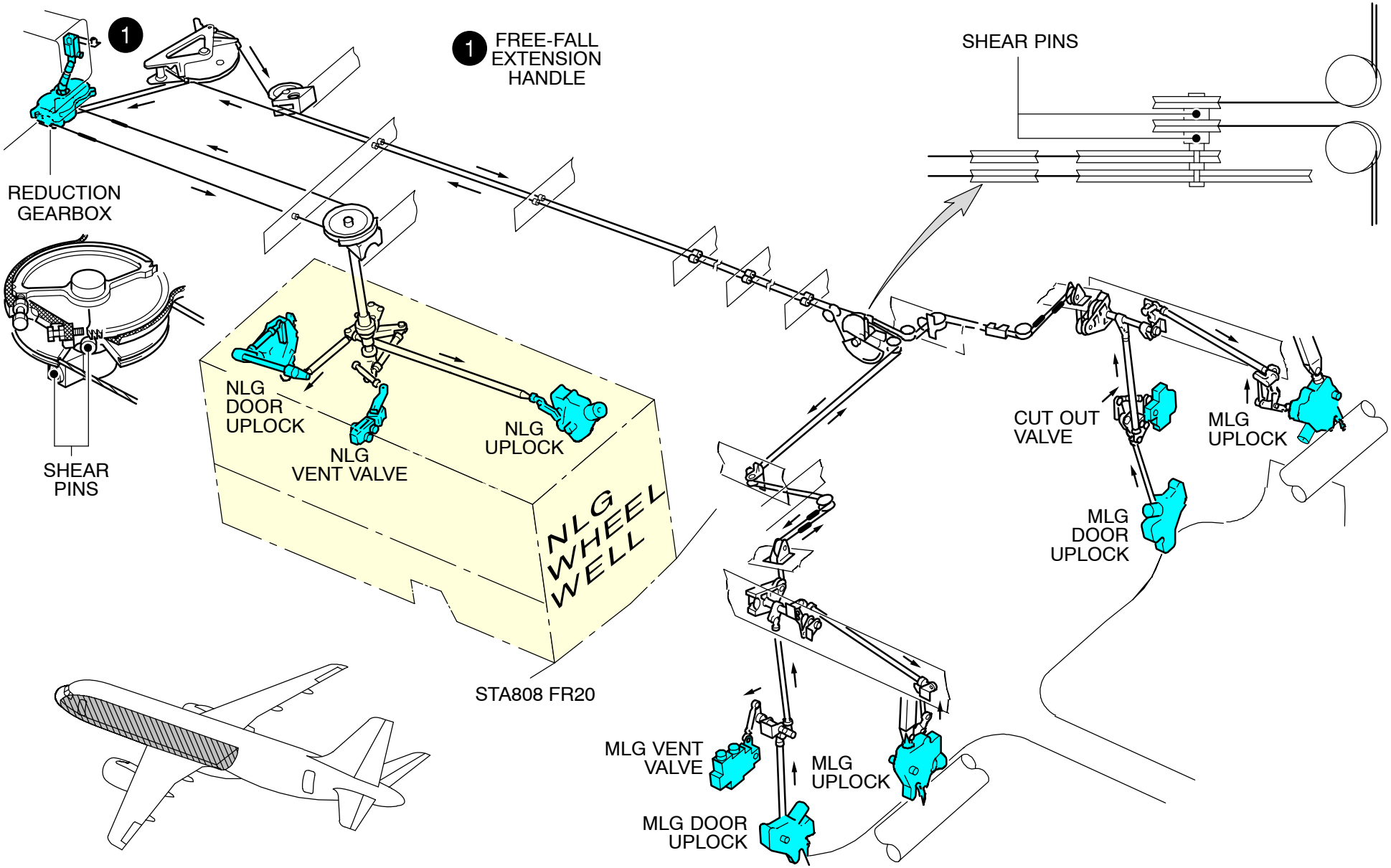


Figure 56 Free-Fall Extension System

FREE–FALL CUT–OUT VALVE

The mechanically operated Cut–Out Valve is installed in the RH MLG bay upstream of the electro–hydraulic selector manifold. The valve is equipped with a rigging hole for locking the input handle and to permit system rigging.

The valve has three hydraulic ports, identified A, B and C:

- port A is hydraulic pressure supply inlet
- port B is hydraulic pressure supply to the L/G selector manifold
- port C is hydraulic reservoir return

During a normal extension and retraction operation, the cut-out valve port A is open to port B, so that hydraulic power is supplied to the L/G selector manifold.

During a L/G free-fall extension, the cut-out valve closes port A before it closes port B to C and connects the L/G selector manifold to the reservoir.

Vent Valves

There are two mechanically–operated vent–valves (of the same type) in the L/G free–fall extension system, one for the MLG and one for the NLG.

The MLG vent–valve is in the LH MLG bay. The NLG vent–valve is in the NLG bay, to the left and forward of the NLG uplock.

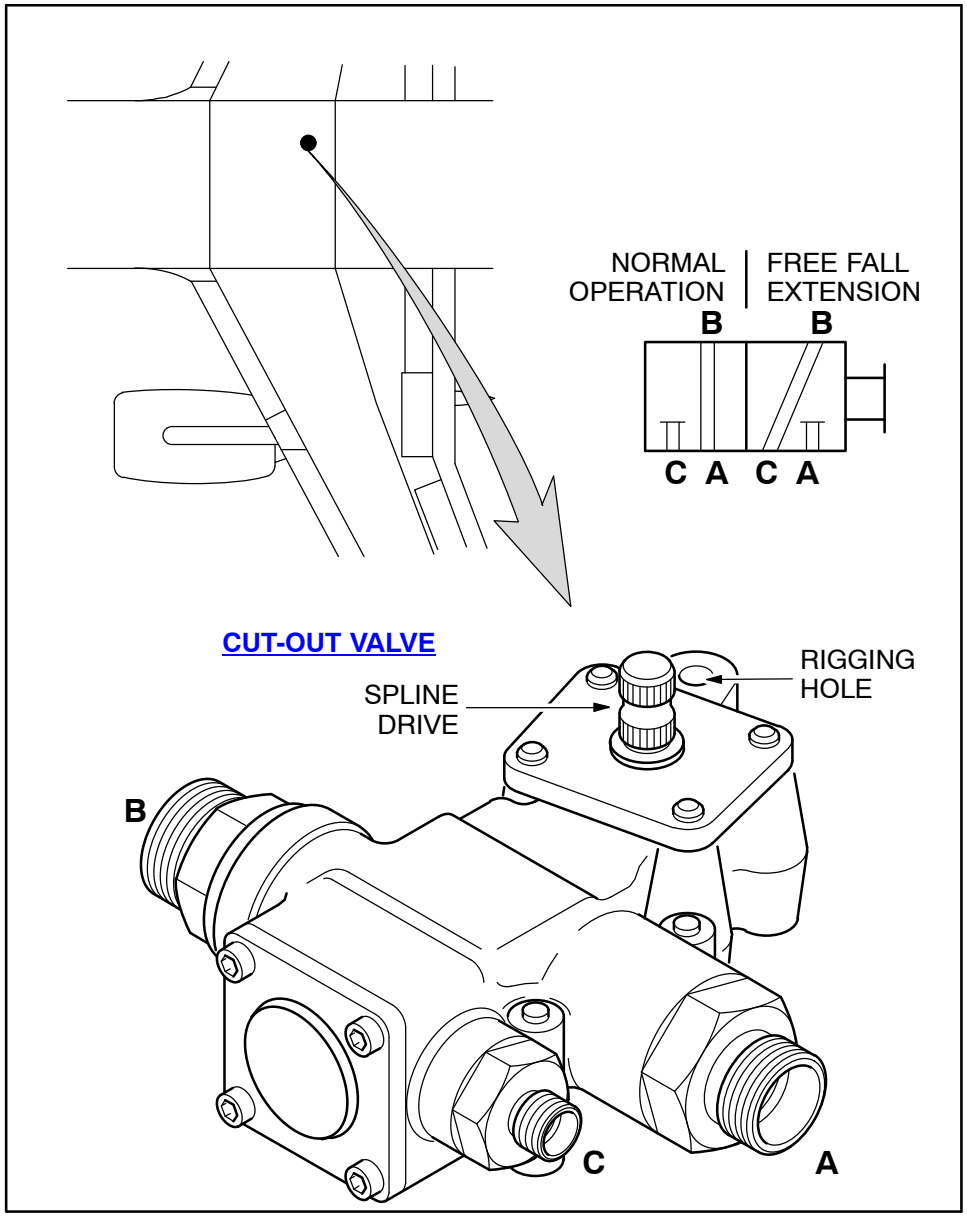
There is a rigging hole for locking the input handle in the closed position, to permit system rigging.

Each vent–valve has three hydraulic–port connections identified A, B and C:

- port A is the L/G door close line
- port B is the L/G lift line
- port C is the hydraulic–reservoir return line

During a L/G normal extension and retraction operation, ports A and B are closed. The internal leakage vents to return through port C.

During a L/G free–fall extension, the operation of the vent valve opens ports A and B to port C so that hydraulic fluid returns to the reservoir.



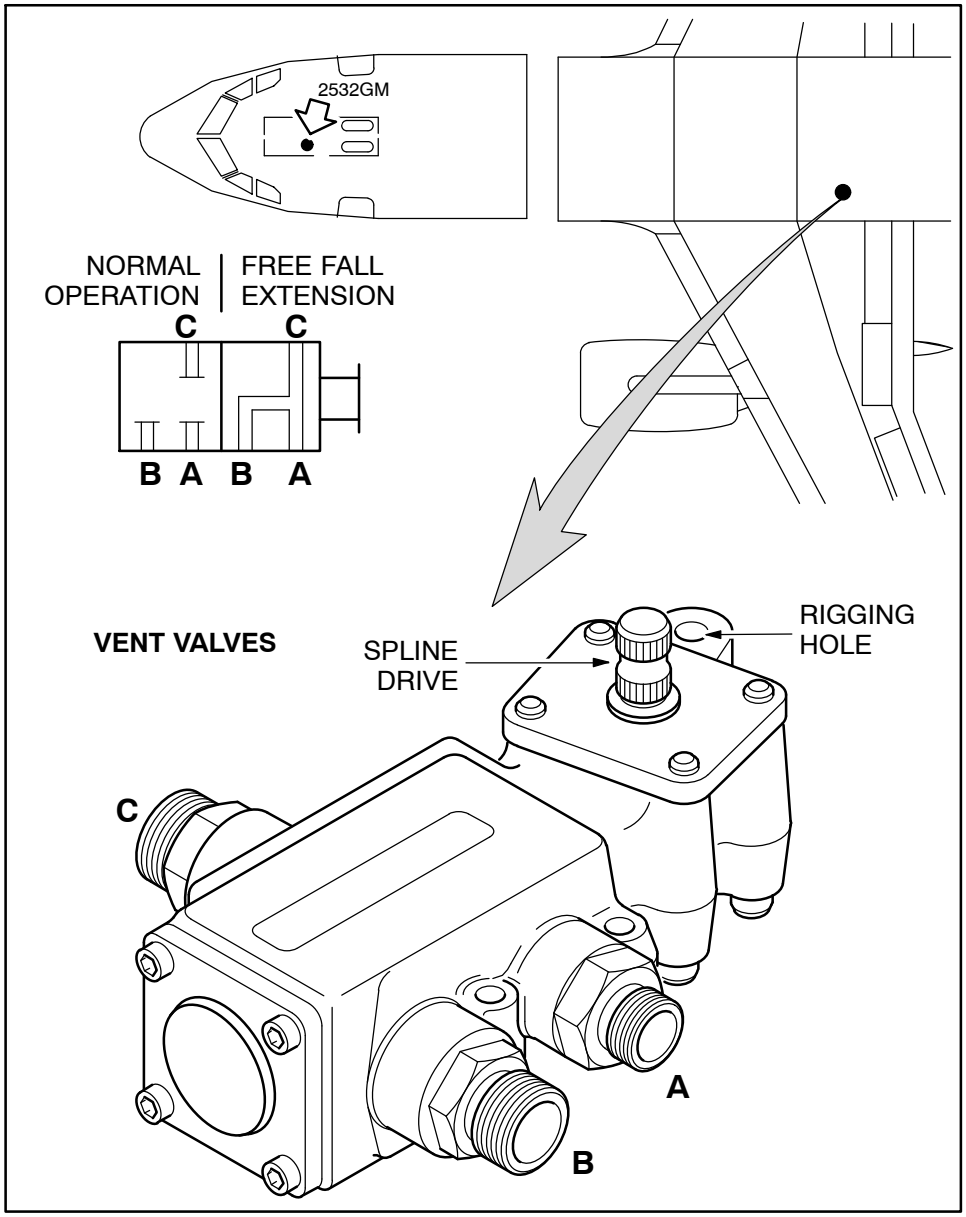


Figure 57 Cut-Out and Vent Valves

32–40 WHEELS AND BRAKES

INTRODUCTION

General

The Wheel and Brakes system permits controlled movement of the aircraft on the ground.

The wheels are made of two half wheels machined from aluminum alloy forgings and have a tubeless tire installed. The tires are Radial tires or (optional) Bias tires. The main gear wheels have multi–disc carbon brakes.

Two sets of independently supplied pistons operate the brakes.

The Green hydraulic system supplies one set. It is used for the Normal braking System.

The Yellow hydraulic system supplies the other set of pistons under aid of one yellow pressure accumulator. This set is used for the Alternate braking system and the Parking brake.

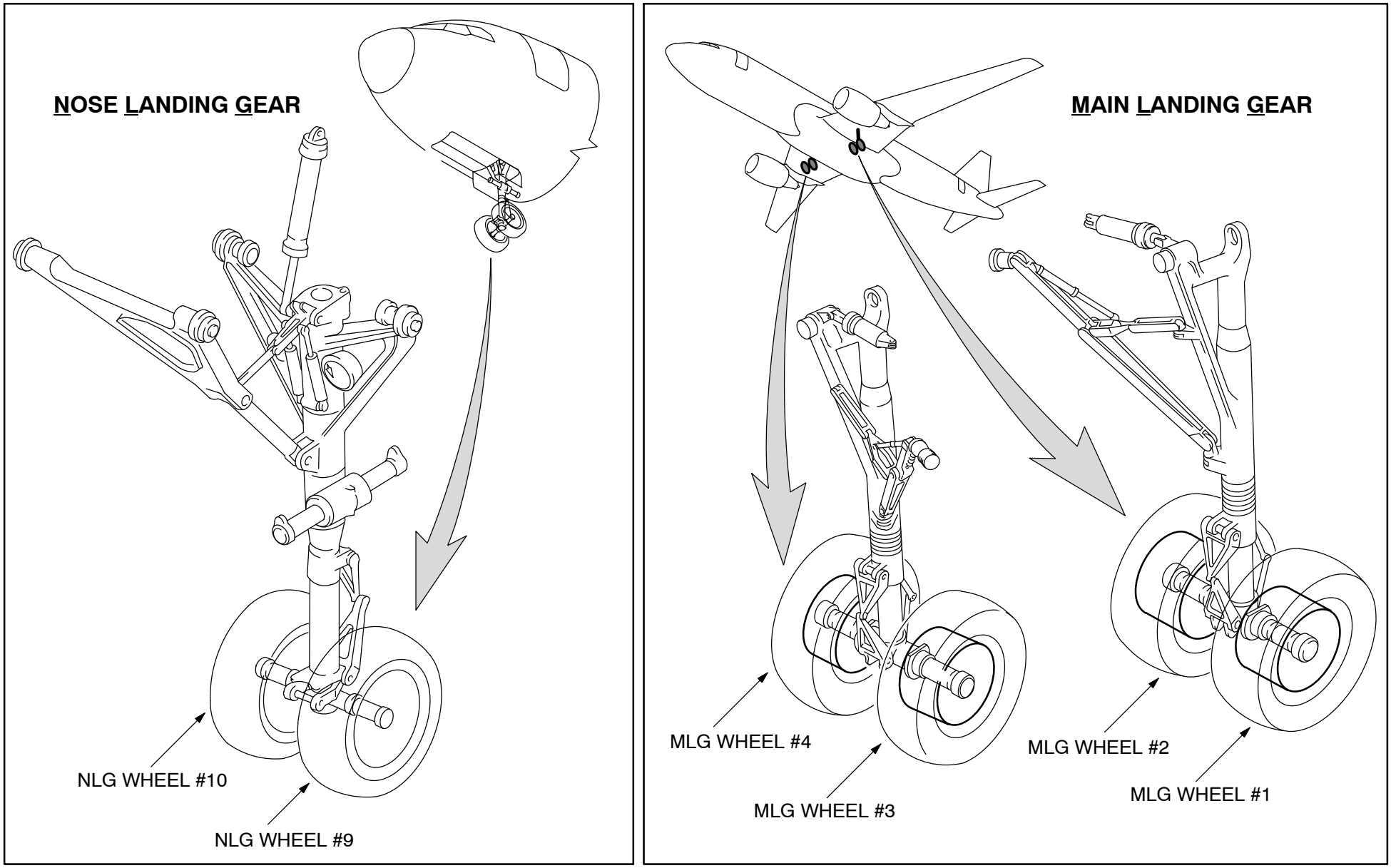


Figure 58 NLG and MLG Wheels Numbering

WHEELS AND TIRES GENERAL DESCRIPTION

Main Gear Wheels

The wheels consist of two forged half–wheels made of light alloy. They are attached together with bolts made of high–tensile steel and self–locking nuts.

An O–ring seal is put between the two half–wheels.

The wheels are equipped with:

- Taper roller bearings with protective seals,
- drive keys for the brake rotor disks,
- fuse plugs which deflate the tire in the event of excessive brake overheat and thus protect against tire burst because of excessive pressure,
- one standard inflating valve which you can replace by a valve with an incorporated pressure indicator (PSI type),
- a provision for installation of a transducer for the Tire Pressure Indicating System (optional system).

Each wheel is installed on the axle with an axle sleeve.

Characteristics on A319/320 A/C:

- weight: 60.6 kg max.,
- melting point of the fuse plug:
  - first set, inside keys: 300 °C,
  - second set, on wheel web: 183 °C.

Characteristics on A321 A/C:

- weight: 81.5 kg max.,
- melting point of the fuse plug: 182 °C.

On A319/320 A/C it is possible to use either 45 X 16 R20, 46 X 17 R20 and 49 X 19 R20 radial tires or 46 X 16 – 20, 49 X 17 – 20 and 49 X 19 – 20 conventional tires (bias tires) on these wheels.

On A321 A/C it is possible to use either 1270 X 455 R22 radial tires or 49 X 18 – 22 conventional tires on these wheels.

Nose Gear Wheels

The wheels consist of two forged half–wheels made of light alloy. They are attached together with bolts made of high–tensile steel and self–locking nuts.

An O–ring seal is put between the two half–wheels.

The wheels are equipped with:

- taper roller bearings with protective seals,
- one standard inflating valve which you can replace by a valve with an incorporated pressure indicator (PSI type),
- one overpressure relief valve,
- a provision for installation of a transducer for the Tire Pressure Indicating System (optional system).

The landing gear manufacturer supplies the axle sleeve installed between the wheel and the axle.

Characteristics:

- weight: 15.95 kg, including hub cap.

It is possible to use either 30 X 8.8 R15 radial tires (basic) or 30 X 8.8 –15 conventional tires (option) on these wheels.

ATTENTION: Tire Mixing

Mixing of radial and Bias tires is not totally forbidden but it is restricted.

Precautions are given in the AMM.

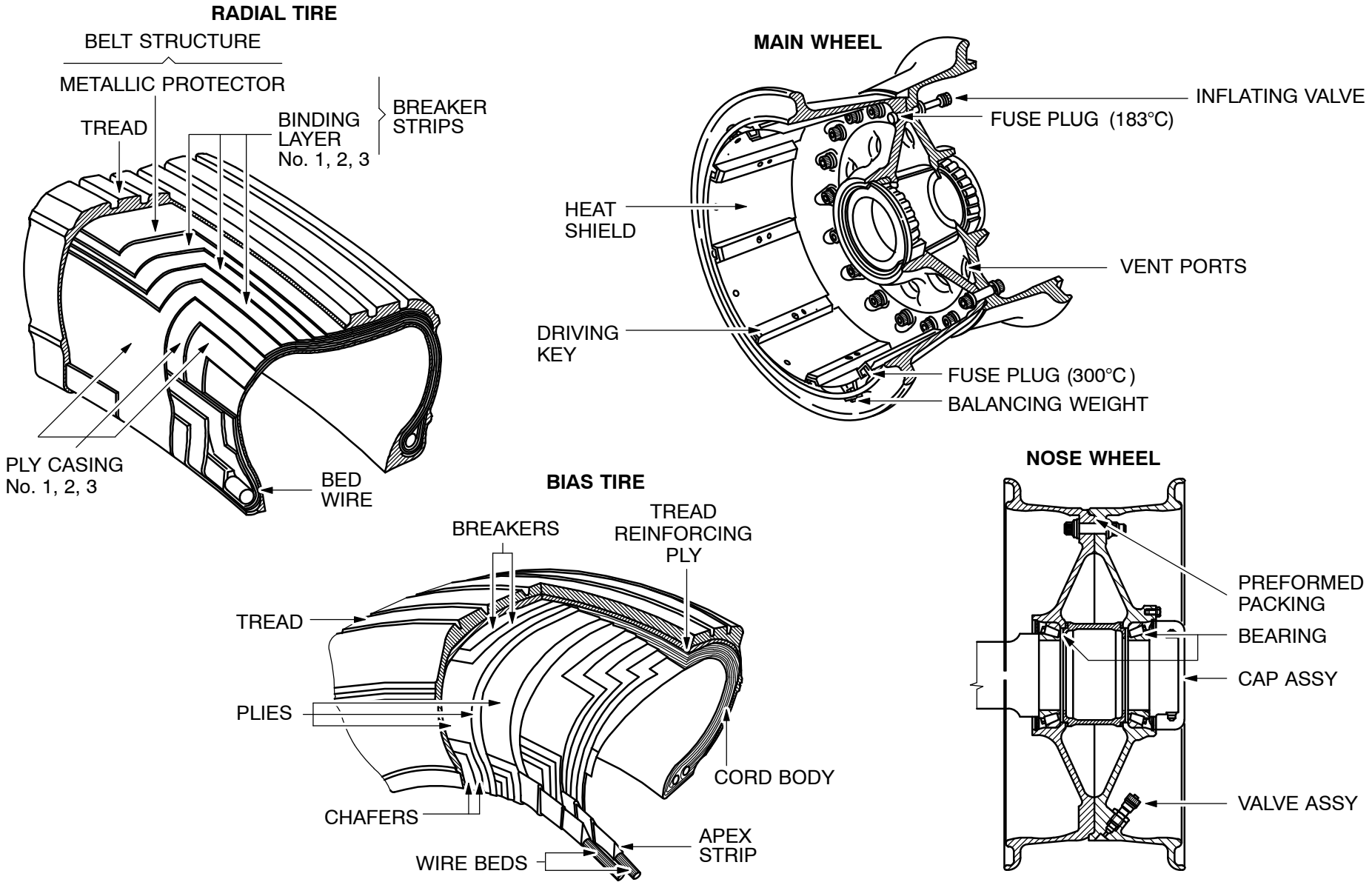


Figure 59 MLG and NLG Wheel

BRAKES GENERAL DESCRIPTION

The brakes are of the multi–disc type. Each brake includes:

- a piston housing,
- a torque tube,
- a carbon heat pack.

Piston housing

The piston housing is a forged aluminum–alloy part which changes the hydraulic pressure into a load by the use of pistons.

The piston housing has:

- two hydraulically independent sets of pistons,
- a bleeder for each of the two systems,
- a half self–sealing coupling for each system,
- a torque tube,
- two wear indicators for the heat pack,
- a brake temperature sensor.

Two 1/4 in. hoses supply the hydraulic pressure to the brake.

Pistons

There are seven pistons for each system.

The pistons have a return spring and a spiral friction spring which:

- cause the automatic return of the piston,
- take–up the play in the heat pack caused by the wear of the carbon discs.

Insulators give a protection to the pistons against the heat. They are installed on a steel plate.

The pistons act on a pressure plate which applies the braking loads evenly to the brake discs.

Torque tube

The torque tube is a forged steel part with a bolted back plate. The braking reaction is transmitted:

- from the stators to the torque tube by splines,
- to the landing gear axle by three attachment bolts and nine pins.

Tie bolts of high–tensile steel attach the torque tube to the piston housing.

Three bolts and nine pins attach the brake to the axle flange of the landing gear.

They also transmit the torque from the torque tube to the axle.

Heat pack

The heat pack has several structural carbon rotors and stators. There are four rotors. Steel drive keys which are riveted to the discs give a protection to the two rotors and stators.

Wear pin indicator

Two wear pins are attached to the pressure plate. They give a visual indication of the overall wear of the heat pack without removal (Parking brake applied).

Temperature sensor

The temperature sensor gives the temperature of the heat pack. The body of the temperature sensor is attached to the piston housing.

Characteristics

- Weight: approx. 67.1 kg
- Maximum energy: 70 MJ
- Maximum capacity: approx. 45 cubic centimeter
- Warning temperature: 300 °C

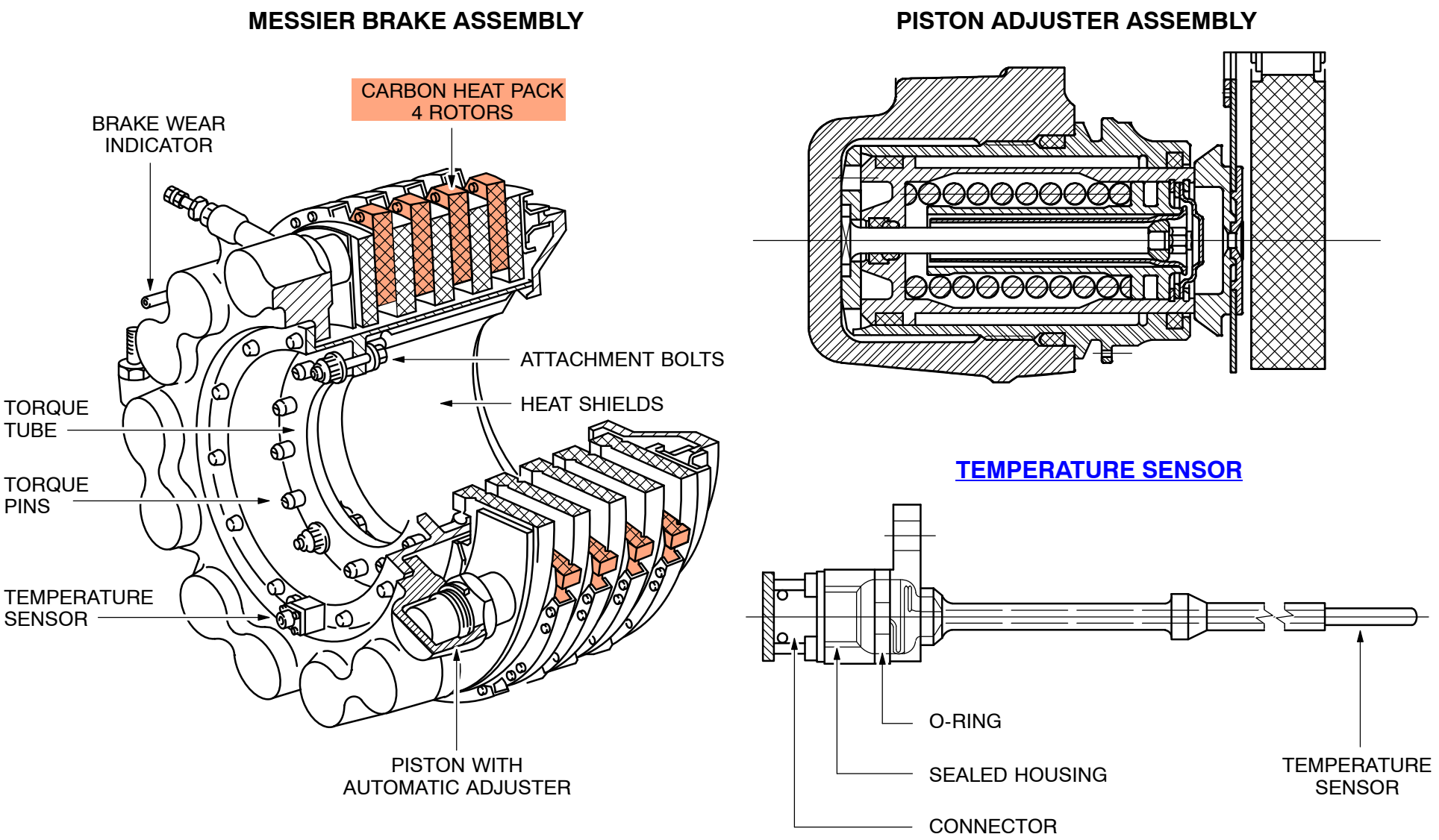


Figure 60 Brake Assembly

NOSE WHEEL BRAKING

Brake bands stop the nose gear wheels at the end of the gear retraction cycle.

NOTE: The brake band is optional.

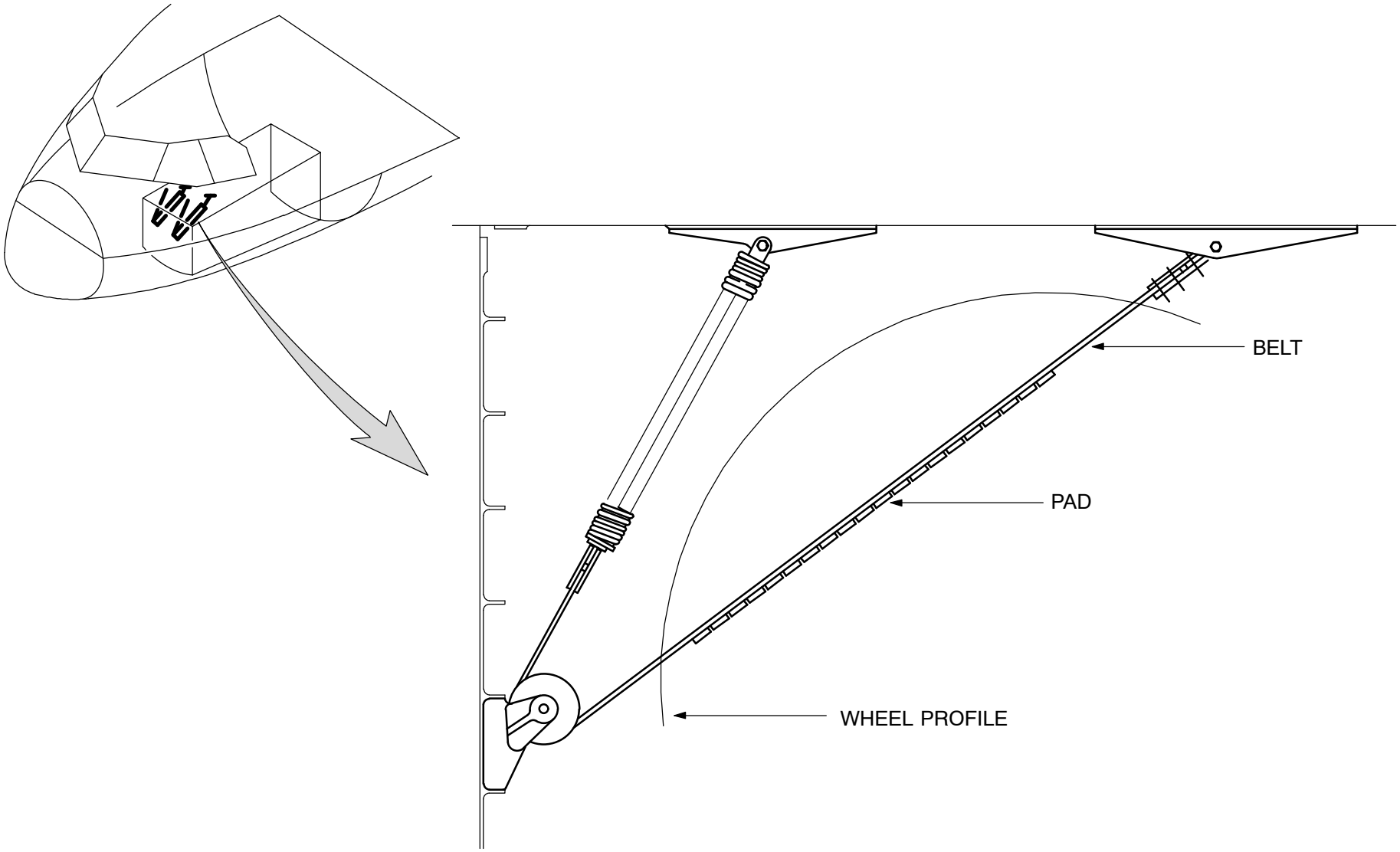


Figure 61 Nose Wheel Braking

BRAKE SERVICING/INSPECTION

Brake Leak Check Normal Braking

To check the normal braking system for hydraulic leaks:

- Pressurize the green hydraulic system
- Parking brake off
- Anti skid switch on
- Push the brake pedals a few times
- Check for leaks on the piston housing, pistons and hydraulic lines

Brake Leak Check Alternate Braking

To check the alternate braking system for hydraulic leaks:

- Pressurize the yellow hydraulic system
- Parking brake OFF
- Anti skid switch OFF
- Push the brake pedals a few times
- Check for leaks on the piston housing, piston and hydraulic lines

Check of Brake wear

- Apply brakes
- Measure the wear pin when the brake is cold
  (less than 100 °C)
- If the end of one of the two wear pins touches the machined surface of the piston housing, the brake unit is fully worn and must be replaced

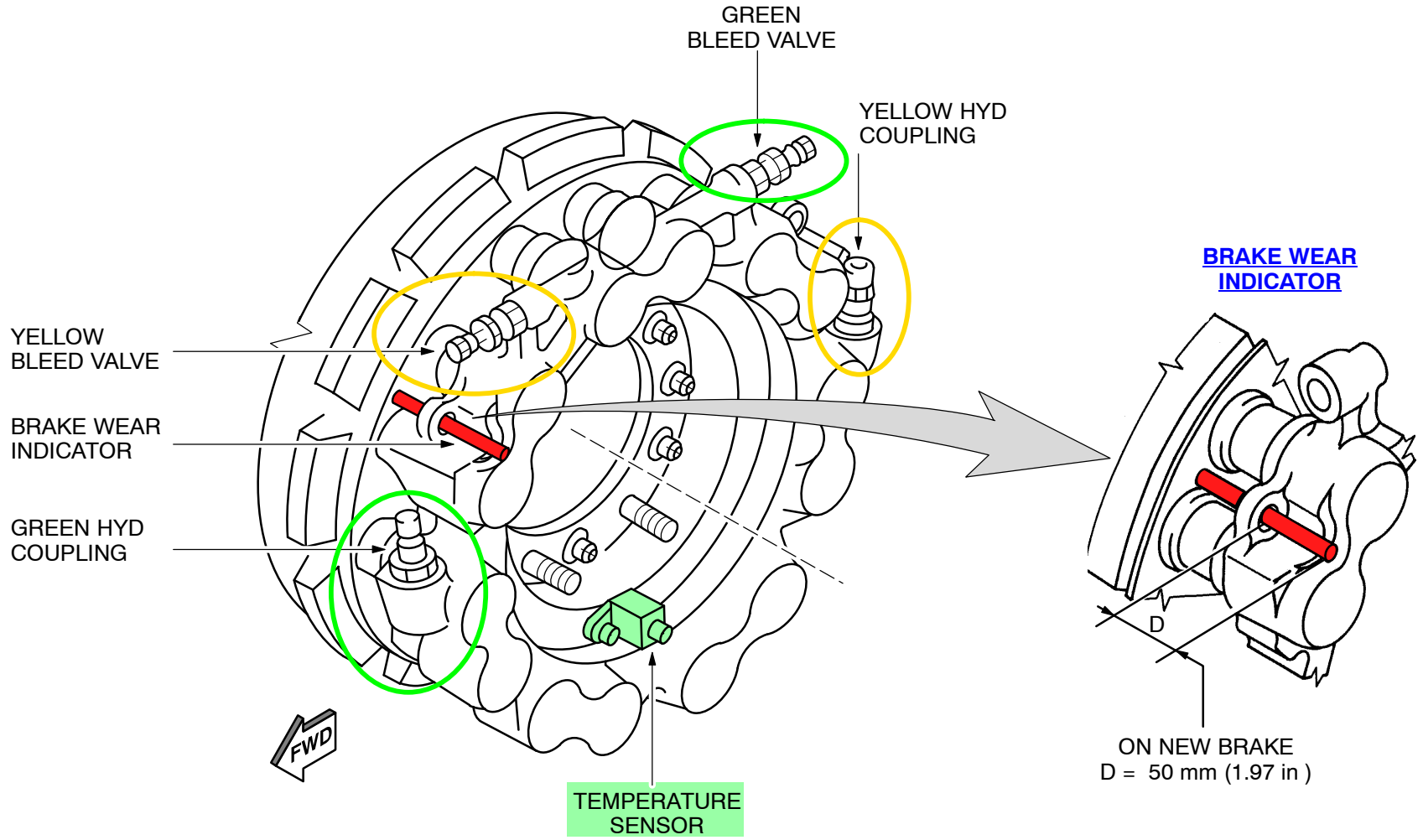


Figure 62 Brake Inspection

BRAKE SYSTEM DESCRIPTION

Normal Braking

The Normal braking system is electrohydraulic and includes a computer, which is the BSCU (**B**rake and **S**teering **C**ontrol **U**nit). The BSCU controls the operation of the electrohydraulic valves in the system. The System includes a switch, the A/SKID & N/W STRG switch, which isolates the system when set to OFF. The hydraulic pressure that operates the brake pistons is supplied from the Green Main Hydraulic Power System.

The system has two modes of operation, manual and automatic, and gives automatic anti skid protection in each mode.

During manual braking, the input signals to the computer come from two pairs of brake pedals. The input signals are proportional to the amount of pedal travel and supply braking independently to each MLG.

For automatic braking, three P/BSWs (**P**ush**B**utton **SW**itches) each set an automatic braking program (LO, MED or MAX) in the BSCU, which gives a different deceleration rate. Use of the pedals cancels an automatic braking program.

The BSCU uses the input signals to make output signals which control the operation of the electrohydraulic valves.

The WHEEL page shows data for the anti skid and braking functions. Lights on each P/BSW show the program selection and when it is in operation.

If specified failures occur in the system, control automatically changes to the Alternate braking system mode.

Alternate Braking with Anti Skid

The Alternate braking system with anti skid is the secondary, electrohydraulic braking system. It automatically becomes available if:

- specified failures occur in the Normal braking system
- the pressure of the Green main hydraulic power supply is less than a specified value.

Braking inputs can only be made at the brake pedals. These operate a low–pressure hydraulic system. This system causes the Yellow main hydraulic power supply to go to the second set of pistons in the brakes. The quantity of hydraulic pressure that goes to the brakes (of the left and right MLG) is in proportion to the travel of each brake pedal.

The BSCU controls the four servo valves in the system to supply the anti skid function.

Alternate Braking without Anti Skid

The Alternate braking without anti skid system is the secondary mode of operation of the Alternate braking with anti skid system. The system is automatically available when the anti skid function is not available. This occurs when:

- the A/SKID & N/W STRG switch is set to OFF
- electrical control of the Alternate Braking with Anti Skid System is not available.

The system uses the same hydromechanical components as the Alternate braking with anti skid system. Braking inputs can only be made at the brake pedals. When the brake pedals are operated, hydraulic pressure from the Yellow main hydraulic power system is connected to the brakes.

If the Yellow hydraulic supply is not available, an accumulator (filled from the Yellow hydraulic system) give sufficient pressure for at least 7 full operations of the brakes. As electrical power is not necessary to operate the brakes, this system is usually used when the aircraft is towed.

A triple pressure indicator shows the supply pressure and the pressure at the brakes.

Parking Braking

The parking braking system is an electrohydraulic system. Its primary function is to prevent movement of the aircraft when it is parked. It can also be used to stop the aircraft. The parking braking system gets its hydraulic power supply from the accumulator of the Alternate braking system or the Yellow main hydraulic power system. The accumulator has sufficient capacity to hold the brakes on for a minimum time of twelve hours (or supply braking pressure for a specified number of operations). The brake pressure supplied to each MLG and the accumulator pressures are shown on the triple pressure indicator.

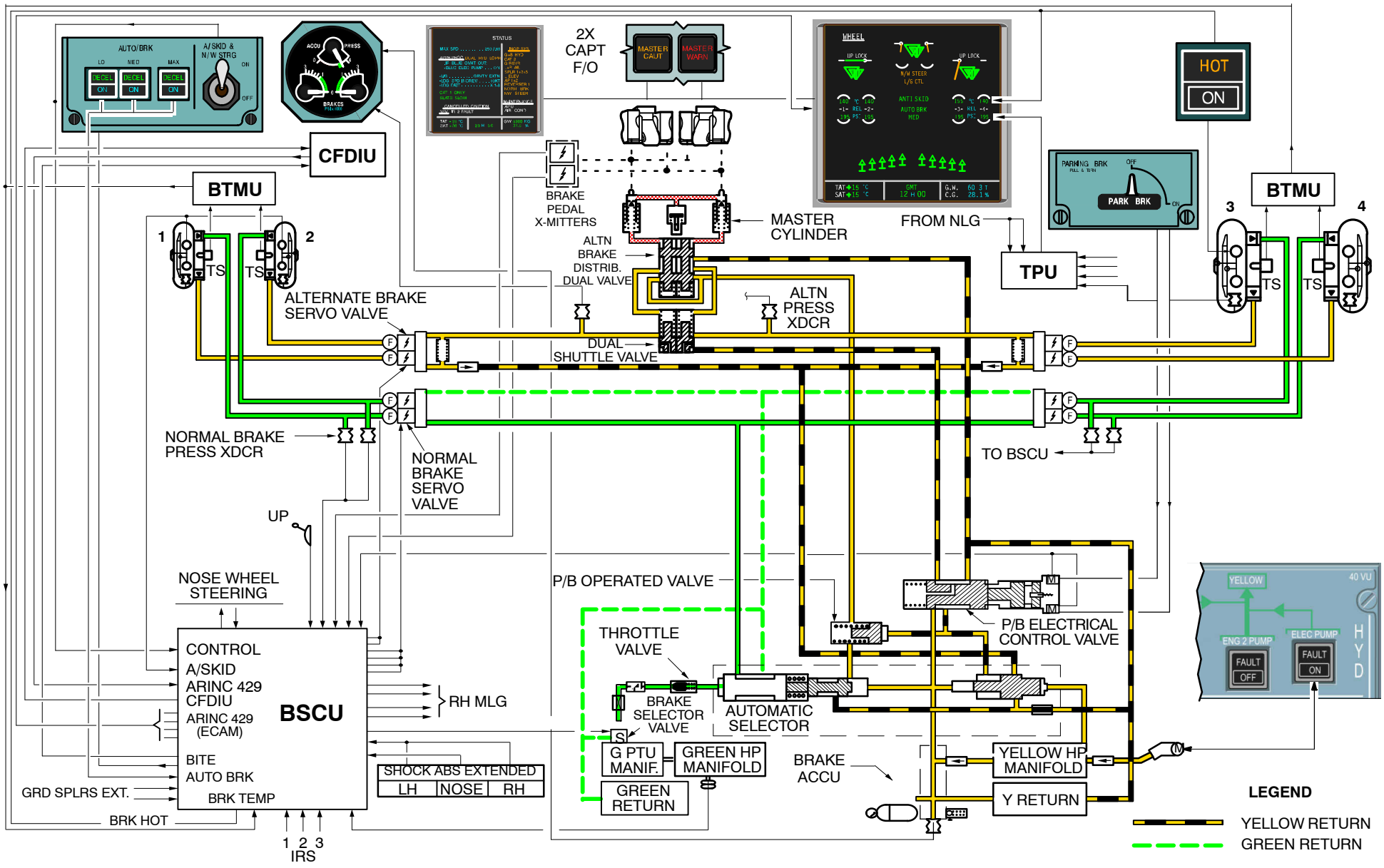


Figure 63 Brake System - Schematic

32–42 NORMAL BRAKING

SYSTEM PRESENTATION

General

The braking is normal:

- when the green high pressure is available,
- when the A/SKID & NOSE WHEEL control switch is in the ON position
- and when the PARK BRK control switch is in the OFF position.

The Normal braking uses the first set of brake pistons. The control is electrical and is achieved either via the pedals or automatically on the ground by the auto brake system and in flight, when the landing–gear control–lever is put in the UP position. In all the cases, the energization of the brake selector valve causes the supply of the system.

When you put the A/SKID & NOSE WHEEL control switch in the OFF position or when you apply the parking brake:

- the selector valve is de–energized
- the Normal mode is de–activated

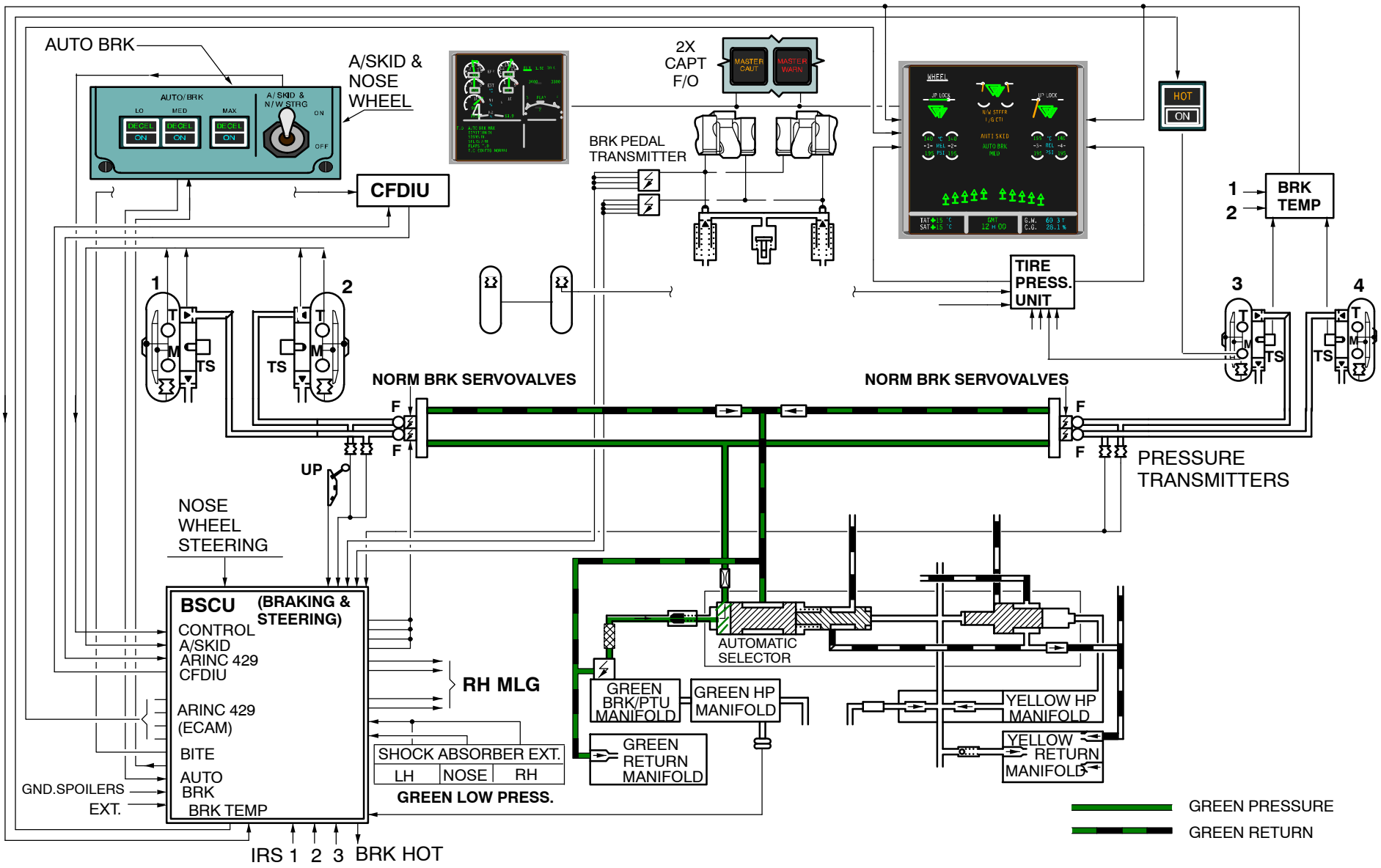


Figure 64 Normal Braking Schematic

BRAKE PEDAL COMPONENT DESCRIPTION

BRAKE PEDAL CONTROL

Rods and bellcranks mechanically link the Captain and First Officer pedal controls.

The left pedals control one of the input levers of the brake pedal transmitter unit. The right pedals control the other lever.

BRAKE–PEDAL TRANSMITTER UNIT

The brake–pedal transmitter unit is located underfloor on the First Officer side.

It transforms the mechanical input from the left and right pedals into four identical electrical voltages per side. This is done via plastic–track potentiometers. These voltages are sent to the Braking/Steering Control Unit (BSCU).

For a given position of the pedals, the BSCU delivers a command for the energization of the selector valve.

When the pedals are depressed, any over–travel is absorbed by the spring rods which actuate the levers of the transmitter unit.

PEDAL ARTIFICIAL FEEL

The artificial feel at the pedals is identical in the Normal and Alternate Braking modes. The master cylinders of the Alternate system give the artificial feel (master cylinder spring + pressure in the master cylinder).

The diagram shows the pedal load/angle in relation to the pressure supplied to the brakes in the Normal mode. The graph 1 shows the influence of the master cylinder spring alone and the combined action of the spring and the pressure in the master cylinder. The graph 2 shows the pressure supplied in the Normal mode.

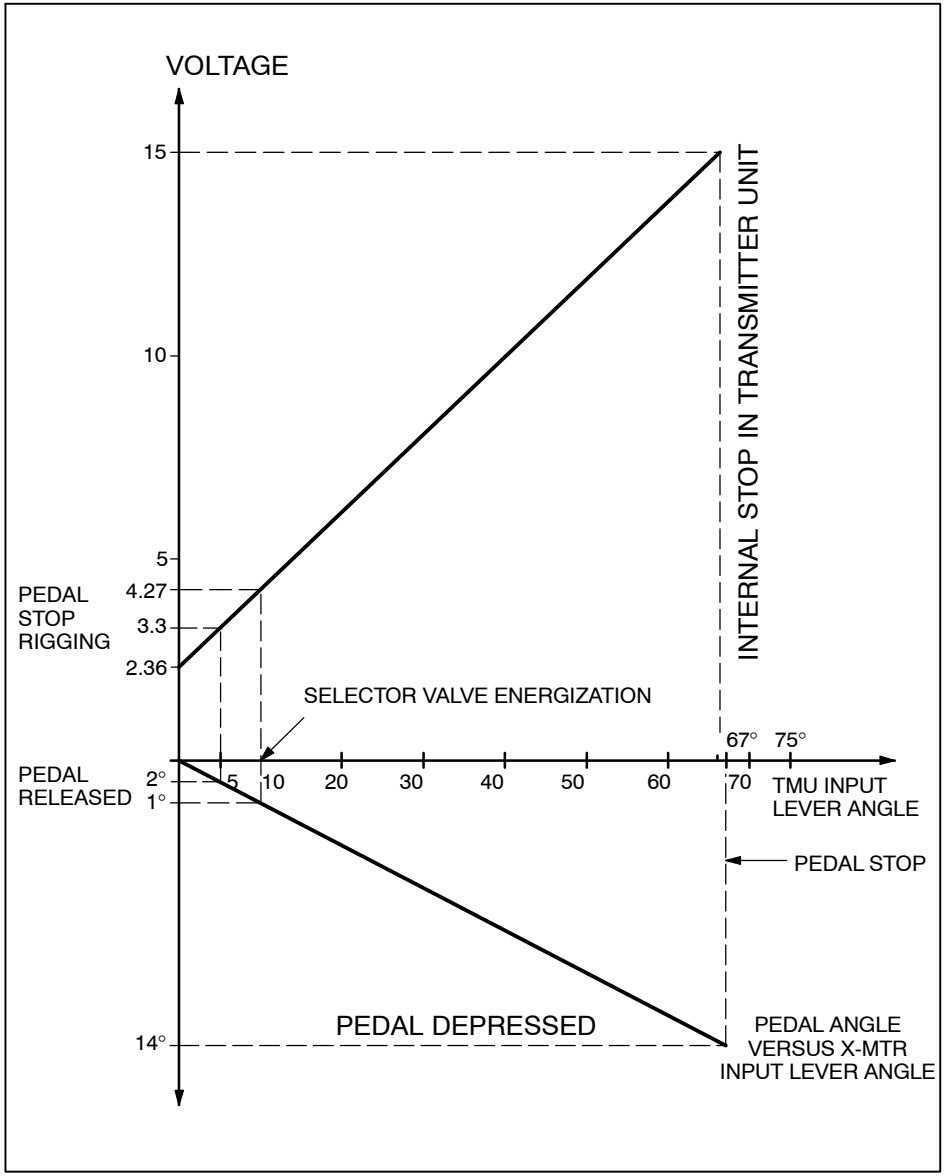
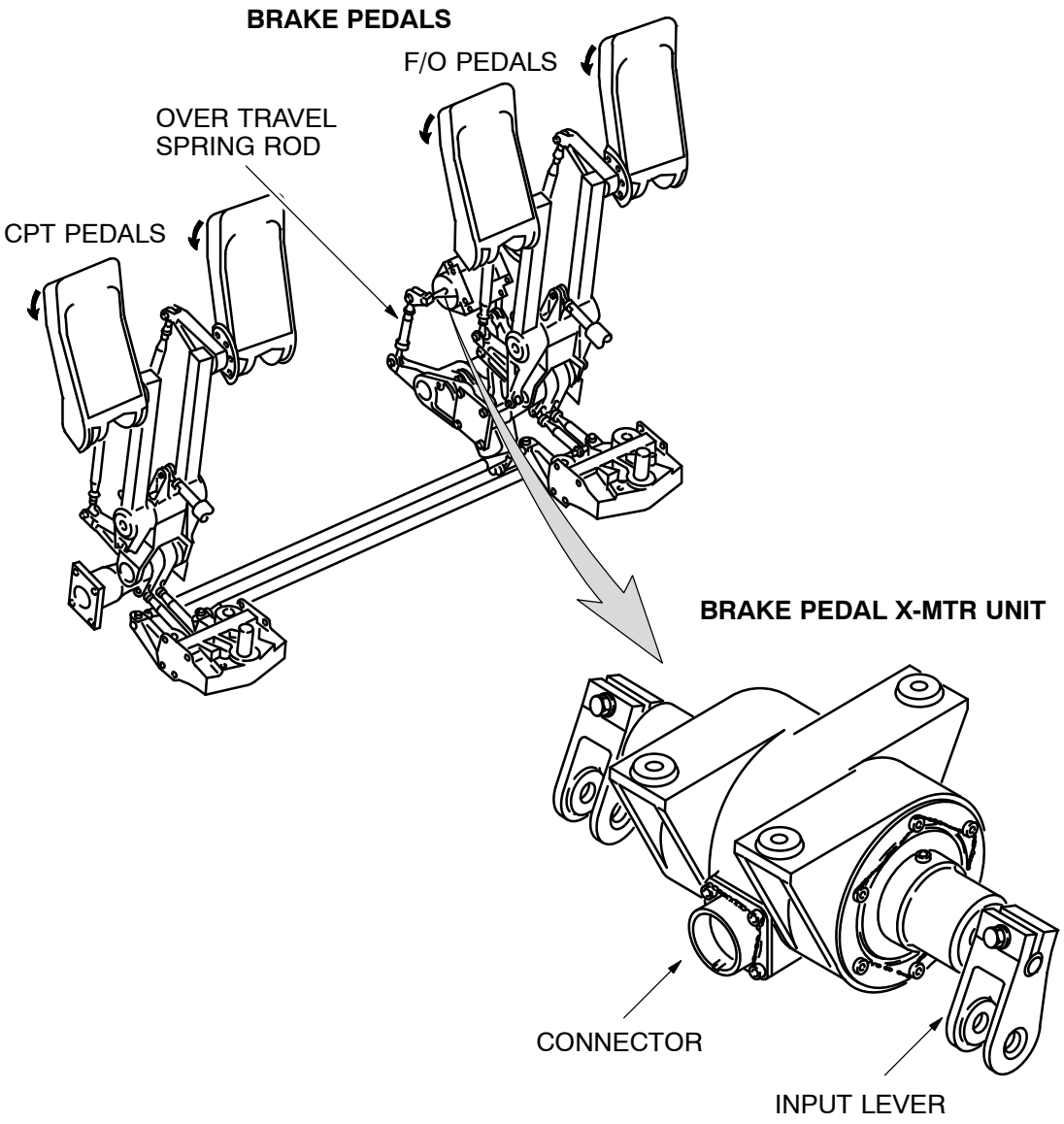


Figure 65 Transmitter Unit Diagram



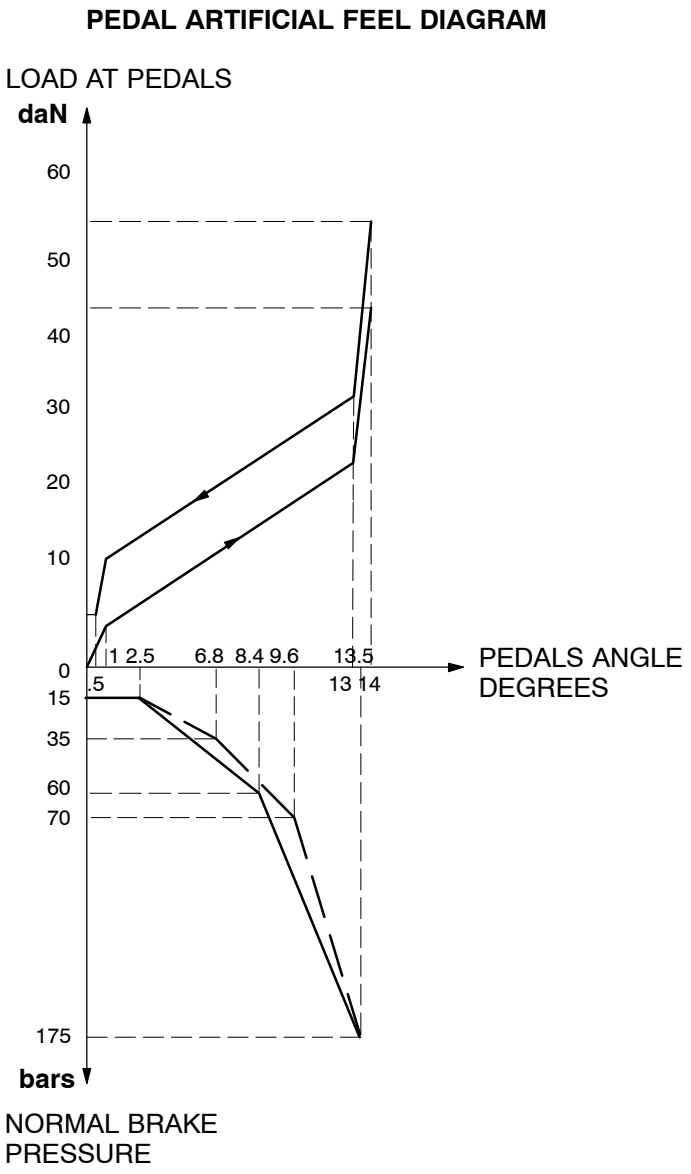


Figure 66 Brake Pedal Control

NORMAL BRAKE COMPONENTS

SELECTOR VALVE AND FILTER

The selector valve is located in the wheel well in the Green hydraulics compartment. The selector valve is of the 3–way type and isolates the Normal braking system when:

- the solenoid is de–energized,
- the Normal braking is not selected, or
- the pedals are released.

An internal valve progressively opens the supply–to–delivery passage of the selector valve. A filter with a filtering capacity of 15 microns absolute is installed on the delivery port. The purpose of the filter is to protect the supply to the servo valves downstream of the selector valve.

AUTOMATIC SELECTOR

The primary function of the automatic selector is to select the Normal Hydraulic System (Green) or the Alternate System (Yellow) for the supply of the brakes.

The Alternate system is used if the green pressure is not available (selector valve de–energized or faulty, or selector valve energized but with the green hydraulic system not available).

The automatic selector includes a primary stage which selects the system. The primary stage includes a differential section piston which operates a slide valve, for Normal braking and a set of valves for Alternate Braking. Thus the two systems are isolated from each other.

The automatic selector also includes a secondary stage. This secondary stage is used to cut off the return from the servo valves of the Alternate Brake System if:

- the Yellow system pressure is lost

The brake Yellow–pressure accumulator is used and the Alternate Servo Valve return is isolated, this prevents leakage.

- the Parking brake is used

As the return is isolated, this causes the inhibition of the Alternate Servo Valves. The release of the brake during the electrical test of the servo valves is no longer possible.

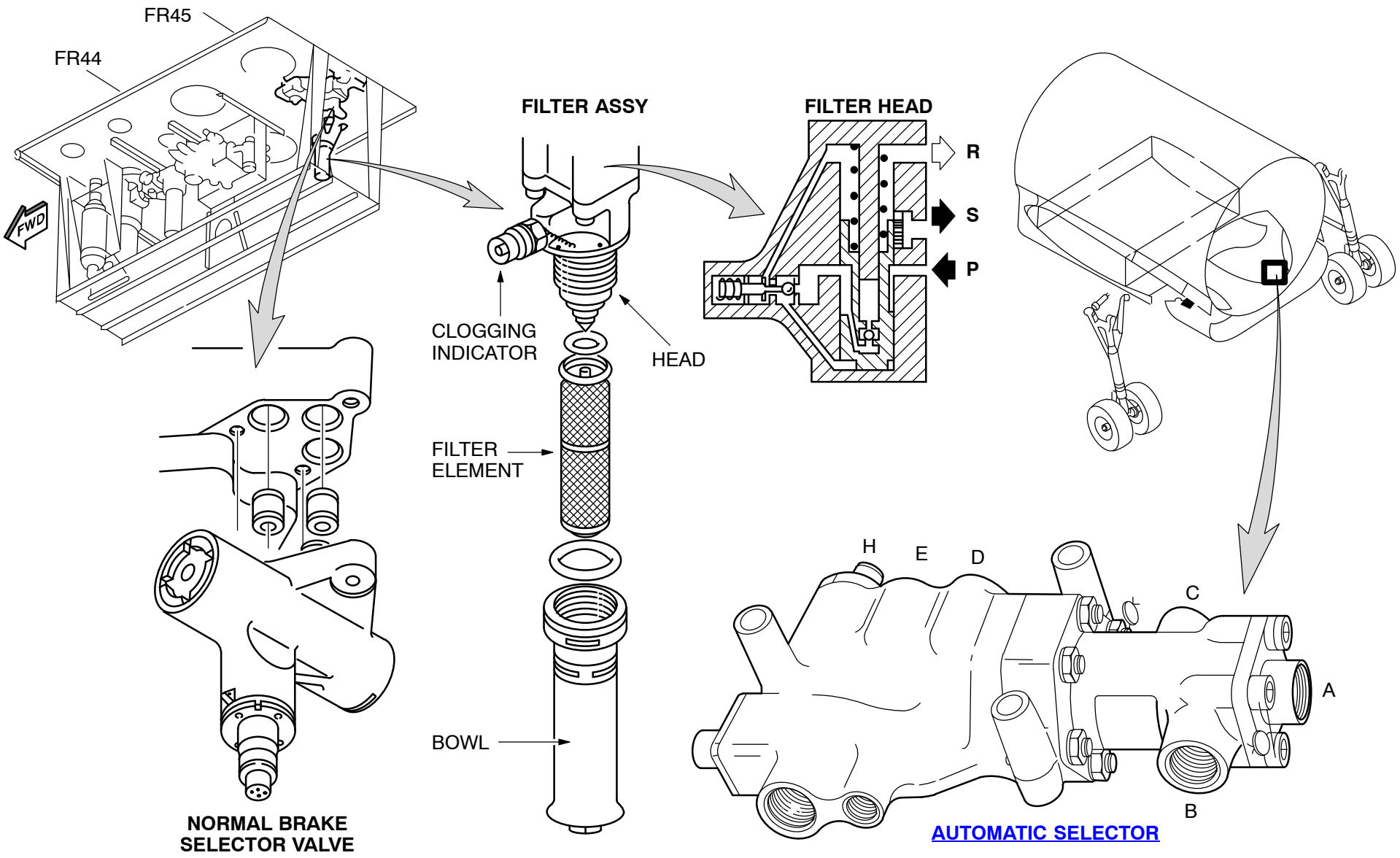


Figure 67 Normal Brake Components

NORMAL BRAKE SERVO VALVE MANIFOLD

There are two servo valve manifolds installed, one on each main gear. Each manifold includes:

- two Servo Valves
- two associated Safety Valves with integrated downstream filter
- two Pressure Transducers located downstream of the safety valve

Normal Brake Servo Valves

Four Servo Valves, one for each brake, controlled by the Brake and Steering Control Unit (BSCU) regulate the brake pressure in the normal brake system independently for each brake. The Brake Servo Valve supplies a pressure inversely proportional to the current it receives from the BSCU. If there is no supply pressure, the Servo Valve connects the brake to the reservoir return system.

Safety Valves

A Safety Valve is installed between the Brake Servo Valve and the brake. It stops the flow in the line if there is a leakage. The Safety Valve operates only if the flow is more than or equal to 4 l/min. To prevent the untimely operation of the Valve when the brake are bled, the bleeders are moderately open and the brake pressure must not be more than 50 bars. The valve stays closed after operation for a supply pressure more than or equal to that of the reservoir. The valve is reset when you de–pressurize the reservoir return systems or when you open the bleed screw on one end of the valve.

Two different designs of Safety Valves are in use. The connection and operation of both valves is equal.

Normal–Brake Pressure Transducers

The Brake Pressure Transducers are installed on the manifold of the Normal Brake Servo Valve, one downstream of each Servo Valve. The integrated–logic transducer supplies a DC voltage between 1 and 5V for a pressure signal between 0 and 200 bars. Zero bar value is for enabling BITE testing.

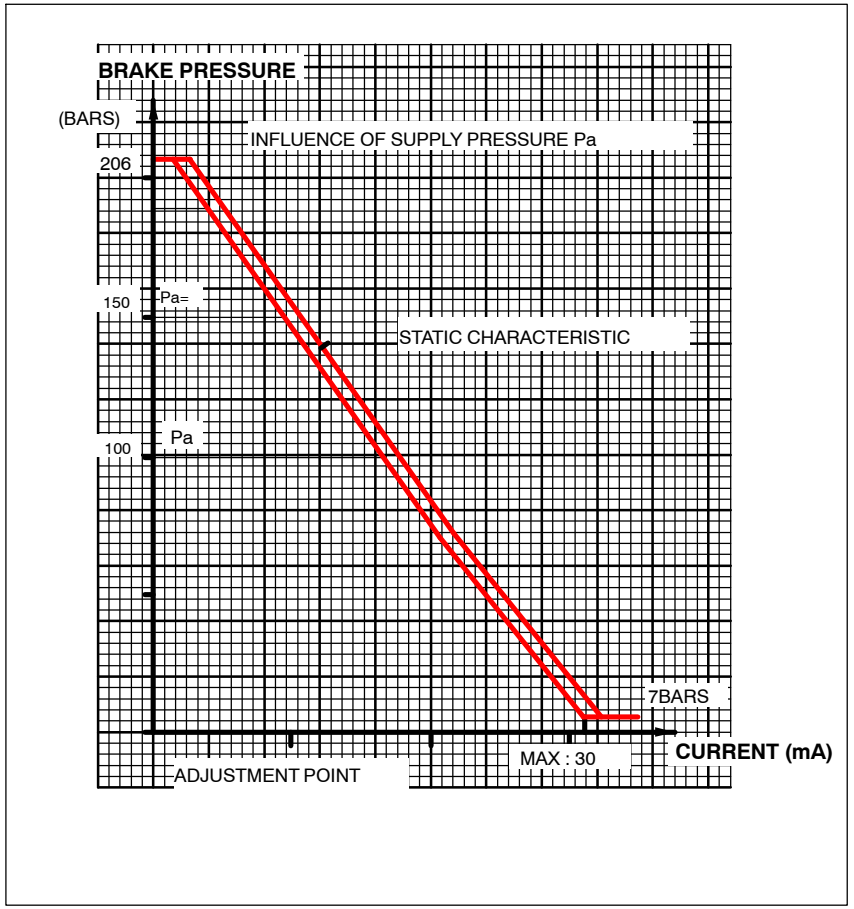
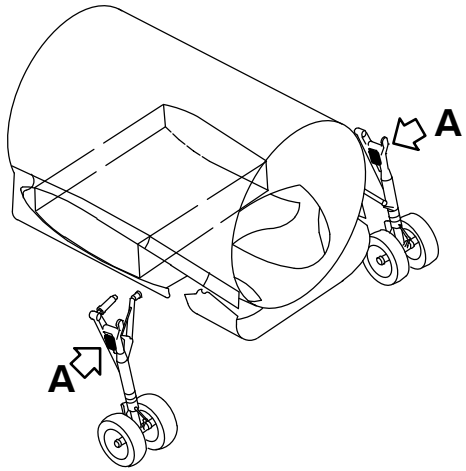
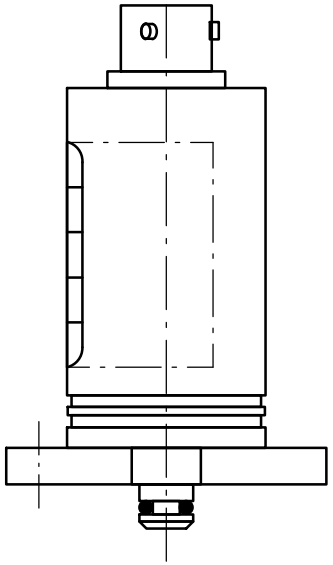


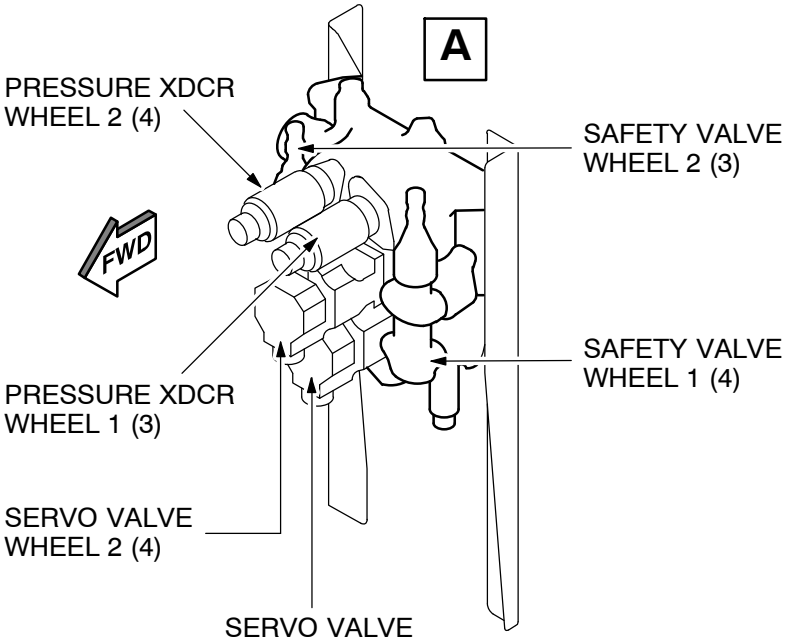
Figure 68 Normal Brake Servo Valve



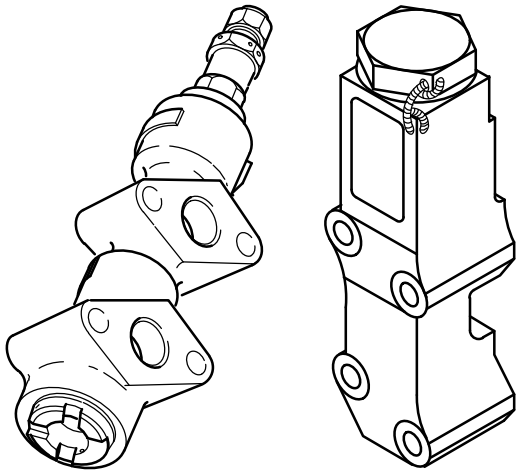


PRESSURE TRANSDUCER

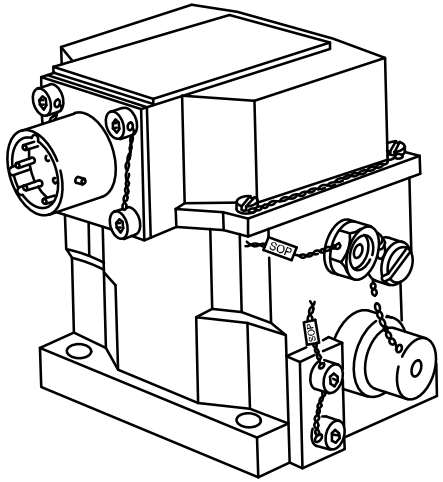
NORMAL BRAKE
SERVO MANIFOLD



SAFETY VALVE



VERSION 1 *VERSION 2*



SERVO VALVE

Figure 69 Normal Brake Servo Valve Manifold

TACHOMETER

Four identical Tachometers are installed in the main–gear wheel axles (one for each wheel).

The tachometers supply wheel speed information. Each tachometer has two 200–tooth rings:

- One stationary ring associated with a coil and a permanent magnet
- One ring driven by the wheel

The rotation of the wheel causes variations in the induction frequency which are proportional to the angular speed (Frequency = 200 x angular speed). The variable–frequency voltage supplied by the tachometer is sent to the Brake and Steering Control Unit (BSCU).

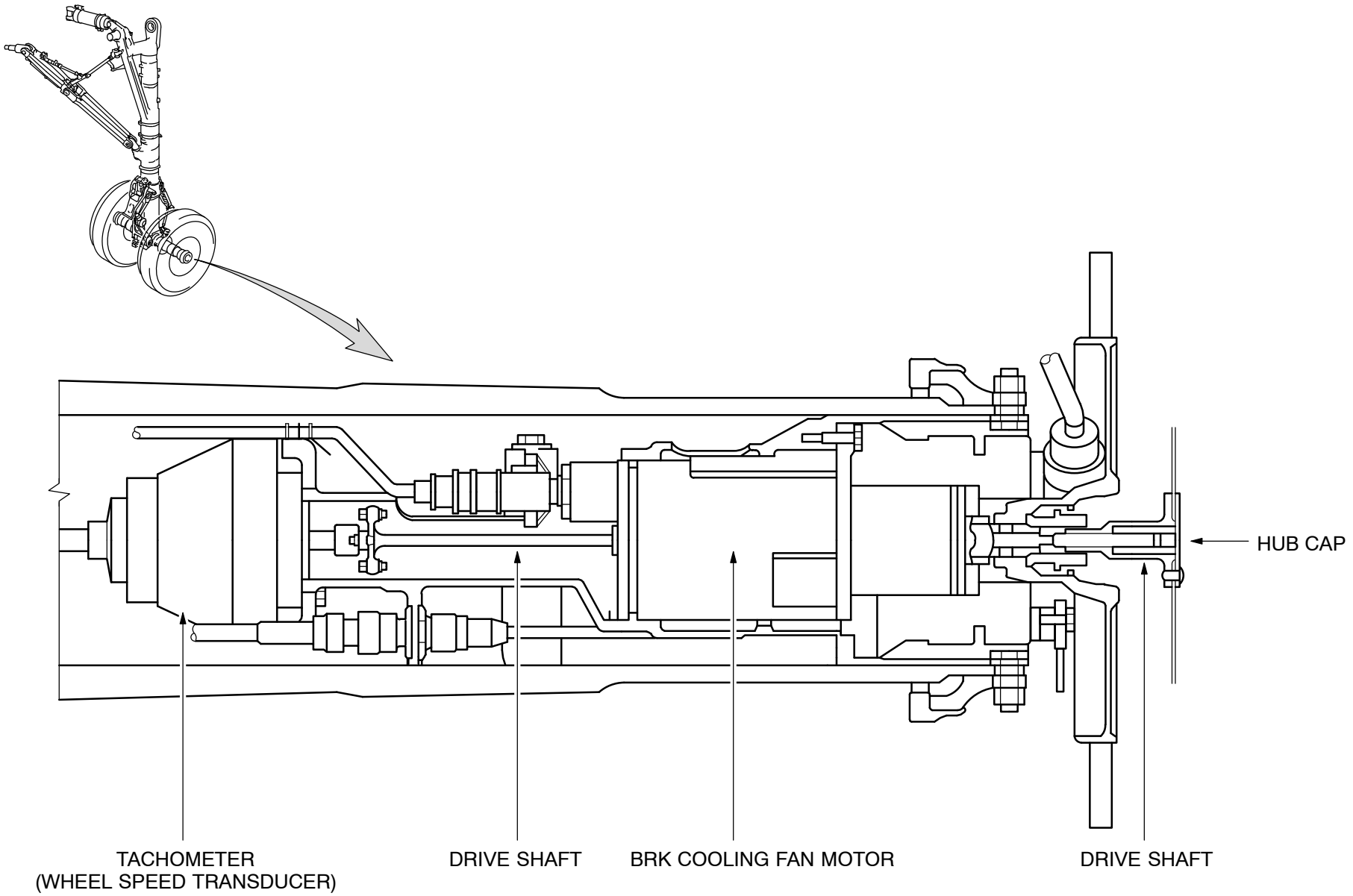


Figure 70 Tachometer

BSCU INTRODUCTION

The **B**rake and **S**teering **C**ontrol **U**nit (BSCU) is installed in a 6MCU–size case in rack 90VU (Shelf 94VU). Its functions are:

- Braking control through the servo valves and the pressure transducers
- Braking regulation through the check of the speed of each braked wheel
- Integrated monitoring with memorization of the failures which come from the different LRUs of the system. It permits to locate the failures during maintenance operations, from the CFDS
- Automatic braking control through the substitution of a programmed speed with a given acceleration rate to the anti–skid reference speed
- Nose wheel steering control through a hydraulic block and an actuating cylinder
- Conversion into ARINC 429 data of the brake temperatures which come from the Brake Temperature Monitoring Units (BTMU) attached to the main landing gear.

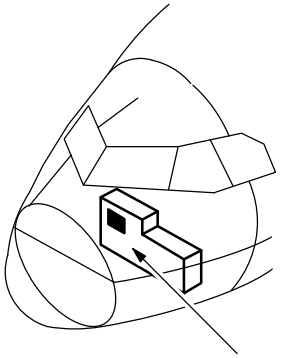
All the functions use the digital technology.

Description of the BSCU

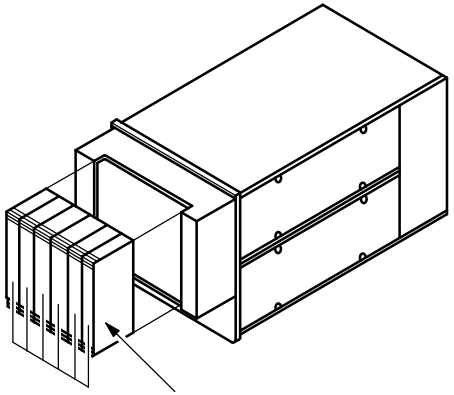
The BSCU has:

- four power supply units grouped two by two. They form the sides of the case
- an ARINC 600 connector at the back (Size 2, 300 contacts)
- a rear interface in the form of two U–shaped boards (around the connector) It comprises the lightning protection and the switching assemblies
- six electronic boards

The dimensions of these boards are 225 x 175 mm. They are installed vertically and lengthwise in the case. They are connected together and to the rear interface through two connectors which occupy the totality of their back faces. There are two identical sets of three boards which form the systems 1 and 2. Each board with a microprocessor is connected to an On–Board Re–Programmable Module (OBRM) which includes PROMs.



RACK 90 VU



ON BOARD REPLACEABLE MODULE

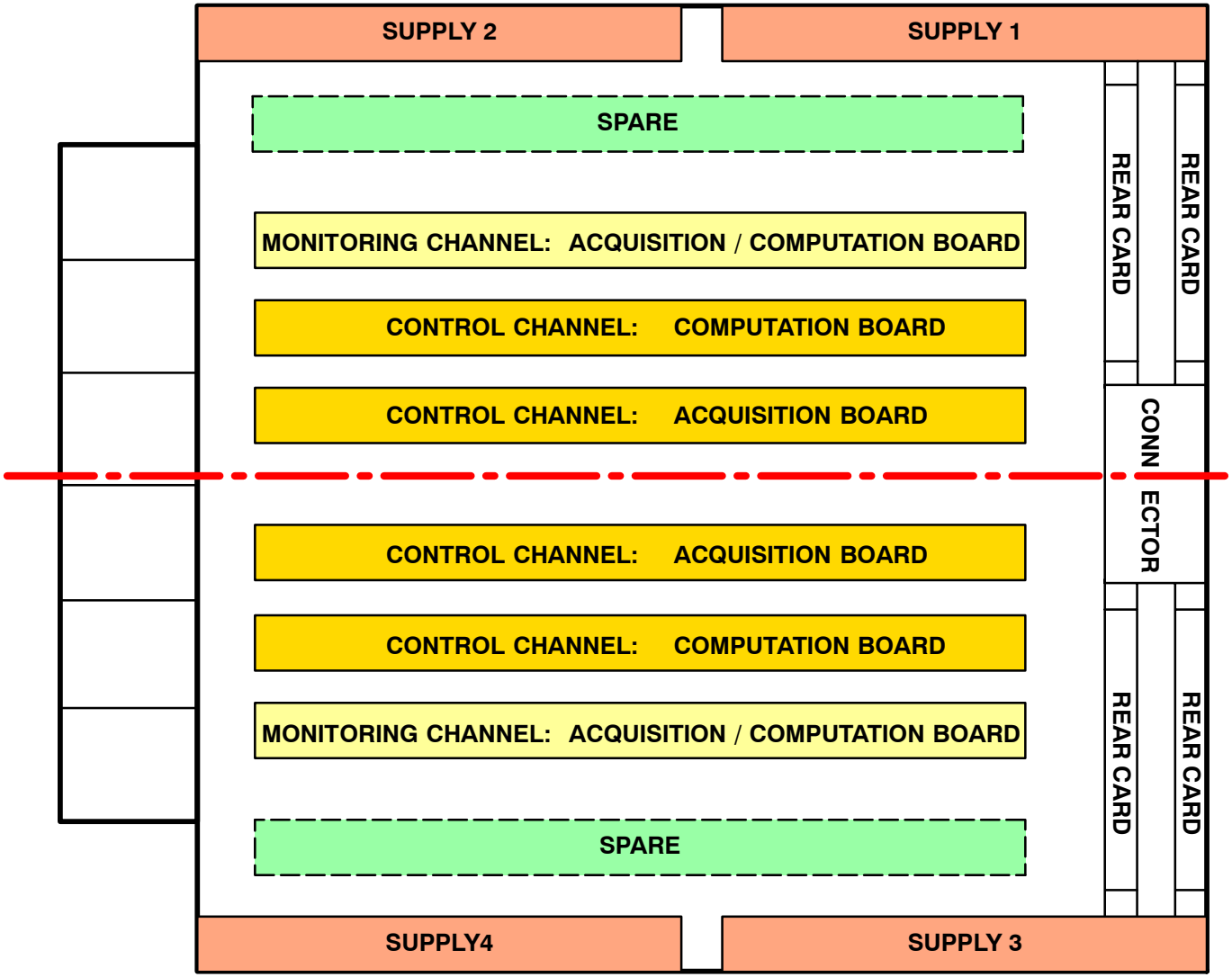


Figure 71 BSCU

BSCU SYSTEM INTERFACE DESCRIPTION

Systems 1 and 2

Each system is supplied independently with 115V 400 Hz power and has two channels. Each channel has its own power supply (5V plus or minus 15V) and acquisition modules.

- A control channel ensures the slaving functions and produces the currents which are sent to the electro–hydraulic components
- A monitoring channel dialogues with the control channel through a serial link and monitors the control channel.

Connection between System 1 and System 2

The dialogue is through 4 validity discretes (1 for each channel). During the functional test upon the landing gear extension an exchange of the codes sent over 8 discretes enables to test the two systems.

Operation

At each energization the first system supplied takes control. The exclusion between the two systems is ensured by the software. If the two systems are supplied simultaneously the SYS1 has priority. If there is a disagreement between the control and monitoring channels of the system engaged:

- the system is disconnected, it cancels its validity bits and isolates its commands
- the system in standby takes over. It validates its commands and ensures again all the functions of the unit with the same level of performance.

Software Organization of the BSCU

The BSCU is made of two systems physically distinct but functionally identical:

- System 1
- System 2

The unit has two identical software programs (one for each system). Each system itself has two channels:

- Control Channel
- Monitoring Channel

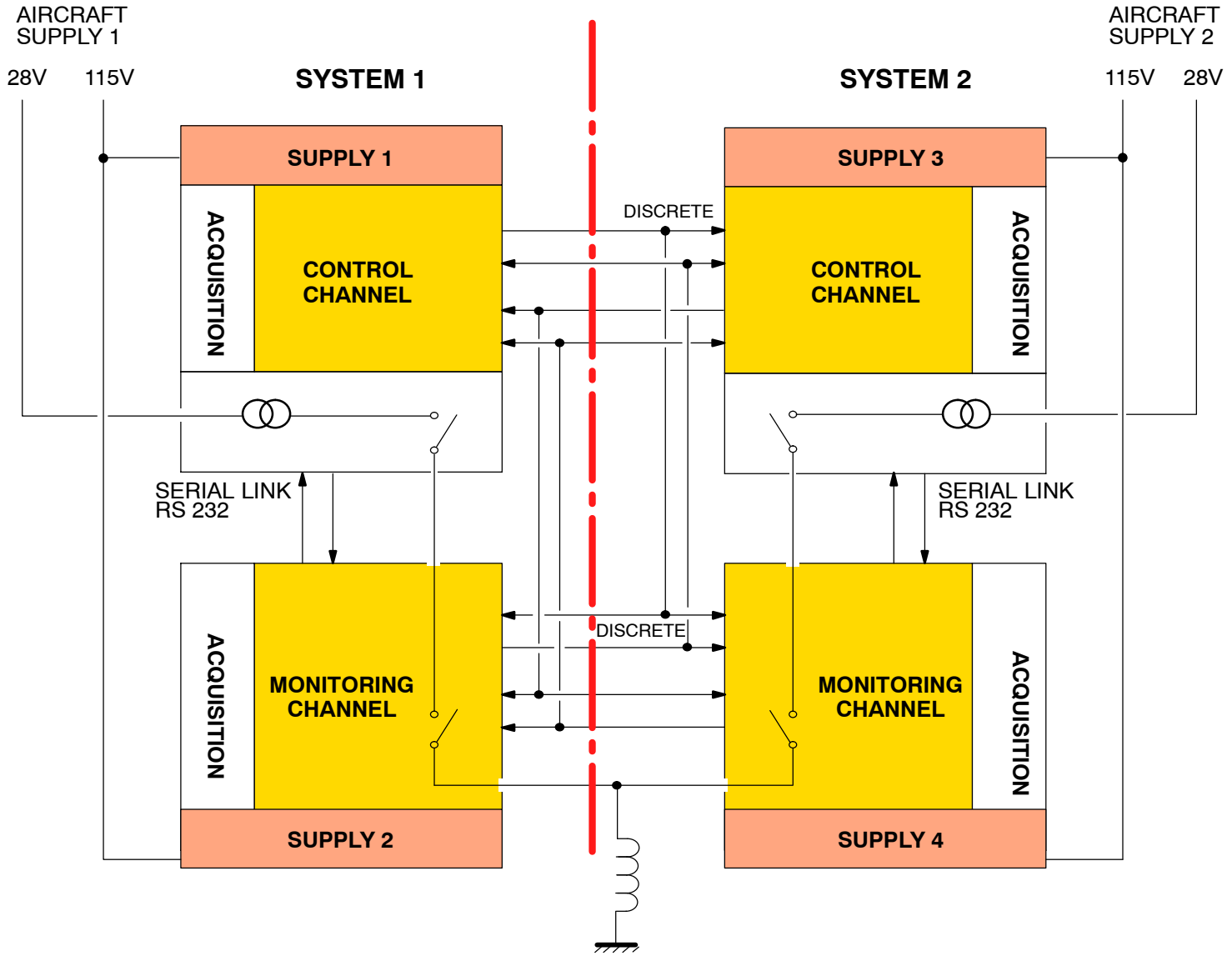


Figure 72 BSCU System Interface

BSCU FUNCTIONAL OPERATION

CONTROL

The various inputs and outputs associated with the control are shown in the schematic below.

Functions performed:

- Control of the brake selector valve
- Automatic braking of the wheels upon initiation of the landing gear retraction
- Auto brake

Selector Valve Control

The opening of the selector valve results from the actions given below:

- depression of a left or right pedal past the load threshold
- activation of the auto brake
- automatic braking of the wheel during the landing gear retraction.

Pressure Slaving of the Normal Servo Valve

For each gear, the brake command obtained by the depression of a pedal is transformed into a pressure by the normal servo valve. The servo valve is internally servoed to prevent pressure shifts. A feedback loop which uses a pressure transducer adjusts the controlled pressure. The maximum pressure supplied by the servo valve is 175 bars.

BSCU Configuration (PIN PROGRAMMING)

At BSCU energization, the pin programming integrated in the BSCU is compared with the aircraft pin programming (strap connection). Any disagree results in switching the Normal braking to the Alternate mode without anti–skid regulation (ALT OFF–NWS OFF). The BSCU pin programming can be adapted by means of the BSCU menu mode, via the CFDIU. This procedure is described in Brakes and Steering BITE.

The various configurations available depend on the parameters are:

- Aircraft Type
- Brake Type
- Wheel Type (different diameters)
- Deceleration Rate in Special Automatic Braking Mode
- Brake Fan Option

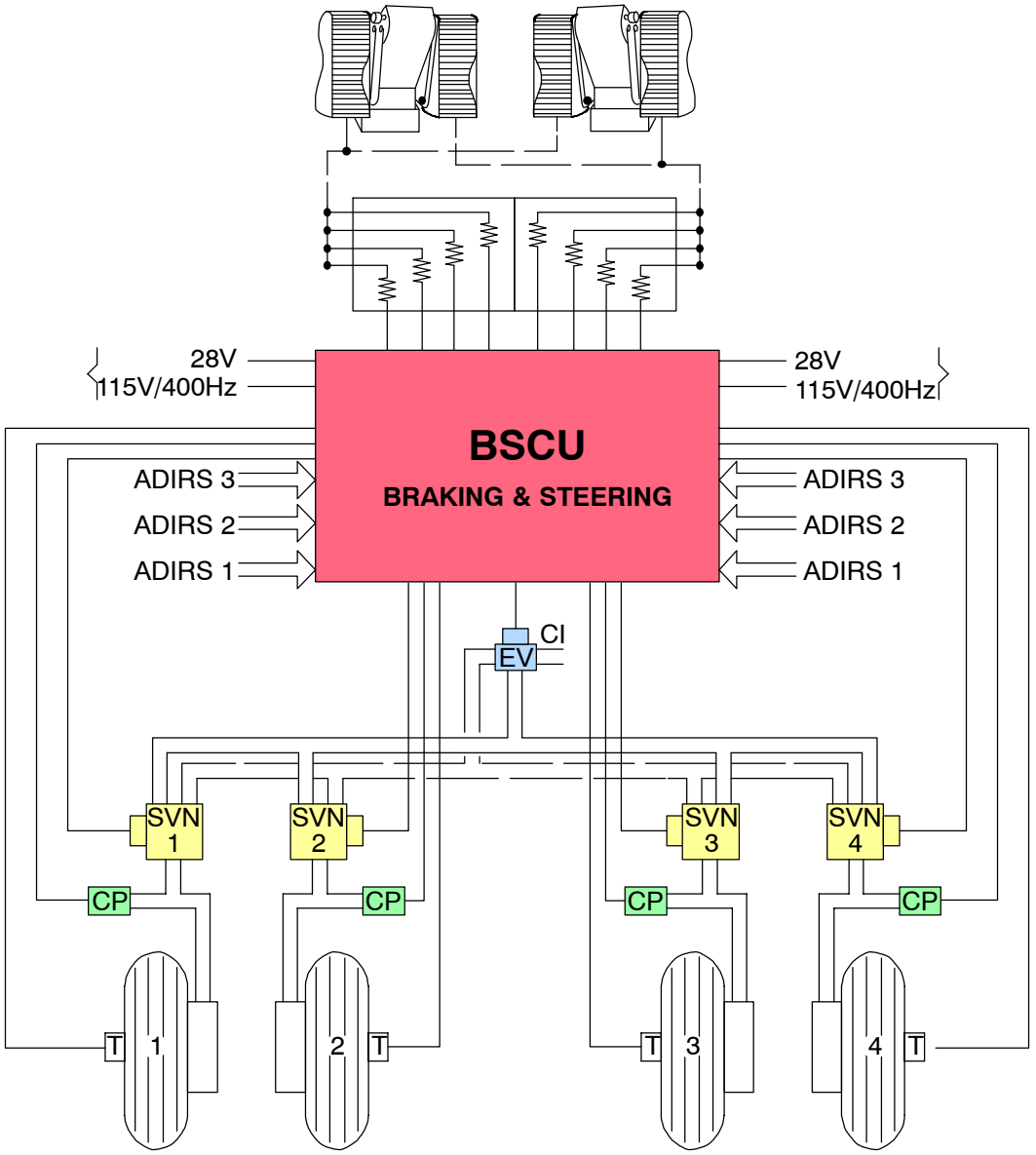


Figure 73 BSCU Controls

ANTI SKID INTRODUCTION

NOTE: The Braking/Steering Control Unit is designed for use with two types of brakes. The selection is made through shunts located at the rear of the unit, on the wiring side of the aircraft.

Principle

The speed of each main gear wheel is compared to the reference speed. With braking ordered, when the speed of a braked wheel decreases to below the input control speed (Vc), the anti skid system sends a brake release order. This order keeps the wheel speed value at the input control speed. A slip law function of the reference speed is introduced.

The anti skid system has the corrective networks necessary to stabilize the feedback loop.

The servo valve is the pressure–servoed electro–hydraulic component.

The static gain of the brake is approximately 450 mN/bar depending on the brake type.

The tachometer transforms the angular velocity of the braked wheel into a frequency.

A converter transforms the input frequency into a digital signal that the microprocessor can use directly.

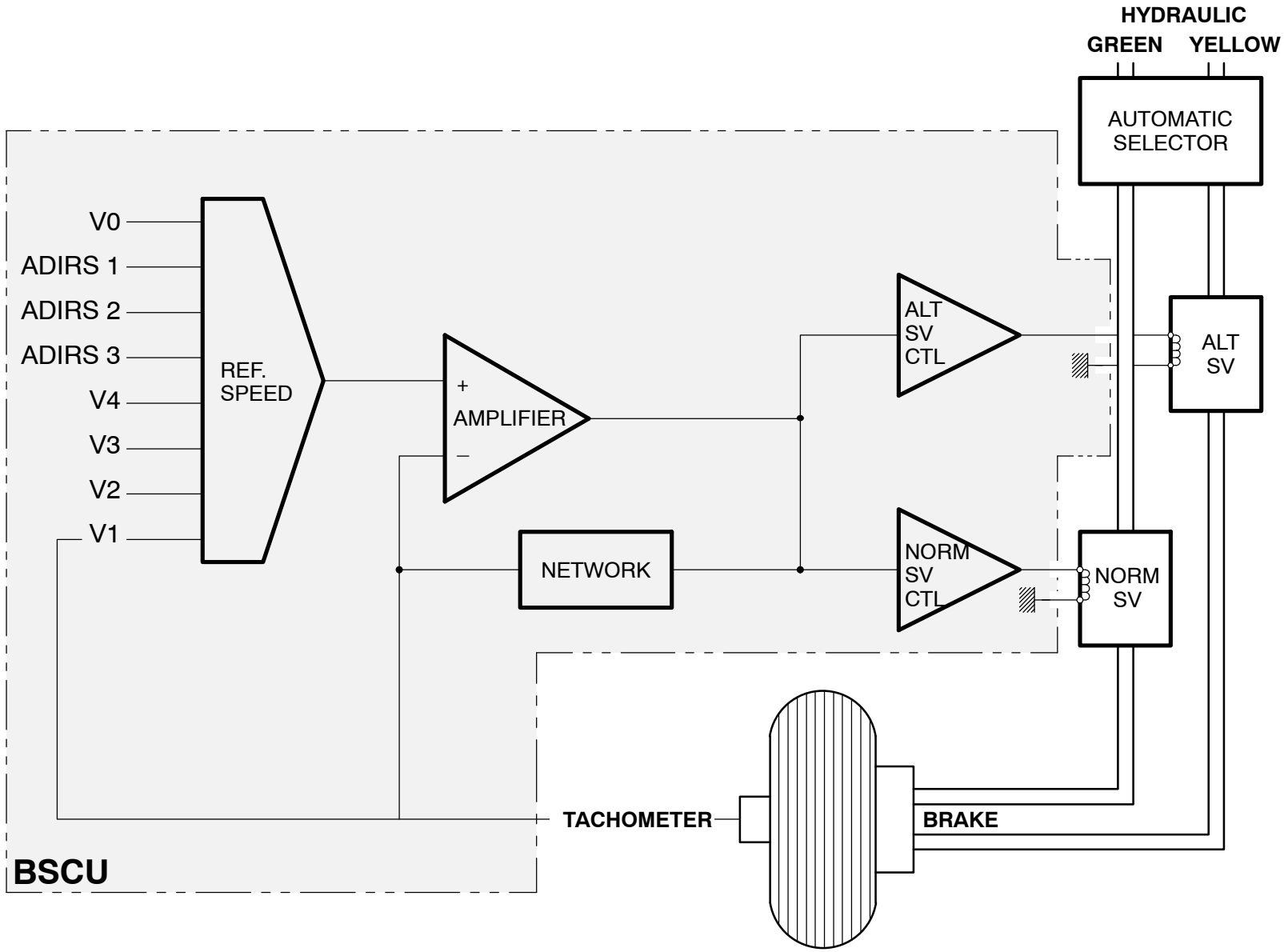


Figure 74 Anti Skid - Schematic

BSCU CONTROLS AND INDICATION

The A/SKID & NOSE WHEEL Control Switch is located on the center instrument panel. All the indications are transmitted to the crew through the ECAM:

- On the lower display unit, the WHEEL page gives the release information, the NORMAL/ALT braking mode and the selected deceleration
- On the upper display unit the related warnings are displayed

FAILURE WARNING	CLASS	LEVEL	ASSOCIATED WARNING
L/G AUTO BRK FAULT	1	2	MASTER CAUTION SINGLE CHIME
L/G N.W.STEER. FAULT	1	2	MASTER CAUTION SINGLE CHIME
L/G A/SKID FAULT	1	2	MASTER CAUTION SINGLE CHIME
L/G TYRE LO PR	1	2	MASTER CAUTION SINGLE CHIME
BRAKE BSCU SYS 1(2) FAULT	1	1	
CONFIG PARKING BRK ON	1	3	MW, CRC
N.WHEEL DISC	1		MEMO (A)
L/G BRAKE OVERHEAT	1	2	MASTER CAUTION SINGLE CHIME

BSCU failure categories

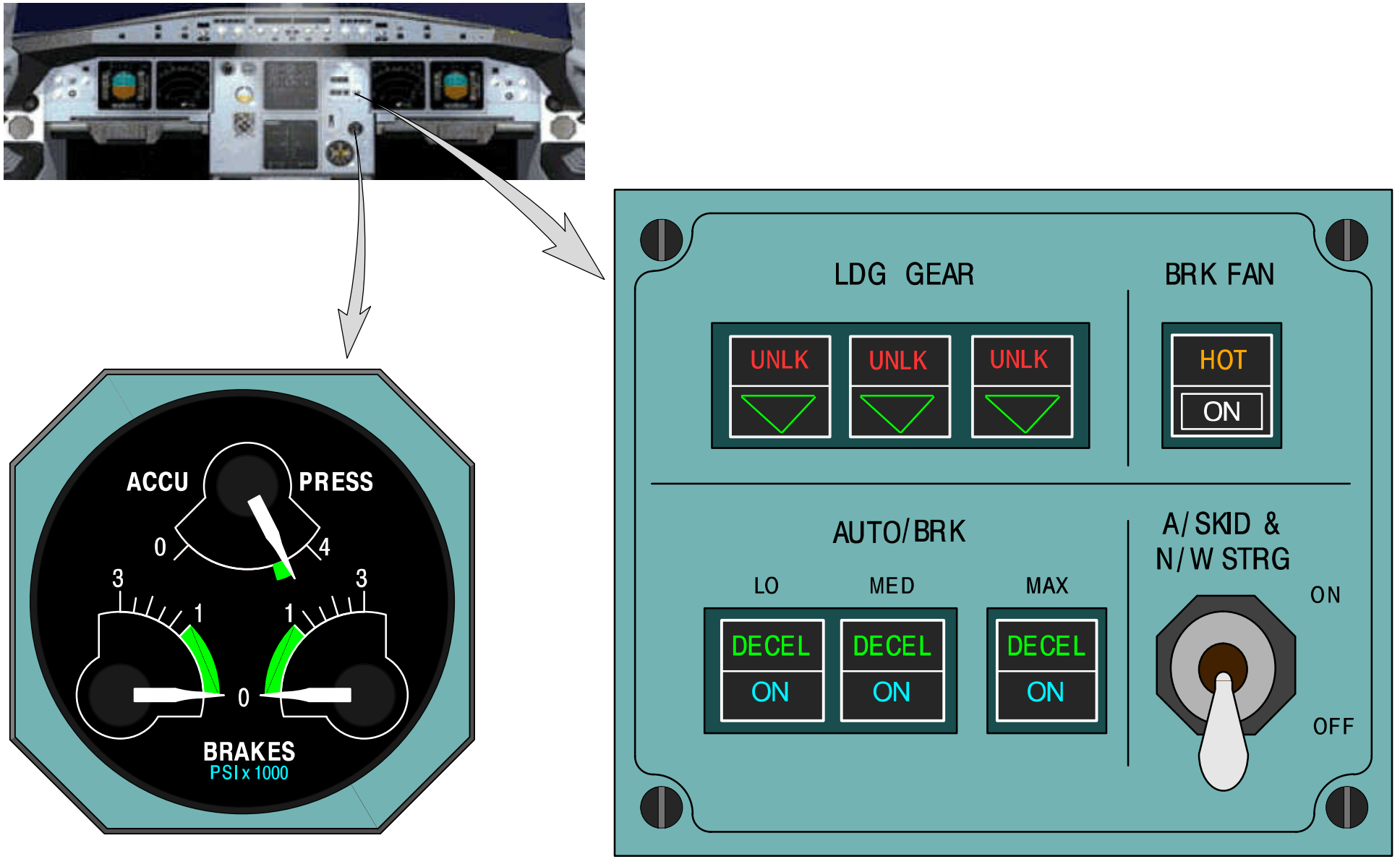


Figure 75 BSCU Controls and Indication

ANTI SKID SYSTEM OPERATION

REGULATION

The control speed of the speed servoing of each wheel (4 independent wheels) is calculated by decreasing the reference speed by the value of the slip ratio.
Vc (t) = 0.91 VRef (t) –1.5 (in m/s)

The regulator compares the control speed to the braked wheel speed to establish, if necessary, a brake release order so as to decrease wheel slip. The corrective networks and the static gain of the regulator of one wheel are adjusted to maintain a high level of stability and accuracy.

Below a 10 m/s reference speed, the regulator action is inhibited by forcing the control speed value at 0 m/s (enabling wheel locking).

The regulator supplies numerical values converted into electrical current to supply the coil of the Normal Servo Valve and the Alternate Servo Valve. The current control is not affected by the impedance of the servo valve coil.

The maximum pressure supplied to the brakes is limited by I1 or I2 which cannot fall below I MIN.

When sufficient brake release current is available, the voltage at the terminals of a resistor is sent to the lower ECAM DU. It supplies the brake–release indication, REL (Release) symbolized by 5 green bars on the wheel concerned. The regulation circuit of the Normal or Alternate Servo Valve supplies the REL information.

A regulation–inhibition circuit eliminates all the brake–release orders that could occur during an automatic in–flight wheel braking when the gear retracts, or during application of the Parking brake (for 3 s only).

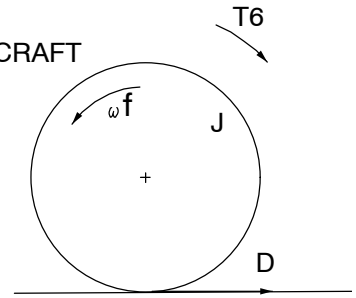
WHEEL/RUNWAY BEHAVIOUR IS GOVERNED BY THE EQUATION:

$Tb - DRb = J\omega b'$

Tb' = BRAKE TORQUE
D = DRAG
D = μW

TIRE/GROUND FRICTION COEFFICIENT DEPENDENT ON THE STATE OF THE RUNWAY AND THE WHEEL SLIP VALUE

W = LOAD APPLIED ON THE WHEEL
Rb = BRAKED WHEEL ROLLING RADIUS
J = WHEEL INERTION
$\omega b'$ = DECELERATION OF THE BRAKED WHEEL



CALCULATION OF WHEEL SLIP VALUE

LET ωb = ANGULAR VELOCITY OF BRAKED WHEEL
ω = FREE ROLLING SPEED OF SAME WHEEL

$\theta = \frac{\omega - \omega b}{\omega}$

θ = 0 IF THE WHEEL IS FREE ROLLING
θ = 1 IF THE WHEEL IS LOCKED

SERVOVALVE TRANSFER FUNCTION (APPROX.)

$\frac{P}{i} = \frac{K}{1 + \frac{2\varepsilon}{\omega n}s + \frac{1}{\omega^2 n}s}$

WHERE : P = DELIVERY PRESSURE
i = INPUT CURRENT
K = STATIC GAIN
ε = DAMPING RATIO
s = LAPLACE VARIABLE
ω = NATURAL FREQUENCY

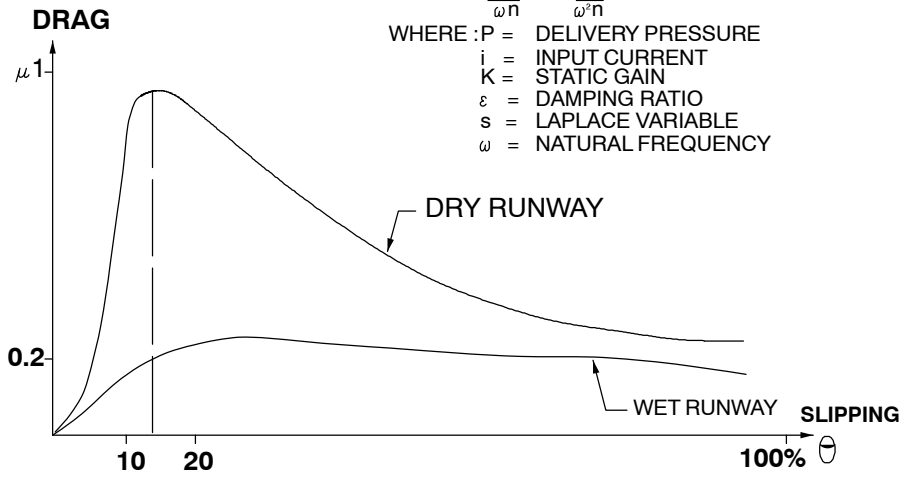


Figure 76 Wheel slip value

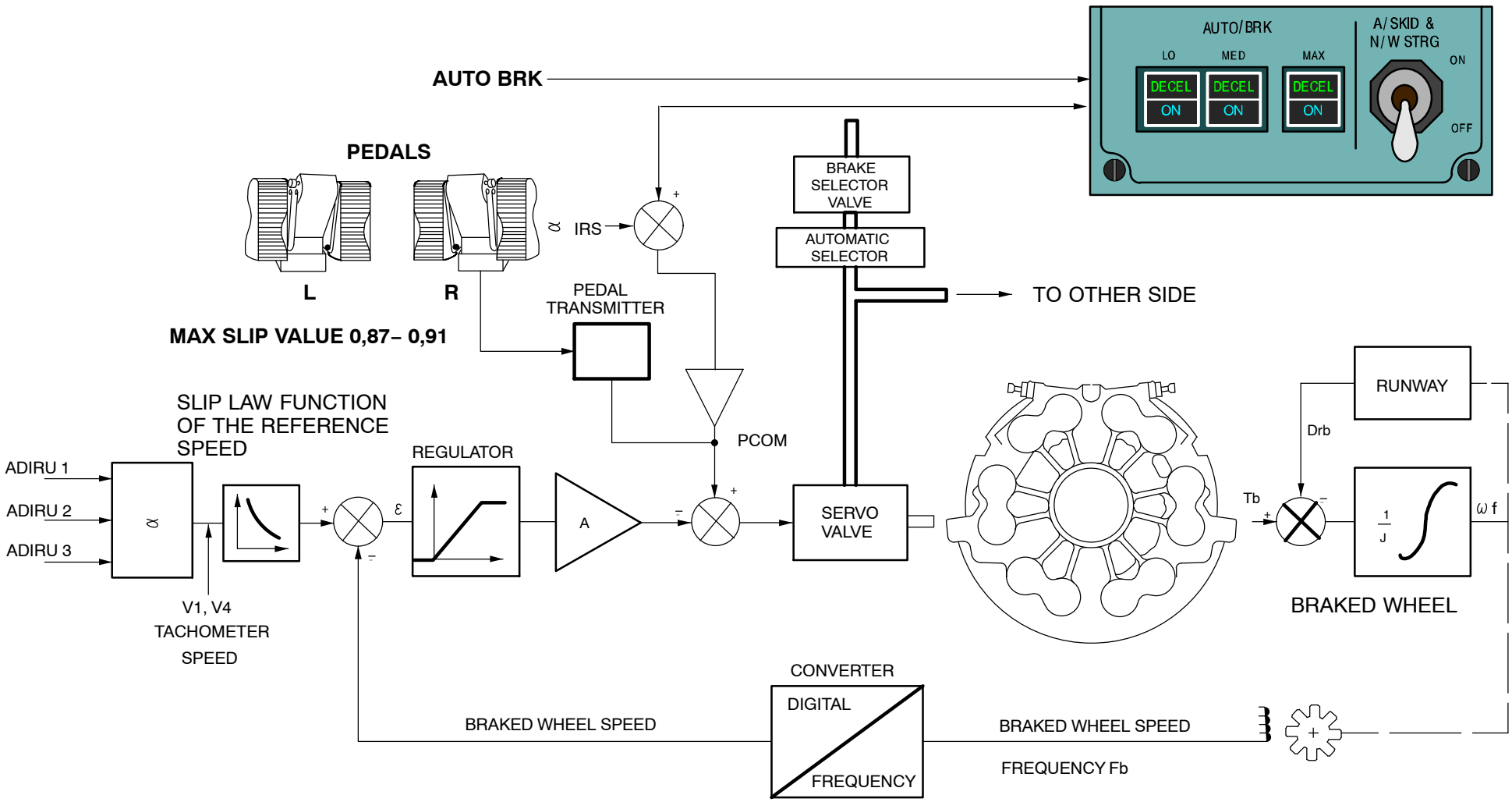


Figure 77 Anti Skid - Principle

AUTO BRAKE SYSTEM OPERATION

General

The automatic braking system has the two functions below:

- generation of the arming or disarming orders to the system
- supply of a programmed speed to the braking controller

The programmed speed depends on the aircraft speed and decreases according to the deceleration ratio selected by the crew. It is used as a reference speed signal for the anti skid controllers of the braked wheels and will be maintained as long as it is higher than the aircraft speed. Thus each wheel is servoed to this speed.

If the tire–runway grip does not permit to get the selected deceleration:

- the aircraft speed is then higher than the programmed one
- the anti skid operates to get the optimum deceleration

When the tire-runway grip permits again to get the selected deceleration:

- the programmed speed is then higher than the aircraft speed
- the automatic braking limits again the deceleration progressively to the selected value.

The auto brake system performs the following actions:

- get the optimum deceleration rate compatible with the length of the runway
- decrease the pilot workload during landing
- decrease the number of pilot actions at take–off (one action on throttle instead of two actions: braking + throttle)
- improve passenger comfort.

Before landing, the pilot sets the appropriate deceleration rate to be adapted for the runway. For this purpose he uses the AUTO BRK LO/MED and MAX PBSWs on the center instrument panel. The pilot can disengage the autobrake by depressing the pedals or when he pushes again the AUTO BRK LO/MED or MAX PBSW. Before takeoff, the pilot can select the MAX mode.

Indicating

Each illuminated PBSW is divided into two parts:

- the lower part (ON legend) comes on blue to shows that the pushbutton switch has been selected and the system is armed.
- the upper part (DECEL legend) comes on green when the corresponding deceleration rate has been reached, (LO and MED pushbutton switches) or during a deceleration rate higher than 0.27 g (MAX pushbutton switch).

AUTO BRAKE LOGIC

The auto brake logic is located in the BSCU on the control and monitoring boards of the SYS 1 and SYS 2.

The signals listed below are sent to the logic circuits of the auto brake:

- selected deceleration rate from the cockpit center instrument panel LO=1.7 m/s^2, MED 3 m/s^2, MAX=6 m/s^2
- Three signals which tell that the ground spoilers are extended. Two of them have to be present to permit the automatic braking
- a signal which gives the pedal position
- ,a signal which tells that the pressure in the Green system is low
- a signal which gives the longitudinal deceleration of the aircraft ADIRs
- no tachometer failure
- GROUND/FLIGHT information

The auto brake logic supplies:

- the command for the energization of the selector valve
- the braking command to the four servovalves
- selected deceleration rate information to the cockpit
- Auto brake disarm signal
- Auto brake fault signal if arming is not possible

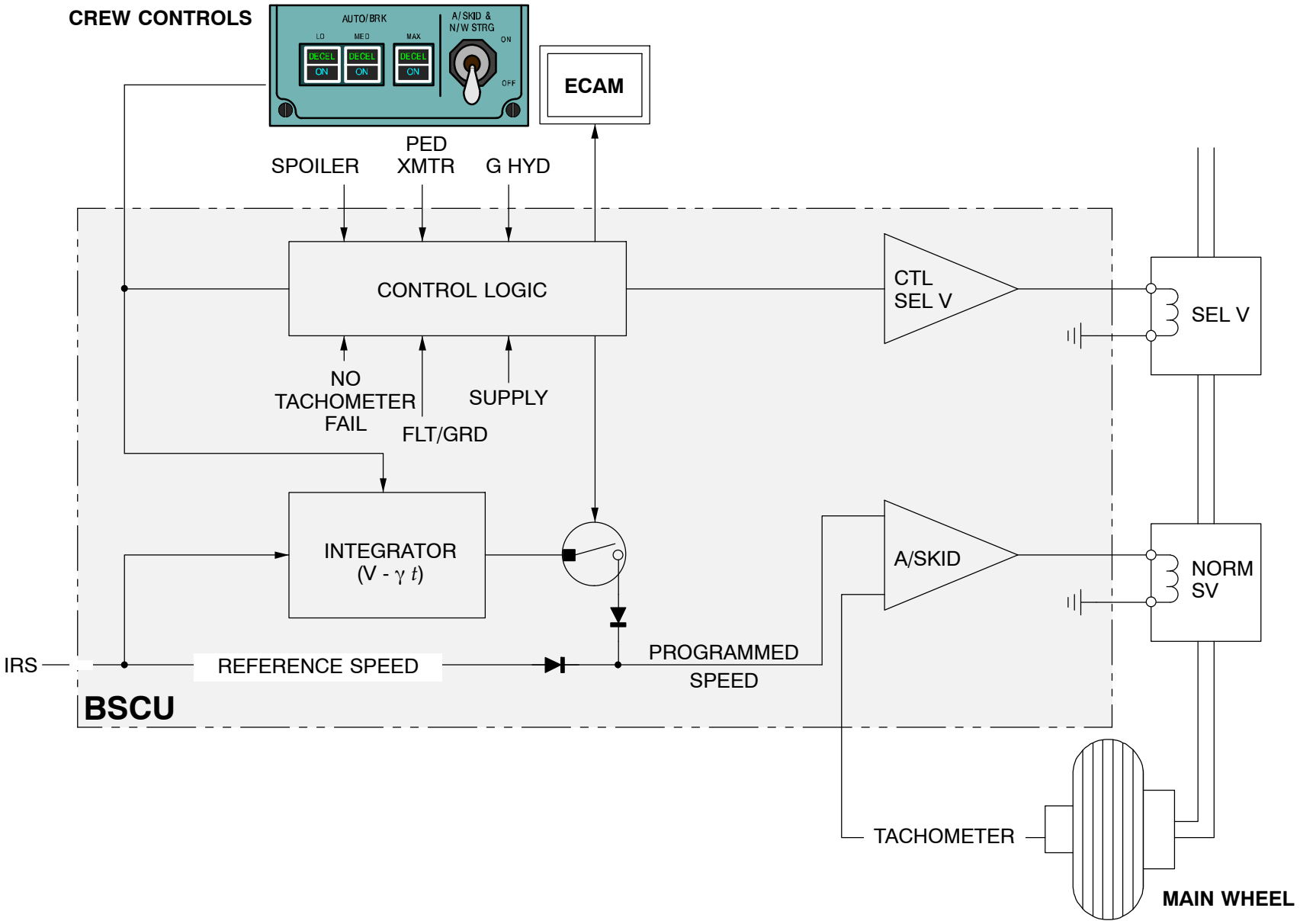


Figure 78 Auto Brake Control

AUTO BRAKE SYSTEM OPERATION

MED and LOW modes:

These modes are used at landing. The selector valve is energized by the extension command of the ground spoilers. It is possible to apply the brakes if the ground–spoilers extension signals are present (speed of the main gear wheel > 72 kts).

The braking has a delay of 4 seconds for the LOW mode and 2 seconds for the MED mode. It is then progressively applied. The pressure supplied by the 4 servovalves gradually increases, t = 3 s approx. The programmed reference speed is reached progressively.

The control circuit sends identical commands to the 4 servovalves. The integrator recopies the reference speed, it limits its decrease according to the deceleration that the crew selects.

MAX mode:

This mode can be selected for acceleration–stop (aborted take-off). The command for the ground spoiler extension controls the energization of the selector valve and the immediate delivery of a maximum pressure to the four brakes. The programmed deceleration rate is such as the full pressure is applied on the four brakes.

AUTOMATIC BRAKING CUTOFF

In MED and LOW modes the pilot can take-over braking control in two ways:

- by applying a fairly high load to one pedal
- by simultaneous application of a moderate load on both pedals

The automatic braking stops gradually. The AUTO BRK indication on the lower ECAM DU flashes during 10 s. The selected pushbutton switch goes off. If the braking input from the pedals is lower than that from the auto brake system, the transition is gradual (pressure gradient 50 bars/s approx. 725 psi/s). If not, the transition occurs without delay.

A small differential braking is not permitted the auto brake system is disengaged:

- when you put the landing–gear control lever in the UP position
- or when you push again the mode–selection pushbutton switch already selected.

There is no AUTO BRK indication on the ECAM.

The automatic braking is only re–initiated after the selection of a new deceleration rate. This occurs if the signal for the extension of the ground spoilers is still generated.

The automatic braking is totally and immediately cut off as soon as a ground spoilers–retraction signal is applied (this signal possibly results from a go–around command). The braking is inhibited but the system stays armed.

The automatic braking is re–initiated as soon as there is a new mode selection (LOW or MED mode). In the MAX mode, the load required at the pedal to cut off the automatic braking is greater than that in the LO or MED mode (half travel).

- Travel of the two brake pedals: 7.5 degrees in LOW and MED
- Travel of the one brake pedal: 10 degrees.

The pilot can disengage the AUTO BRAKE MAX mode when he depresses just one pedal

Disengagement in the Event of Failure

The system cannot be armed and is disengaged in the cases below:

- arming is impossible when there is a Green low pressure or A/SKID failure (servovalve, pressure transducer, tachometer) or electrical supply failure
- disengagement when there is a loss of the arming conditions

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32–43 ALTERNATE BRAKING

SYSTEM DESCRIPTION

ALTERNATE BRAKING WITH ANTI SKID

General

The Alternate braking with anti skid associates the Yellow high pressure with the anti skid regulation. You get this mode automatically:

- if Green pressure is not available or falls during braking
- or if certain failures occur on the Normal Braking system.

A hydraulic selector causes changes between the Green and Yellow systems automatically.

You control only with the pedals. An auxiliary low–pressure hydraulic–system transmits the orders. The pressure supplied to the left and right brakes is shown on a brake Yellow–pressure triple–indicator installed on the center instrument panel.

The anti skid system and related indicating are operative.

This braking mode uses the second set of pistons of the brake unit.

Control

A hydro–mechanical system transmits control inputs at the pedals. This hydro–mechanical system is installed between the master cylinders and the distribution dual valve (auxiliary low–pressure control–system).

Anti Skid Regulation

The regulators used for the Normal system are also used for anti skid regulation.

The servovalve gets brake release orders.

The servovalves can decrease the pressure at the brakes.

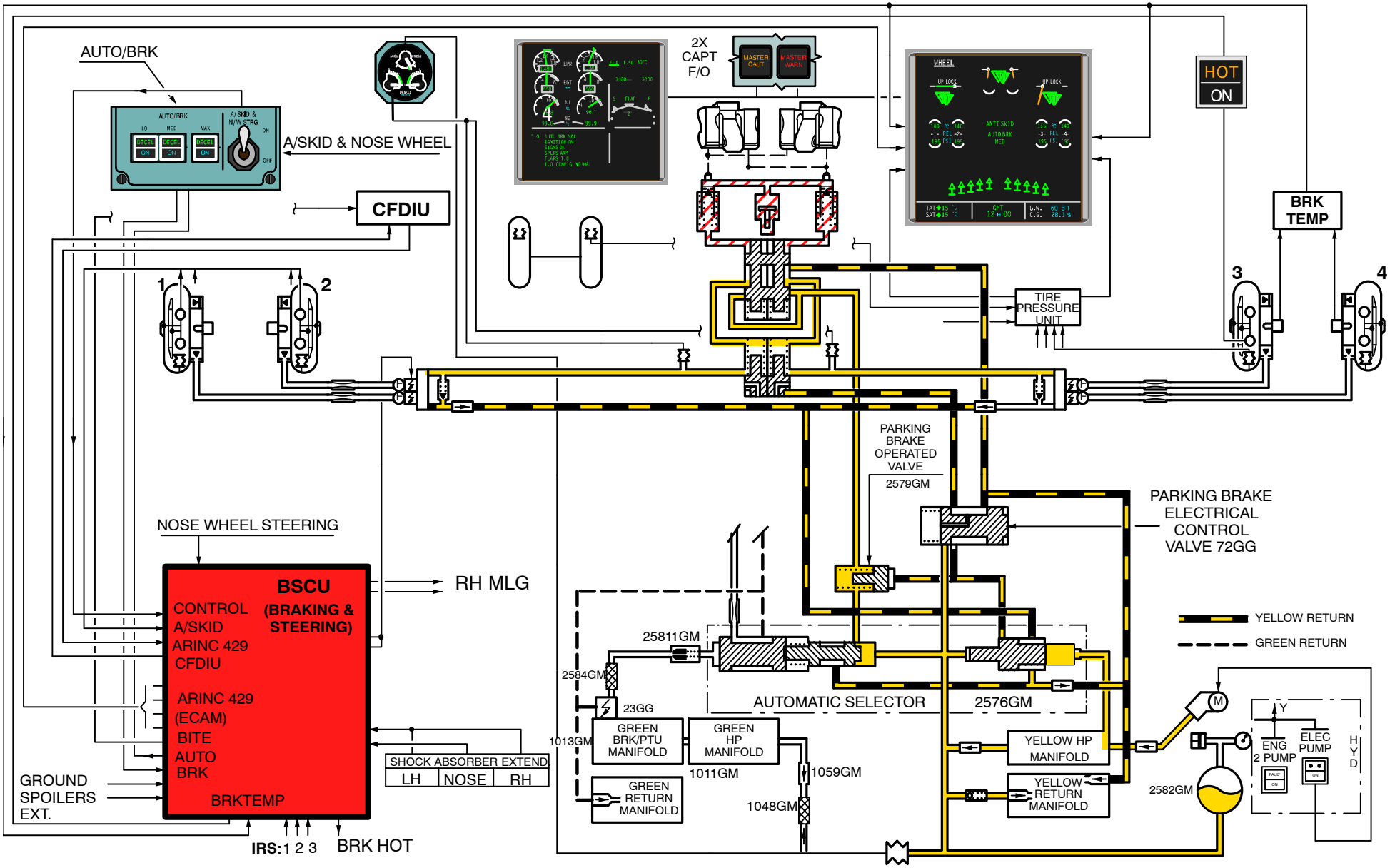


Figure 79 ALTN BRK with A/SKID

ALTERNATE BRAKING WITHOUT ANTI SKID

General

The ALTN/OFF mode is different from the mode identified above in that there is no anti skid regulation. The anti skid regulation can be disconnected:

- either electrically (A/SKID NOSE WHEEL switch in the OFF position or power supply failure)
- or hydraulically if the brake Yellow–pressure accumulator only supplies. the brakes (then the A/SKID NOSE WHEEL switch can be in any position).

Hydraulic changes between the Yellow high–pressure system and the accumulator are automatic and reversible.

The brake Yellow–pressure triple–indicator shows the pressure of the accumulator.

The Yellow electric pump fills the accumulator.

The accumulator can supply at least seven full brake applications. This braking mode uses the second set of pistons in the brake units.

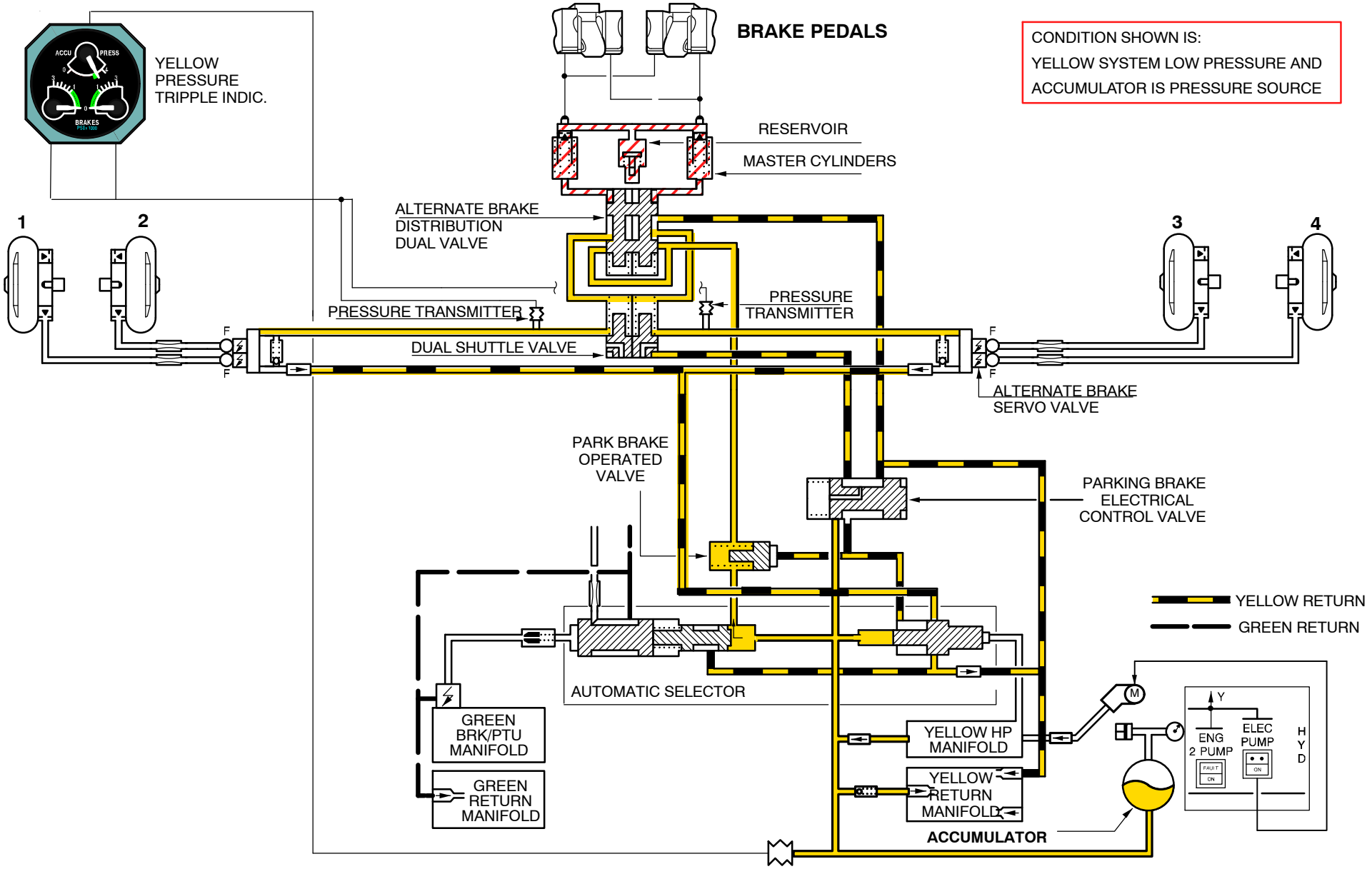


Figure 80 ALTN BRK without A/SKID

ALTN BRAKING COMPONENT DESCRIPTION

AUXILIARY LOW–PRESSURE CONTROL SYSTEM

Brake Control Hydraulic Reservoir

The reservoir supplies the master cylinders of the Alternate system with hydraulic fluid to make allowance for the changes in the volume of the fluid, and possible leakages.

A spring–loaded piston pressurizes the reservoir lightly (1.5 bars absolute).

The reservoir has a filling valve and two calibrated valves. One valve which limits the internal pressure, the other removes fluid if an overpressure occurs.

Master Cylinders

There are two master cylinders (one for the left side, one for the right side).

The master cylinders are used to control the distribution dual valve of the Alternate brake system by displacement of a volume of fluid and give artificial feel at the pedals by means of an internal spring and the load resulting from the pressure that increases in the control circuit.

When the pedals are released an internal valve opens to connect the output chamber to the hydraulic reservoir.

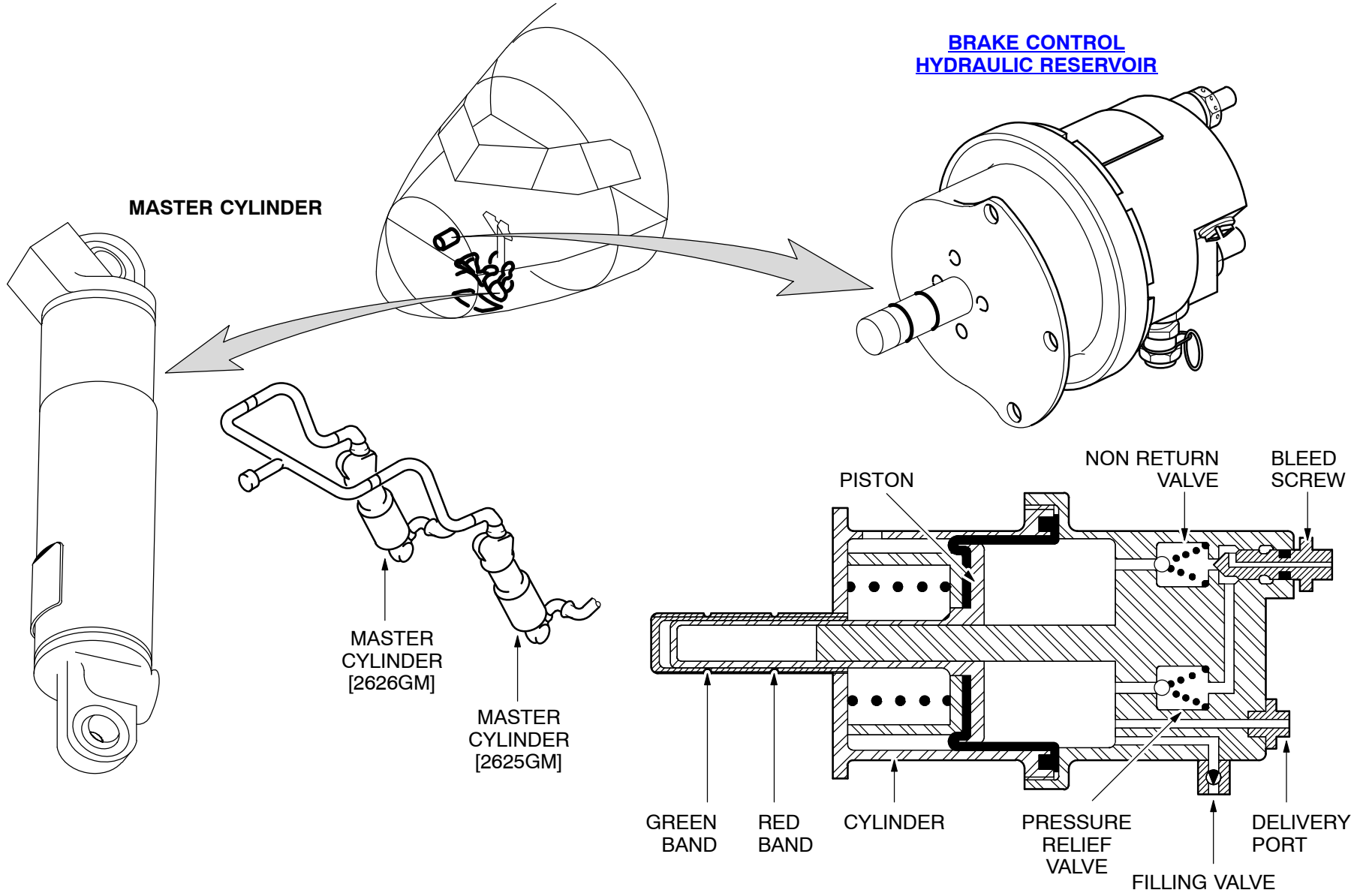


Figure 81 Brake Control Hyd. Reservoir and Master Cylinder

ALTERNATE–BRAKE DISTRIBUTION DUAL–VALVE

The distribution dual valve includes two independent pressure–reducing valves, one for each main gear. A master cylinder operates each valve. The distribution dual valve is installed in the hydraulics compartment.

Each pressure reducing valve includes a control piston which operates a distribution slide valve through a spring and a rocker arm. When the pedal is released, the Yellow pressure is shut off and the brake port is connected to the reservoir return.

When the pedal is pushed in, the volume of fluid moved by the master cylinder causes the displacement of the piston which then operates the rocker arm and the slide valve; the reservoir return is shut off and the pressure port is connected to the brake port.

A check valve is installed to rapidly move the fluid to the brake port: thus the slide valve can be in the fully open position as soon as the pedals are pushed in and the brakes are filled without delay.

In balanced state, the pressure supplied is in proportion to the compression of the spring and consequently to the displacement of the control piston.

The maximum pressure supplied is 175 bars (2537 psi).

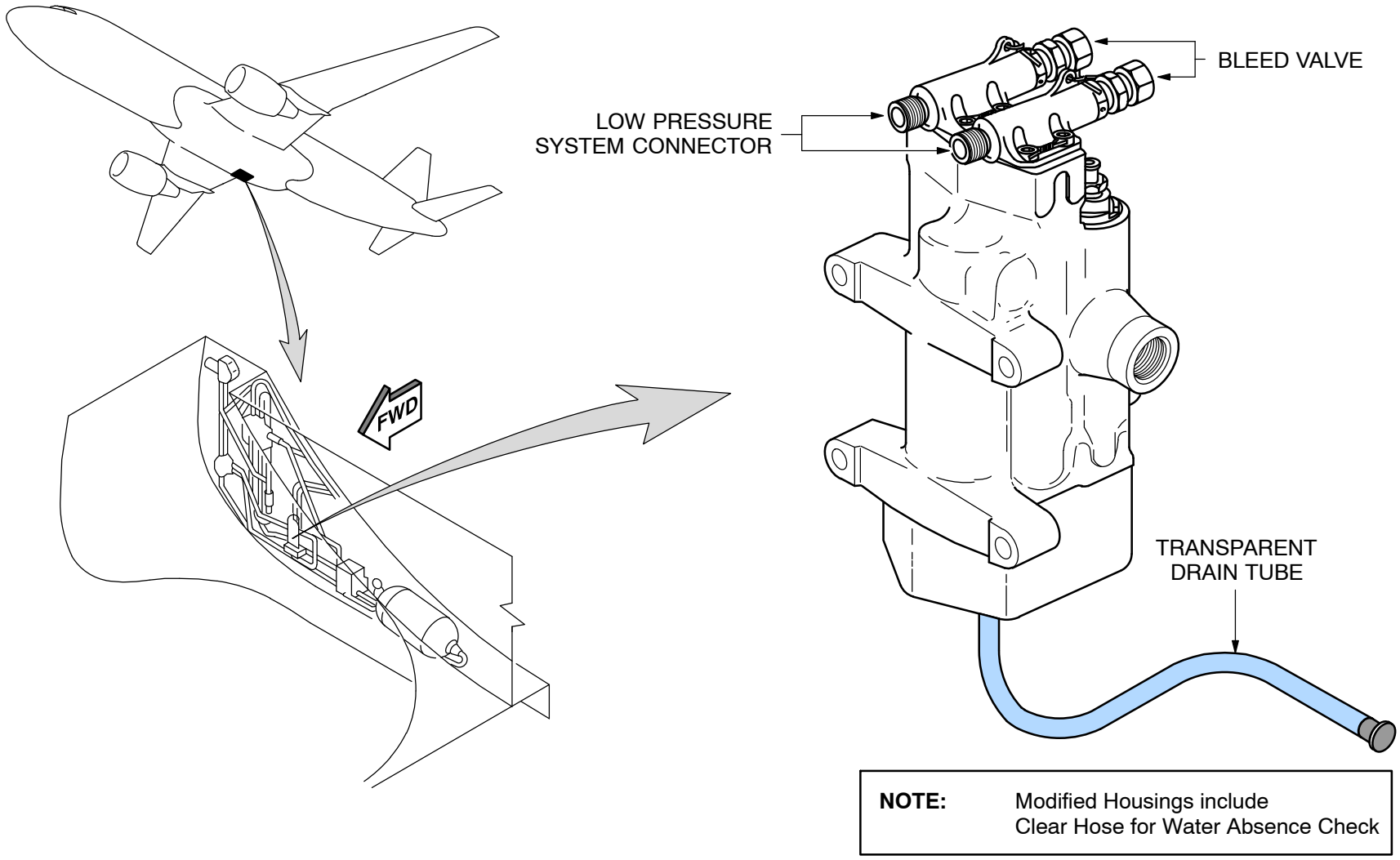


Figure 82 ALT BRK Distribution Dual-Valve

DUAL SHUTTLE VALVE

The dual shuttle valve includes two valves, one for each main gear, installed in a single block adjacent to the Alternate–brake distribution dual–valve.
Each valve is used to select either the Alternate system E or D (spring biased position) or the Parking system (A) to supply the brake system of the corresponding gear C or B.

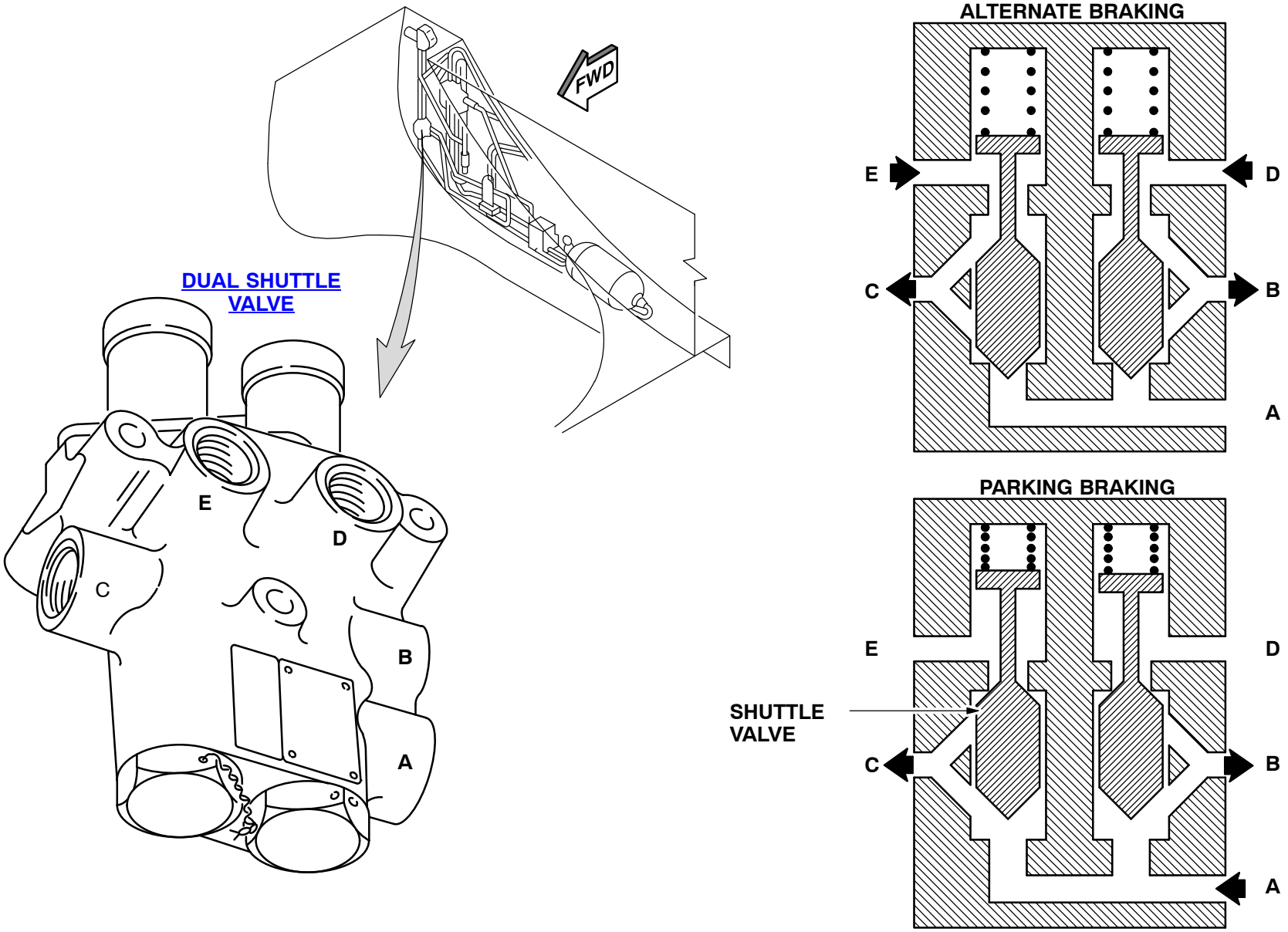


Figure 83 Dual Shuttle Valve

ALTERNATE BRAKE–SYSTEM PRESSURE–TRANSMITTERS

Two pressure transmitters measure the pressure at the outlet of the dual shuttle valve, i.e. the pressure supplied either by the Alternate–Brake Distribution Dual–Valve or by the Parking–Brake Pressure Limiter.

The pressure transmitters send the information to an indicator (brake Yellow–pressure triple–indicator) in the cockpit. The indicator also shows the pressure of the brake Yellow–pressure accumulator.

Brake Yellow–Pressure Triple–Indicator

The brake Yellow–pressure triple–indicator shows the pressure supplied by the distribution dual valve to the LH and RH brakes. This indicator thus shows that the system is supplied with the Yellow pressure.

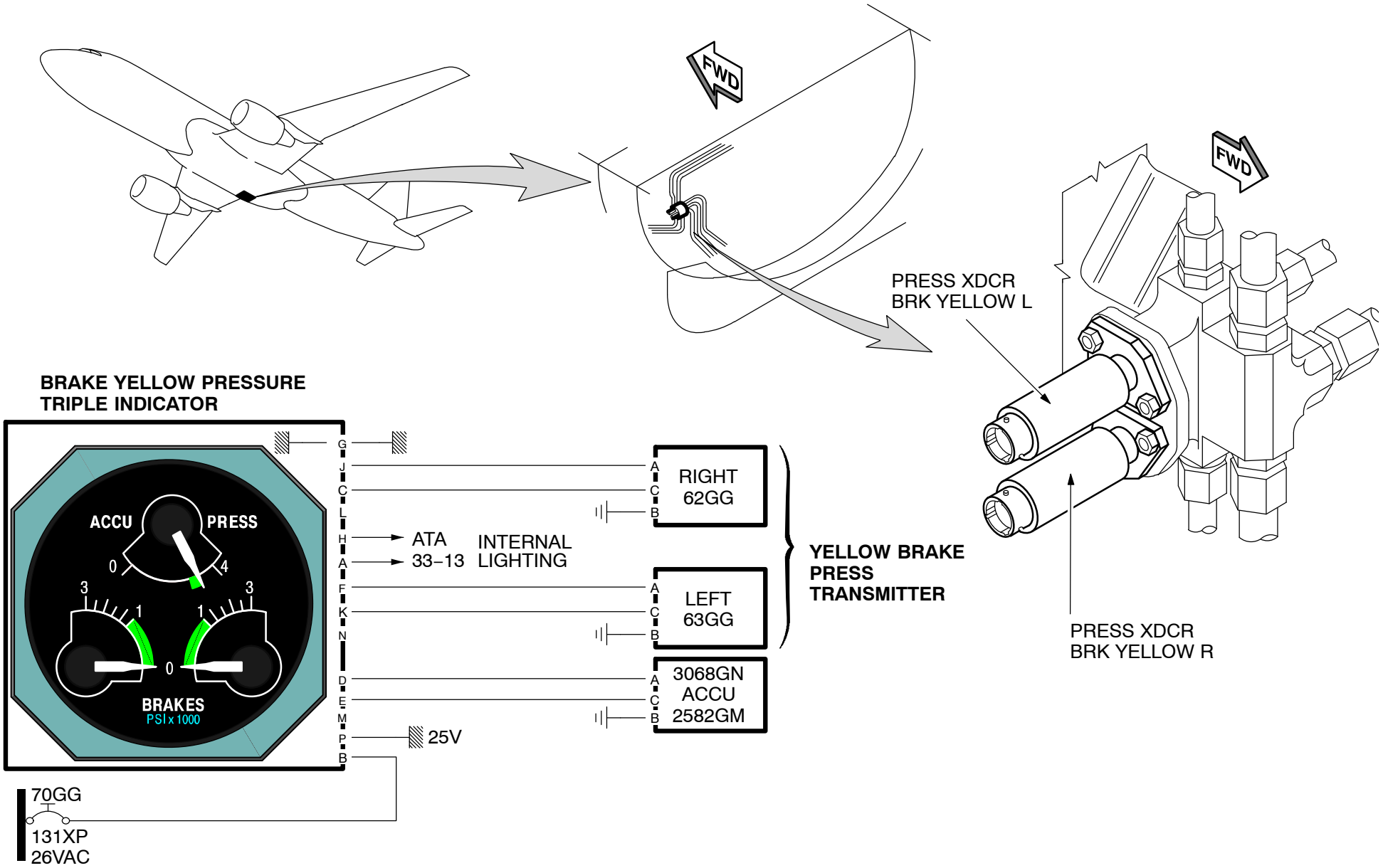


Figure 84 Brake Yellow Pressure Transmitters

ALTERNATE BRAKE SERVO VALVE MANIFOLD

There are two alternate brake servo valve manifold assemblies installed, one for each main gear. Each manifold includes:

- 2 servo valves
- 2 safety valves with integrated downstream filter
- 1 filter in the manifold pressure supply

NOTE: There are two different kinds of safety valves in use which work in the same principle. Thus you will find Safety Valves of Version 1 or Version 2 installed on Alternate Brake Manifolds.

Servo Valves

One servo valve supplies one brake only. The servo valves are supplied with pressure when the pedals are pushed in.

When there is no anti skid regulation, the pressure applied to the brakes is equal to the pressure supplied to the servo valves. The anti skid system regulation decreases the pressure at the brake.

The BSCU controls the servo valve by current.

With zero current in the coil, the pressure supplied is equal to the pressure supplied to the servo valve.

Safety Valves

The principle of operation is the same as that of the normal brake safety–valves.

Alternate Brake Manifold (2. Version)

The two alternate brake servo valve manifold assemblies are the same but they have other safety valves installed.

The operation of the safety valve is the same as the other type.

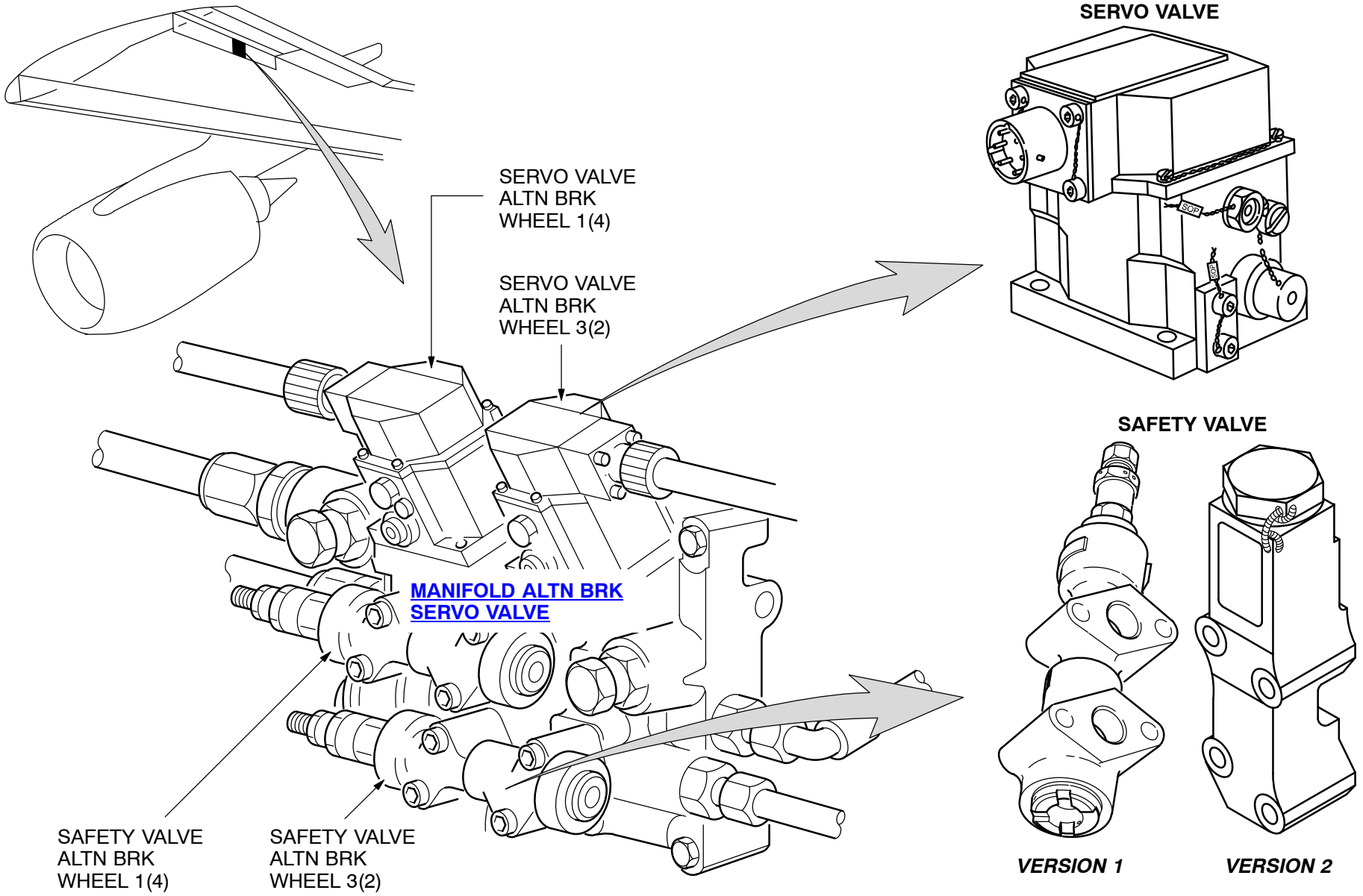


Figure 85 ALTN BRK Servo Valve Manifold

BRAKE YELLOW–PRESSURE ACCUMULATOR

The accumulator is of the bladder type filled with nitrogen. Filling pressure:

- 114 bars at 60 °C (1653 psi at 140 °F)
- 100 bars at 20 °C (1450 psi at 68 °F)
- 90 bars at – 10 °C (1305 psi at 14 °F)
- 86 bars at – 20 °C (1287 psi at –4 °F)

Volume of fluid given : 2700 cubic centimeter.

This accumulator is used only for braking. It is pressurized by either the Yellow hydraulic system or an electrical pump.

Check valves isolate the supply lines.

Pressure Relief and Check Valves

Two pressure relief valves, included in the Alternate–brake servo valve manifold, connect the supply to the manifold return. This connection enables the brakes to be drained in any position of the servo valve slide valve.

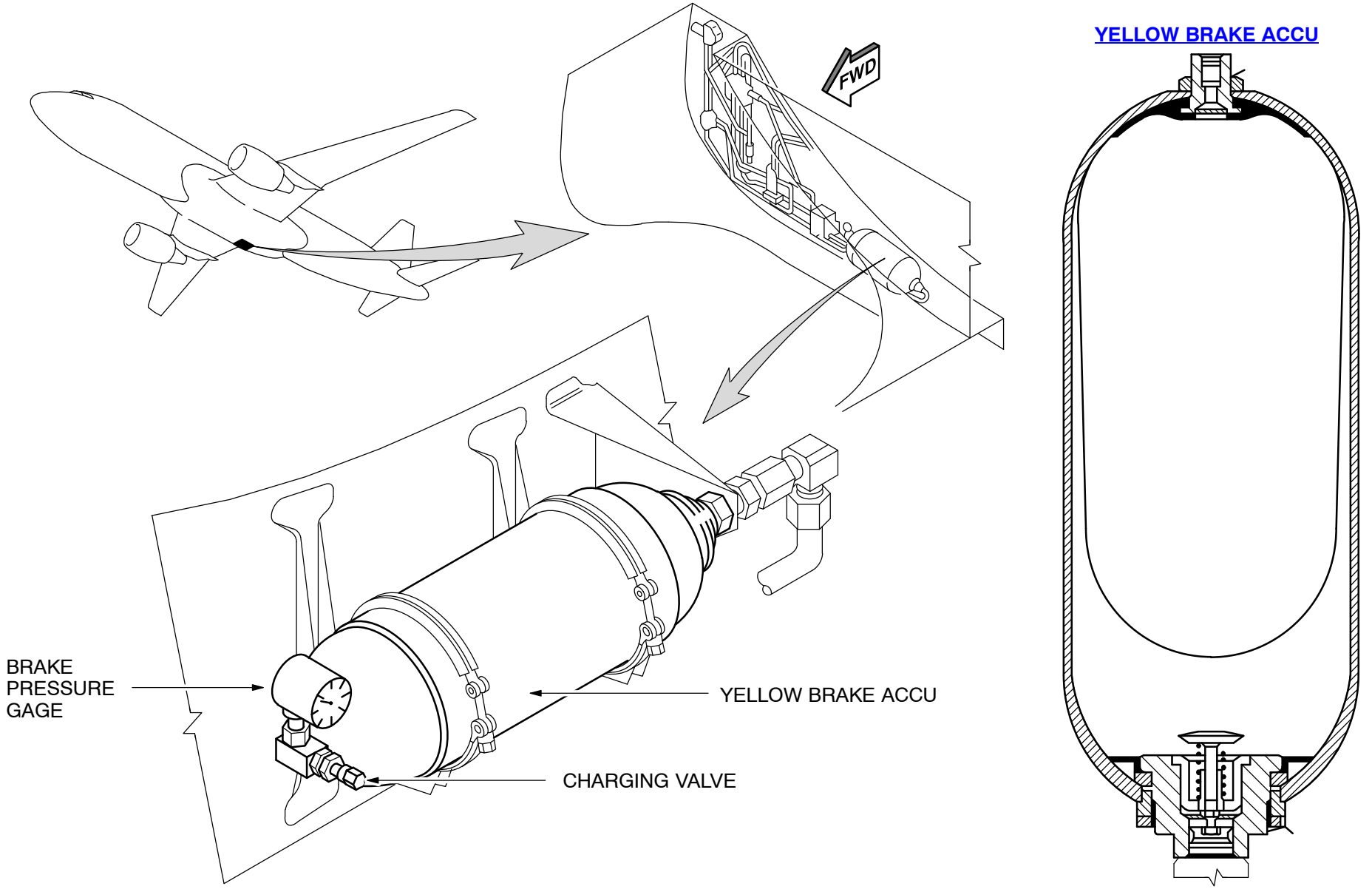


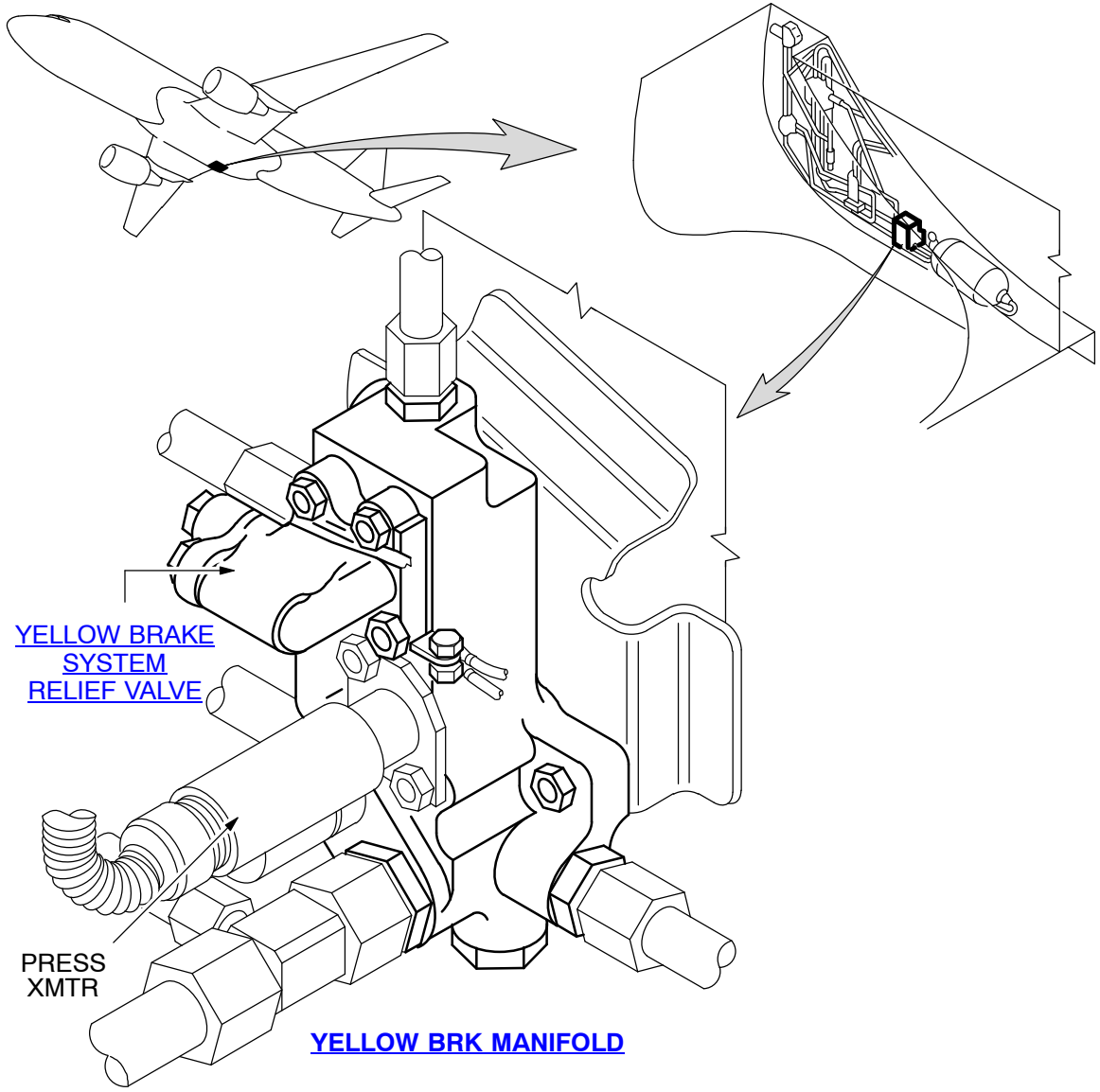
Figure 86 Brake Yellow Pressure Accumulator

BRAKE YELLOW PRESSURE TRANSMITTER

A pressure transmitter is installed in the common supply line. It transmits data on the hydraulic fluid pressure to the third input of the brake Yellow–pressure triple–indicator.

Brake Yellow Pressure Relief Valve

The brake Yellow–pressure accumulator supplies the system that a thermal pressure–relief valve protects. This pressure relief valve limits the pressure to 237 bars (3436 psi) if a thermal expansion occurs, and is also used for manual pressure release.



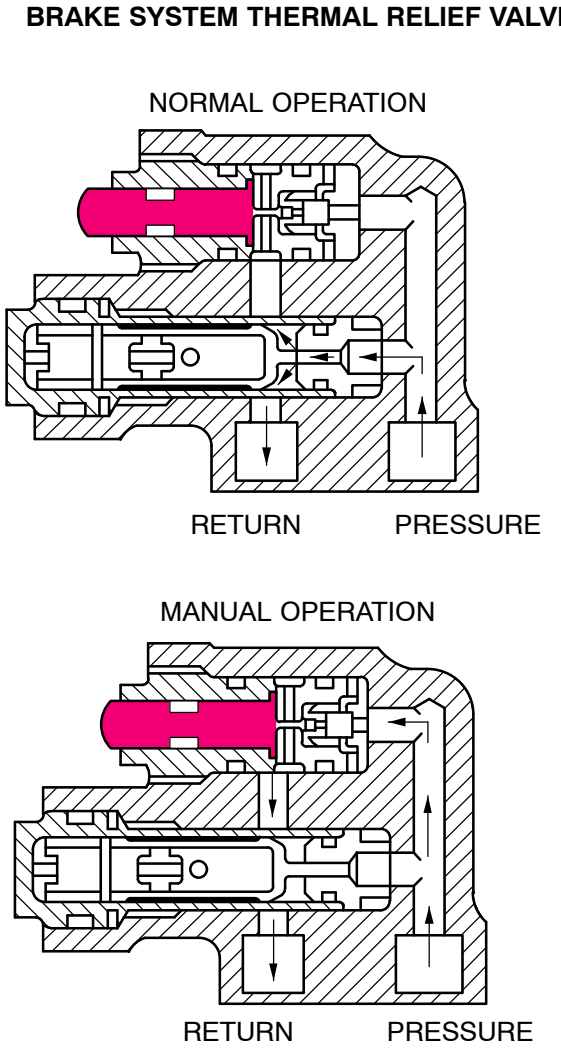


Figure 87 Yellow Brake Manifold

32–45 PARKING/ULTIMATE EMERGENCY BRAKING

DESCRIPTION

GENERAL

When you set the PARK BRK control switch to the ON position, this deactivates the other modes and supplies the brakes with Yellow high pressure. If Yellow high pressure is not available the brake Yellow pressure accumulator supplies power limited at 145 bar (2103.0466 psi) to the brakes.

The accumulator has sufficient capacity to hold the brakes on for a minimum time of twelve hours. The TO CONFIG warning light (on the ECAM control panel) reminds the crew to release the parking brake when the engine is at full throttle.

Park Brake Control

A two–position control switch identified PARK BRK installed on the center pedestal controls the parking/ultimate emergency braking system.

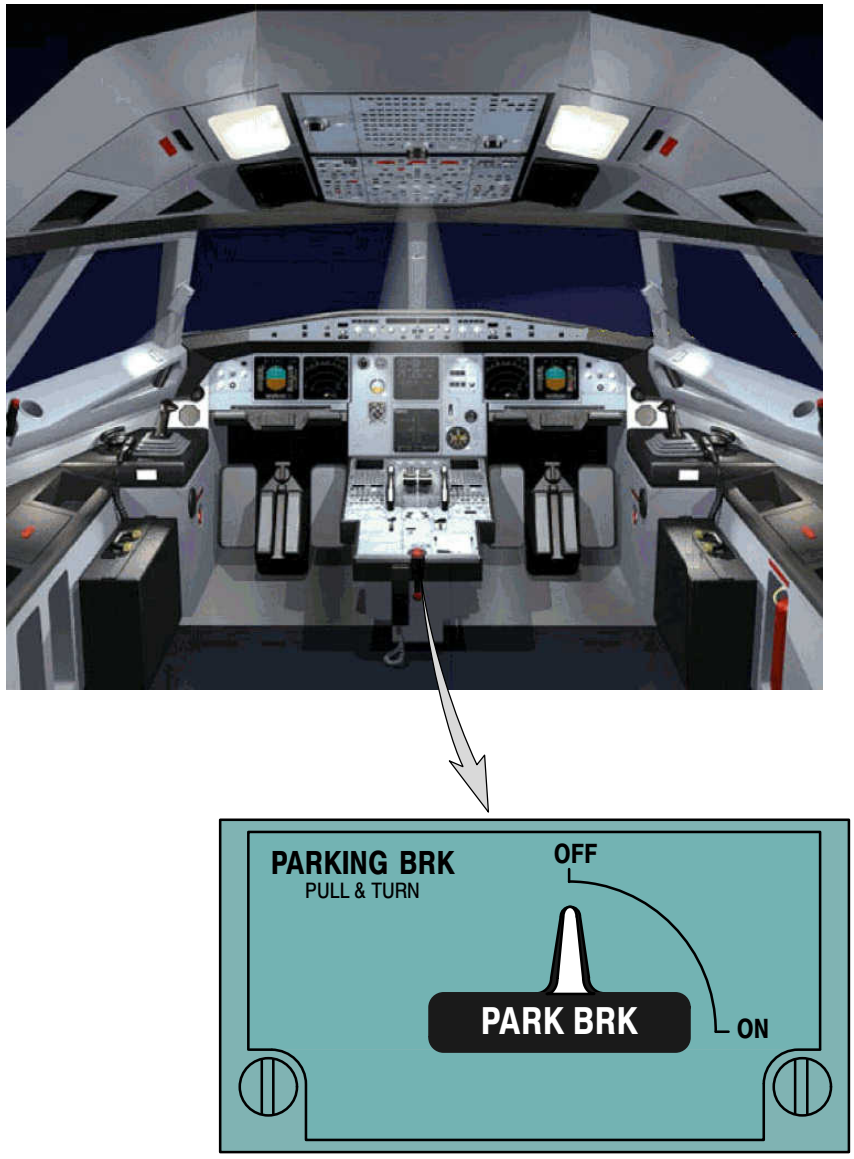


Figure 88 Park BRK CTL Switch

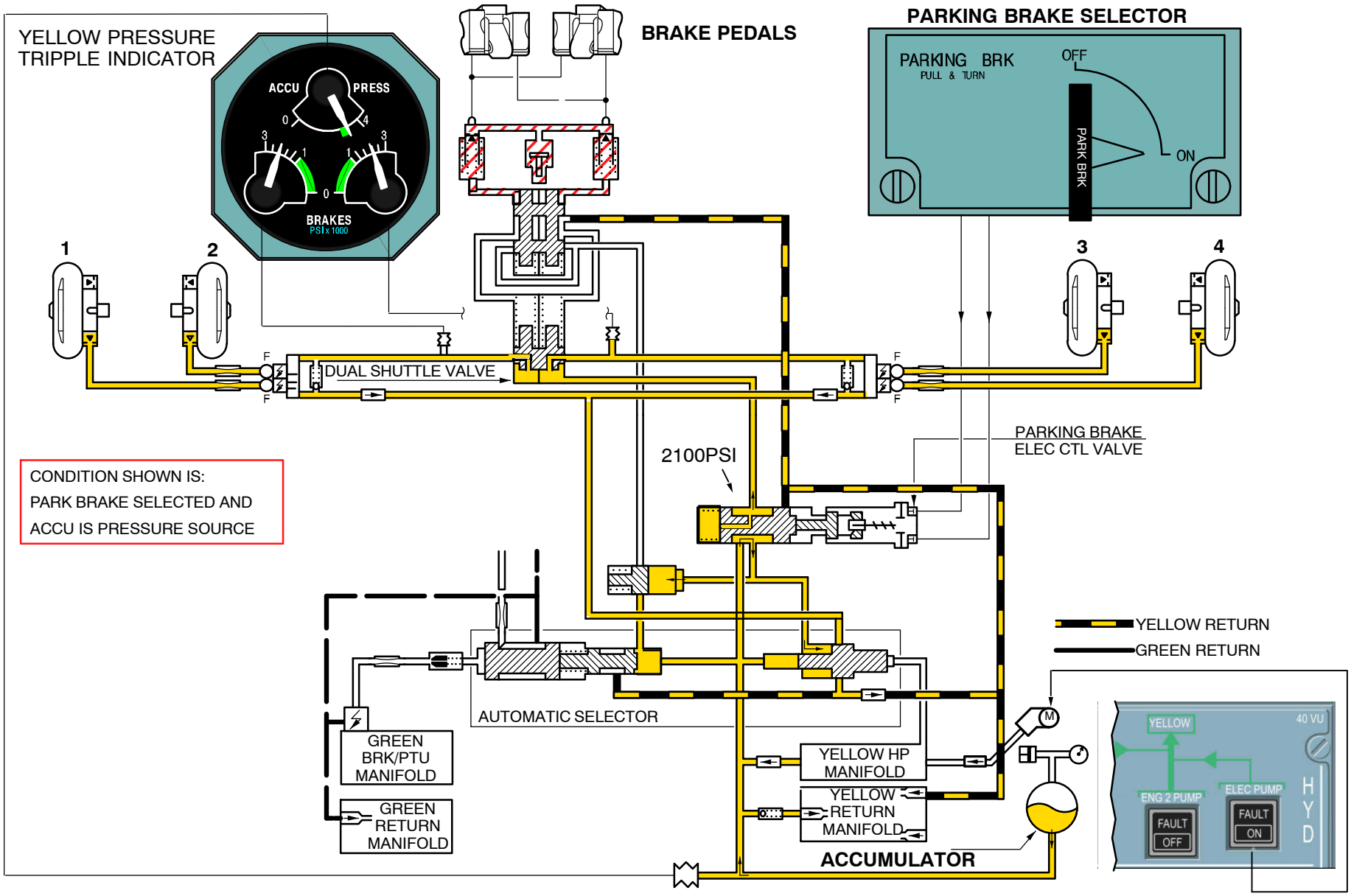


Figure 89 Park/Emergeny BRK Schematic

YELLOW BRAKE COMPONENT LOCATION

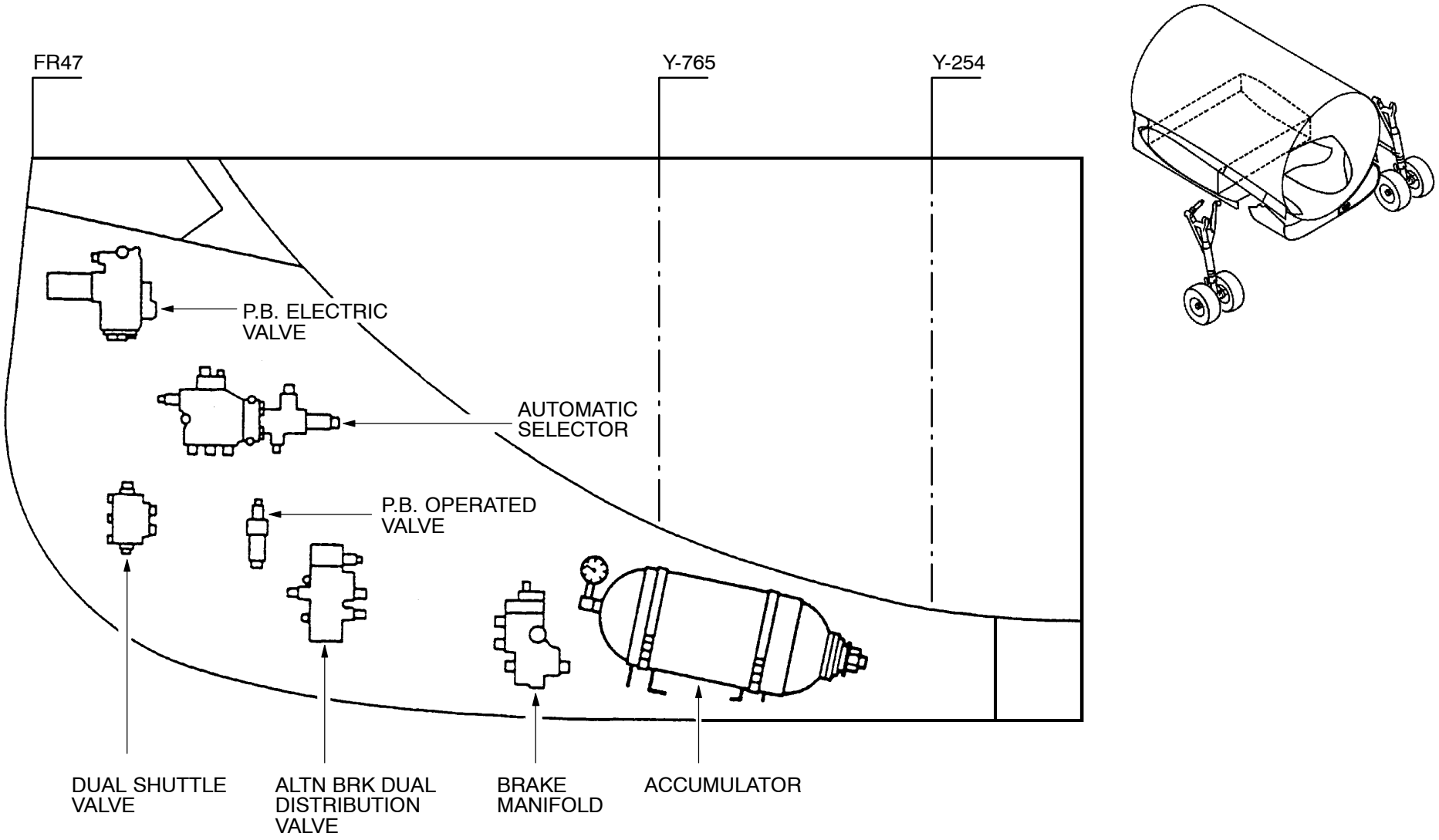


Figure 90 Brake Yellow Components

PARKING BRAKE COMPONENT DESCRIPTION

PARKING–BRAKE ELECTRICAL CONTROL–VALVE

The parking–brake electrical control–valve is located in the hydraulics compartment. It receives signals from the ON position of the PARK BRK control switch through an electrical linear transmitter.

The electrical control is duplicated (2 channels).

When you put the PARK BRK control switch in the ON (Park) position, this energizes the linear transmitter coil. The transmitter then reaches the stop in almost 2 seconds. The limit switch de–energizes the coil.

The limit position is indicated in the cockpit through a switch connected in parallel.

When you set the PARK BRK control switch to the OFF (Normal) position, this energizes the opposite contact. The transmitter then reaches the opposite stop in almost 2 seconds. Then, another limit switch de–energizes the coil.

The linear transmitter operates a hydromechanical valve.

The valve limits the parking brake pressure up to 145 bar (2103.0466 psi).

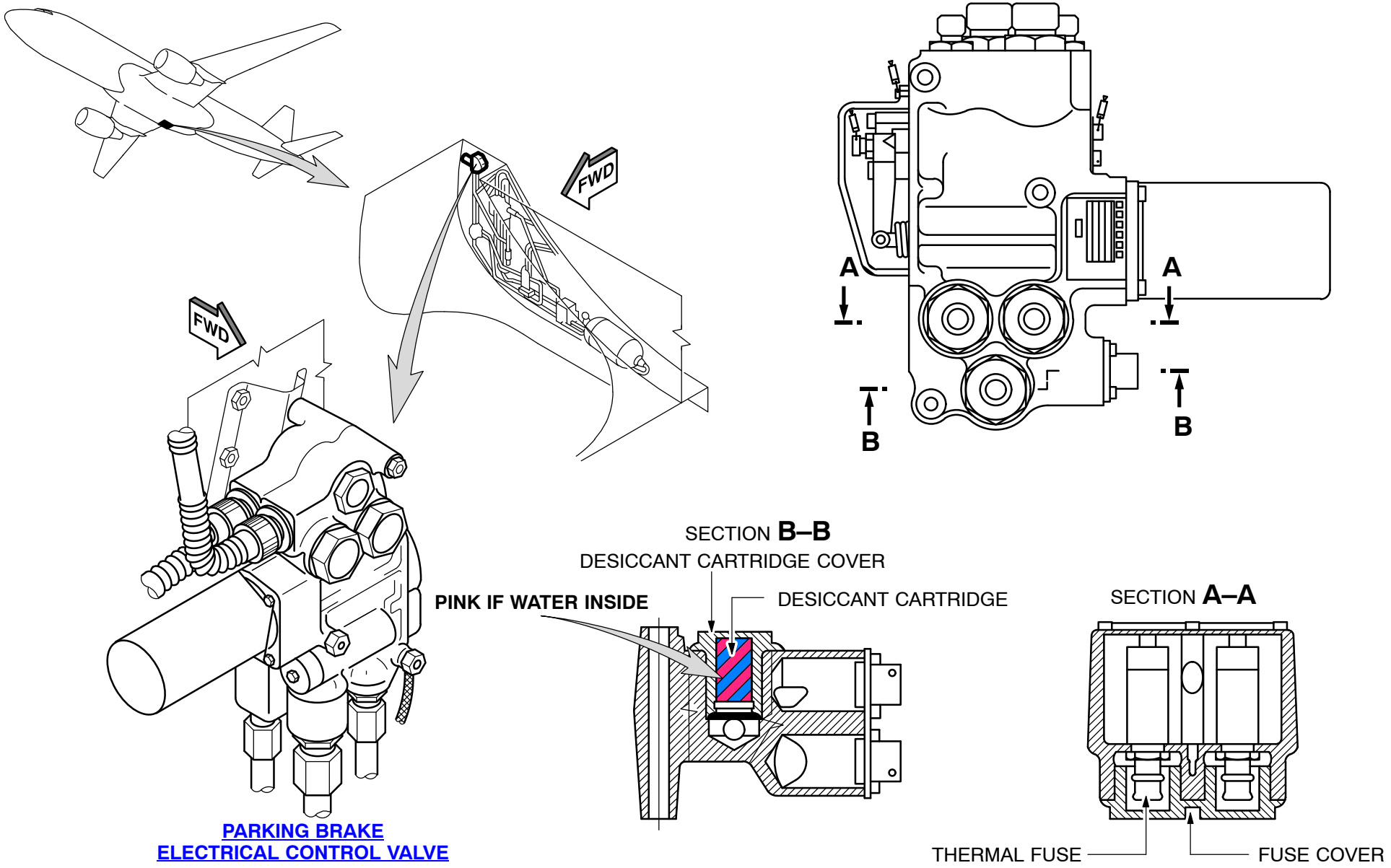
This pressure causes:

- – operation of the secondary slide valve of the brake automatic selector to isolate the return line of the alternate brake servo valve. This prevents leakage of fluid to the Yellow reservoir.
- – operation of the parking–brake operated valve.

The mechanism which includes electrical parts is installed in a sealed case.

It is possible to check the inside humidity through a transparent cover. A replaceable desiccant cartridge indicates the humidity conditions. The cartridge is blue and becomes pink when in contact with water.

A thermal fuse installed in the case prevents overheating of the linear transmitter coil. The fuse is visible through a transparent cover. This cover is attached by screws. It is possible to remove this cover to reset the fuse.



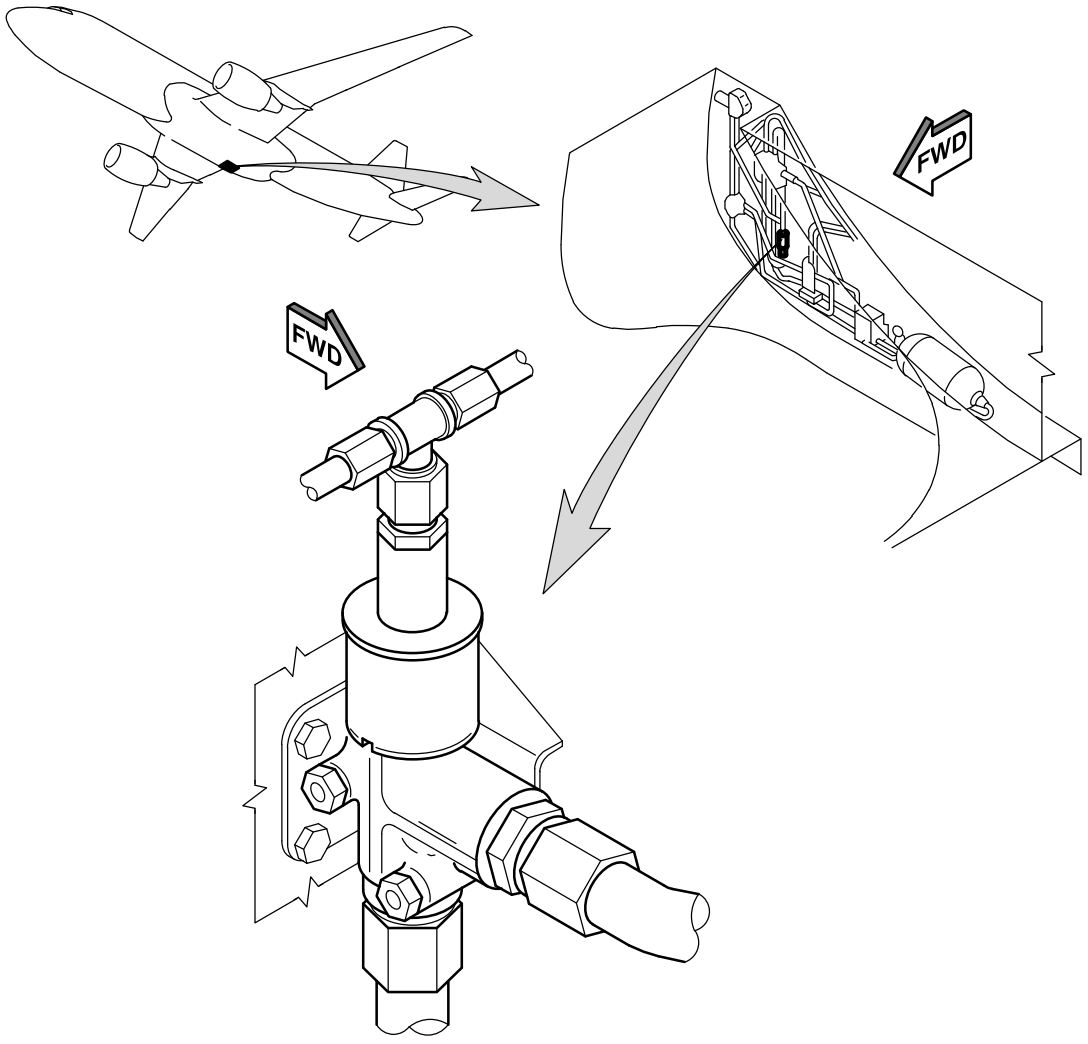
PARKING BRAKE
ELECTRICAL CONTROL VALVE

Figure 91 PRK BRK Electrical Control-Valve

PARKING–BRAKE OPERATED VALVE

The parking–brake operated valve is installed between the brake automatic selector and the dual valve of the Alternate brake distribution. It shuts off supply to the Alternate brake system to prevent leakage through the distribution dual valve.

Parking brake pressure is delivered through port C.



PARK BRAKE OPERATED VALVE

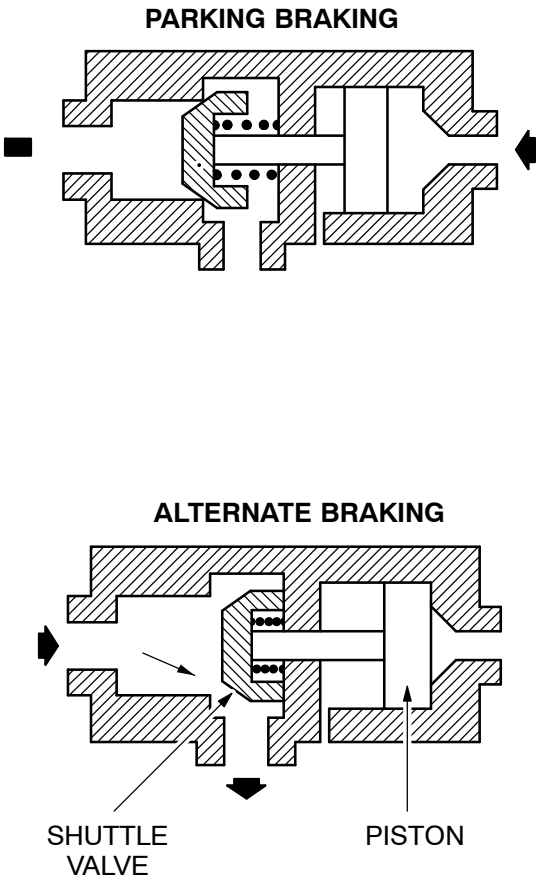


Figure 92 Parking Brake Operated Valve

32–46 BRAKES AND STEERING-BITE

BITE DESCRIPTION

BITE and Maintenance Test

Depending on the different phases of flight, the BSCU automatically triggers the tests below:

- Power–Up Test
- Auto Test:
  in flight with the landing gear retracted during the power supply rise
- Functional Test:
  in flight with the landing gear extended until touchdown of the main gear
- Tachometer Test:
  rolling without brake application
- Permanent Monitoring:
  during operation of the braking or steering system.

Dialogue with the Centralized Fault Display System (CFDS)

At a line stop, the Centralized Fault Display System permits to check most of the aircraft systems from the cockpit. The electronic functions of the BSCU are designed as BITE systems, i.e. they are capable of a certain self–diagnosis.

The CFDS includes:

- a Centralized Fault Display and Interface Unit (CFDIU) which ensures the junction with the BITE of each system and manages the display of messages
- a Multifunctional Control and Display Unit (MCDU)

The BSCU is connected to the CFDS by a bi–directional ARINC 429 link (type 1 system). The type 1 system comprises one ARINC 429 bus input and output which enables bi–directional dialogue. The system has the capability to memorize data which concern the faults detected over a maximum of 64 flights.

The system BITE comprises non volatile memory zones (EEPROM of BSCU). This link permits to transmit the failure messages in 2 operating modes:

- Operation in the Normal Mode
- Operation in the Menu Mode.

Operation in the Normal mode

During a flight, as soon as a failure is detected by the BITE of the BSCU, it is sent to the CFDIU.

These failures are sent in plain english in accordance with the ISO 5 encoding, through the ARINC 429 link, under the label 356.

Transmission in the Menu mode

The Menu mode corresponds to a phase of maintenance on the ground. In this mode, the computer displays a menu on the screen.

The selection of the menu items is made with keys placed at level of the lines displayed on the side of the screen.

The procedure is conversational. This means that the operator can call certain sub–functions of the menu (for example: auto test, reminder of the last failures) and receive in return this information in plain language.

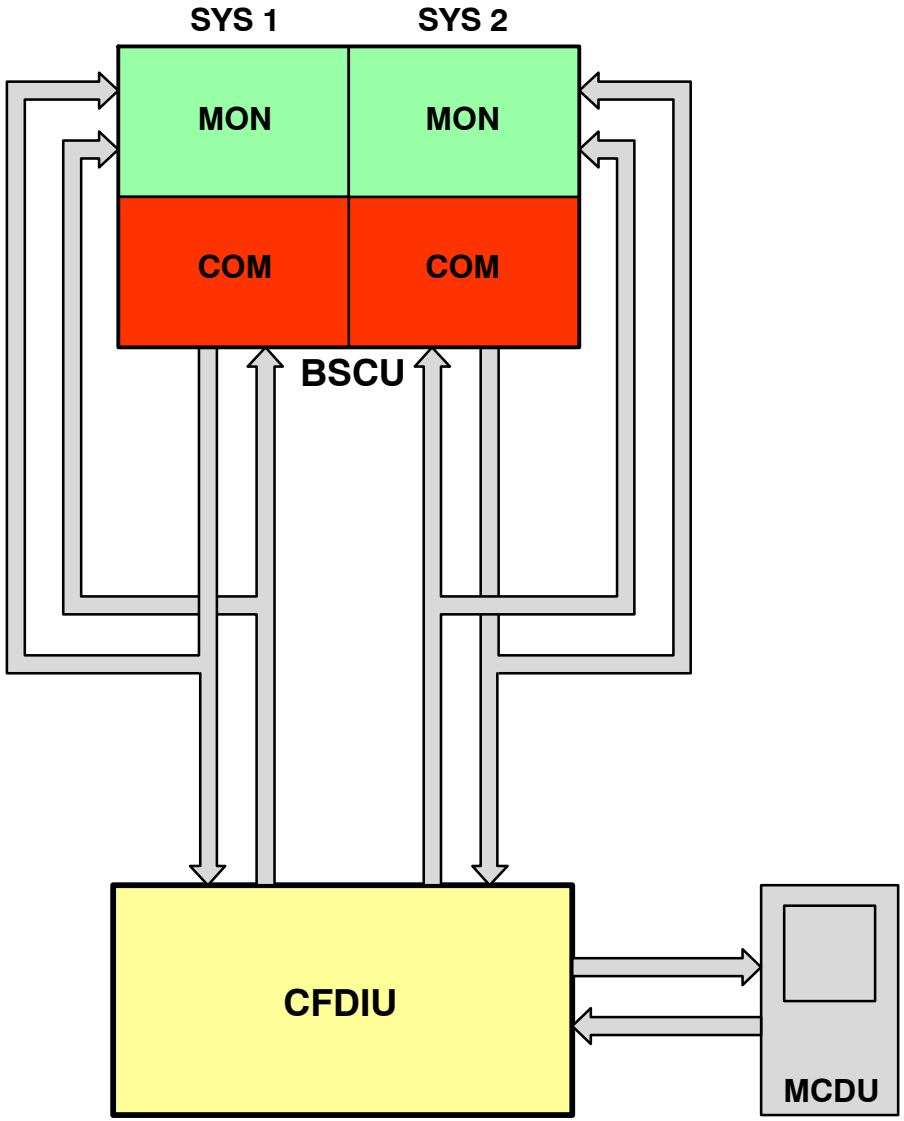


Figure 93 CFDIU/BSCU Interface

CFDS MENU MODE DESCRIPTION

The functions accessible in Menu mode are:

Last Leg Report

The purpose of this function is to present the internal and external failure messages detected by the braking system, that appeared during the last flight.

Recorded Class 1 and 2 failures:

Class 1: failures which have an operational consequence on the current flight. They are indicated to the crew in flight.

Class 2: failures which do not have operational consequence on the current flight but which may affect the aircraft availability. They are not indicated to the crew but are the subject of an ECAM report.

Previous Legs Report

The purpose of this function is to present the internal and external failure messages (Class 1 and 2) that appeared during the 64 previous flights (failure history).

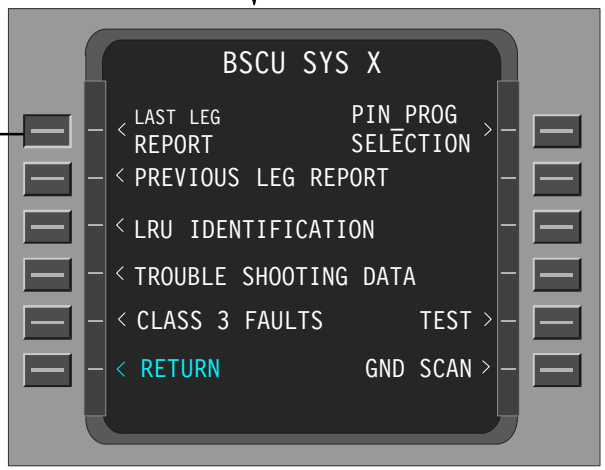
This is the ”sum” of the LAST LEG REPORT items over several flights.

LRU Identification

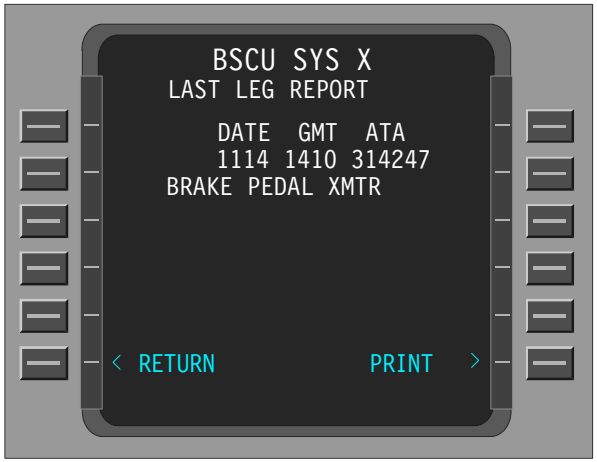
The purpose of this item is to present the P/N of the BSCU hardware and software configuration (configuration of software of BSCU calculation, acquisition and monitoring board).

Figure 94 BSCU Menu

LBL227–CODE 06E-ENQ

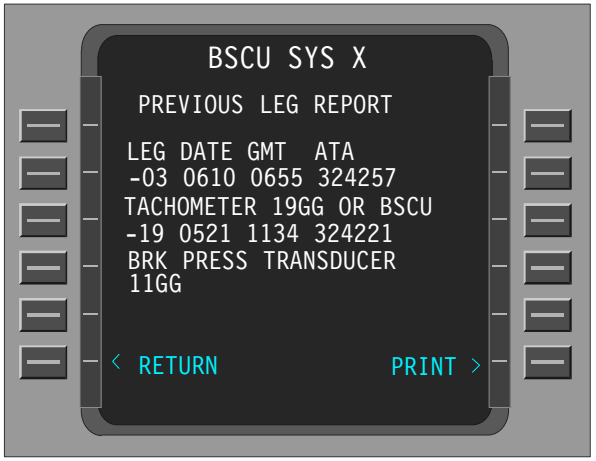


LBL227–CODE 06E-L1



(FAILURE MESSAGES STORED IN ZONE 1
DURING THE LAST FLIGHT)
FAILURES CLASSIFIED 1 AND 2 ONLY

LBL227–CODE 06E-L2



(FAILURE MESSAGES STORED IN ZONE 1
DURING THE LAST FLIGHT)
FAILURES CLASSIFIED 1 AND 2 ONLY

LBL227–CODE 06E-L3

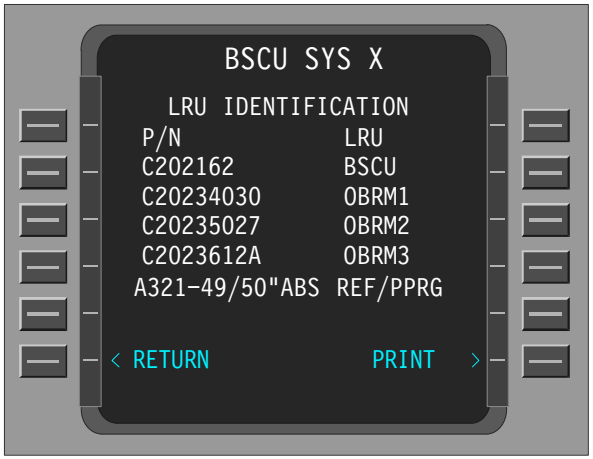


Figure 95 CFDIU Menu (Sheet 1)

TROUBLE SHOOTING DATA

This function presents the complementary information concerning the failures.
(”Snapshot” of the system environment at the moment of the failure).

CLASS 3 FAULTS

The purpose of this function is to present the Class 3 messages that appeared during the previous flights.

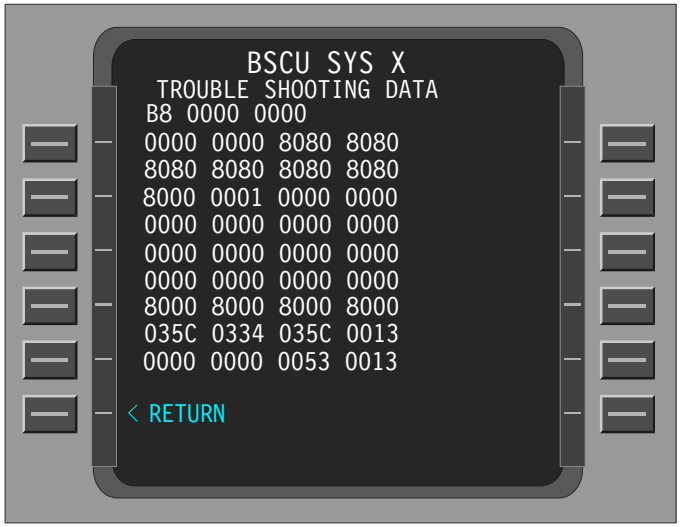
Class 3: failures having no consequence on the aircraft safety and availability. They are not indicated to the crew.

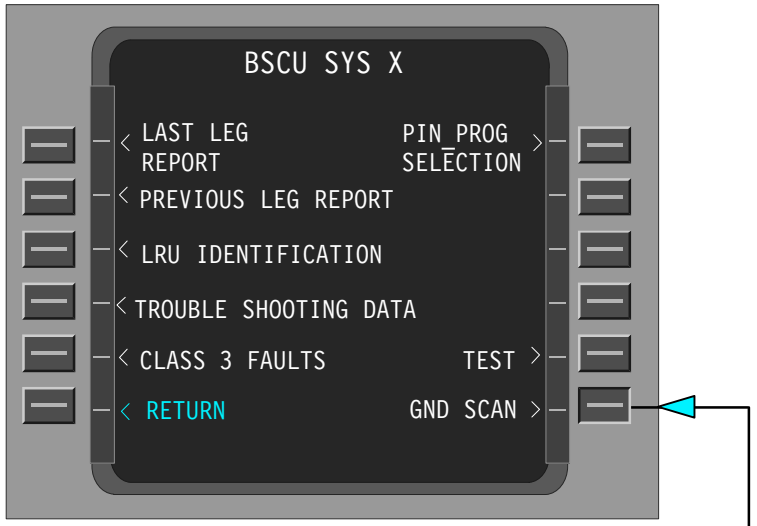
Ground Scanning

The purpose of this function is to present the internal and external failures. These will be detected as failures only in the ground stop configuration.

LBL227-CODE 08E-L4

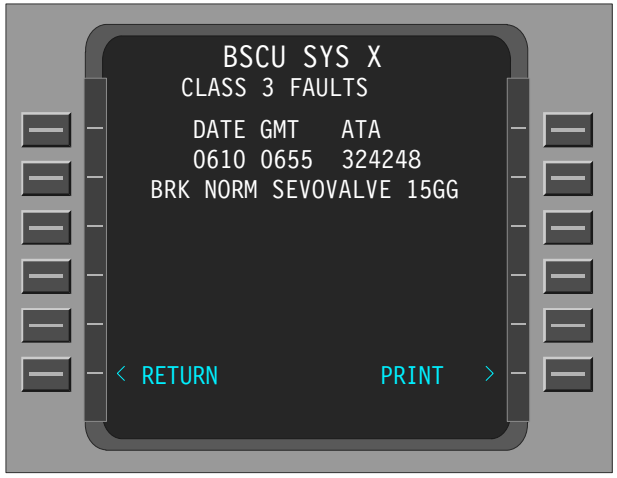
(CODED DATA STORED IN ZONE2 USED FOR TROUBLE SHOOTING IN WORKSHOP)





LBL227–CODE 06E-L5

(CLASS3 FAILURE MESSAGES STORED IN ZONE5)



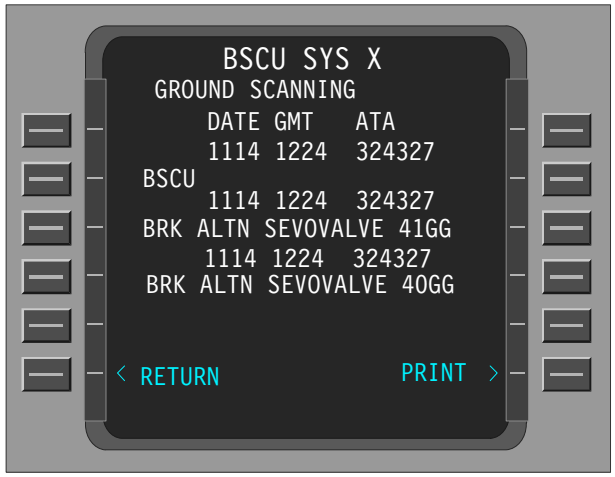


Figure 96 CFDIU Menu (Sheet 2)

BSCU BITE TEST

This function is to be activated after any maintenance action on the aircraft. Its purpose is to re–configure the BSCU (if necessary) and to check its correct operation and the continuity with the different peripherals.

Its system is separately actuated.

The test control must trigger:

- the power–up test of the system concerned
- the peripheral continuity test (permanent monitoring and specific test for the ALTERNATE and NWS servo valves, through transmission and check of calibrated currents).

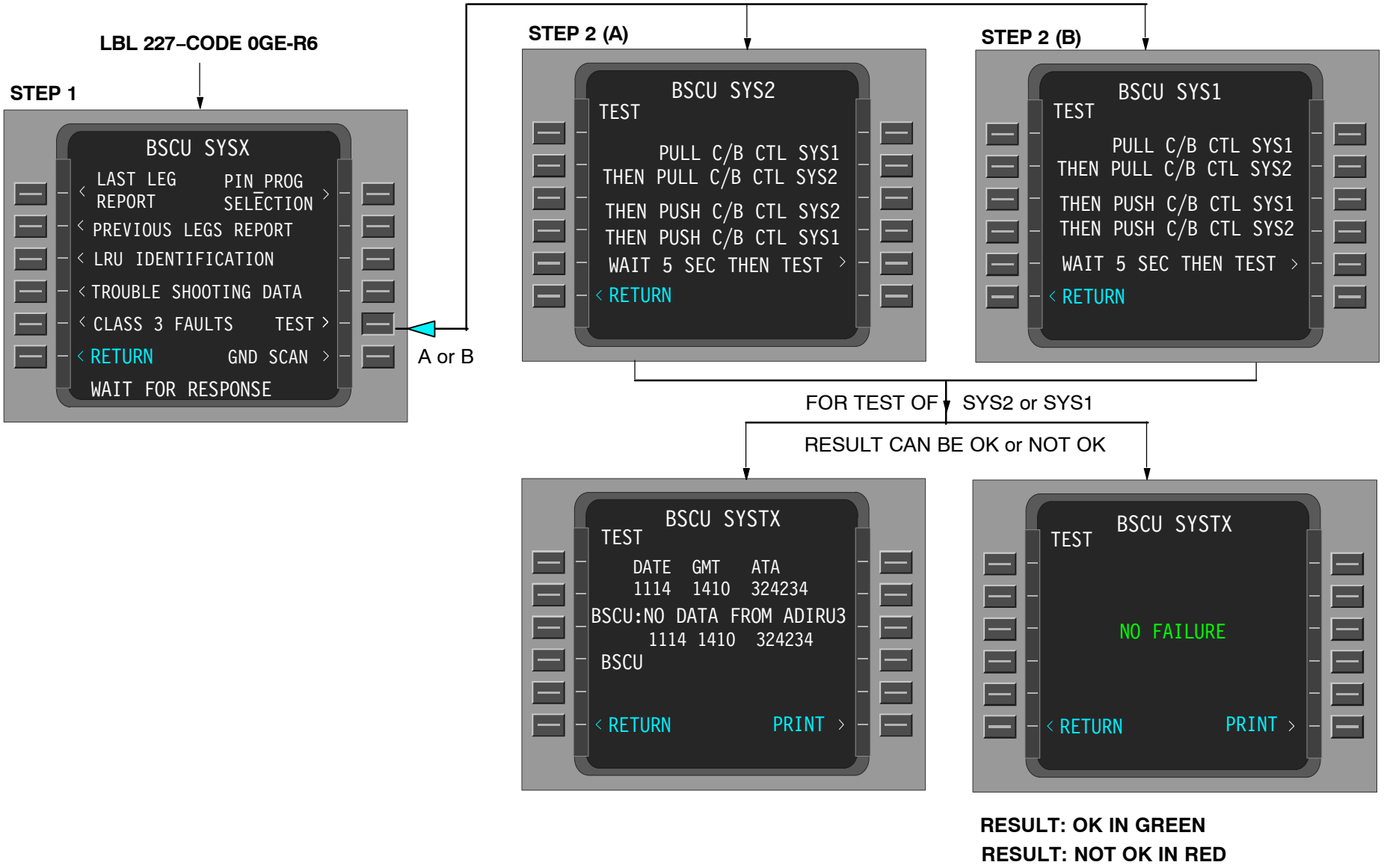


Figure 97 CFDIU Menu (Sheet 3)

PIN PROGRAMMING SELECTION

This function is to be performed **after removal/installation** of the BSCU.

Its purpose is to adapt the BSCU pin programming to the aircraft pin programming (strap connection).

At the end of the Menu mode, the system must be set to OFF then to ON to be correctly reset.

Moreover, the pin programming selection must also be performed on the second BSCU system.

The various configurations available depend on the parameters below:

- **Aircraft Type**
- **Brake Type**
- **Wheel Type (different diameters)**
- **Deceleration Rate in Special Automatic Braking Mode**

NOTE: DEPEND. ON SOFTWARE SELECTION IS DE_ACTIVATED, (ENH. ALWAYS).
CHECK DATA ACC. AMM AND HARDWARE STATUS!

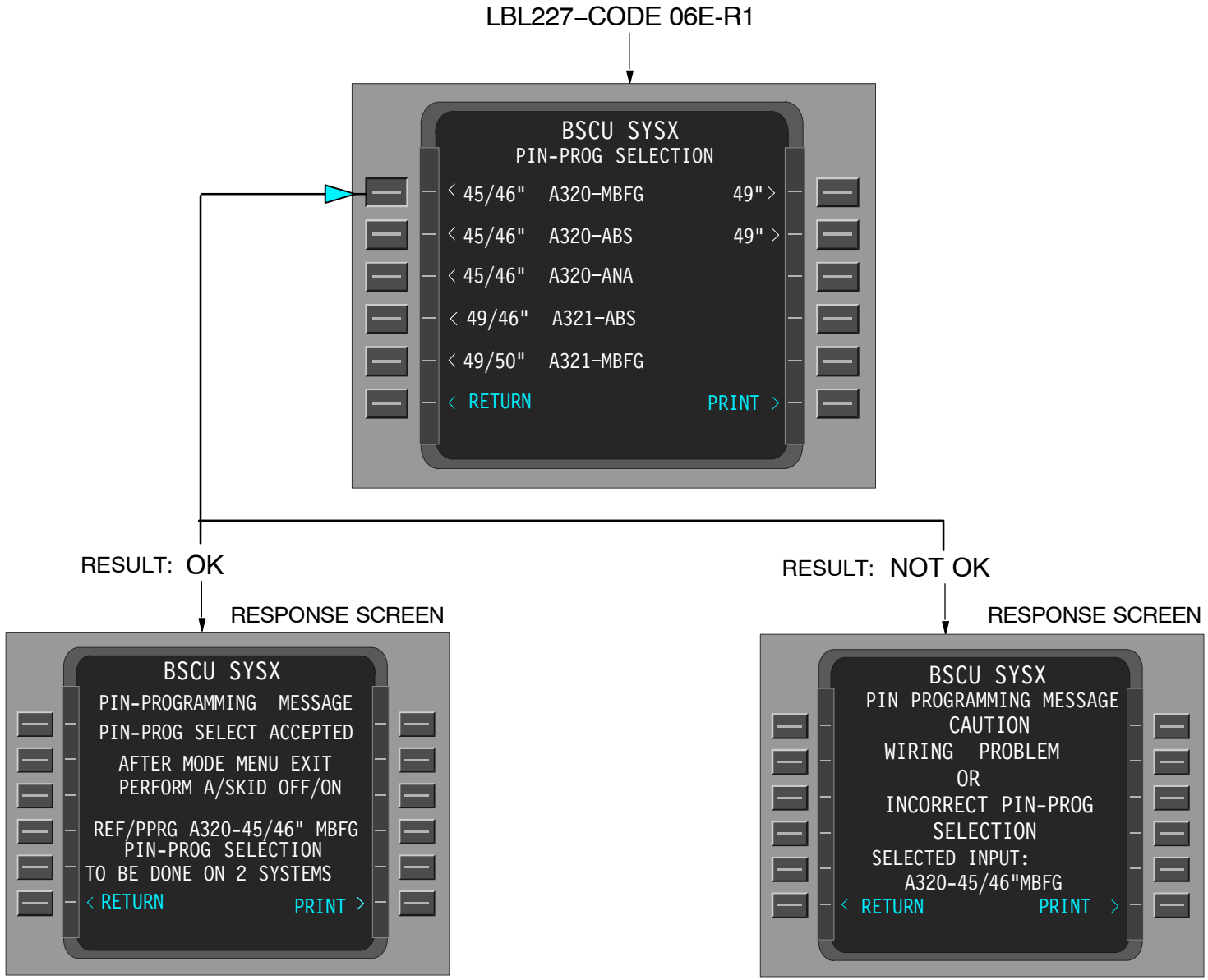


Figure 98 CFDIU Menu (Sheet 4)

32–47 BRAKE SYSTEM - TEMPERATURE

SYSTEM DESCRIPTION

GENERAL

The brake temperature system comprises:

- four temperature sensors (one chromel–alumel thermocouple per brake)
- two brake–temperature monitoring units (one per gear)
- one braking/steering control unit (BSCU).

A twisted pair cable connects each brake temperature sensor to a brake–temperature monitoring unit. The brake–temperature monitoring unit processes the signals and compensates the thermocouple cold junction. The BSCU provides the indicating systems with the temperature at each of the four brakes and the BRAKE HOT warning.

Principle of Operation

Each brake–temperature monitoring unit receives the voltages from the two temperature sensors.

After processing, the electronic circuits deliver a voltage proportional to the temperature of each brake heat–sink. This voltage varies between 1V and 9V, which corresponds to a temperature range of 0 to 999 °C.

In the BSCU, the four voltage values are compared to a voltage corresponding to an overheat threshold of 300 °C. If the temperature of a brake is **more than 300 °C a BRAKE HOT** warning message is shown on the upper ECAM DU.

If the brake fans are installed, the HOT legend on the BRK FAN pushbutton switch comes on (the BRK FAN pushbutton switch is installed on panel 402VU).

The four ARINC 429 values go to the lower ECAM DU.

When the brake temperature remains lower than the overheat detection threshold, the temperature values are shown green. The highest temperature has a green arc above it (if > 100 °C). When a temperature value exceeds the detection threshold it is shown amber.

A difference between the temperature of two brakes higher than 100 °C increases the brightness of the temperature indication of the hottest brake.

Temperature Sensor to Brake–Temperature Monitoring Unit Connections

The connections from the temperature sensor to the brake–temperature monitoring unit are in chromel–alumel.

In the event of rupture of at least one wire of the thermocouple, the brake–temperature monitoring unit sends a high signal > 9V to the BSCU (normal range : 1V = 0 °C, 9V = 1000 °C). The failure is detected and a flag comes into view on the ECAM DU.

In the event of a short circuit between the two thermocouple connecting wires, the temperature indicated is low.

In the event of a short circuit between the line and ground the temperature indicated is high.

90% of the electronic failures lead to an out–of–range signal < 1V or > 9V.

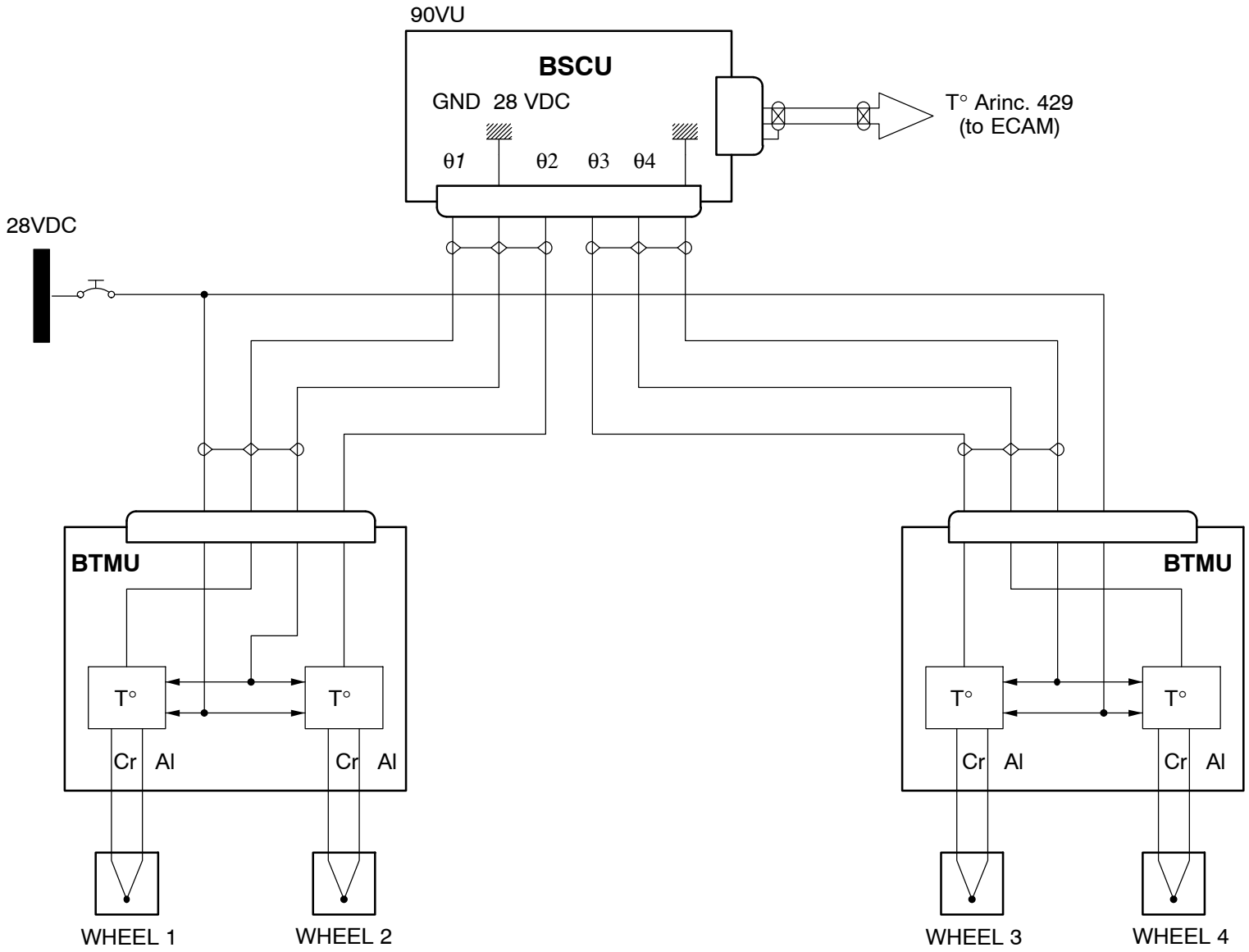


Figure 99 Brake System Temperature-Schematic

BRAKE TEMPERATURE SYSTEM DESCRIPTION - COMPONENTS

Temperature Sensor

The chromel–alumel temperature sensor delivers a voltage proportional to the temperature difference between the cold junction and the hot junction.

The temperature sensor located on each brake is housed in the torque tube.

Brake–Temperature Monitoring Unit

The brake–temperature monitoring unit is equipped with two printed circuits required to:

- process the data from the temperature sensor
- compensate the thermocouple cold junction
- send a voltage proportional to the temperature to the BSCU

The brake–temperature monitoring unit is installed on each main gear.

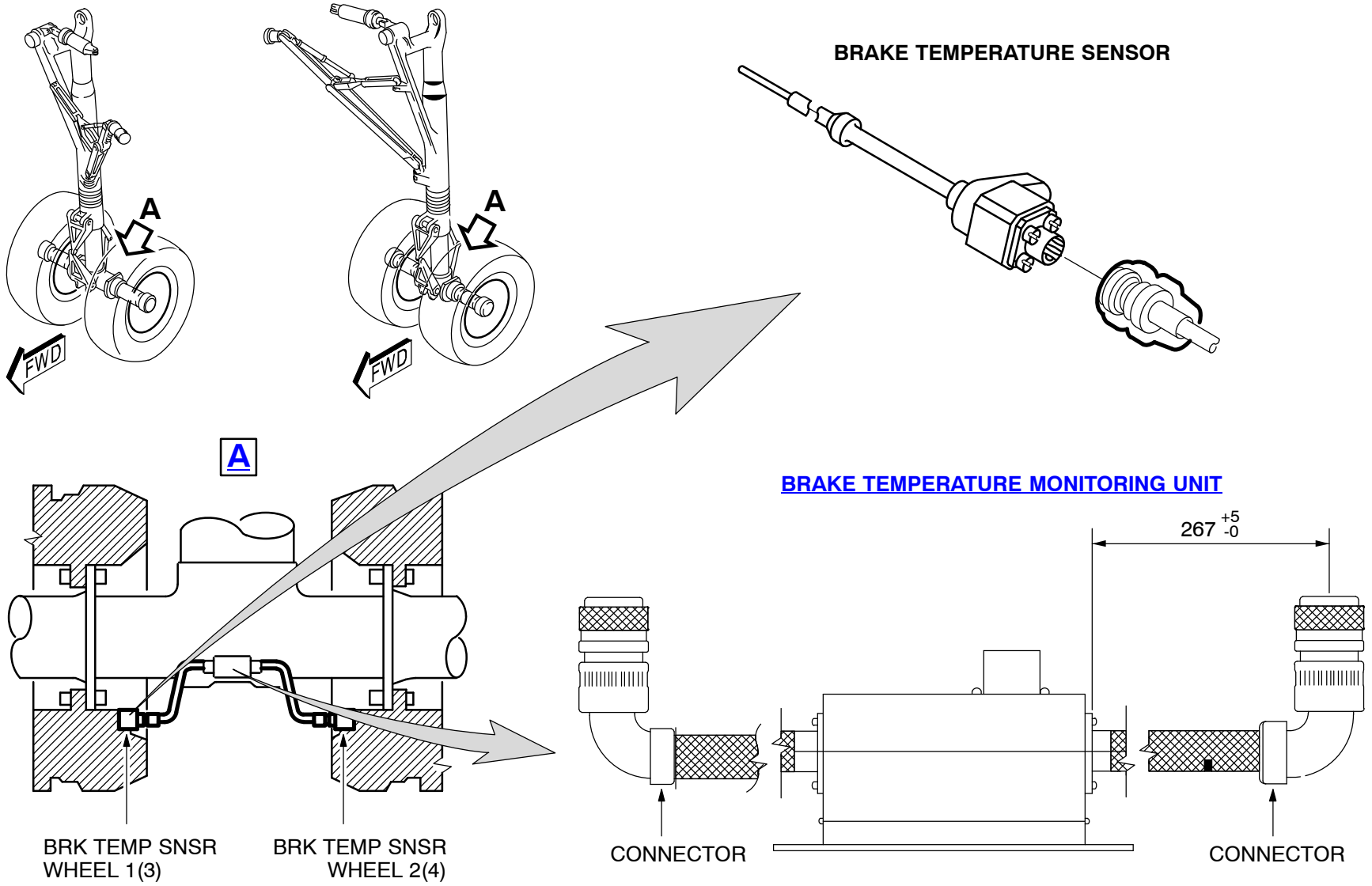


Figure 100 Brake Temperature Sensor and Monitoring Unit

32–48 BRAKE COOLING

DESCRIPTION

Brake Cooling Fan

The fans permit high speed cooling of the brakes. They thus decrease the turn around time of the aircraft if you make short flights with high energy braking.

One fan is installed on each wheel of the main gear.

Each fan includes:

- a Motor
- an Impeller
- a Shroud with a Debris Guard

The fan motor is installed in the wheel axle, where an adaptor ASSY holds it in position. The motor drives the impeller which makes a flow of air from the heat pack to the exterior through the debris guard. The tachometer drive shaft passes through the hollow shaft of the fan motor. The shroud drives the tachometer.

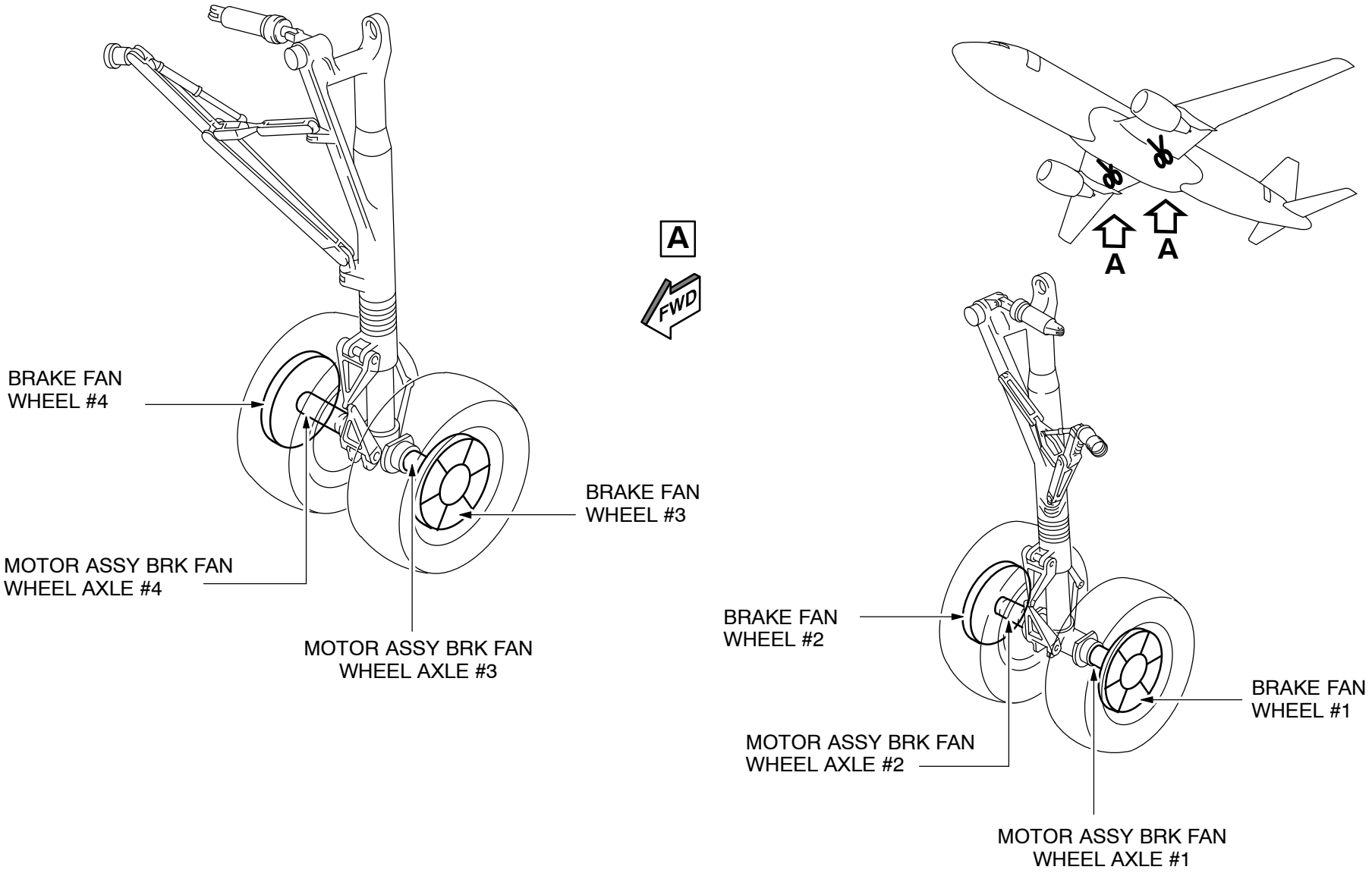


Figure 101 Brake Cooling System Components

BRAKE FAN SYSTEM OPERATION

Electrical Components

The fan motor is of the three–phase type. The two motors in each twin–wheel axle have a common supply. With the landing gear down and locked, pushing the illuminated pushbutton switch 4GS will start the fans.

CAUTION: THE FANS MUST BE STARTED AS SOON AS THE HOT LEGEND OF THE P/BSW ILLUMINATES.

Illumination of the HOT legend indicates that the temperature of one brake is above the brake overheat threshold.

The control relays are located in the relay box 103VU, the circuit breakers on the panel 121VU.

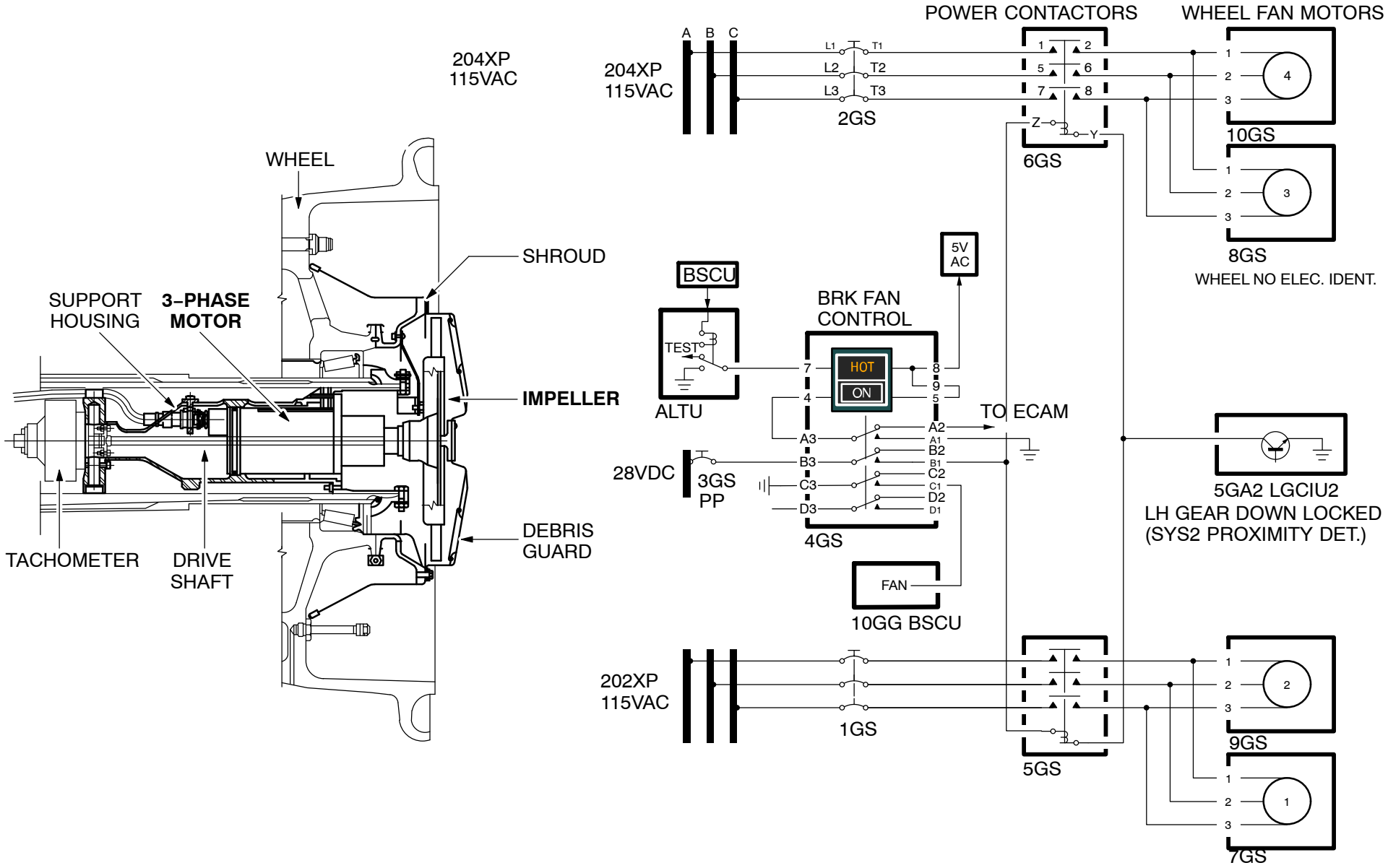


Figure 102 Brake Fan Installation

32–51 STEERING

NOSE WHEEL STEERING CONTROLS

Cockpit Location

- Captain Handwheel
- First Officer Handwheel
- Rudder Pedals

Nose Gear Location

- Electrical Box
- Swivel Fitting
- Steering Actuating Cylinder
- 2 feedback sensors
- Hydraulic Block (attached to the rear of the nose gear strut) including a:
  - Electrically–operated Selector Valve
  - Servo Valve
  - Anti–Shimmy Accumulator

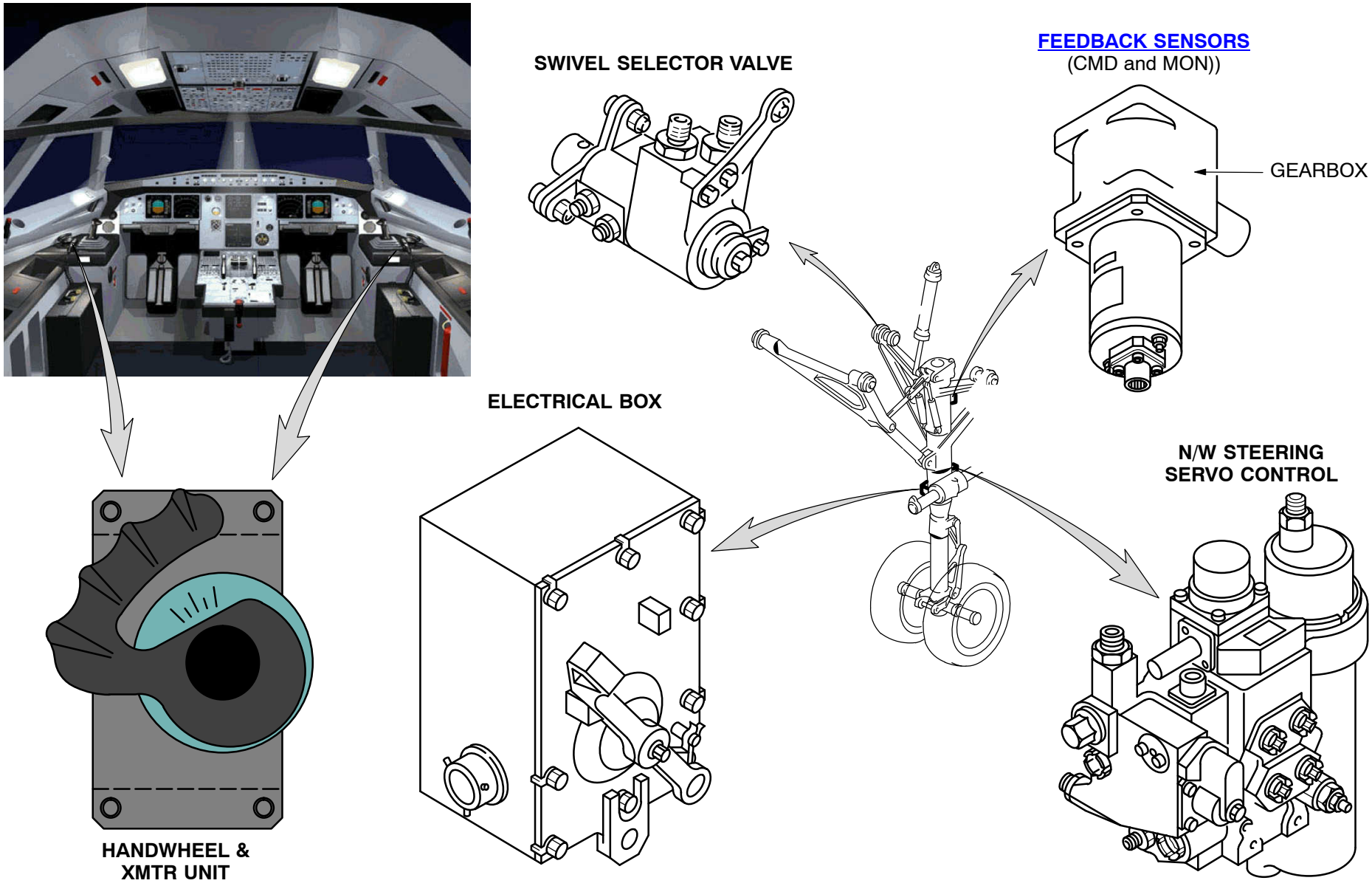


Figure 103 N/W Steering System Components

NOSE WHEEL STEERING DESCRIPTION

GENERAL

Nose wheel steering is possible from the cockpit as follows:

1. During taxiing, and more generally at low speed, through action on a handwheel.

   There are two identical handwheels, one for the Captain, and one for the First Officer. In the event of simultaneous operation, the orders that the handwheels give are algebraically added. The maximum travel of the wheels is plus or minus 74°. The maximum corresponding travel of the handwheel is plus or minus 75°. However, the law between these two travels is not linear. The servoing is active with the aircraft on ground upon impact of the main landing gear. The steering angle is limited as a function of the aircraft speed.

2. During takeoff or landing, and more generally at high speed either through action of the Captain (or First Officer) on the rudder pedals, or automatically through the autopilot (yaw control).

   In both cases, the steering angle is limited as a function of the aircraft speed and the origin of the orders. When the aircraft speed is above 130 knots, the steering is not available. The pilot can disconnect the control through the pedals from the steering control. To obtain this, the pilot presses and holds a pushbutton switch located on each handwheel.

3. After takeoff, the nose wheels are automatically centered under the action of cams in the shock absorber.

4. Before the aircraft is towed, the hydraulic system must be de–pressurized through action on a lever which can be locked in its two positions.

   This lever is located on an electrical box easily accessible from the ground. The maximum towing angle is plus or minus 95°. The control is electro-hydraulic with position feedback of the nose wheel assembly. The Brake and Steering Control Unit (BSCU) controls the nose wheel steering system.

Control Components

- Captain handwheel which actuates a transmitter unit

In addition, it includes a pushbutton switch for the disconnection of the steering control through the rudder pedals.

- First Officer handwheel, designed in a similar way
- Rudder pedals Steering by pedals.

This is limited to 6°. depending on A/C speed. Steering orders from the pedals are sent to the BSCU via the ELAC.

NOSE WHEEL STEERING (PRINCIPLE)

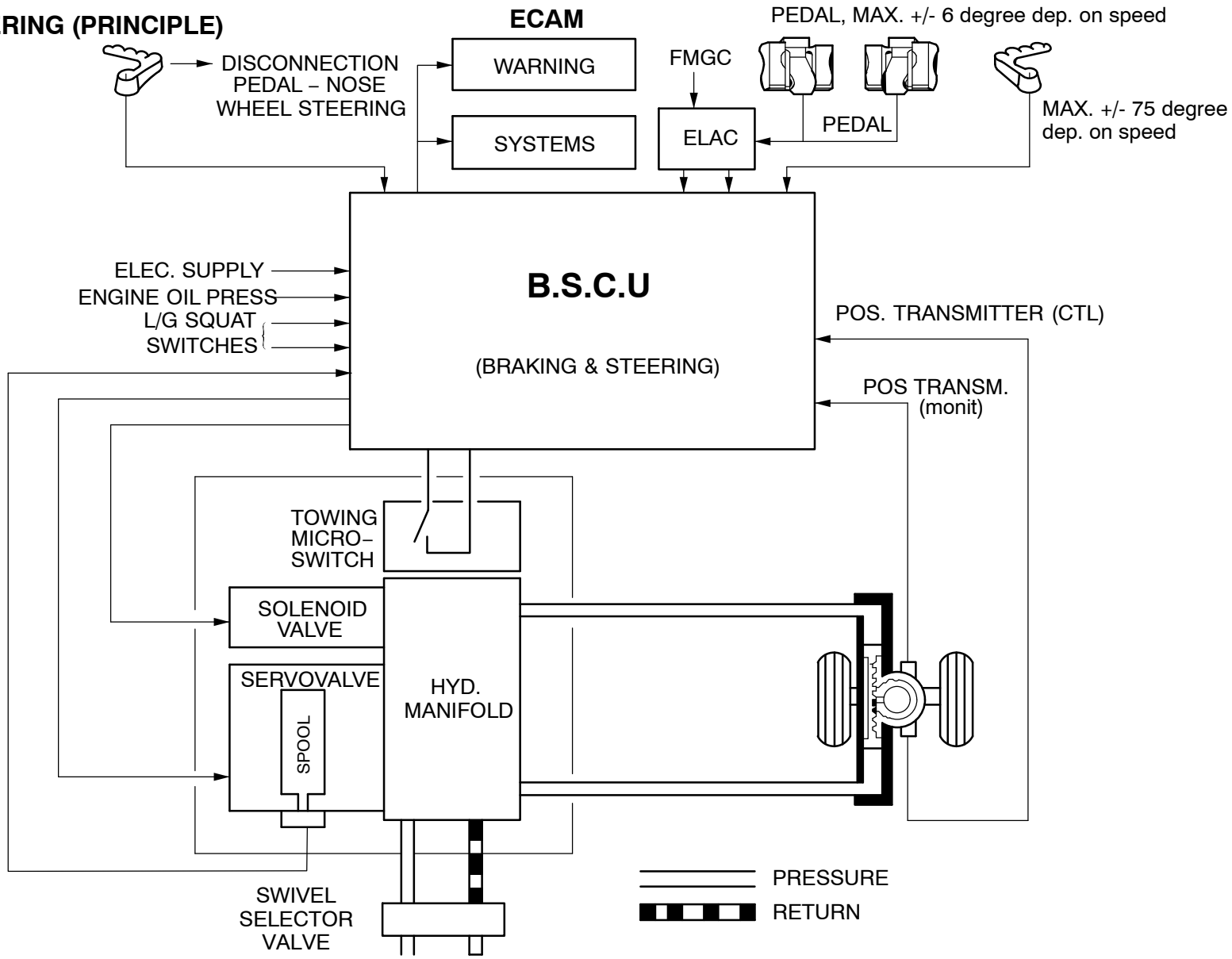


Figure 104 Nose Wheel Steering-Principle

NOSE WHEEL STEERING COMPONENT DESCRIPTION

Swivel Selector Valve

A Swivel Selector Valve is installed co–axially with respect to the landing gear retraction axis. It provides the hydraulic interface between the aircraft and the landing gear.

When the landing gear starts to retract, the rotating joint cuts the hydraulic power supply and connects the hydraulic block to the reservoir return line.

Steering Handwheel Transmitter Unit

The steering handwheel actuates a transmitter unit.

The transmitter unit includes two control potentiometers and two monitoring potentiometers driven by different gears to permit the detection of any rupture of the control.

The travel of each potentiometer is plus or minus 150°.

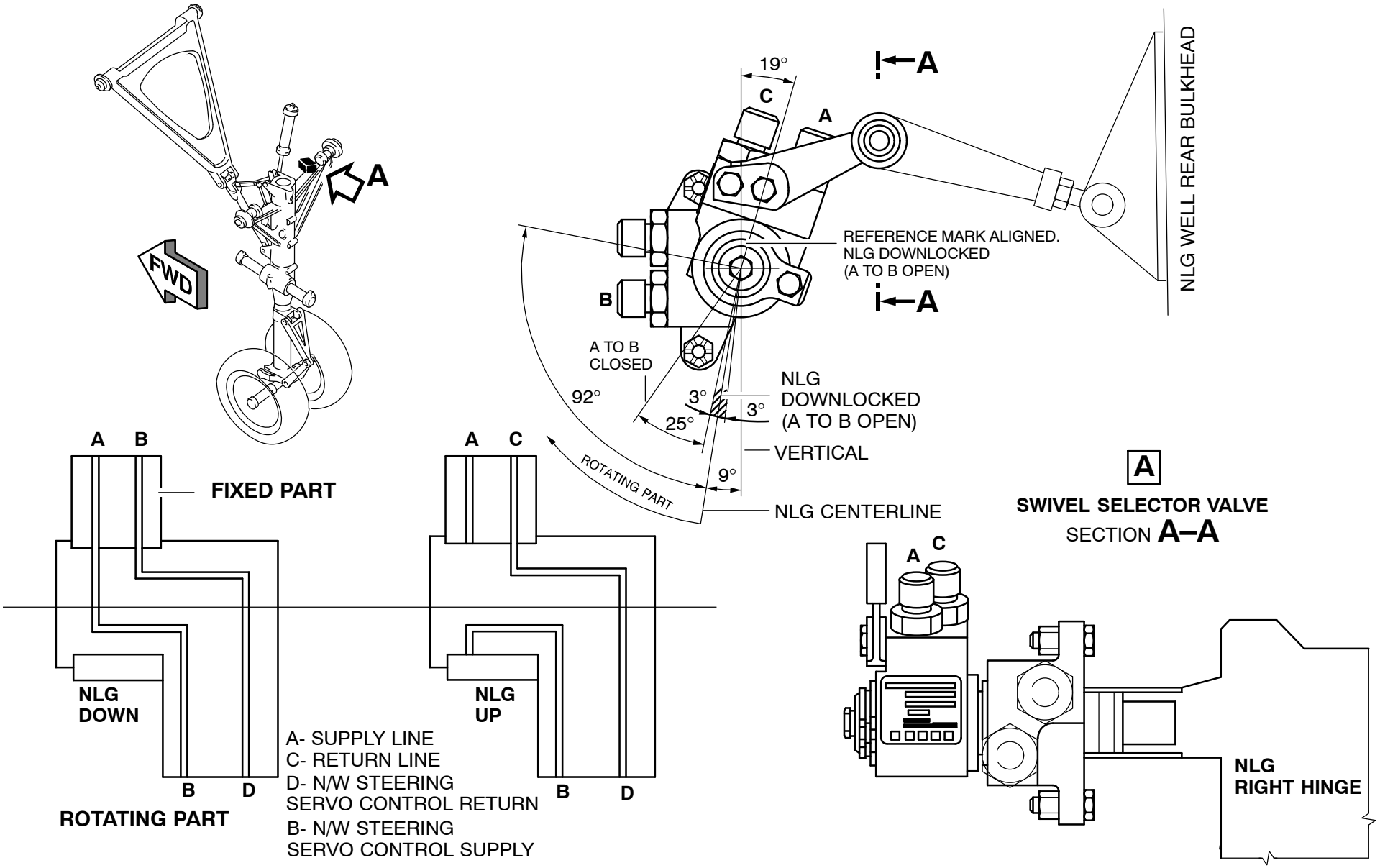


Figure 105 Nose Wheel Steering System - Swivel Selector Valve

ELECTRICAL BOX COMPONENT DESCRIPTION

An electrical box with a towing control lever is installed on the nose gear.

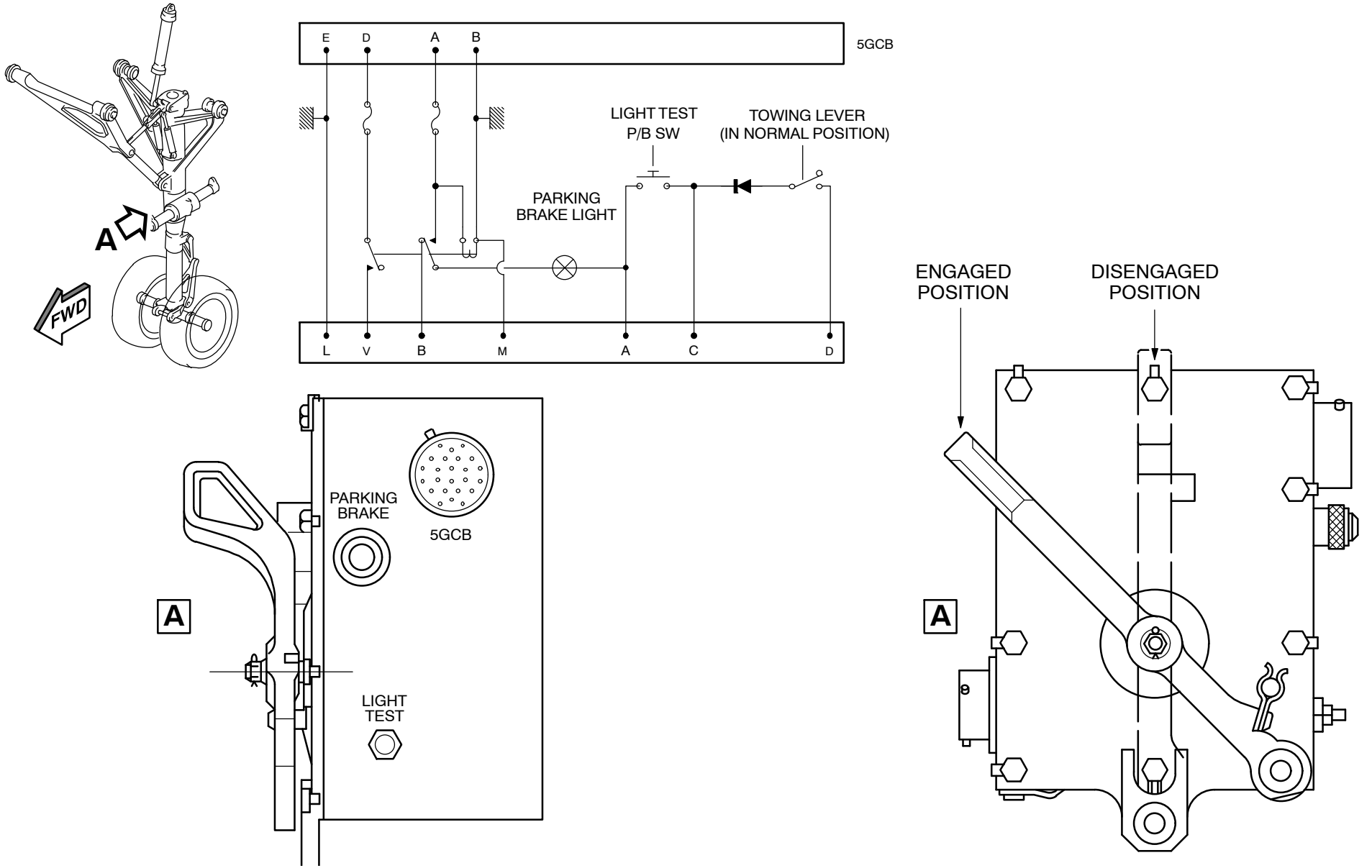


Figure 106 Nose Gear Electrical Box

STEERING HYDRAULIC BLOCK DESCRIPTION

The hydraulic block is attached to the rear of the nose gear strut and includes:

- a check valve which keeps the anti–shimmy accumulator pressurized
- a 40 micron filter
- an electrically–operated selector valve and its slaved valve.

  When the selector valve is energized, the pressure is applied to the servo valve.
- a servo valve of the deflection–jet type, equipped with a LVDT sensor which detects the position of the slide valve
- an adjustable diaphragm located on each output line of the servo valve, this diaphragm is used to adjust the flow to each actuating cylinder chamber and consequently the wheel steering speed
- a by–pass valve which interconnects the two chambers of the steering cylinder in the event of hydraulic system de–pressurization.
  When the hydraulic system is pressurized, the bypass valve can open for a pressure exceeding 273 bars. Any overpressure is then limited in the steering cylinder
- an anti–shimmy accumulator with a built–in pressure–relief valve
  It can supply fluid pressurized to 15 bars in case of cavitation in one chamber of the cylinder, initiated by the shimmy.
- two check valves which ensure the distribution of fluid from the accumulator to the chamber of the steering cylinder
- a screw for the bleeding and/or de–pressurization of the hydraulic block

Anti–Shimmy Accumulator

- Maximum capacity: 80 cubic centimeters
- Pressure at max. capacity: 15 bars
- Pressure at zero capacity: 7.5 bars

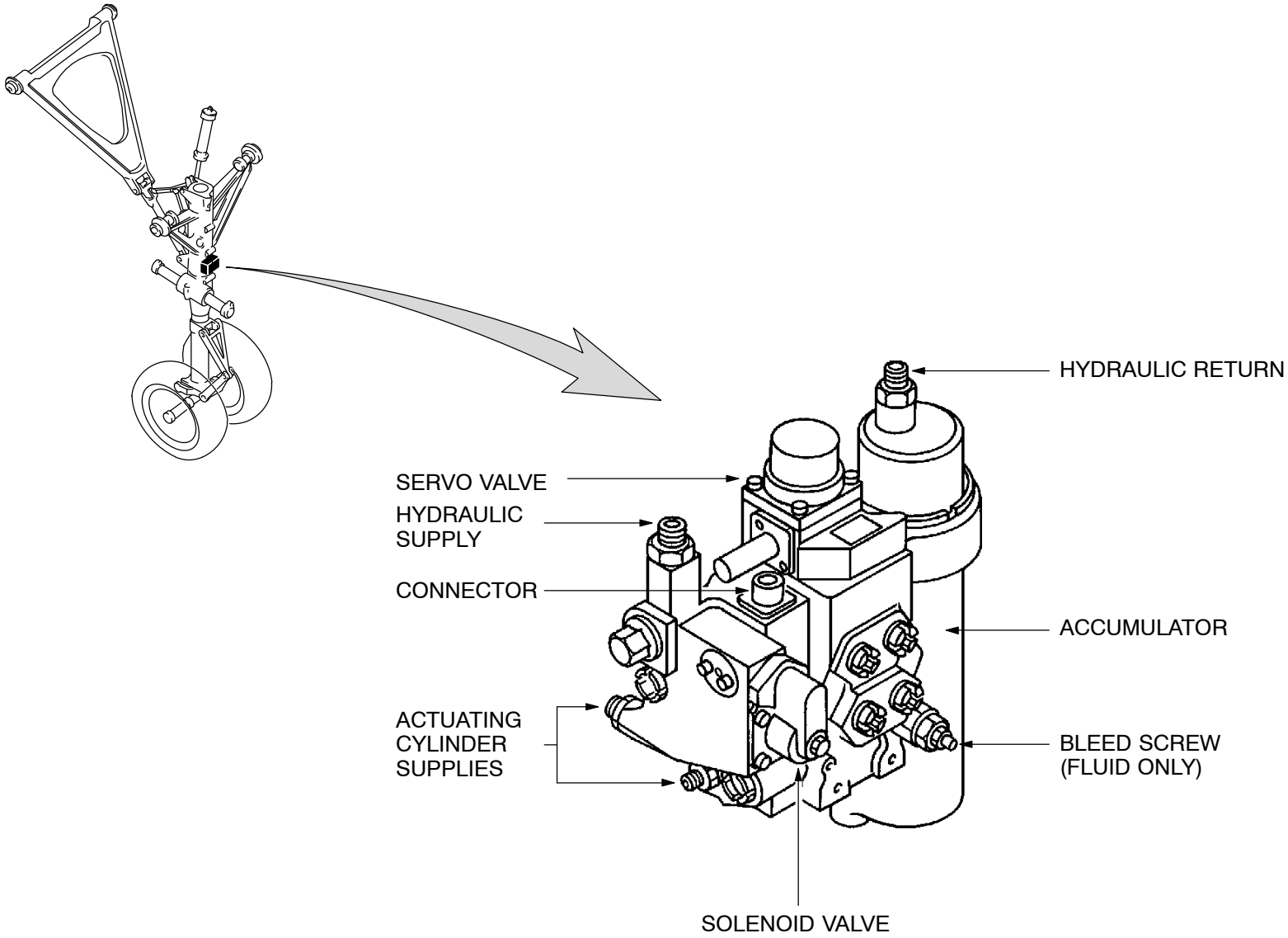


Figure 107 Nose Wheel Steering System - Hydraulic Block

NOSE WHEEL STEERING FEEDBACK SENSORS

There are two feedback sensors installed on the nose gear. Each sensor includes a reduction gearbox and a RVDT sensor.

The RVDT sensors give the position of the rotating tube. The sensor is driven by a reduction gearbox attached to the landing gear strut.

One sensor is part of the electrical channel of the steering control, the other sensor is part of the monitoring channel. These two sensors are supplied with 115 V from AC BUS 1 through the BSCU system 1.

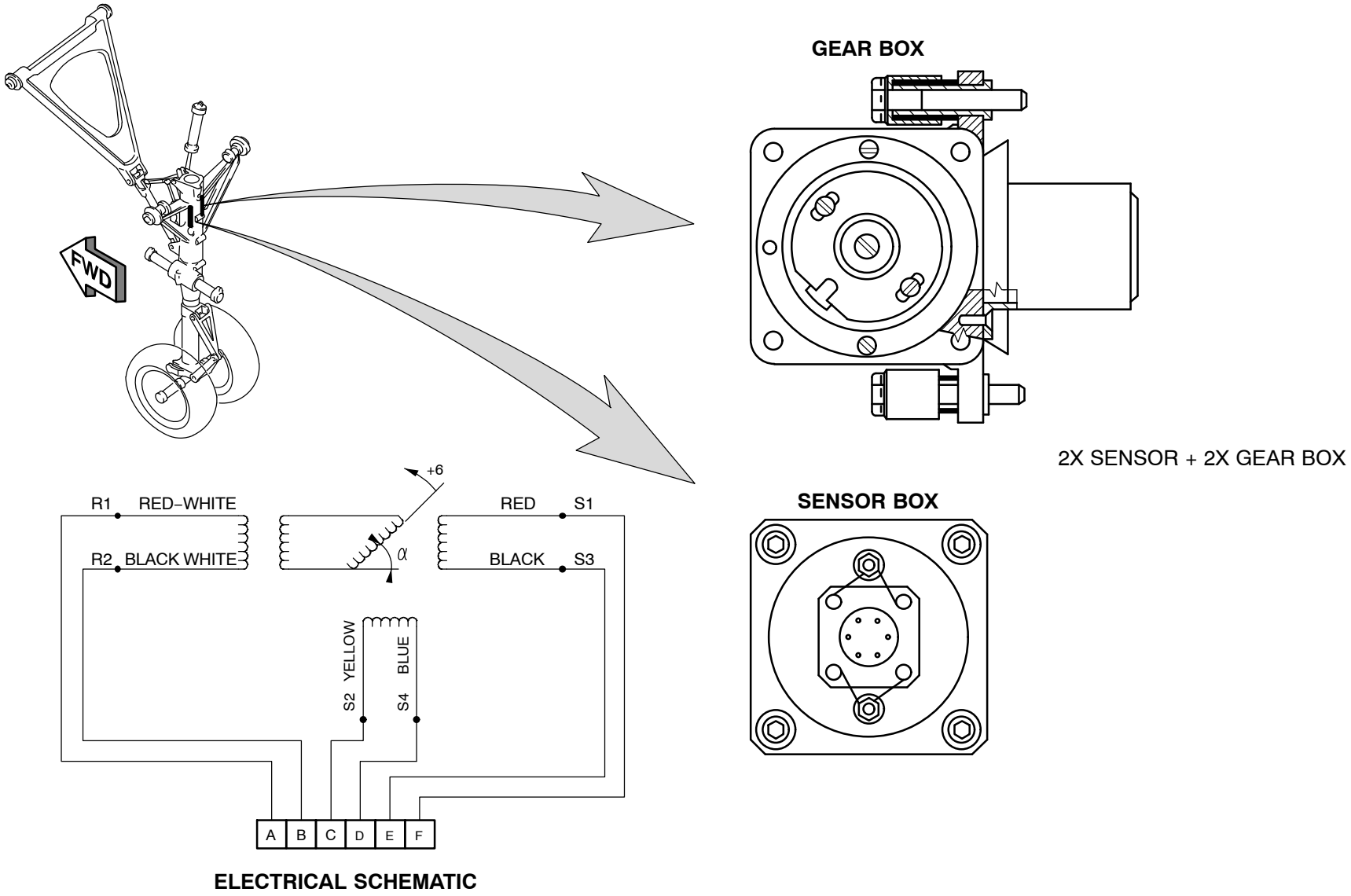


Figure 108 N/W-Steering System Sensors

NOSE WHEEL STEERING FUNCTIONAL OPERATION

OPERATION/CONTROL

Hydraulic pressure is sent to the hydraulic block when the nose gear is extended and when its doors are closed. I.e. after a free–fall extension of the gear, when the doors normally remain open, the steering control is lost.

On the ground, when you open the NLG doors with the Ground Door Opening Handle the steering is still operational.

On the ground the energization of the selector valve causes the pressurization of the hydraulic block. This is done under the following conditions:

- towing control lever in the normal position
- at least one engine in operation
- main gear shock absorber compressed
  - no steering > 130 knots

The BSCU controls the steering at 0°. until aircraft speed is lower than 130 kts. After that, the BSCU uses input signals from the handwheels,- rudder pedals or from the-auto flight system for steering control.

In flight, as soon as the gear is extended for landing, the test of the steering control is made by the BSCU. In this case the energization of the selector valve occurs under the following conditions:

- towing control lever in the normal position
- at least one engine in operation
- shock absorbers of the main landing gears extended

The test starts 10 seconds after the nose gear is down and locked and stops upon touchdown of the main gears. During this test, an electrical signal is temporarily sent to the servo valve, causing a slight motion of the nose wheel assembly (less than 2 degrees). AUTO TEST in air after L/G down.

The monitoring channel checks that the order has been correctly executed. The steering actuating cylinder which is part of the nose gear structure drives the rotating tube via a rack–and–pinion assembly. Two anti–shimmy valves (one per chamber) are installed on the steering cylinder.

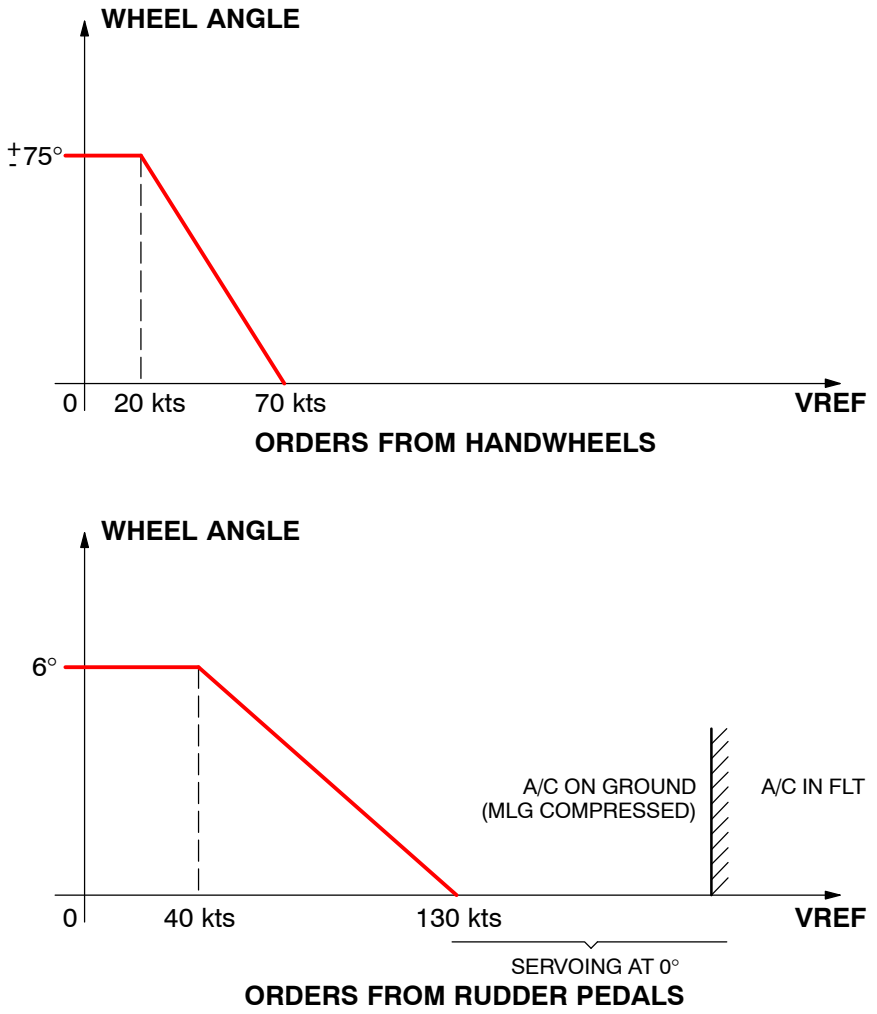


Figure 109 Steering Wheel CTL Takeoff/Landing

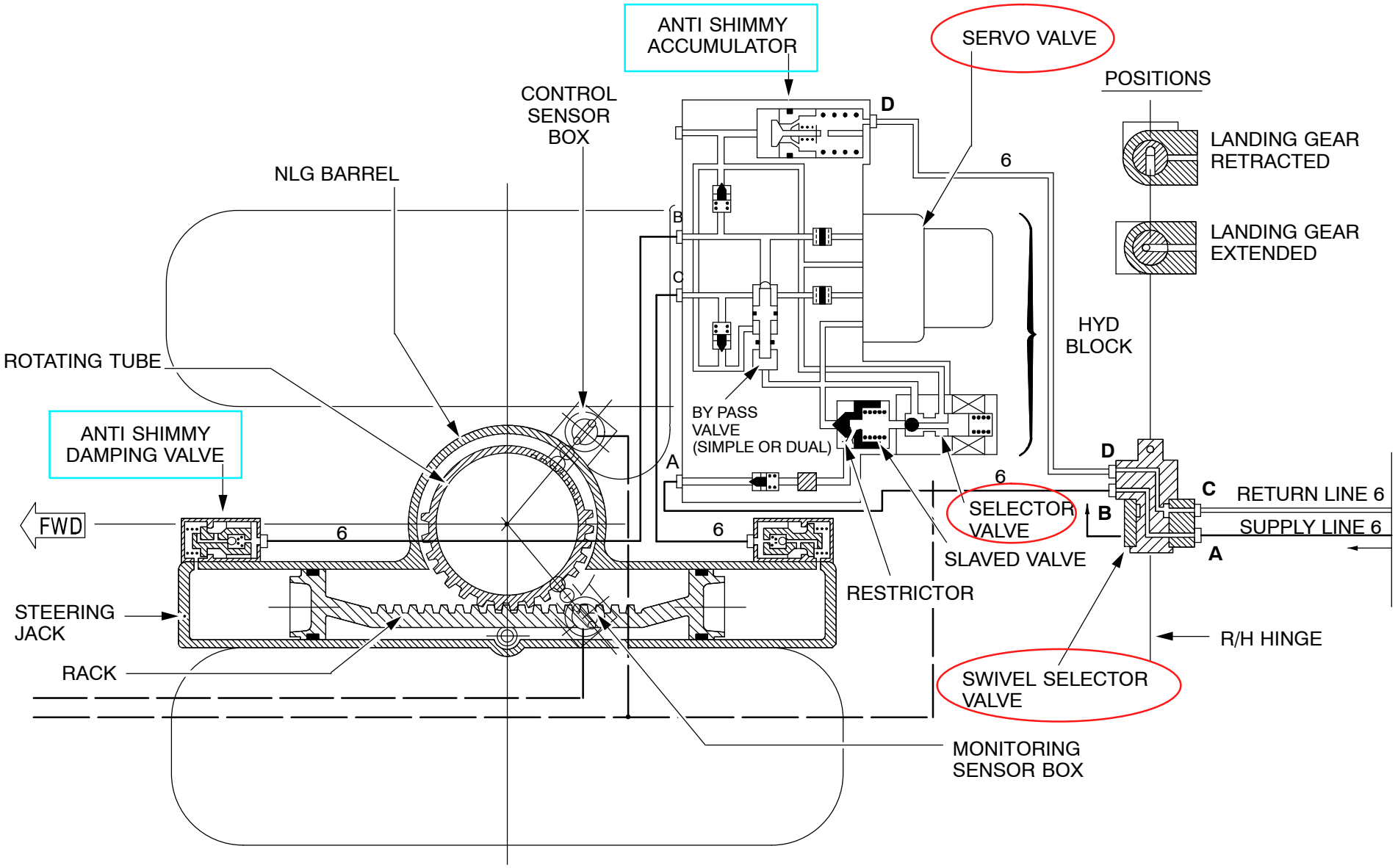


Figure 110 Nose Wheel Steering Schematic

NOSE WHEEL STEERING INTERFACE

The corresponding figure shows the electrical interface between the BSCU, the various system components and the ECAM.

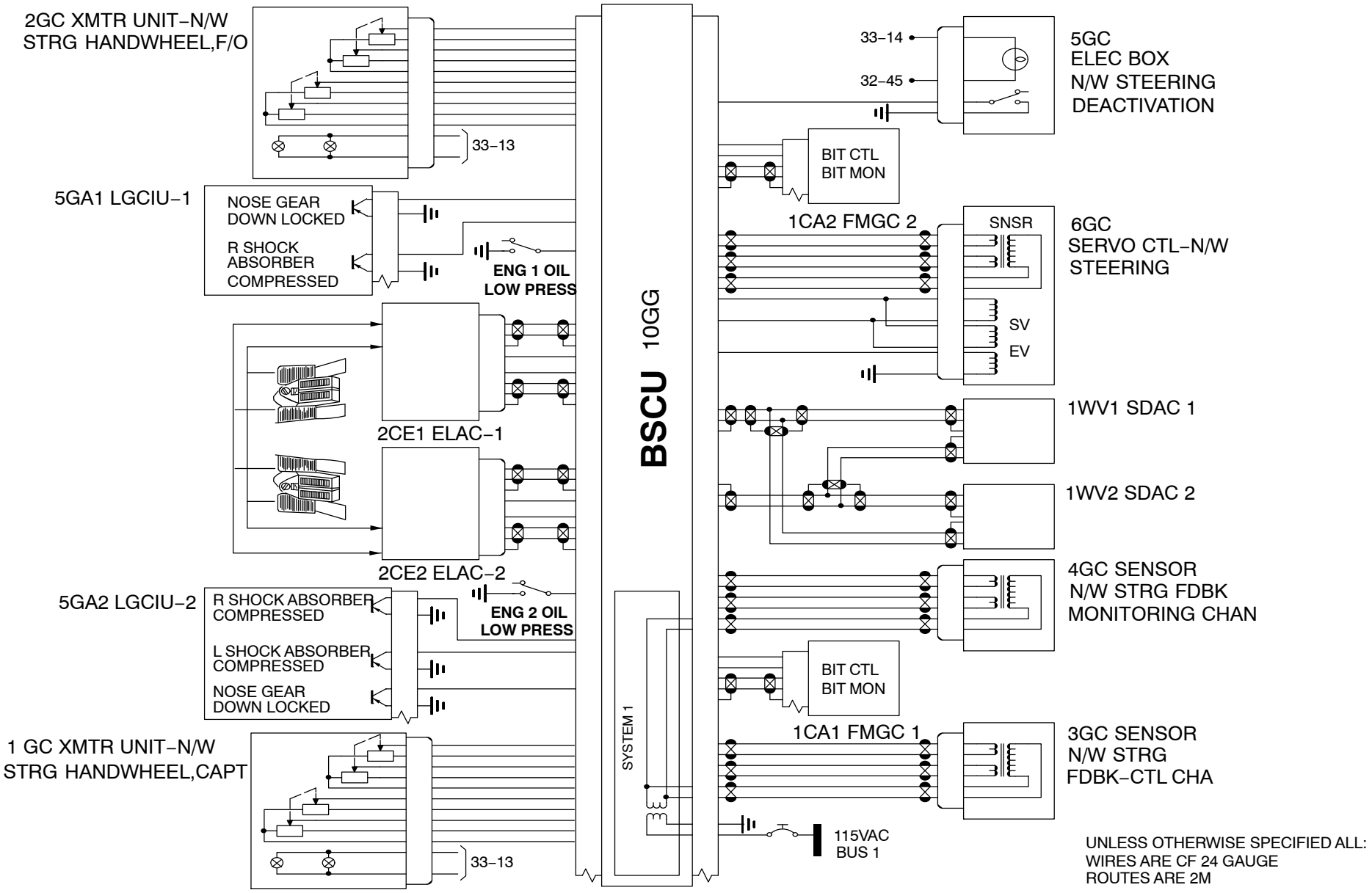


Figure 111 N/W Steering System Wiring

32–60 POSITION AND WARNING

GENERAL

The Position and Warning sub–system contains two sub-systems which are:

- Indicating and Warning
- Landing Gear **B**uilt **I**n **T**est **E**quipment (BITE)

Indicating and Warning

The proximity sensors on the Landing Gear and Landing Gear doors provide position data the two Landing Gear Control and Interface Units (LGCIUs). The sensors in System 1 supply data to LGCIU 1 and the sensors in System 2 supply data to LGCIU 2. Each LGCIU sends the position data to the Electronic Instrument System (EIS). The EIS includes the Engine/Warning Display (E/WD) and the System Display (SD). Together these make the Electronic Centralized Aircraft Monitoring System (ECAM).

The position of each Landing Gear and its associated doors are shown on the System Displays Wheel Page. If specified failures or incorrect L/G configurations occur, the E/WD gives a warning or caution message. Also, the Master Warning, or Caution lights, come on and an aural warning operates.

The downlock indicator lights show the position of each L/G (but not the L/G doors). The downlock indicator lights for the MLG and NLG are independently supplied through LGCIU 1. Position information is described in Landing Gear Position Information (Ref. 32–62)

Landing Gear BITE

The LGCIU's supply L/G position data to other aircraft systems. Two types of data are given. These are:

- Discrete Logic Signals
- ARINC 429 Data

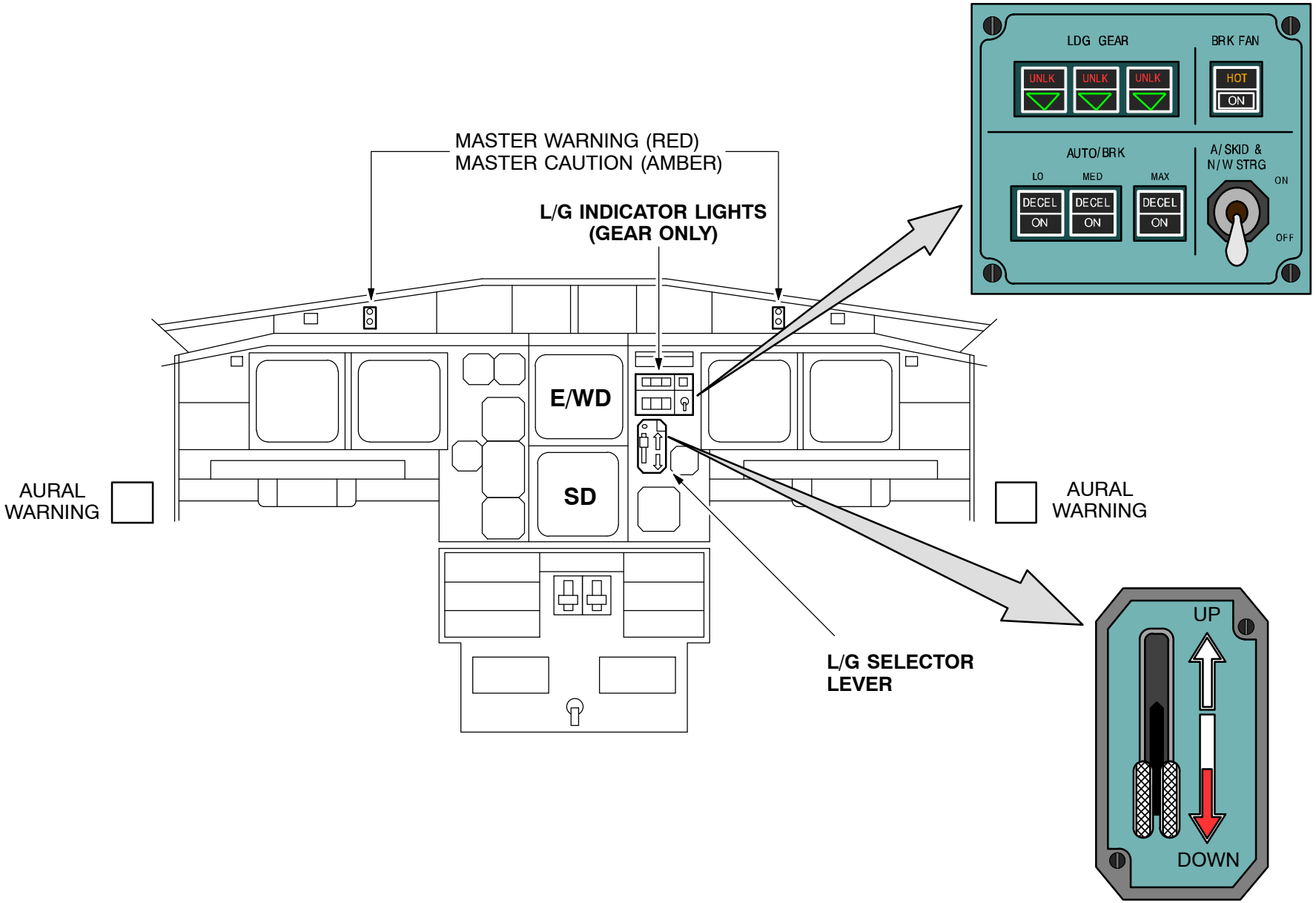


Figure 112 Position and Warning System

LGCIU BITE DESCRIPTION

GENERAL

Each of the LGCIU's contains BITE. The BITE has hardware and software for these functions:

- Continuously Monitoring for System Failures
- Testing of System Parts during Power–Up
- Recording of failures and providing to the Centralized Fault Display System (CFDS) and Data Recording System
- System Test during Ground Maintenance
- Simulating of L/G configurations during Maintenance

BITE Test

The BITE test is software controlled and to start it you must make a test selection on the MCDU. The test is a process that operates most of the LGCIU hardware circuits. To prevent movement of the L/G and the L/G doors, it does not operate the solenoid driver of the:

- Selector Valves
- Baulk Solenoid of the L/G Control Lever

Approximately 7 seconds is necessary to complete the test. The failure conditions that do not show during the normal operation of the LGCIU can be found during the BITE test. This is because this function operates the hardware circuits.

Landing Gear Simulation Function

The L/G simulation function is an aid to the maintenance technicians during the trouble shooting and the maintenance tasks. With this function it is not necessary to lift the aircraft on jacks (to operate the proximity sensors on the shock absorbers) or to operate the L/G.

lgciu

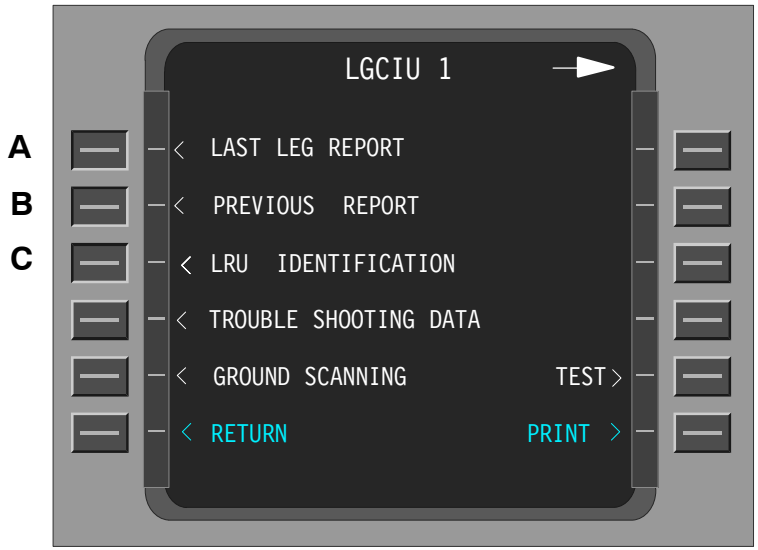


Figure 113 LGCIU BITE

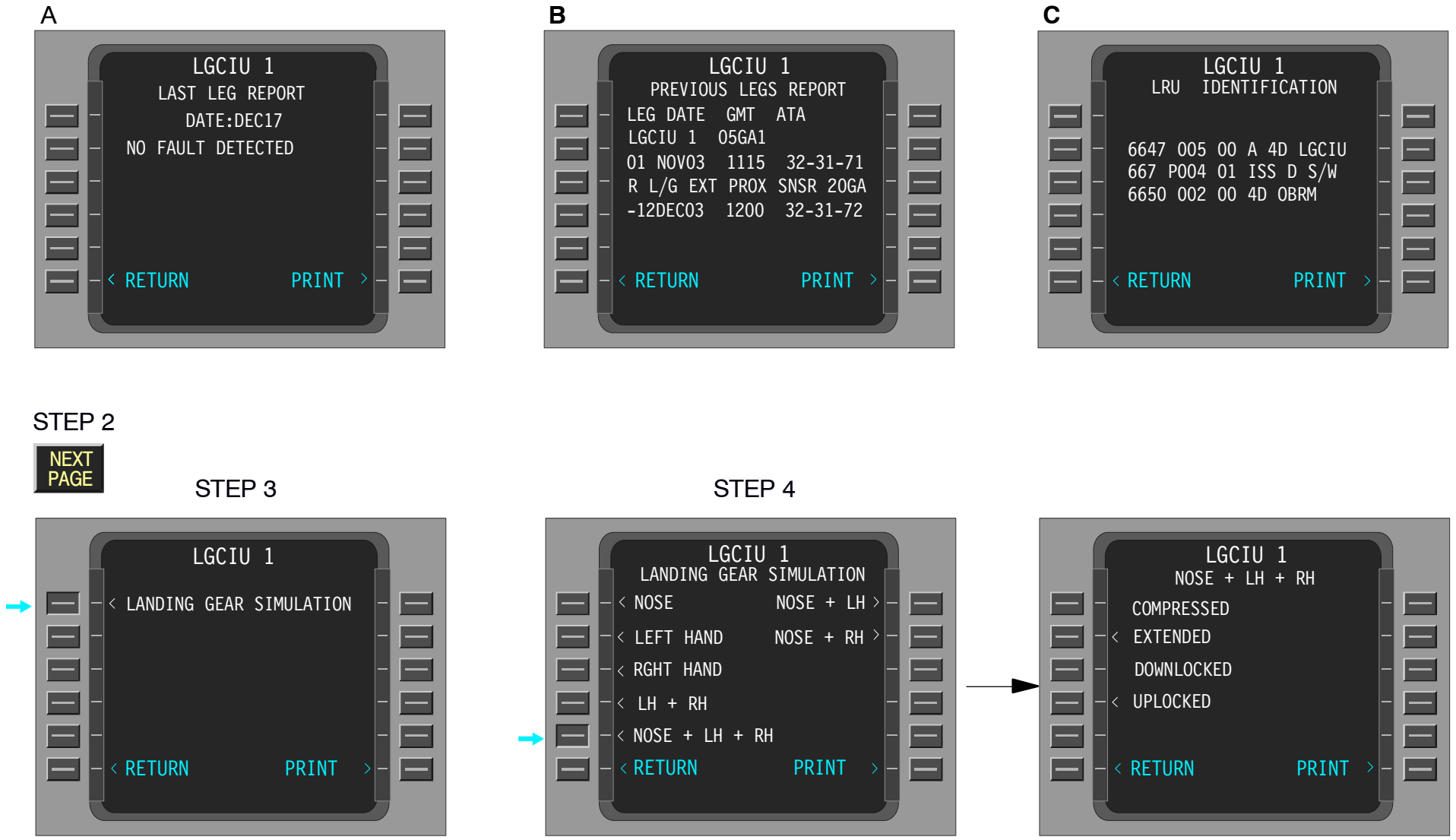


Figure 114 LGCIU Utilisation

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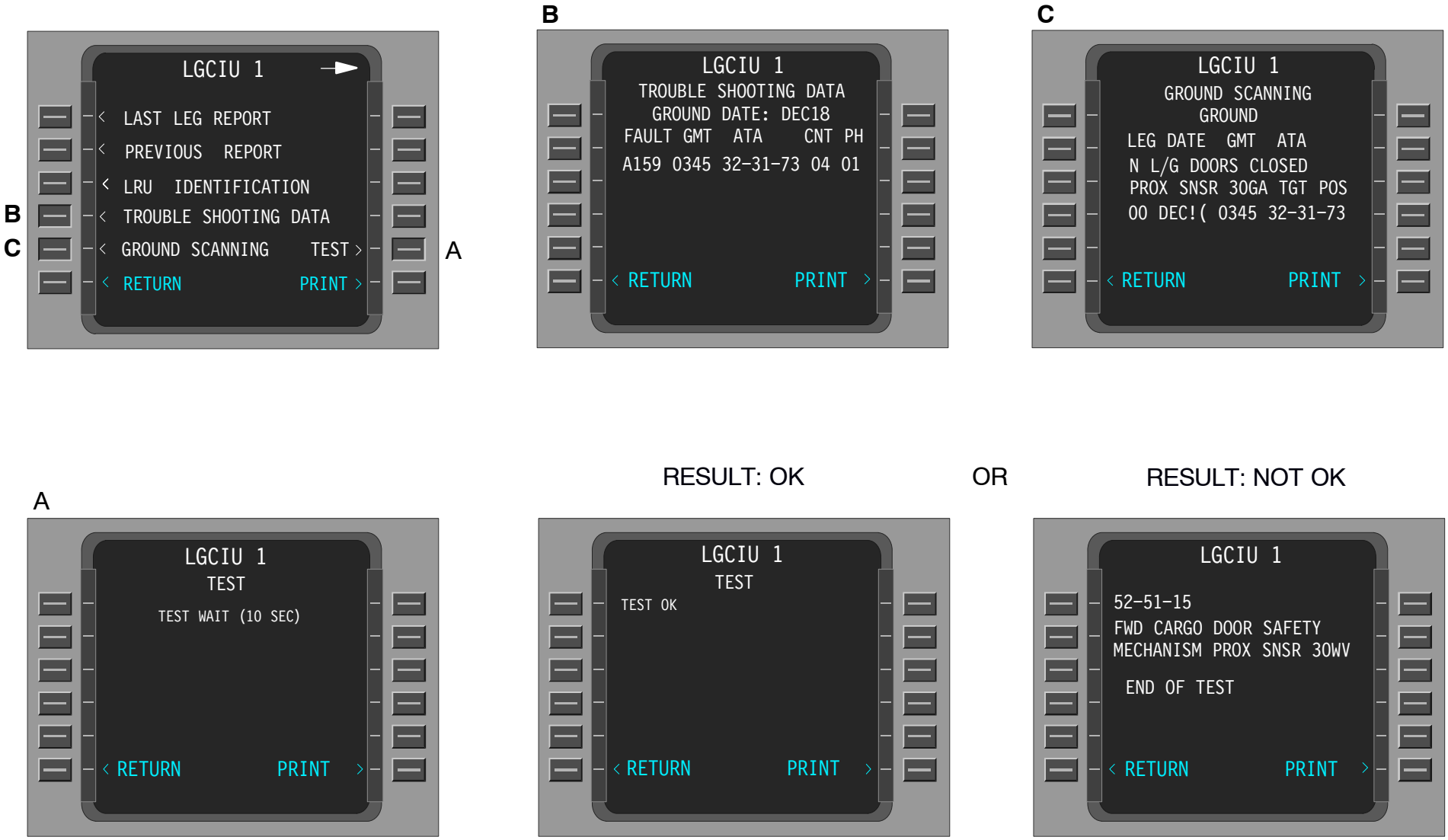


Figure 115 LGCIU Utilisation

32–61 INDICATING AND WARNING

INDICATION GENERAL

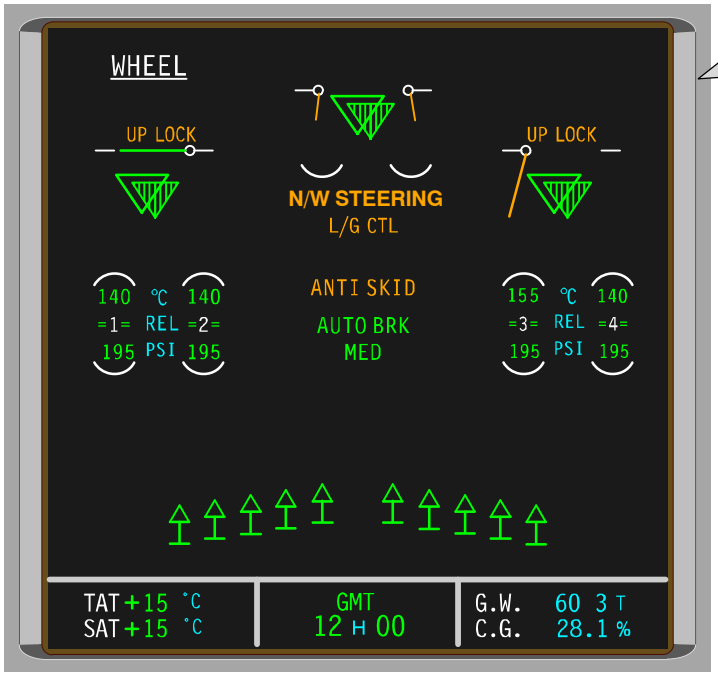
The indicating and warning system provides position and warning data for the Landing Gear and Landing Gear Doors. The system uses the data from proximity sensors in the Normal Extension and Retraction System.

Proximity sensors supply the positions of the L/G components to the Landing Gear Control and Interface Units (LGCIUs). The LGCIUs process the L/G position data and indications are given to the flight crew on the:

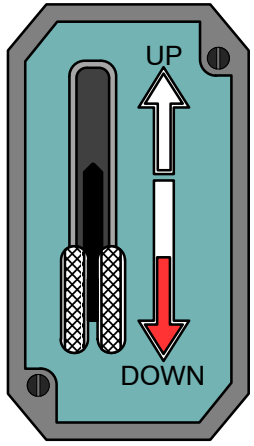
- Electronic Centralized Aircraft Monitoring (ECAM) Display Units (DU)
- L/G Position Indicator Lights

The Central Warning system uses aural and visual equipment to tell the flight crew that a fault has occurred in the L/G system.

L/G ANNUNCIATOR PANEL



L/G ECAM SYSTEM DISPLAY



L/G CONTROL LEVER

Figure 116 Indicating and Warning Locations

POSITION AND WARNING SYSTEM DESCRIPTION

General

The Indicating and Warning System performs three functions:

- Supply of L/G Position Data to Interfaced Systems
- Landing Gear Position Indication
- Generating of Warnings and Cautions related to L/G System Failures

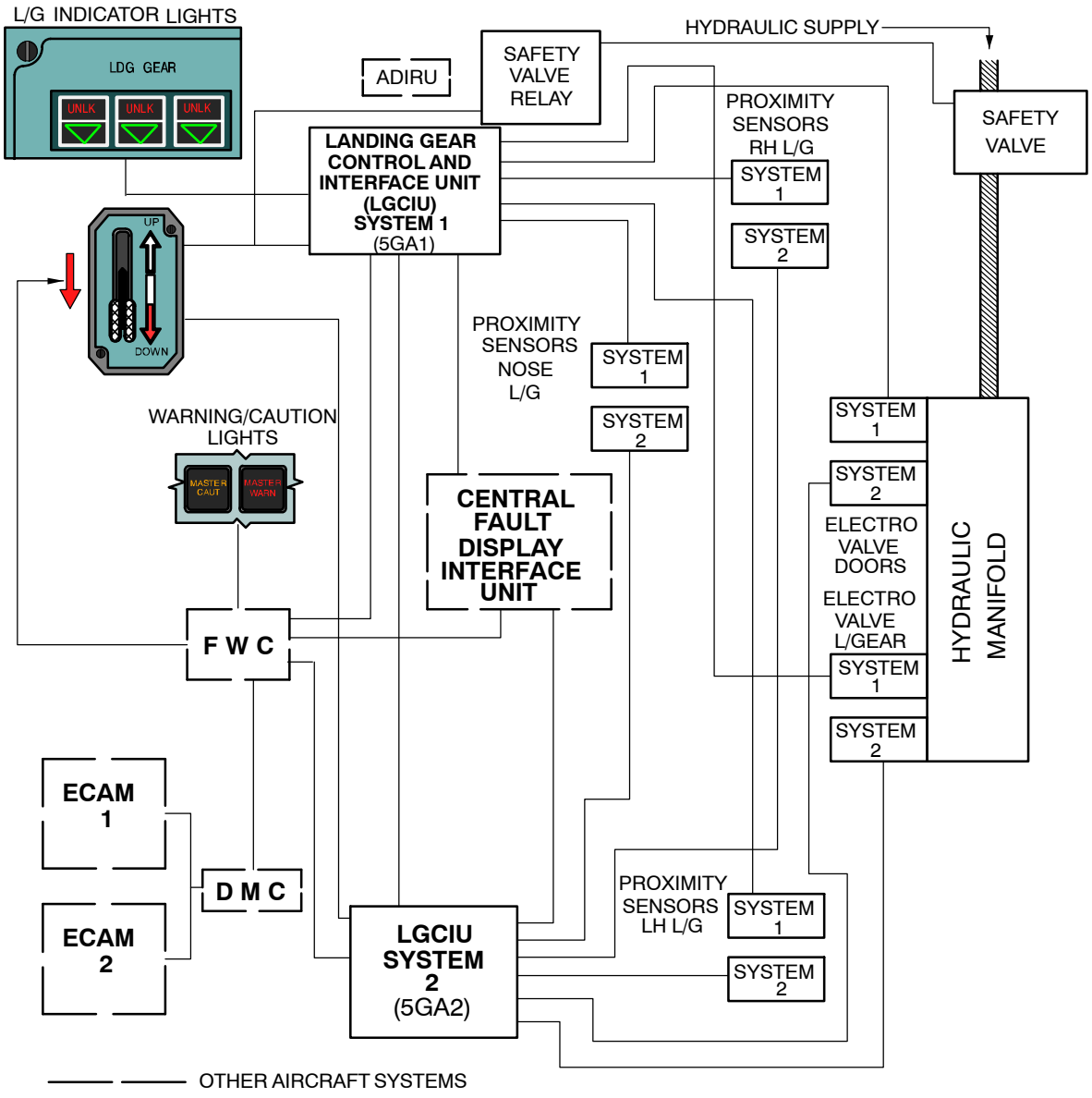
Position Data

Proximity sensors (installed on the L/G and L/G doors) give position data to the LGCIUs. There are two sets of sensors (System 1 and System 2), one set for each LGCIU. The LGCIU's process the data and provides Discrete Logic and ARINC 429 signal outputs. ARINC 429 data is given to the applicable systems all the time.

Discrete logic signals are given to the applicable systems when:

- the NLG shock absorber is compressed
- the NLG shock absorber is not compressed
- the NLG or the L/H MLG or the R/H MLG are down and locked
- the L/H or the R/H MLGs are in a ground condition (the applicable gear(s) is (are) locked down)
- the L/H or the R/H MLGs are in a flight condition (not the ground condition)

These outputs give the L/G and L/G doors position data together with other L/G system status data.



CONDITION	DISPLAY
DOOR CLOSED	G
DOOR IN TRANSIT	A
DOOR FULLY OPEN	A
GEAR LOCKED DOWN	G
GEAR IN TRANSIT	R
GEAR LOCKED UP	
GEAR NOT LOCKED IN SELECTED POSITION	L/G CTL A
GEAR UPLOCK ENGAGED WITH GEAR DOWNLOCKED	UP LOCK A

A AMBER
G GREEN
R RED

Figure 117 Position and Warning System

FAILURE INDICATION

The position of the L/G is shown to the crew on the:

- Wheel page of the ECAM System Display
- Landing Gear Downlock Indicator Lights

The Wheel Page shows the position of each L/G and its door. The L/G and L/G door indications are given with data from LGCIU1 System 1 and LGCIU2 System 2.

The WHEEL page occurs automatically when the first engine starts until the first engine gets to take–off power or the L/G is selected DOWN or at 1600 ft radio altitude (whichever is the first to occur) until the second engine shutdown. If it is necessary for the crew to see the Wheel Page at other times, they can made a selection on the ECAM control panel.

The L/G downlock indicator–lights each show the position of a L/G (but not the L/G doors). Each light is in two parts and can show:

- the color red and the legend UNLK in the top half (L/G not in selected position)
- the color green in the bottom half (L/G downlocked)
- no lights (L/G uplocked)

The green lights for the NLG and each MLG have different proximity sensors, logic circuits and power supplies. This makes sure that the NLG and MLG green lights operate independently.

CAUTIONS AND WARNINGS

Cautions and warnings are given with the:

- Wheel Page of the ECAM System
- CWS
- Landing Gear Control Lever

The WHEEL page occurs automatically with the following warning messages shown on the ECAM upper Display Unit:

- LGCIU 1 (2) FAULT
- L/G DOORS NOT CLOSED
- L/G GEAR NOT UPLOCKED
- L/G GEAR NOT DOWNLOCKED
- L/G GEAR UPLOCK FAULT
- L/G SYS DISAGREE

If necessary, a procedure to correct the effects of the failure is given with the warning message. When some of these failure messages show, the master warning or caution lights come on and a continuous or single chime sounds.

Landing Gear Control Lever

The Down Arrow Light in the Landing Gear Control Lever illuminates when the conditions that follow occur:

- Landing Gear is down but not locked
- The Aircraft is in a Landing Configuration

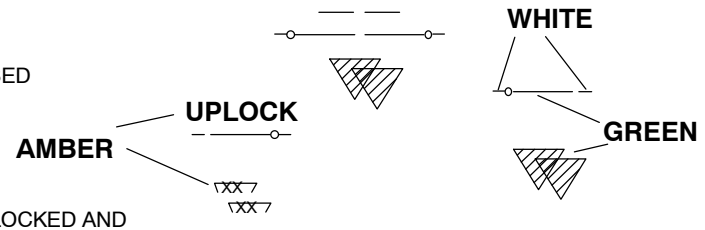
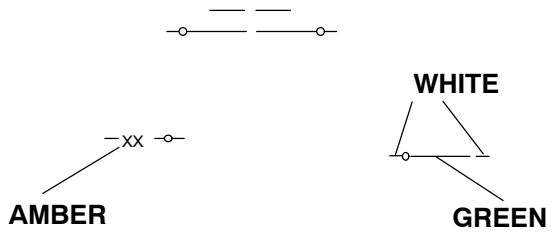
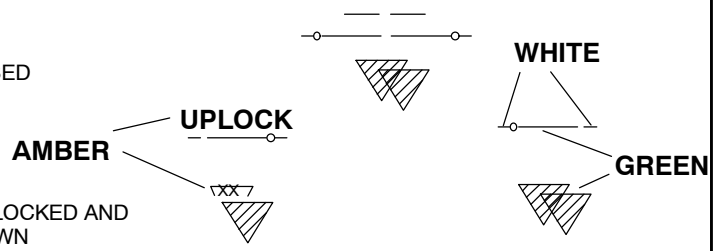
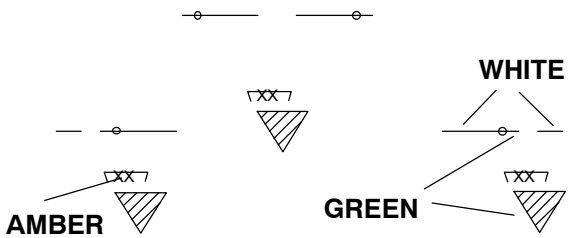
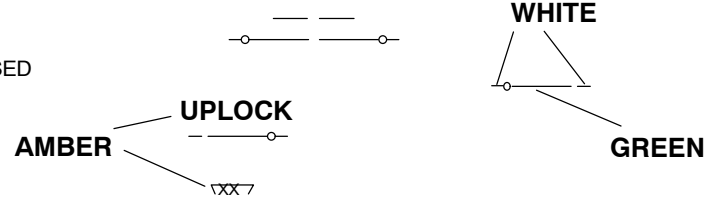
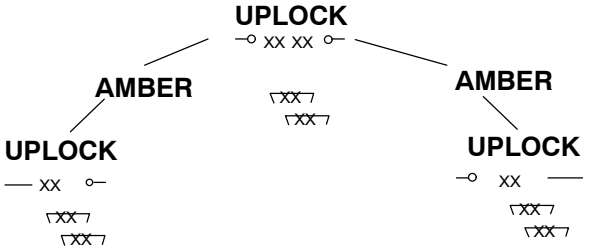
DATA FROM L/G SYSTEM	WHEEL PAGE	DATA FROM L/G SYSTEM	WHEEL PAGE
NORMAL DATA: DOWN SELECTED GEAR LOCKED DOWN DOORS LOCKED CLOSED FAILURE DATA: LH GEAR UPLOCKED LOCKED AND LH GEAR LOCKED DOWN		NORMAL DATA: UP SELECTED GEAR LOCKED UP DOOR LOCKED CLOSED FAILURE DATA: LH DOOR LOCKED CLOSED AND LH DOOR LOCKED FULLY OPEN	
NORMAL DATA: DOWN SELECTED GEAR LOCKED DOWN DOORS LOCKED CLOSED FAILURE DATA: LH GEAR UPLOCKED LOCKED AND LH GEAR LOCKED DOWN		NORMAL DATA: DOWN SELECTED GEAR LOCKED DOWN DOORS LOCKED CLOSED FAILURE DATA: FAILURE OR ELECTRICAL POWER LOSS OF LGCIU1 OR LGCIU2	
NORMAL DATA: UP SELECTED GEAR LOCKED UP DOOR LOCKED CLOSED FAILURE DATA: LH GEAR LOCKED DOWN AND LH GEAR LOCKED UP		ALL GEAR UPLOCKS LOCKED AND ALL GEARS DOWN LOCKED AND ALL DOORS LOCKED CLOSED AND ALL DOORS FULLY OPEN E.G. DURING GRAVITY EXTENSION ADJUSTMENT AS PERAMM PROCEDURE	

Figure 118 Failure Indications

12–14 MAIN LANDING GEAR SERVICING

SHOCK ABSORBER SERVICE DESCRIPTION

INTRODUCTION

The A319-A321 AMM subtask 12–14–32–614–080 provide a detailed procedure for replenishment of the nitrogen in the main landing gear (MLG) shock absorber when the aircraft weight is on the wheels. The purpose of the following explainations is to describe some of the procedures steps and why the procedure must be followed as prescribed.

General

The A319-A321 Main Landing Gears all have two stage shock absorbers. The procedure for servicing the main landing gears of each aircraft is identical, with the exception of the nitrogen pressures. These pressures vary depending upon the aircraft (A319/A320 and A321) to which the MLGs are fitted, creating a shock absorber spring curve characteristic that is best suited to that aircraft. The two–stage shock absorber comprises two nitrogen chambers, whose charging valves are referred to in the AMM as the Top Charging Valve and the Bottom Charging valve.

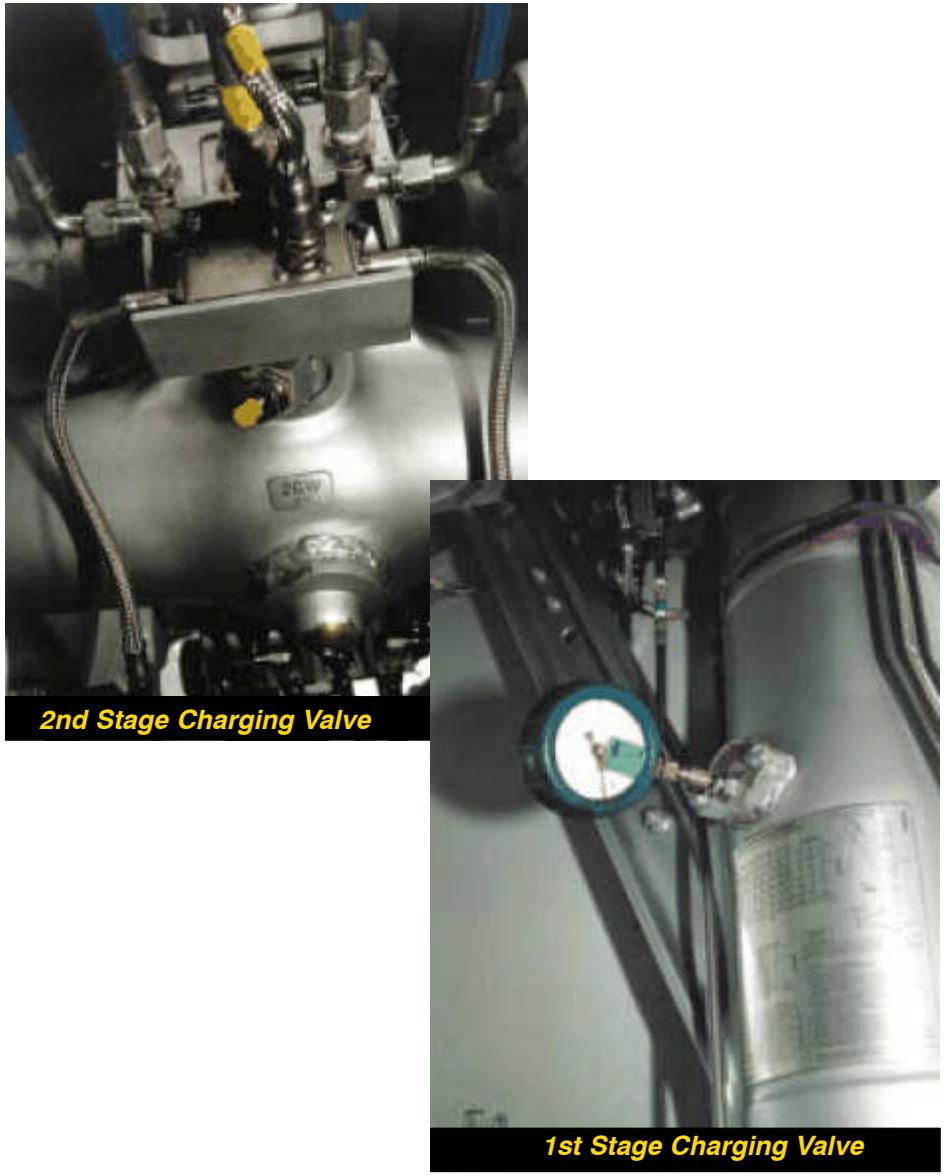
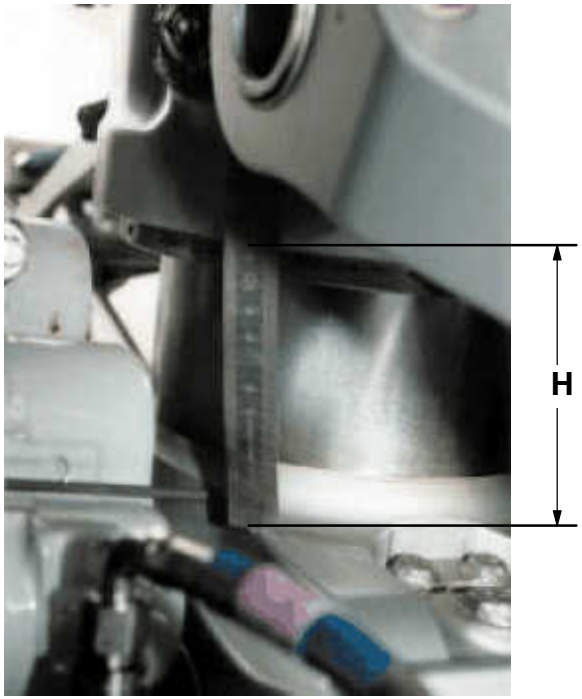
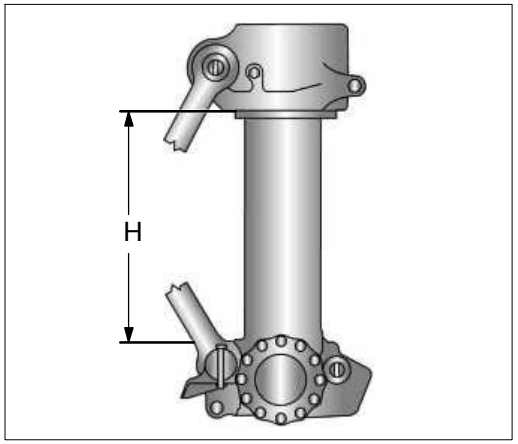


Figure 119 MLG Servicing Points

TOP CHARGING VALVE
TEMPERATURE MEASUREMENT



MEASUREMENT OF DIMENSION-H



SHOCK ABSORBER NITROGEN SERVICING

Figure 120 Shock Absorber Servicing

MAINTENANCE PRACTICES

NOTE: In this section the upper chamber will be referred to as the 1st stage and the lower chamber as the 2nd stage.

Operation

A set of curves like presented in the AMM for maintenance at different MLG temperatures are called DIAGRAM 1. The first part of the procedure in the AMM provides a check to establish whether the shock absorber closure (compression) is within acceptable limits for the measured temperature and 1st stage pressure. (Shock absorber closure is referred to in the AMM as the H–dimension). For any combination of MLG temperature and 1st stage nitrogen pressure the corresponding H-dimension is given a tolerance of ±15mm. This tolerance on the H–dimension applies only at this stage in the check procedure. When adding or removing nitrogen, during the procedure to correct the H–dimension, the required H–dimension is to be achieved within a tolerance of ±2mm.

Before launching into the explanation of the servicing procedure it is worth defining what is meant by MLG temperature, measured temperature, etc. The AMM states that the temperature at the Top Charging Valve is to be measured. Therefore the temperature should be measured using a thermometer whose sensing element can be placed in contact with the Top Charging Valve, such as a probe type digital thermometer. This will provide a sufficiently accurate temperature to use in conjunction with the diagrams in the AMM.

attention: It is important to understand that it is not the ambient air temperature that is to be measured.

When the H–dimension is found to be outside the ±15mm tolerance, replenishment of the nitrogen is required. The replenishment procedure is not as simple as just adding or removing nitrogen from one nitrogen chamber or the other. If this were to be done it would change the H–dimension to give the appearance of a correctly charged shock absorber but with no certainty that this was the case. In fact all that may have been achieved is a new spring curve characteristic that has just one pressure/H–dimension co–ordinate that lies on the true spring curve. When a shock absorber requires replenishment, and it is not convenient to jack the aircraft each nitrogen chamber must be serviced independently. The procedure in the AMM is structured and deals with the correction of the 1st stage and the correction of the 2nd stage. Both parts of the procedure must be completed. There are no short cuts.

UPPER CHAMBER ADJUSTMENT

The 1st stage nitrogen chamber is serviced first. But before this can be done the 2nd stage must be isolated and made inactive. The 2nd stage is made inactive by adding nitrogen at the bottom charging valve to move the floating piston to the top of the 2nd stage cylinder. This condition is achieved when sufficient nitrogen has been added to make the pressure in the 2nd stage cylinder 18 bar (260 psi) greater than the 1st stage nitrogen pressure. This effectively converts the leg into a single–stage shock absorber whose spring curve is shown in illustration 2 by the curve A–B–D, which is simply an extrapolation of the curve A–B. A set of curves like this are presented in the AMM for maintenance at different MLG temperatures. In the AMM these curves are referred to as DIAGRAM 2.

Adding or removing nitrogen from the 1st stage chamber is not intended to change this pressure, it is to change the volume of nitrogen. For instance, adding nitrogen will increase the H–dimension which increases the volume in the 1st stage chamber whilst keeping the pressure constant and consistent with the aircraft weight. There is an exception which arises when nitrogen is initially added or removed. The initial addition or removal of nitrogen will change the pressure because the friction forces that exist in the shock absorber sliding components will inhibit an immediate change in H–Dimension. This is why the procedure states that the initial addition or removal of nitrogen must stop immediately the shock absorber starts to move. At this point the force generated by the change in nitrogen pressure is in balance with the friction force.

The new nitrogen pressure thus generated is the pressure that must be used in conjunction with AMM DIAGRAM 2. This determines the correct H–dimension to be achieved when the addition or removal of nitrogen is recommenced. When the addition or removal of nitrogen is recommenced the H–dimension will smoothly change at constant 1st friction forces and the nitrogen pressure generated forces need to be balanced is further explained below. This first part of the procedure, to correct the 1st stage nitrogen volume, is interspersed with check readings of pressure, temperature and H–dimension. These checks are to ensure that previously achieved conditions have remained unchanged and that a sufficiently–high pressure–differential between the 1st and 2nd stage pressures has been maintained. This will ensure that the floating piston is still at the top of the cylinder, i.e the pressure in the 1st stage is at least 11 bars lower than the pressure in the 2nd stage.

PRESSURE VS. DIMENSION

The 1st stage is separated from the 2nd stage by a floating piston contained in the 2nd stage cylinder.
Typically with a MLG temperature of 20 °C and with no load on the shock absorber the 1st stage is inflated to 7.6 bar and the 2nd stage is inflated to 78 bar (A320–200 pressures).
Initially, as the load on the shock absorber is applied, it is only the nitrogen pressure in the 1st stage that increases.
With increasing load the 1st stage pressure will reach a value equal to the initial charge pressure of the 2nd stage (78 bar).
Further increase in shock absorber load, from this point onwards, causes the floating piston to start moving down the 2nd stage cylinder and the pressures in both to equalize and remain equal for all further compression of the shock absorber.

The schematic shown on the left side illustrates this sequence and a typical pressure versus shock absorber closure curve is shown on the right illustration.
The portion of the curve AB represents the 1st stage compression and the portion of the curve B–C represents the combined compression of the 1st and 2nd stages.

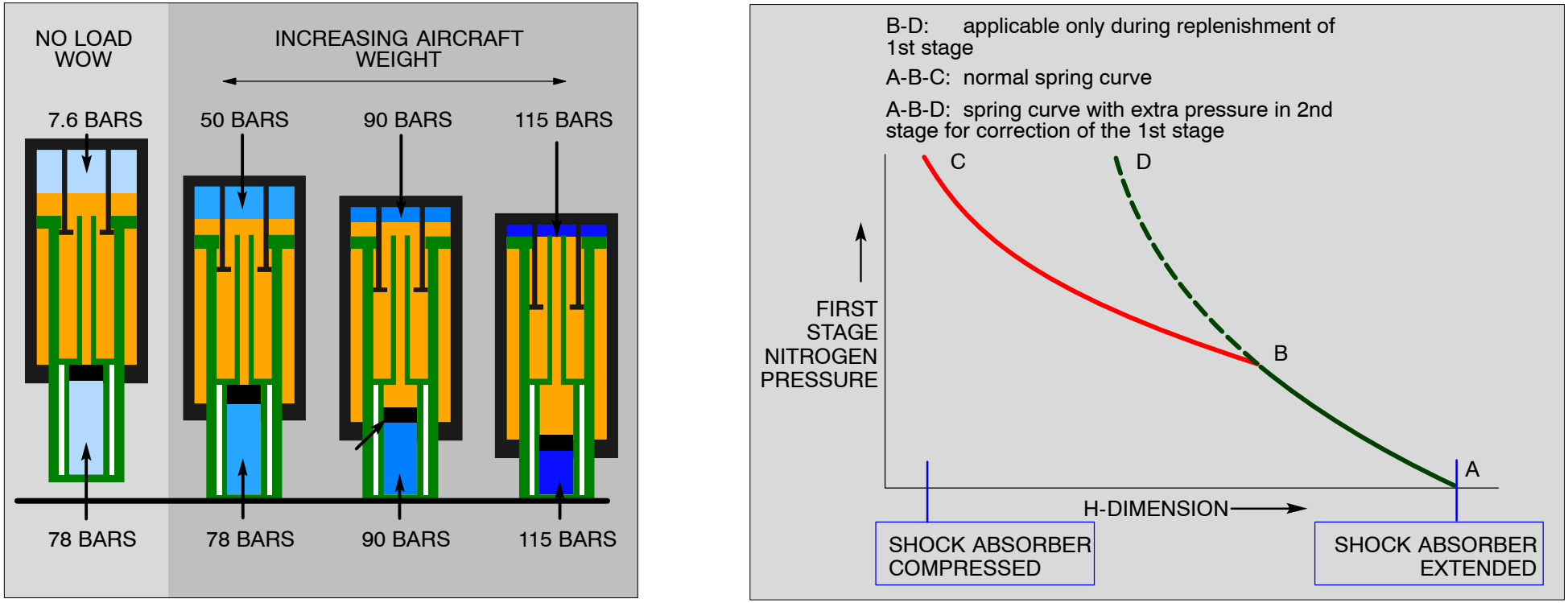


Figure 121 Figure Text

LOWER CHAMBER ADJUSTMENT

The next part of the procedure is to correct the 2nd stage. How this is achieved is dependent on the weight of the aircraft, because at the end of the 2nd stage charging procedure it is possible for one of two conditions to exist:

- Condition (a)

  The weight of the aircraft is such that the shock absorber will be operating on the 1st stage of the spring curve somewhere along the curve A–B of illustration 2. The floating piston is still at the top of the 2nd stage cylinder. (The aircraft is relatively light)

- Condition (b)

  The weight of the aircraft is such that the shock absorber will be operating on the 2nd stage of the spring curve somewhere along the curve curve B–C of illustration 2. The floating piston is at some intermediate position within the 2nd stage cylinder. (The aircraft is relatively heavy).

The AMM deals with these conditions separately. It is not necessary to know the actual aircraft weight because the procedure that is used is determined by the 1st stage pressure and its position relative to the line on DIAGRAM 3 in the AMM. It is shown below and represents the relationship between the 2nd stage pressure and temperature when the floating piston is at the top of the cylinder.

Condition (a)

If the 1st stage pressure is such that it is below the line on diagram 3 it means that the aircraft weight has generated a 1st stage pressure that is not great enough to cause the floating piston to move down from its position at the top of the cylinder. Therefore all that needs to be done in this case, is to remove nitrogen from the 2nd stage cylinder to make the pressure agree with the line on DIAGRAM 3.

attention: it is important that this final step is performed even though there will be no change in h-dimension. if it is not done the second stage will remain over-pressurized.

Condition (b)

If the 1st stage pressure is such that it is above the line on DIAGRAM 3, it means that the aircraft weight has generated a sufficiently high 1st stage pressure to overcome the initial charge pressure of the 2nd stage cylinder and has moved the floating piston away from its stop at the top of the cylinder.

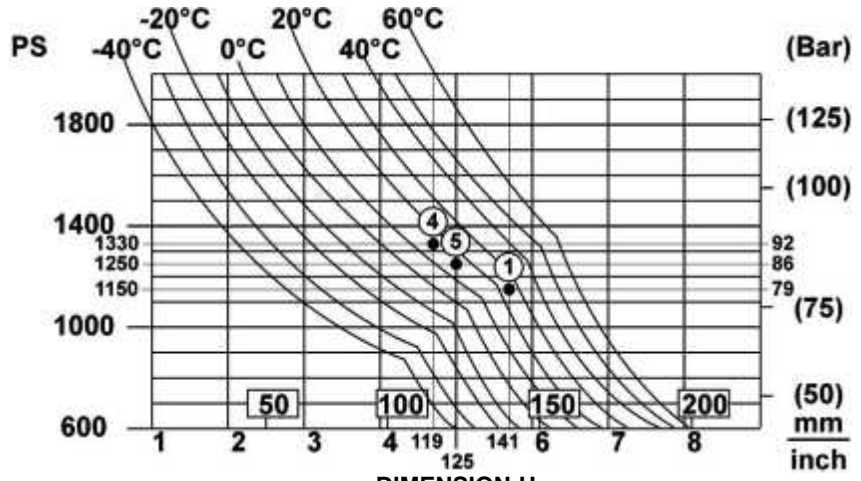
In this case it is necessary to adjust the volume of nitrogen in the 2nd stage to obtain the final correct H–dimension. As the shock absorber will be operating on the 2nd stage of the spring curve refer now to DIAGRAM 1 in the AMM to determine the H–dimension that is to be achieved to complete the procedure. Nitrogen is removed from the 2nd stage cylinder by following the same procedure for removing nitrogen from the 1st stage. In this case nitrogen is removed from the 2nd stage cylinder until the shock absorber just starts to move. When this occurs, stop removing nitrogen and re–measure the 1st stage nitrogen pressure. Use this pressure to determine the correct H–dimension from DIAGRAM 1. Re–commence removing nitrogen from the 2nd stage cylinder until the desired H–dimension is achieved.

Conclusion

The two–stage shock absorber is necessary to give the desired passenger comfort levels when landing the aircraft and it is equally necessary that the charging sequence described in the AMM be adhered to. It is important to remember during the nitrogen replenishment sequence, that an over–pressurized, or under–pressurised shock absorber has the potential for causing internal damage to shock absorber components and of course discomfort to the aircraft's occupants.

AIRCRAFT WEIGHT ON WHEELS (WOW)

DIAGRAM 1



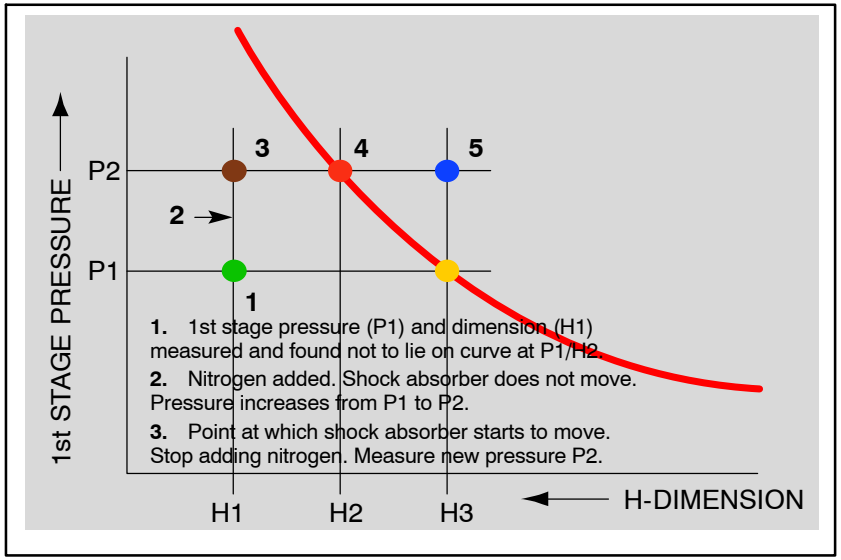


DIAGRAM 2

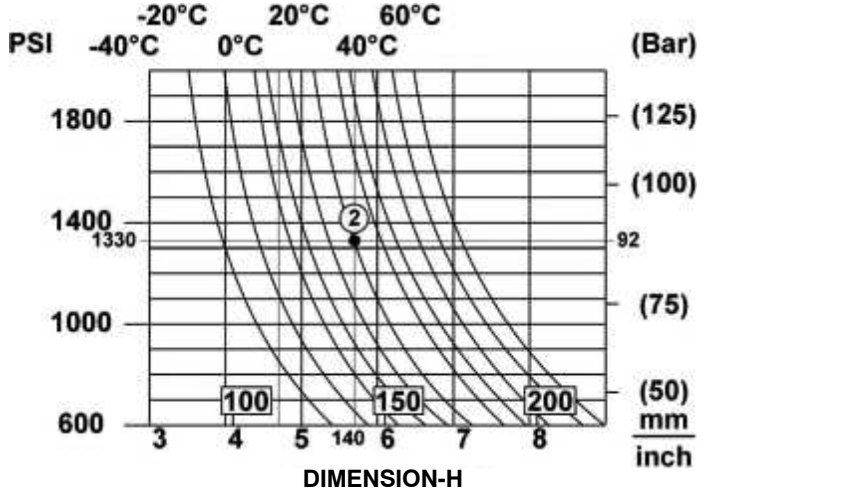


DIAGRAM 3

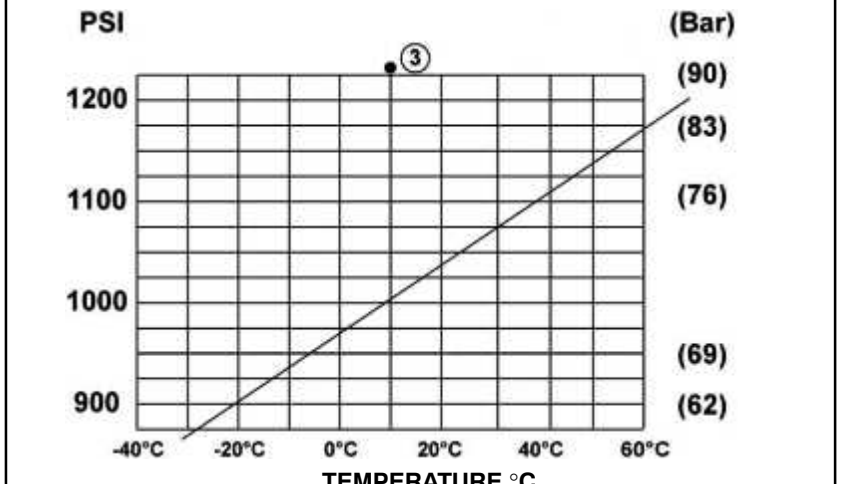


Figure 122 Diagrams

WHEEL PAGE INTRODUCTION (ENHANCED TECHNOLOGY)

Spoiler Position Indication

The spoiler position indiction is located at the top of the page.

Landing Gear Position Arrows

The left triangle is related to the LGCIU in control and the right triangle to the other LGCIU.

ANTI SKID Message

This message is normally not displayed.

It is displayed in green when:

- the message NORM BRK is displayed in amber or
- the message ALT BRK is displayed in amber or
- the message AUTO BRK is displayed in amber

It is displayed in amber when:

- the A/S switch is in OFF position or
- both BSCU channels are faulty or
- the message NORM BRK is displayed in amber and the pressure of the Yellow Hydraulic System is low

System 1/2 related to A/S Status

At the same time as the ANTI SKID message, the status of the BSCU system 1(2) is displayed.

It is displayed in green when:

- the BSCU system1(2) is OK

It is displayed in amber when:

- the BSCU system1(2) is faulty (the figure is surrounded by a half grey box)

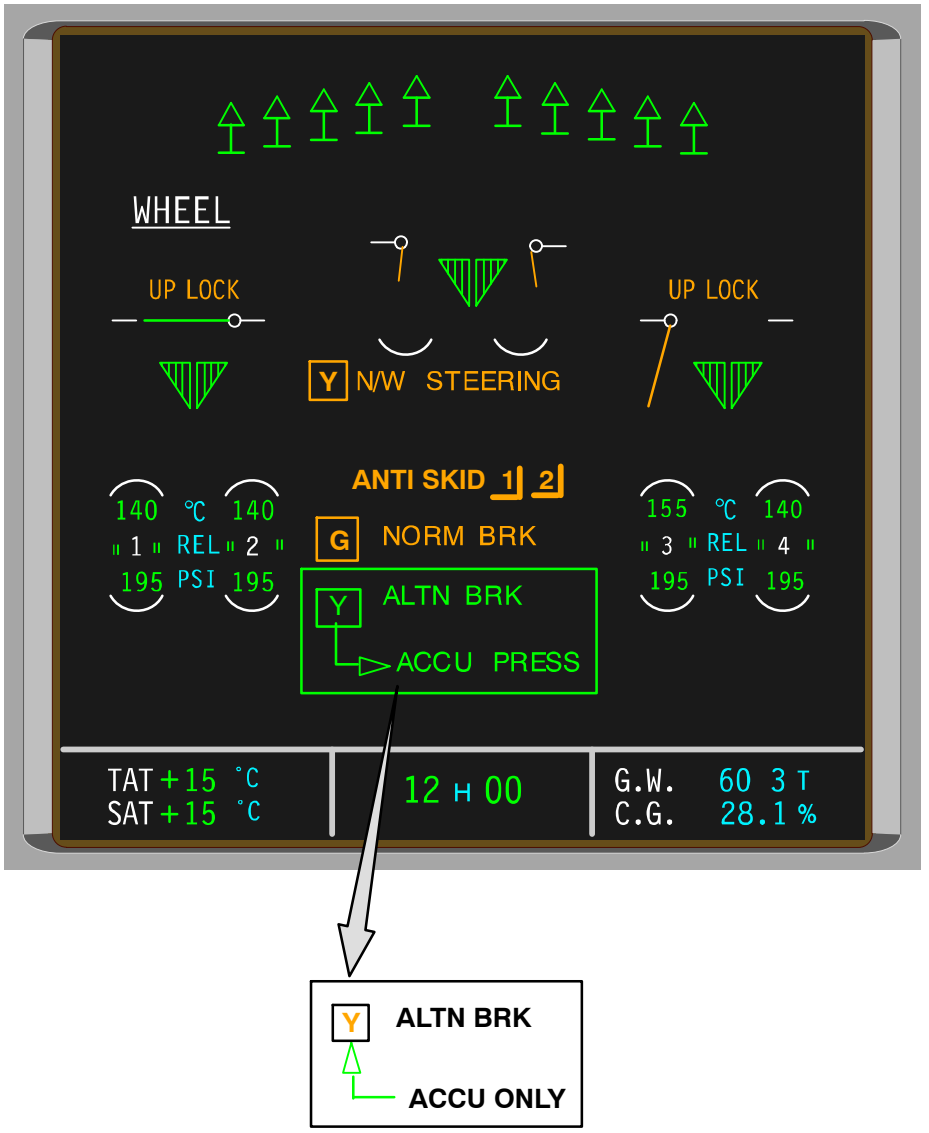


Figure 123 ECAM Wheel Page

NORM BRK Message

This message is normally not displayed.

It is displayed in green when:

- the message ALT BRK is displayed in amber or
- the message AUTO BRK is displayed in amber

It is displayed in amber when:

- the A/S switch is in OFF position or
- both BSCU channels are faulty or
- the normal brake system is faulty or
- the Green Hydraulic System pressure is low

ALT BRK Message

This message is normally not displayed.

It is displayed in green when the alternate brake mode is selected and:

- the Green and Yellow Hydraulic systems are pressurized and
- the A/S switch is in the ON position

It is displayed in amber when:

- there is an alternate brake left and right release fault or
- the Yellow System and the accumulator pressure are low

ACCU PRESS Message

It is displayed in green when:

- NORM BRK, ALT BRK, AUTO BRK, or ANTI SKID is displayed in amber
- together with a Yellow Hydraulic System low pressure

It is displayed in amber when:

- the accumulator pressure drops below a given value

ACCU ONLY Message

It is displayed in green when:

- the Yellow Hydraulic System has low pressure, and the NORM BRK mode is faulty

Arrow Indication

This arrow is displayed in green if ALT BRK is displayed and shows the pressure charging direction when:

- the Yellow Hydraulic System supplies the accumulator or
- the accumulator is supplying in the alternate braking mode

The arrow is not displayed if the yellow hydraulic system and the accumulator are in low pressure.

Hydraulic Status G/Y

The Hydraulic supply indications are displayed at the same time as the messages N/W STEERING,or NORM BRK, or ALT BRK

- the letters, normally displayed in green, are displayed in amber in case of low pressure in the related system.

N/W Steering

This message is normally not displayed.

It is displayed in amber when:

- the nose wheel steering indication from the SDAC is inoperative
- the ANTI SKID & N/W STRG switch is in OFF position or
- both BSCU channels are faulty or
- the pressure of the Yellow Hydraulic System is low

SYSTEM DESCRIPTION (ENHANCED TECHNOLOGY)

MODIFICATIONS

A new valve identical to the alternate brake selector valve replaces the normal brake selector valve. New servo valves with direct control laws replace the normal servo valves. When there is no braking order, the servo valve is fully closed.

A pressure transducer is added downstream of the normal brake selector valve. It sends the hydraulic pressure information to the Braking/Steering Control Unit (BSCU) and the ABCU. A pressure lower than 90 bars allows the ABCU to activate the alternate braking mode.

Normal Brake System

The Normal braking system is electrohydraulic and includes the (BSCU). The BSCU controls the operation of the electrohydraulic valves in the system to decrease the speed of the aircraft. The hydraulic pressure that operates the brake pistons is supplied from the Green Main Hydraulic Power system.

The system has two modes of operation, manual and automatic, and gives automatic anti skid protection in each mode. Each brake unit gets separate pressure control to supply the anti skid protection.

Manual Braking

In the manual braking mode, operation of the brake pedals causes a signal to be sent to the BSCU which is transmitted from the brake pedals through the related transmitter unit in the flight deck. The BSCU energizes the brake selector valve and the servovalves which supply the correct pressure proportional to the brake pedal travel to the brake units. The BSCU automatically releases the brake pressure of the appropriate brakes in the event of anti skid control.

Automatic Braking

In the automatic braking mode the BSCU uses the braking program that is set to control the rate of the aircrafts deceleration. The BSCU starts the braking program when the necessary specified conditions are available. It calculates the correct brake pressure required and controls the servovalves to get the correct deceleration rate.

There are three deceleration modes (LO, MED or MAX) selectable from the cockpit to be used during landing. A brake pedal input signal which is more than the set auto value cancels the automatic braking program.

Anti Skid

The BSCU controls the anti skid function in Manual Braking Mode as well as in Automatic Braking mode. To do this it compares the actual wheel speeds with the aircraft speed. The BSCU then releases the brake of the wheel that starts to be in a skid condition.

The Wheel Page shows when the anti skid function operates. An A/SKID switch in the cockpit enables system cancelling. If the switch is set to OFF, brake operation will go to the Alternate Braking S ystem without Anti Skid .

Alternate Braking with A/SKID

Specified failures within the automatic brake control system will lead to an automatic change over to the Alternate Braking system.

When the brake pedals are operated a signal is sent to the Alternate Braking Control Unit (ABCU). The ABCU controls the system pressure that goes to the brakes. In the anti skid function, the BSCU sends anti skid currents to the ABCU which substracts them to the pressure control currents sent to the Direct Drive Valve to release the pressure to prevent wheel locking.

Alternate Brakling without A/SKID

When the brake pedals are operated a signal is sent to the ABCU.The ABCU controls the Direct Drive Valves in the system to set the necessary pressure at each pair of brake units. A third set of potentiometers in the Alternate Brake Pedal Transmitter Unit (ALTN BPTU) supplied by the Hot Battery Bus allows the ABCU to brake the aircraft during towing operation.

Parking Braking

The parking brake system uses the components of the alternate braking system to send pressure to the brakes. When the PARK BRK control switch is set to ON (applied) it sends an electrical signal to energize an electrohydraulic control valve.The other braking modes are disconnected, the brakes are supplied with yellow high pressure or accumulator pressure.

Landing Gear Retraction

NOTE: The BSCU also puts the brakes on for a short time during retraction of the landing gear.

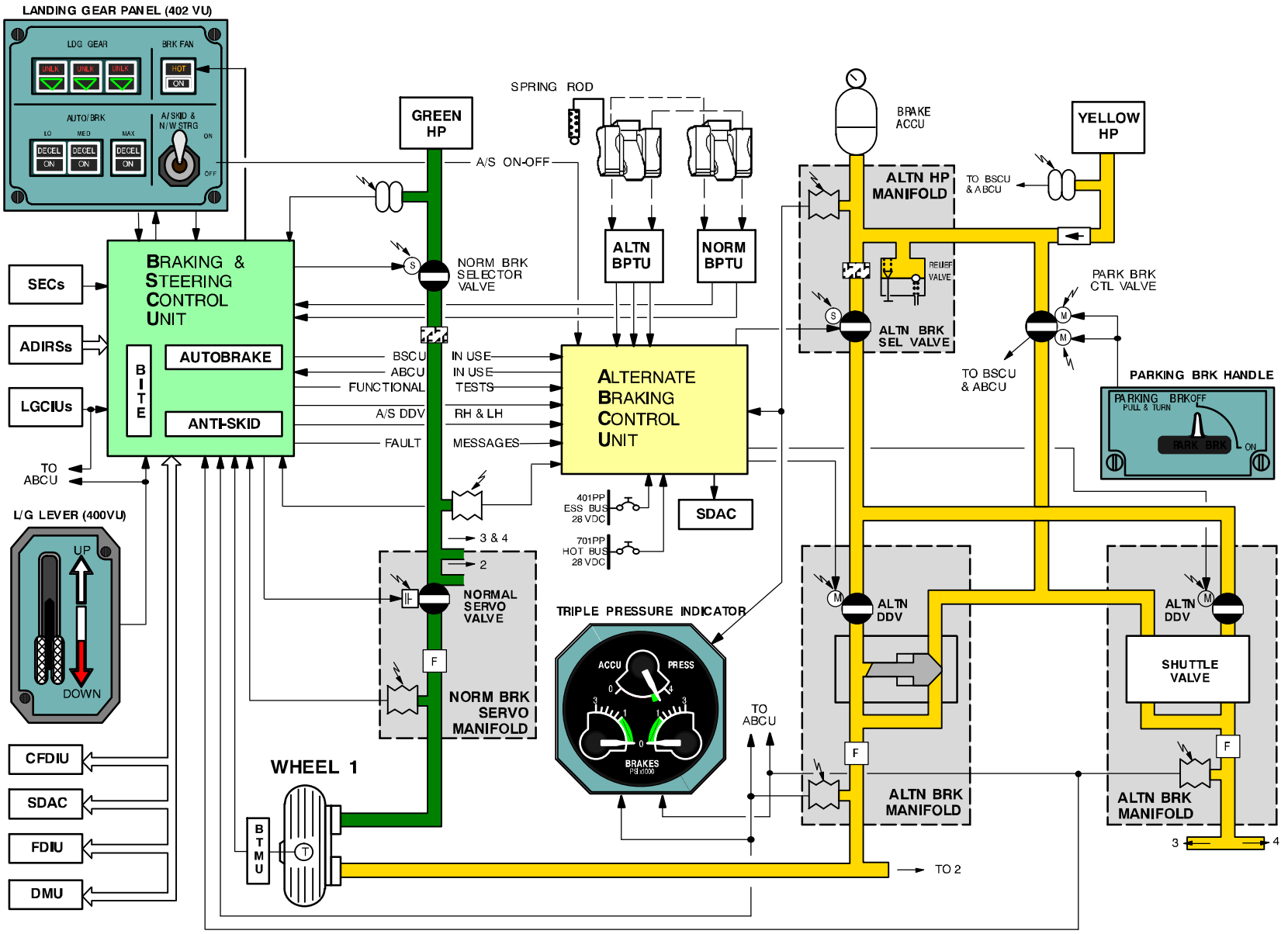


Figure 124 Brake System (Enhanced Technology)

COMPONENT DESCRIPTION (ENHANCED TECHNOLOGY)

Brake Pedal Assembly

There are two brake pedal assemblies (one at the captains position and one at the first officers position) with two pedals in each assembly. They transmit the manual braking inputs through a brake pedal transmitter unit (located at the first officers pedals) to the BSCU.
They also transmit the manual braking inputs through a brake pedal transmitter unit (located at the captains pedals) to the ABCU. Each pedal in each assembly is installed at one side of a vertical column and they are free to turn independently. Levers and rods connect the left/right pedals of each assembly to each other.

- a spring operated actuator (spring rods)
- the input shaft of their related transmitter units

The spring rods give a resistance (artificial feel) when a force is put on the related pedal and put the pedal back to its initial position when the force is removed.

The transmitter unit is an electro–mechanical device connected to the brake pedals. It changes an mechanical input into an electrical output in proportion to the movement of the brake pedals.

Normal Brake Selector Valve

The brake selector valve is a solenoid operated valve (installed on the green PTU manifold) that isolates the green hydraulic supply from the normal brake system. The selector valve is a single solenoidvalve.This component is interchangeable with the alternate brake selector valve and the steering selector valve.

Normal Brake Servovalve Manifold

A similar normal brake servovalve manifold is installed on the upper part of each MLG main fitting.

It contains in a common housing:

- two new normal brake servovalves
- two pressure transducers
- two hydraulic fuses

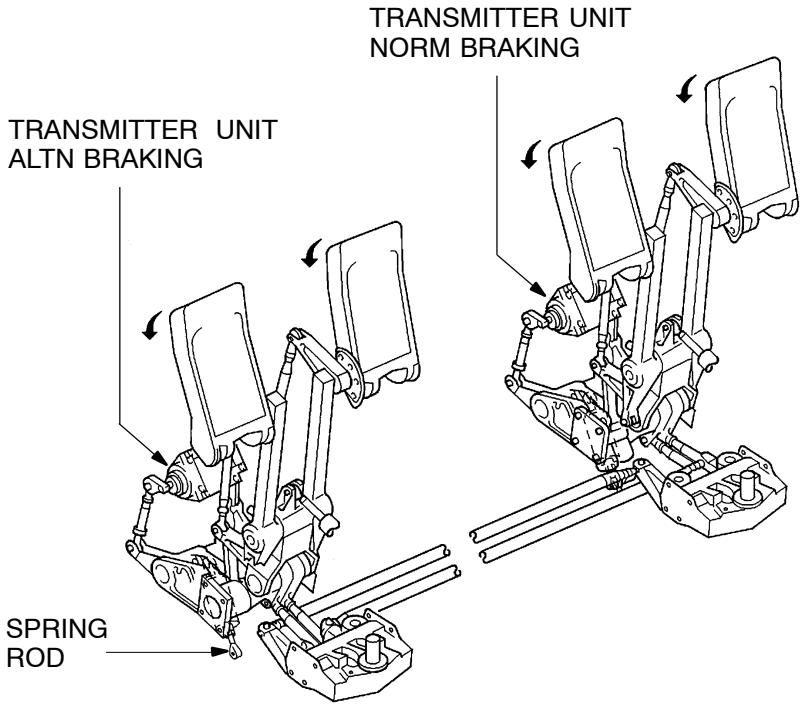


Figure 125 Brake Pedal Assembly

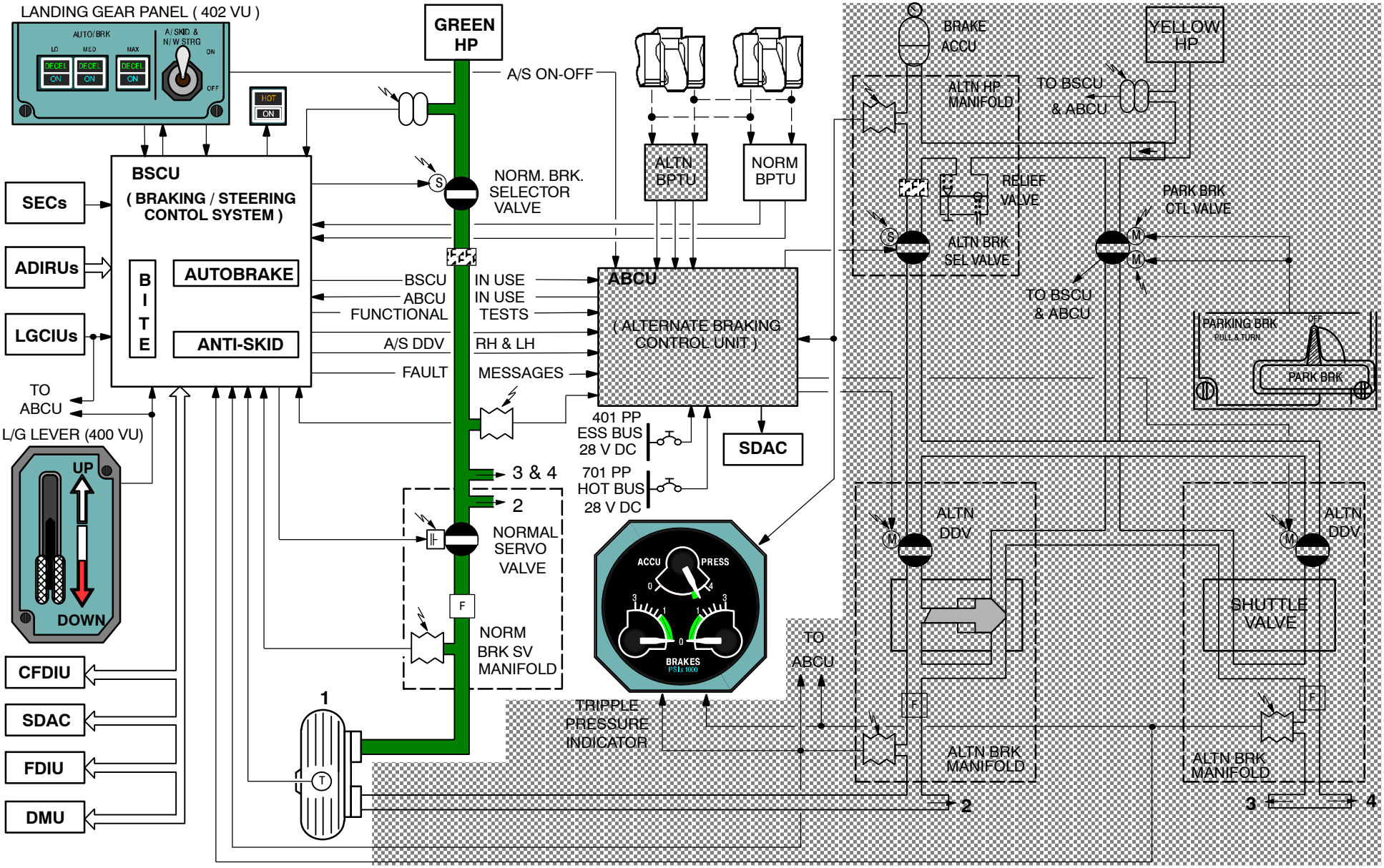


Figure 126 Brake System Basic Schematic

NORMAL BRAKE SERVO VALVE DESCRIPTION (ENHANCED TECHNOLOGY)

The servovalve supplies a pressure proportional to the current which passes through the control coil used. The servovalve is an electro–hydraulic valve that includes a hydraulic assembly with an electrical assembly attached. The valve has three primary positions of operation, with more positions of operation between the primary positions.

The valve is electrically controlled to keep the pressure in its related brake service line at the necessary value, or release the pressure. When there is no braking order the servovalve is fully closed.

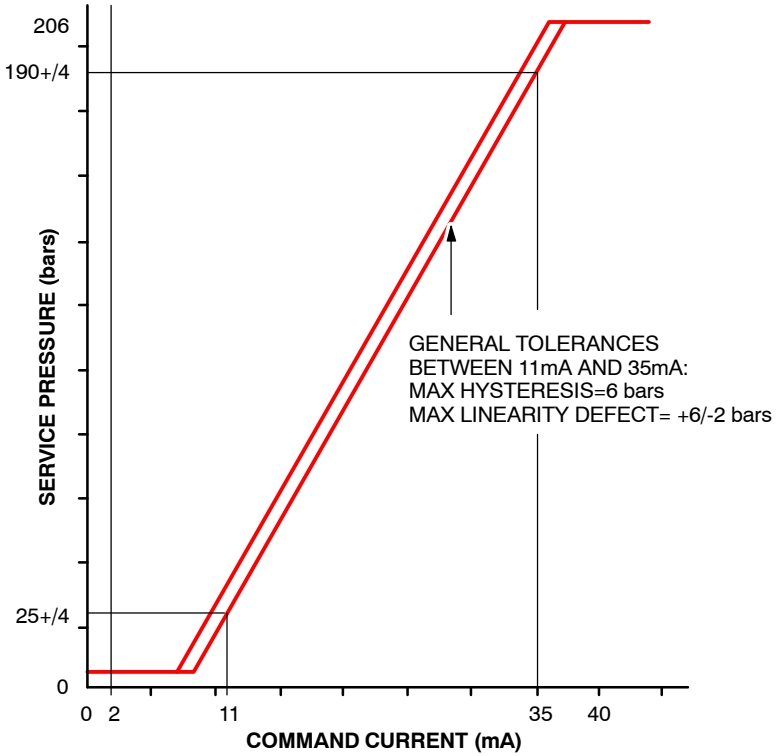


Figure 127 Norm BRK SV Characteristics

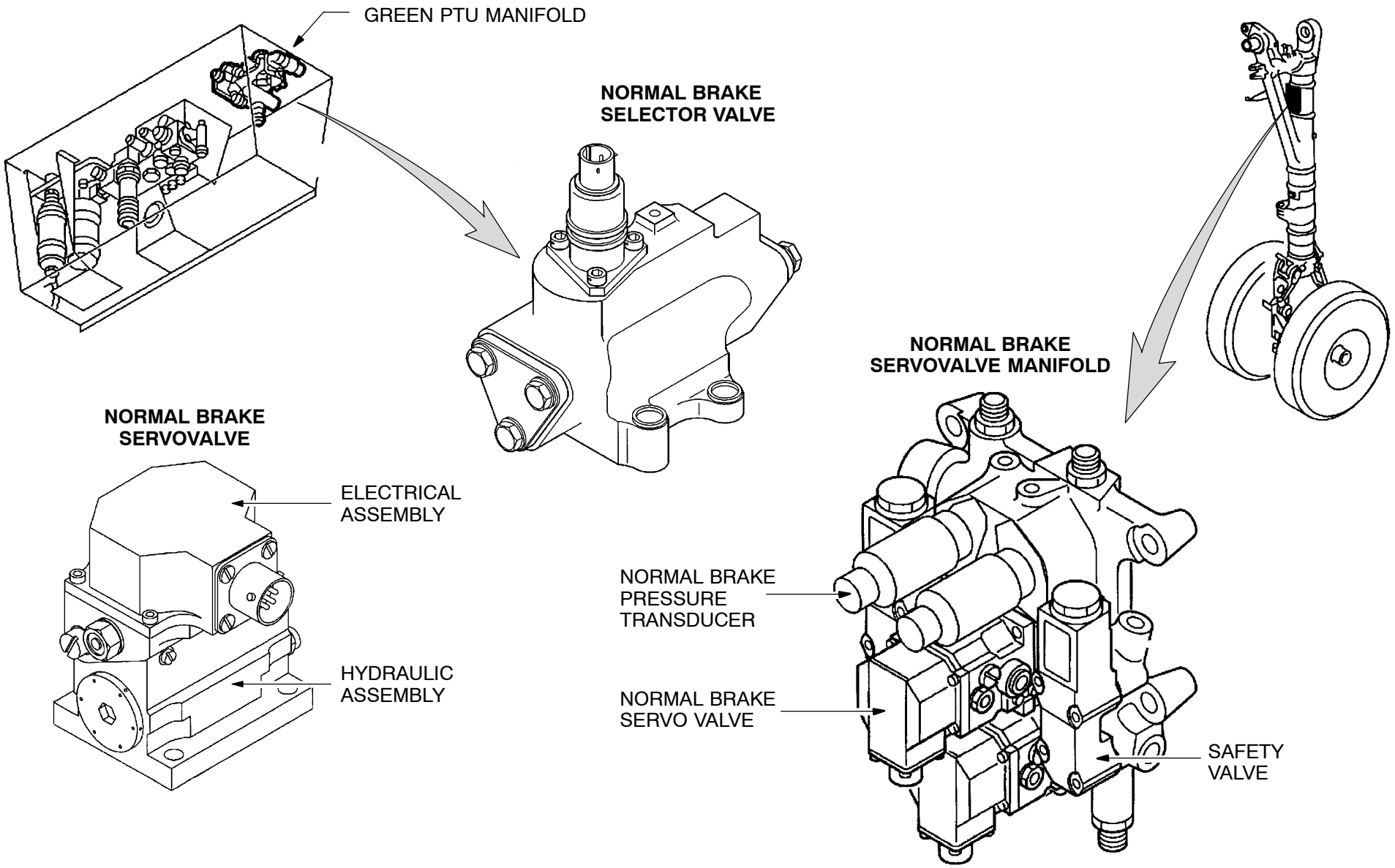


Figure 128 Normal Brake System Components

ALTN BRK WITH A/SKID SYSTEM DESCRIPTION – ENHANCED TECHNOLOGY

GENERAL

Alternate Braking with Anti Skid is the secondary electro-hydraulic braking system (electrically controlled and hydraulically operated). It gives automatic anti skid protection, if available from BSCU, when the aircraft moves at more than five meters per second.

It automatically becomes available if:

- specified failures occur in the Normal Brake System
- the pressure of the Geen Hydaulic System is less than a specified value.

If the Green hydraulic supply increases to more than 2176 psi after braking, the ABCU will give back the control to the BSCU (Normal Brake System), once the brake pedals have been fully released to prevent transient during a braking phase.

Function

When the normal braking is faulty, the BSCU informs the ABCU, which becomes active. The Alternate Braking Control Unit controls the operation of the alternate braking system which is hydraulically supplied from the yellow high pressure system. A pressure transducer informs the ABCU in case of yellow low pressure.

Braking inputs are given by the brake pedals and transmitted through the Alternate Brake Pedal Transmitter Unit (ALTN BPTU) to the ABCU. The ABCU opens the alternate brake selector valve. The current sent to the DDVs is proportional to the pressure applied on the brake pedals. The pressure output from each DDV goes through its related shuttle valve and the hydraulic fuse.

An alternate brake pressure transducer located in the alternate brake manifold downstream the hydraulic fuse, measures the brake pressure and displays it on the ACCU / PRESS triple indicator. These data are also sent to the BSCU for the anti–skid function. If a wheel reaches a skid condition, the anti–skid current is generated by the BSCU and sent to the ABCU, which reduces the current to the appropriate DDV to release the pressure.

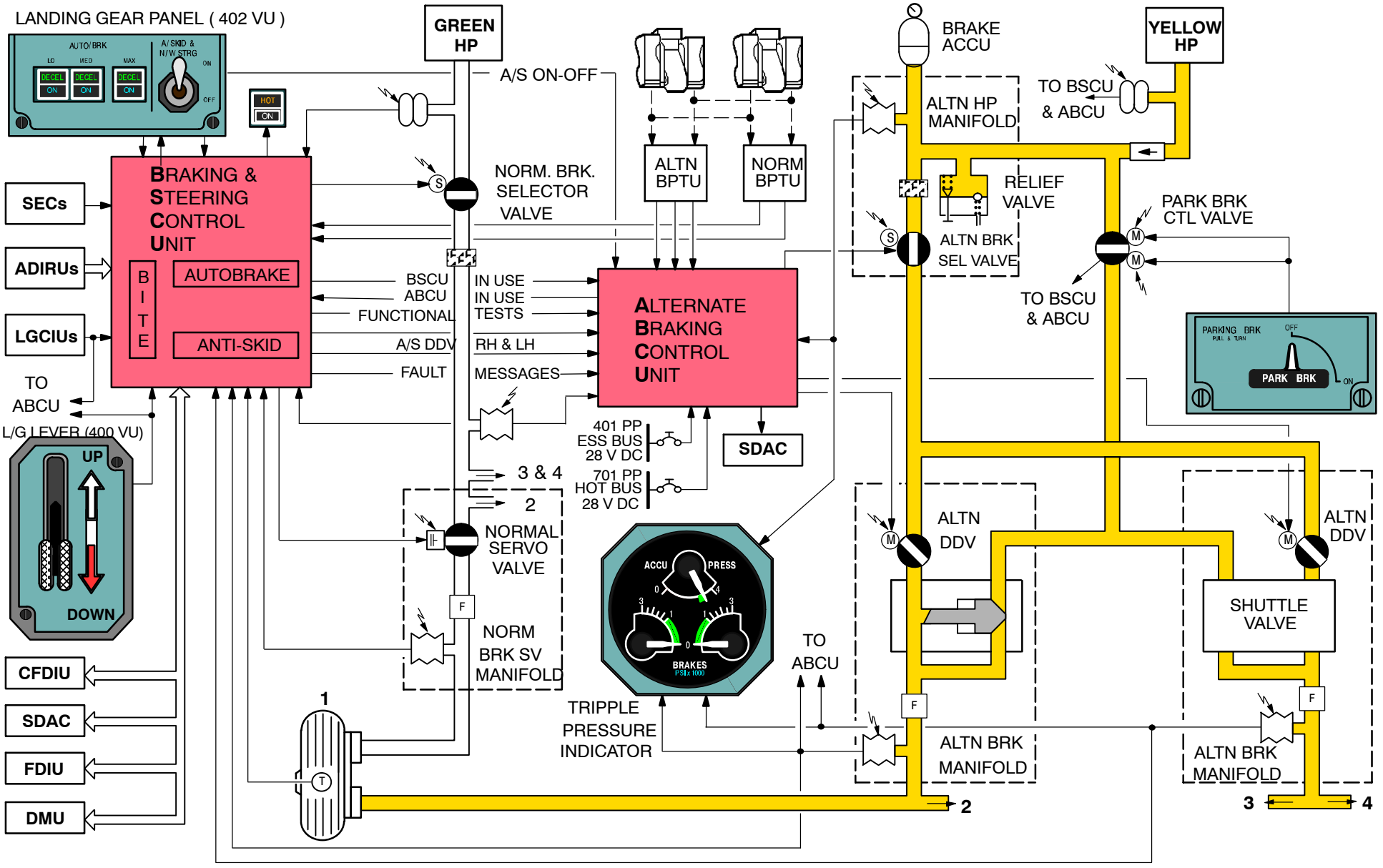


Figure 129 ALTN Brake with A/S

ALTN BRAKING COMPONENT DESCRIPTION ENHANCED TECHNOLOGY

ALTERNATE BRAKING CONTROL UNIT (ABCU)

When NORMAL system is activated, braking control and Anti Skid protection are provided by the BSCU.

When ALTERNATE braking circuit is activated, braking control is provided by the ABCU. Antiskid protection is still provided by the BSCU, which sends antiskid orders to the ABCU.

The ABCU is automatically activated if:

- the A/SKID & N/W STRG switch is selected to OFF position
- the BSCU is not serviceable (system 1 and 2 failures)
- the normal braking system has failed
- only the batteries supply the aircraft

When ALTERNATE braking is activated:

- the ABCU energizes the alternate brake selector valve and indicates to the BSCU that braking is activated on the ALTERNATE braking system
- the ABCU determines the braking orders according to the brake pedal deflections measured by the brake pedal transmitter unit
- the ABCU determines if antiskid protection is inhibited according to a predeterminated logic. If antiskid protection is not inhibited, the unit combines these braking orders with the antiskid orders sent by the BSCU.

The ABCU sends the braking orders, combined or not with antiskid control orders, to the alternate brake DDVs. The ABCU inhibits such braking orders according to a logic based on alternate pressure transducer and park brake on signals. Such inhibition prevents the alternate brake DDVs from operating in low hydraulic load conditions.

When Emergency braking is activated the ABCU inhibits the antiskid protection and maintains a predeterminated level of braking even when the brake pedals are fully released.

The ABCU continuously monitors the specific inputs, coming from the alternate brake pedal transmitter unit and the park accumulator pressure transducer and sends the indications to the BSCU or SDACs in case of failure detection with outputs discretes.

Alternate HP Manifold

The manifold assembly is installed in the MLG bay, hydraulic compartment, on wall C47 right side. The primary components of the manifold assembly are the:

- Alternate Brake Manifold
- Alternate Selector Valve
- Pressure Relief Valve
- Check Valve
- Pressure Transmitter

Alternate Selector Valve

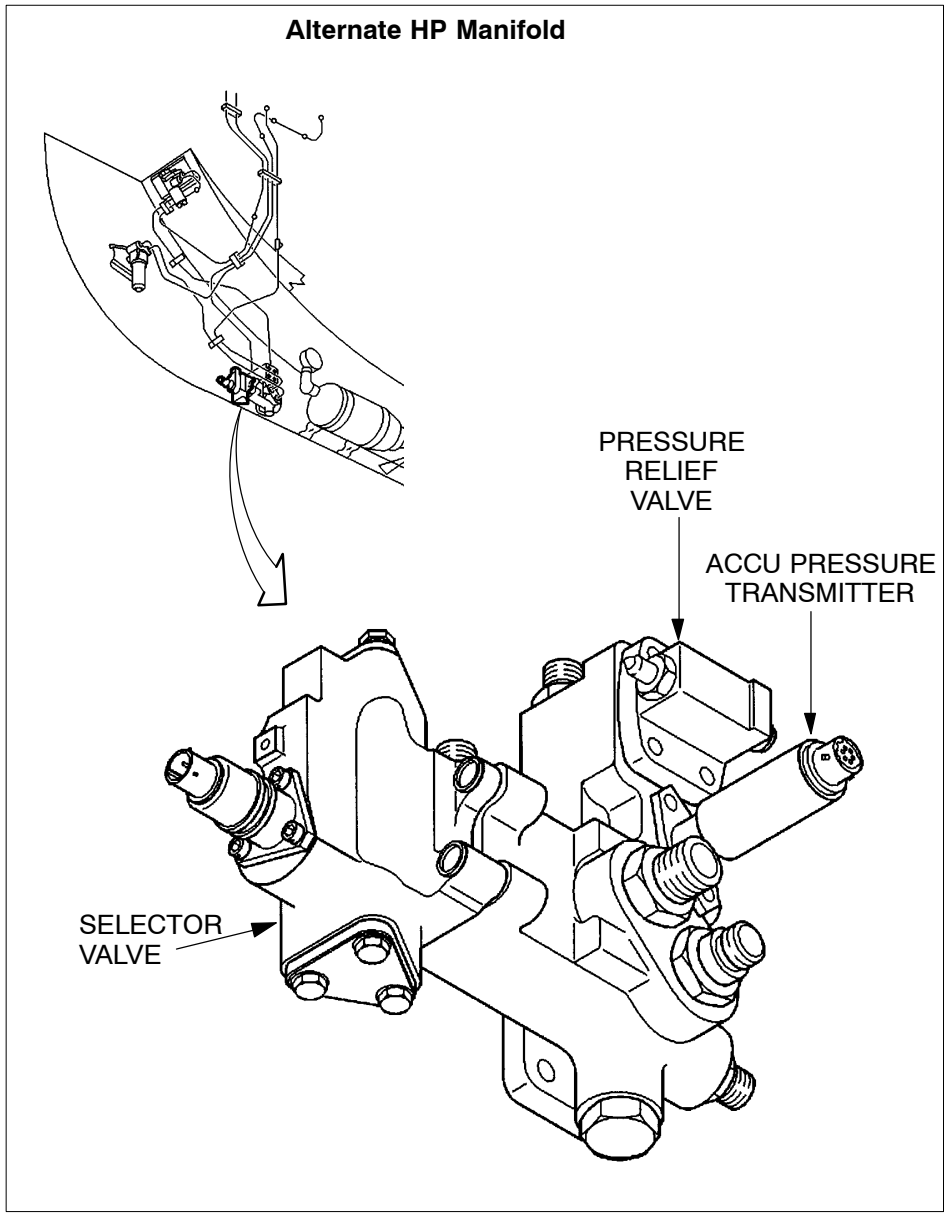
The alternate selector valve is the same as the normal selector valve.

Pressure Relief Valve

The pressure relief valve returns the fluid directly to the reservoir in the case of overpressure. It limits the pressure to 3436 psi if a thermal expansion occurs, and is also used for manual pressure release.

Yellow Accumulator Pressure Transmitter

It is installed in the common supply line. It transmits data of the hydraulic fluid pressure to the third input of the Brake Pressure Triple Indicator and to the ABCU.



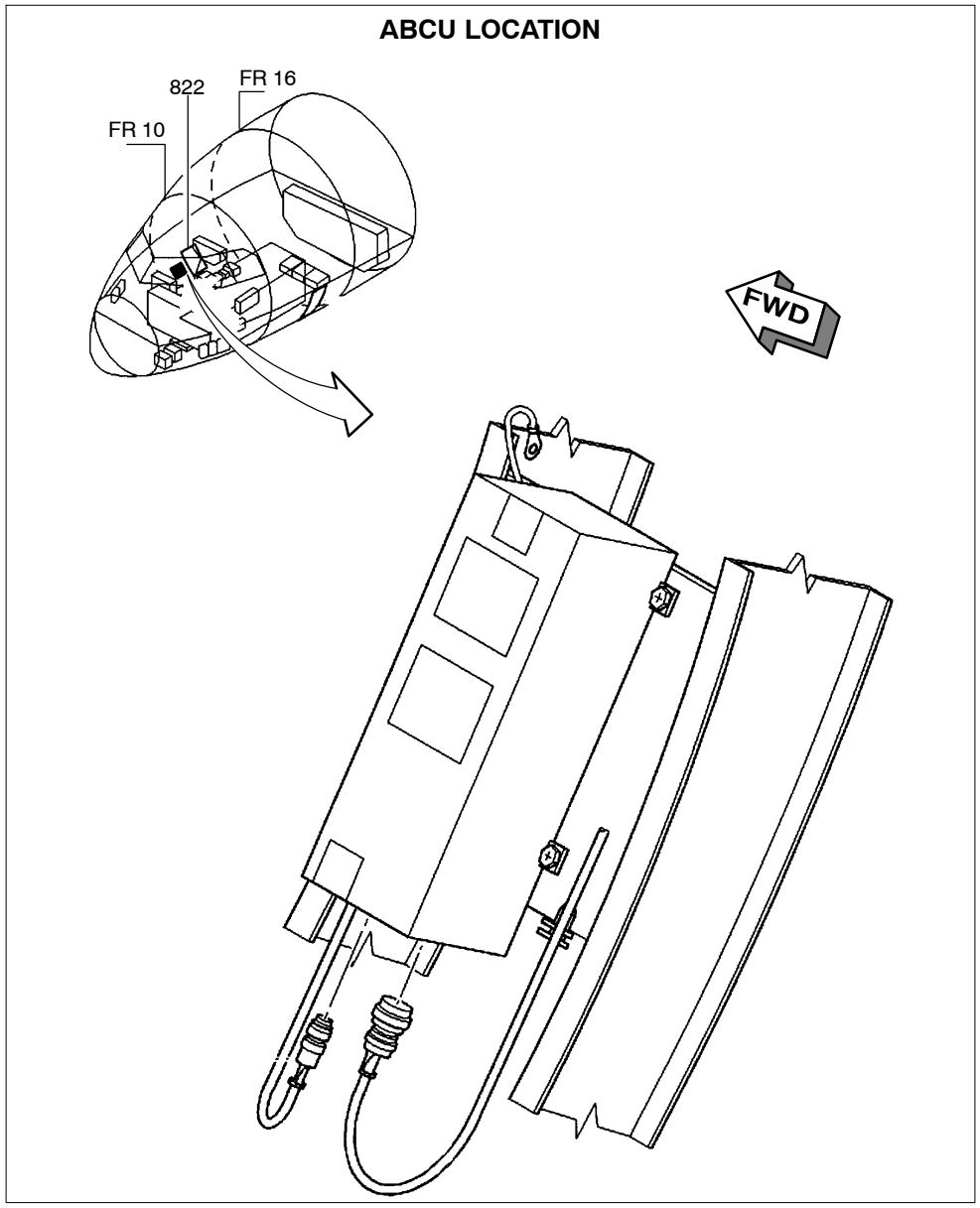


Figure 130 Aternate Brake System Components

DIRECT DRIVE VALVE DESCRIPTION

The Direct Drive Valve receives an input current from the ABCU which corresponds to the required brake pressure. In the DDV an electronic stage controls a hydraulic stage. A Pressure Transmitter is located on the DDV outlet port. The information from the transmitter is sent to the electronic stage which compares it to the current sent by the ABCU. If necessary, hydraulic stage action will be corrected in regards to the required braking pressure. The Direct Drive Valve (DDV) is a three–way servo valve of the pressure control type. The DDV has electrical and hydraulic assemblies.

The electrical assembly has a:

- Torque Motor
- Pressure Transducer
- Electronic Amplifier
- Plug–In Type Electrical Connector

The hydraulic assembly has a:

- Valve Body
- Liner Assembly

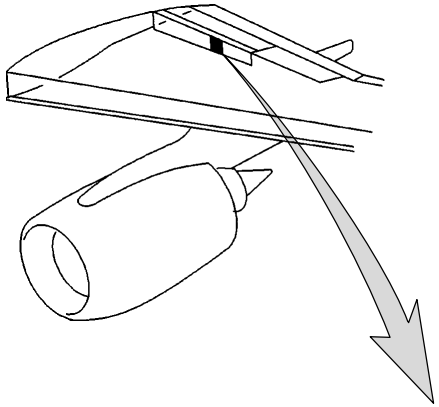
The electronic assembly is installed in a housing on top of the valve body. Clamps and screws attach the torque motor to the valve body. The pressure transducer has a support that connects it to the valve body.

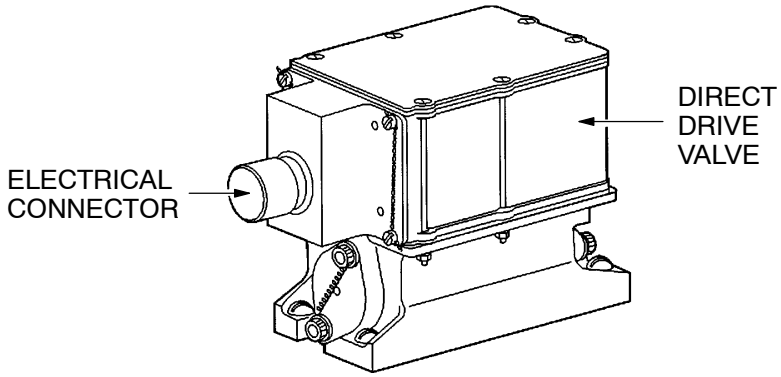
Brake Yellow Pressure Transducers

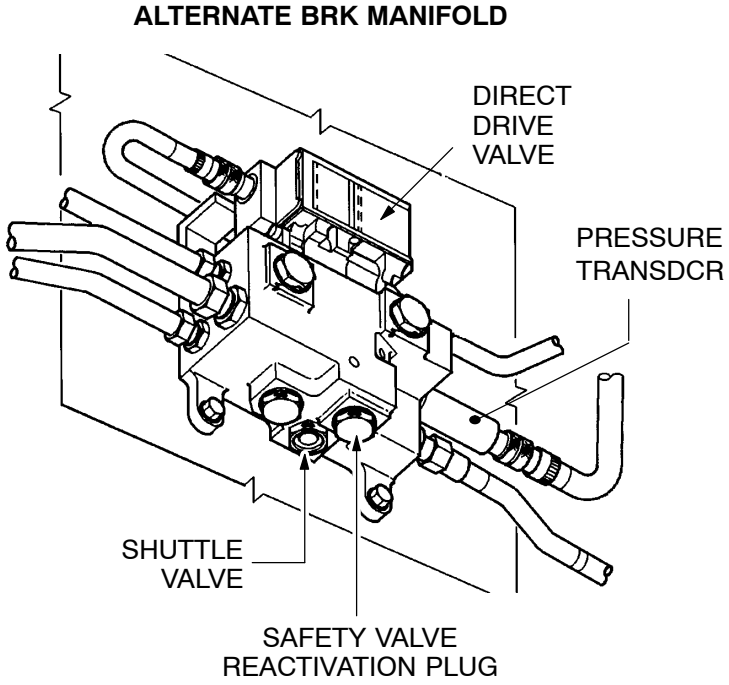
The pressure transducers send data to the BSCU, ABCU and to the Triple Indicator (right & left side).

Safety valves

If a large leak occurs downstream of the safety valve, the valve closes to stop the flow of the hydraulic fluid to its related brakes.







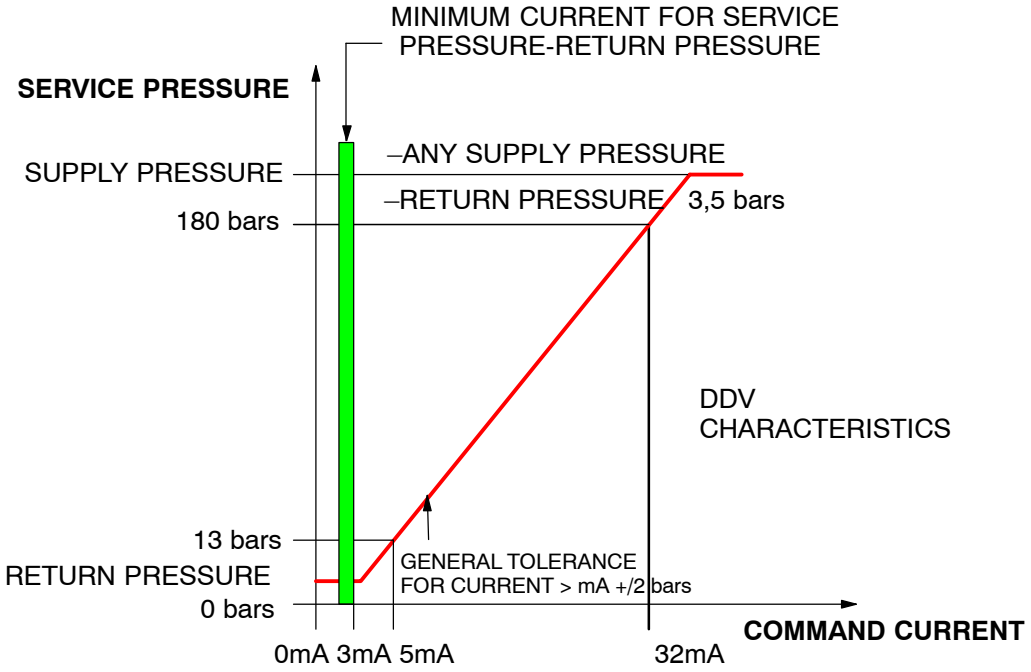


Figure 131 ALTN Brake System Components

ALTN BRK WITHOUT A/SKID DESCRIPTION ENHANCED TECHNOLOGY

GENERAL

Alternate Braking without Anti Skid is the secondary mode of operation of the Alternate Braking system. The system is automatically available when:

- the A/S switch is set to OFF
- In the case of anti–skid failure during the alternate braking with anti–skid
- the Yellow Main Hydraulic System is not available

In this case the ABCU automatically controls the alternate braking system without anti–skid protection. In the event of insufficient yellow hydraulic pressure, the brake accumulator supplies the brakes.

Braking orders are sent to the ABCU via the alternate BPTU. The ABCU energizes the alternate brake selector valve and applies to the DDV a current proportional to the alternate BPTU signals.

To reduce the risk of tire burst when anti–skid is not available, the ABCU limits the brake pressure to 1000 psi. To release this limitation, the alternate brake pressure transducers measure the brake pressure and send data to the ABCU. These transducers also give visual indication on the ACCU/PRESS Triple Indicator.

Braking Operation during Towing

A function in the ABCU allows to brake the aircraft during towing operation.
The ABCU is able to switch from DC Essential Power Supply to the Hot Bus Power Supply when no electrical power supply is available and the pedals are depressed.
The ABCU is connected to a third set of potentiometers in the alternate BPTU and a connection to the Hot bus Power Supply is done.
Park Brake can be applied, as well without electricity on board (batteries only).

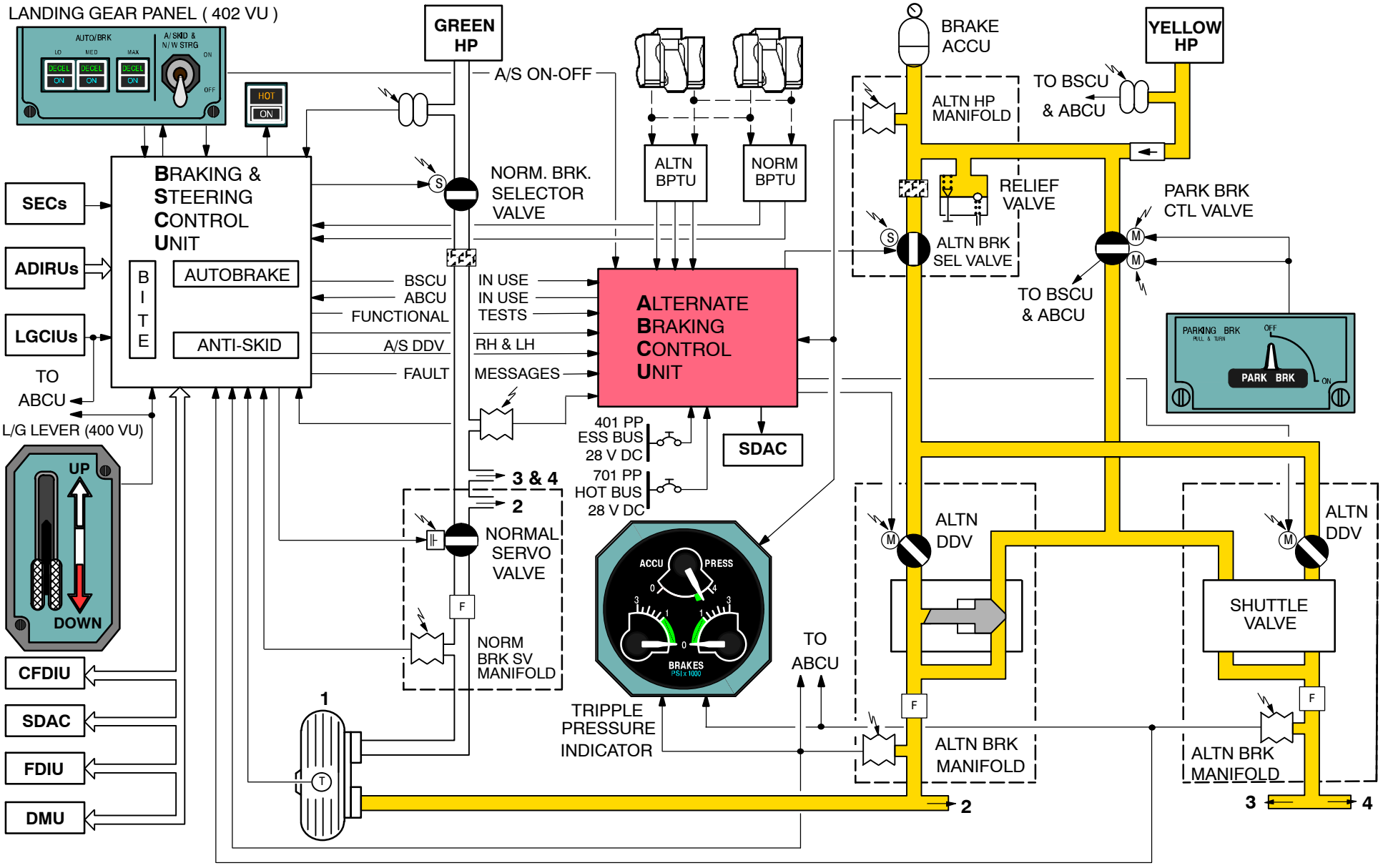


Figure 132 ALTN Brake without A/S

PARKING/ULTIMATE EMERGENCY BRAKING DESCRIPTION (ENHANCED TECHNOLOGY)

GENERAL

The Parking Brake System operation is simplified due to the automatic selector valve and parking brake operated valve deletion. Its primary function is to prevent movement of the aircraft when it is parked. It can also be used to stop the aircraft during towing or in an emergency.

Function

The Parking Brake System receives hydraulic power supply from the accumulator of the Alternate Braking System or from the Yellow Hydraulic System Pressure. The accumulator has sufficient capacity to hold the brakes on for a minimum of twelve hours.

When the parking brake handle is applied, the new shuttle valves serve for hydraulic priority to the parking brake. When the parking brake control valve is open, a signal is sent to the BSCU and the ABCU in order to override all other braking modes.

The brake pressure supplied to the MLG is shown on the Tripple Pressure Indicator.

If the brake accumulator pressure becomes low when parking brake is on, normal braking by using the pedals can be applied in order to stop the aircraft. When the pedal deflection order exceeds the pressure delivered by the parking brake, the BSCU sends a complement of pressure to the normal set of pistons to reach the commanded value.

The CONFIG PARKING BRAKE ON warning message (CRC) appears on the upper ECAM DU when:

- the parking–brake control switch is in the ON (applied) position
- one engine is at full throttle

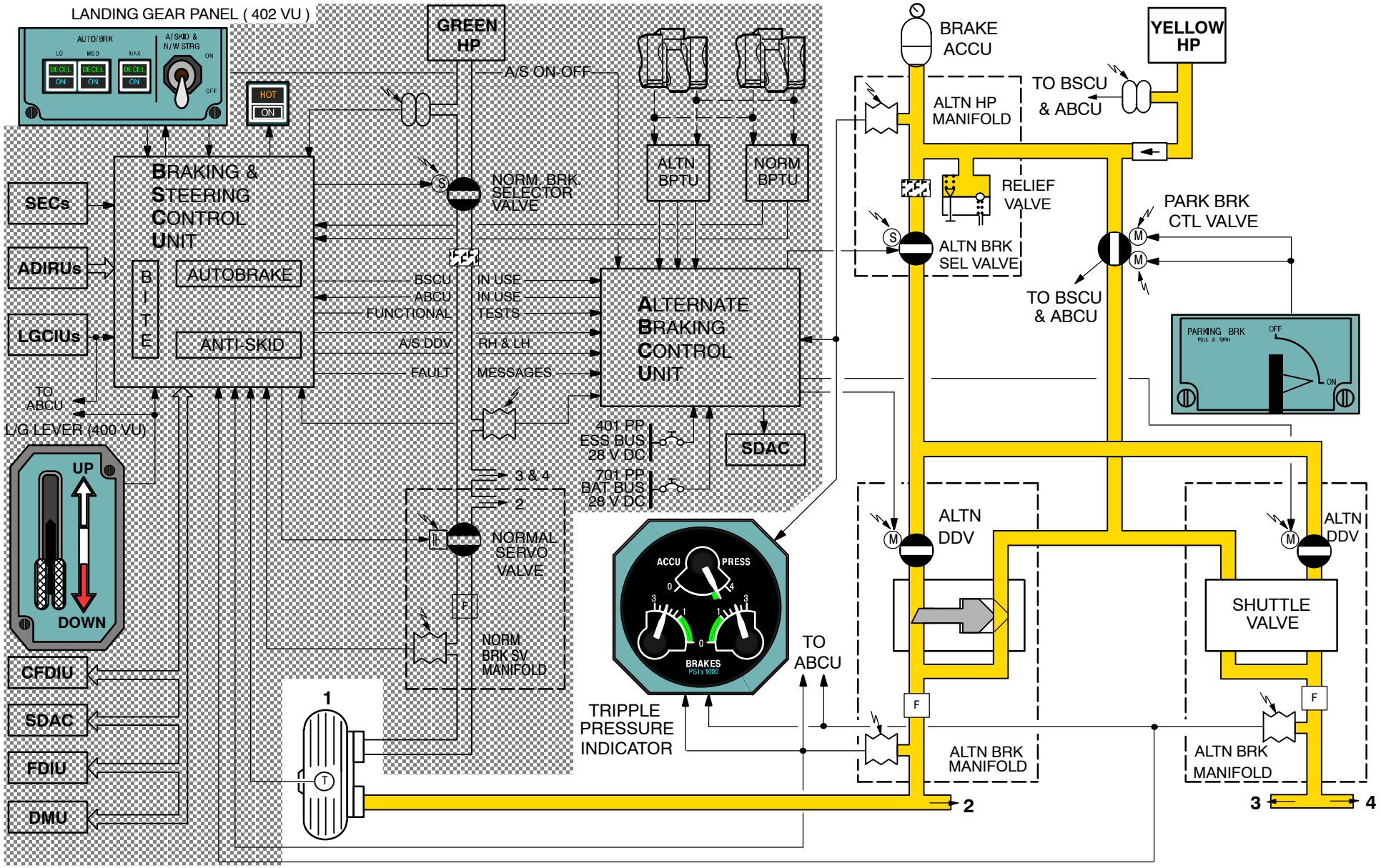


Figure 133 Parking/Ultimate Brake System

COMPONENT DESCRIPTION (ENHANCED TECHNOLOGY)

PARK BRAKE CONTROL VALVE

The Park Brake Control Valve is an electro-hydraulic unit that controls the hydraulic supply pressure to the parking brake system. The valve consist of a body and an electrical actuator. The desiccant cartridge and the thermal fuses are no longer fitted.

When the park brake selector–switch is set to ON, the motors in the Park Brake Control Valve are energized to open the valve. When the valve is open, an electrical contact in the valve sends a signal to the BSCU and the ABCU. This causes the BSCU and the ABCU to isolate the other braking systems.

Another electrical contact in the valve completes a circuit to the Nose Wheel Steeering electrical de–activation box. This sets the NLG PARKING BRAKE indicator light to ON. When the valve opens it connects the accumulator pressure (or yellow system pressure) to its service port.

The valve decreases the supply pressure to 2103 psi. The hydraulic pressure goes to the alternate brake manifolds of each MLG. At the manifolds this causes the shuttle valves to operate and directs the pressure to the second set of pistons in the brake units.

Shuttle Valve

The shuttle valve isolates the parking brake supply from the alternate brake supply.The shuttle valve has a body that is installed in the alternate brake system manifold block.The body holds a valve and a spring. An end plug keeps these items in the body and supplies a seat for the valve.
Usually the spring keeps the valve against the seat to let the alternate brake hydraulic supply go through to the related brakes. When the parking brake is set, the parking brake hydraulic supply moves the valve against the spring. This lets the parking brake supply go through to the related brakes and isolates the alternate brake supply.

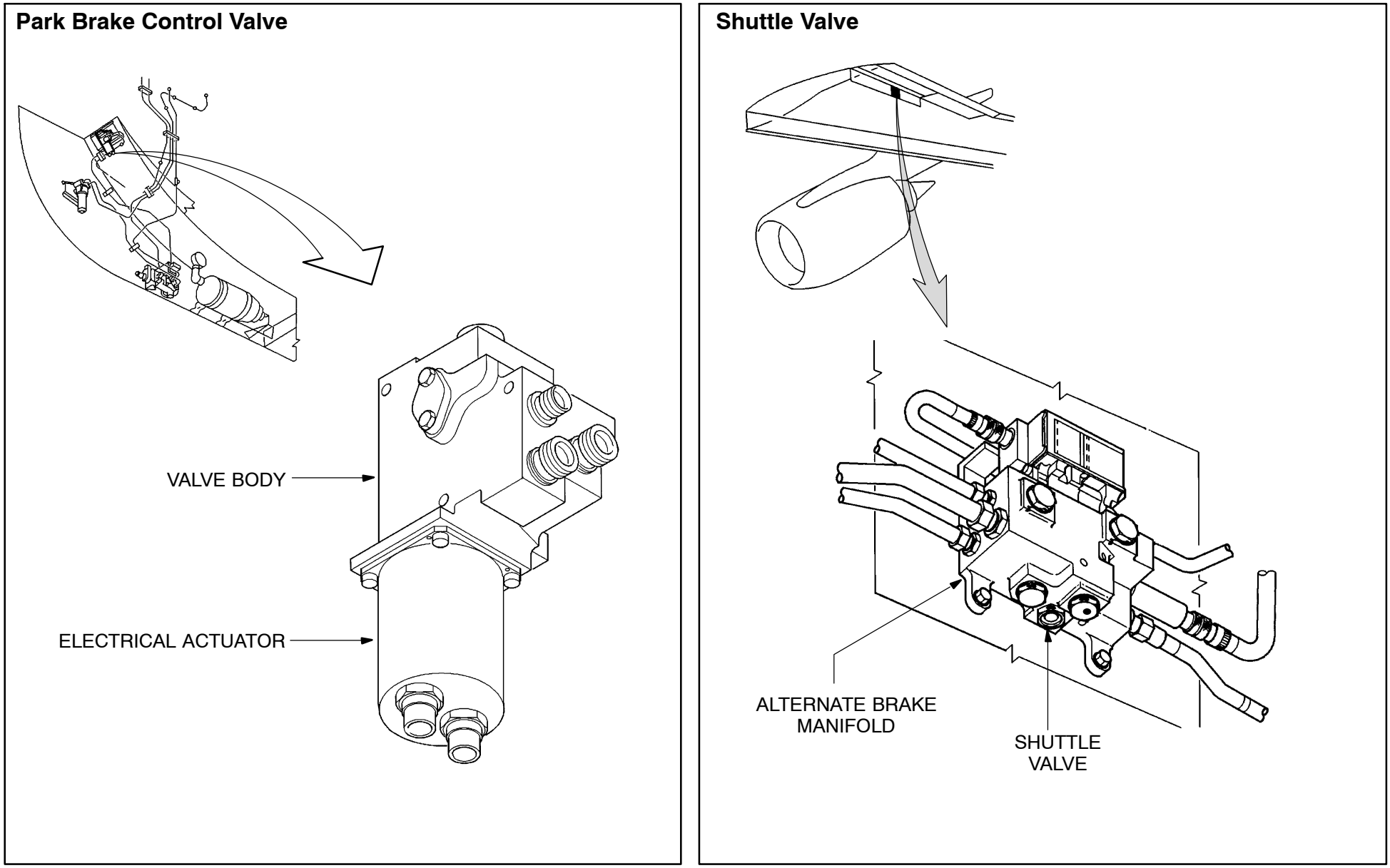


Figure 134 Parking Brake Components

MCDU BSCU PAGES DESCRIPTION (ENHANCED TECHNOLOGY)

MCDU BSCU PAGES

Next to BSCU software evolution some modifications have been applied on the various MCDU menus of the BSCU system 1 and system 2 pages:

- Some minor modifications concerning the display itself
- PIN–PROG SELECTION line key is removed and associated selections are no more available
- STEERING DATA line key is moved from the main menu to a new menu called SPECIFIC DATA
- a GROUND REPORT line key is added
- TEST line key is replaced by the SYSTEM TESTS line key

System Tests

These tests have to be performed after maintenance action on the braking and steering systems. Their purpose is to check the correct operation of the BSCU.

LRU WIRING & BSCU TEST launches the test of the continuity, electrical monitoring and permanent monitoring functions.

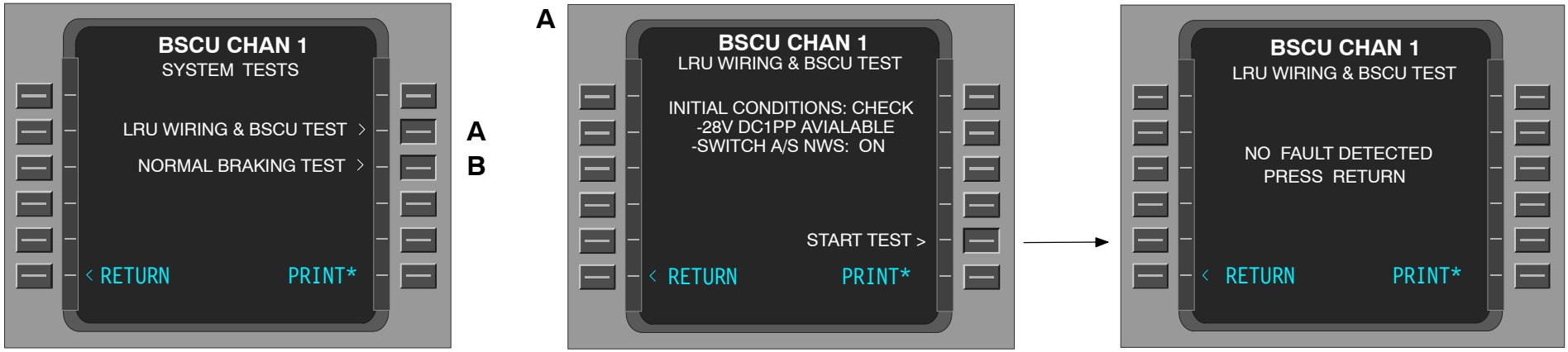
Normal Braking Test

NORMAL BRAKING TEST launches the test of the continuity, electrical monitoring and permanent monitoring and the functional braking tests on the normal system.

Once the test has been selected, the BSCU indicates the conditions required to launch the test. Once these conditions have been met, pushing the START TEST line key launches the test itself. After the test, several response indications are displayed:

- NO FAULT DETECTED: test OK
- Fault detected: test not OK, gives the class 1 and class 3 fault messages detected
- Test not performed: at least one of the conditions required is not fulfilled
- TEST TIME OUT

Figure 135 BSCU Menu



EXAMPLE:
BSCU CHAN 1 SHOWN
CHAN 2 is IDENTICAL

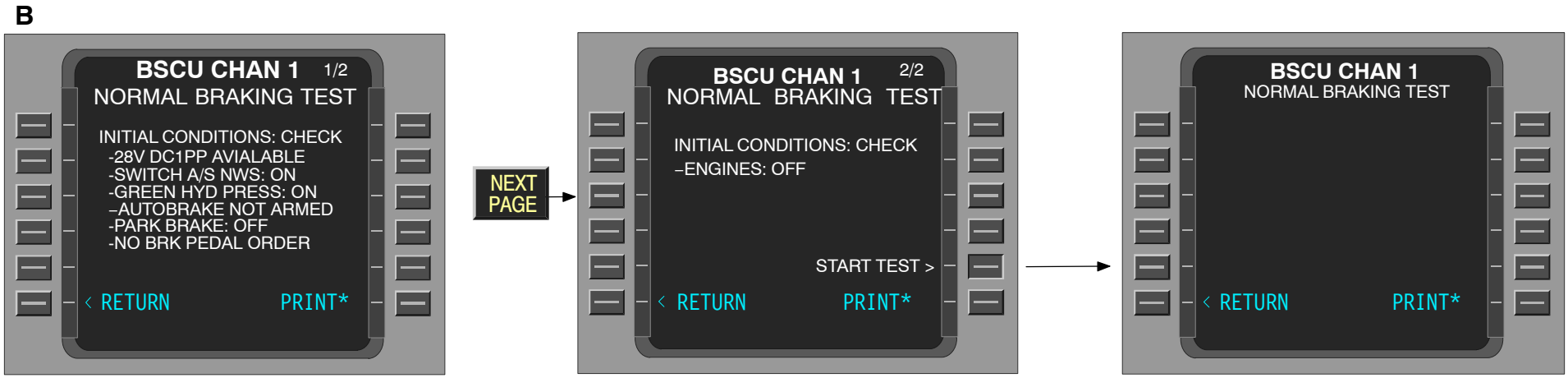


Figure 136 MCDU BSCU PAGES

BSCU SPECIFIC DATA DESCRIPTION

The SERVOVALVE DATA displays the normal brake servo valve drift in psi.

The PIN PROGRAMMING DATA shows:

- the type of brake and diameter of the wheels installed on the aircraft
- the type of automatic braking, type 1 is the standard configuration
- the status of the fans option, installed or not installed

STEERING DATA function displays in real time and clear language some parameters of the nose wheel steering system. This function allows any possible malfunctioning of this system to be identified in case of a steering problem during rollout.
The data displayed are:

- the selector valve status (OPEN or CLOSED)
- the servovalve current in mA
- the nose wheel controlled angle, in degrees
- the RVDT angle (command channel), in degrees
- the RVDT angle (monitor channel), in degrees
- the LVDT displacement, in mm
- the CAPT steering handwheel angle, in degrees
- the F/O steering handwheel angle, in degrees
- the nose wheel steering status, ON or OFF

The REFRESH line key is used to refresh the values of the nose wheel steering parameters, as required.
The SYSTEM DATA function displays on three pages data related to the BSCU environment:

- date, UTC
- Braking System
- Aircraft Identification
- BSCU Status and Configurations
- Braking Commands
- Servo Valve Currents and Voltages
- Brake Pressures
- Brake Temperatures
- Wheel Speed and Wheel Reference Speed
- Nose Wheel Steering Status
- L/G Status
- Hydraulic Status (green and yellow)

The REFRESH line key is used to refresh the various parameters values.

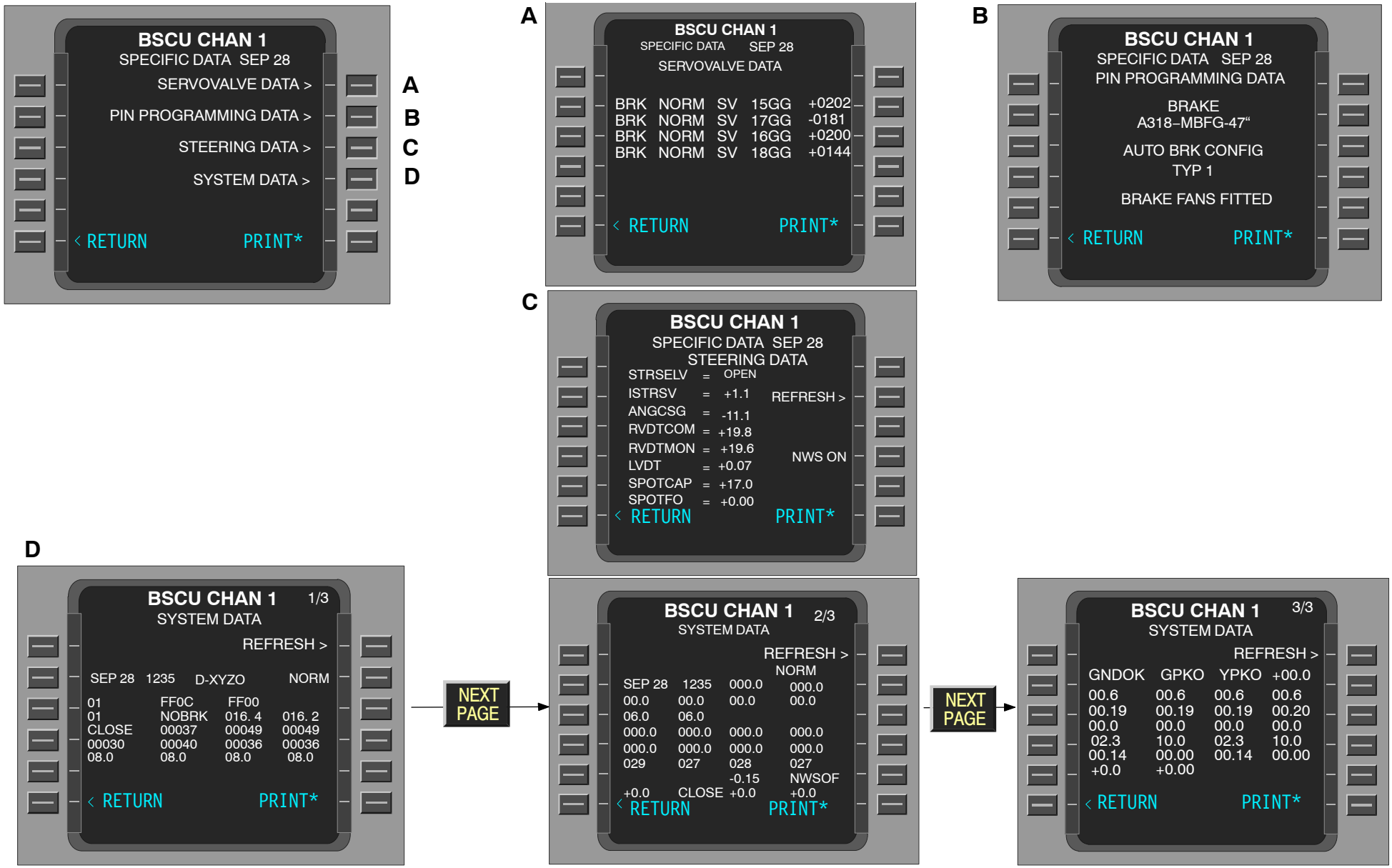


Figure 137 MCDU BSCU Specific Data

N/W STEERING SYSTEM DESCRIPTION (ENHANCED TECHNOLOGY)

GENERAL

In order to improve the aircraft lateral control ability on ground, following the loss of the green hydraulic supply, the modification consists in supplying the N/WS with the yellow hydraulic power.

In addition, the hydraulic block is no longer pressurized from the NLG door close line. The N/WS selector valve has been removed from the hydraulic block and placed on the yellow HP line upstream of the swivel selector valve.

Description

Control inputs, Braking/Steering Control Unit (BSCU) computation, activation and de–activation of the nose wheel steering remains the same. An hydraulic fuse is added downstream of the selector valve.

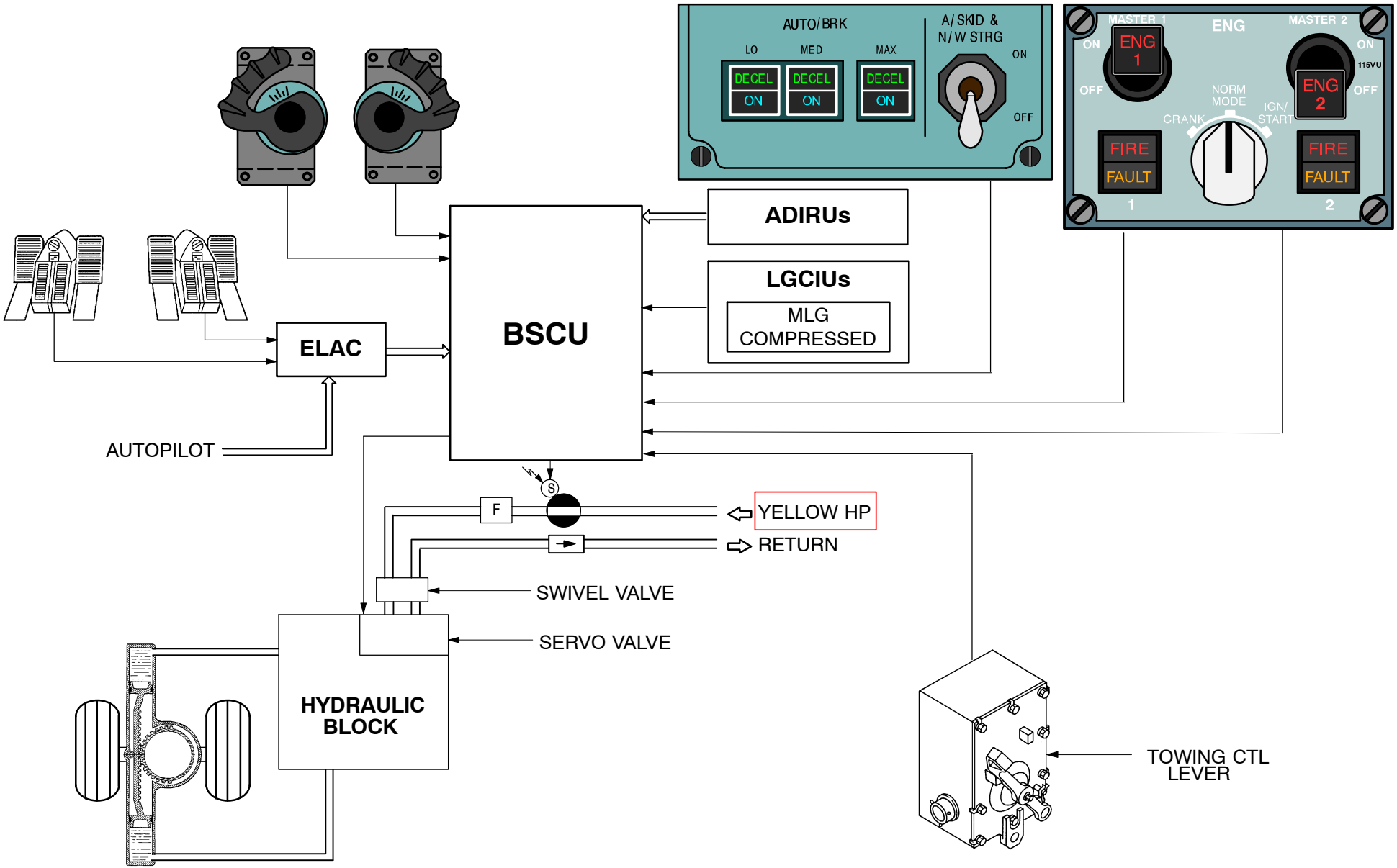


Figure 138 NWS Schematic

COMPONENT LOCATION

The selector valve (identical with the normal and alternate brake selector valve) and the hydraulic fuse are located on the R/H MLG wheel well front spar (Zone 148).

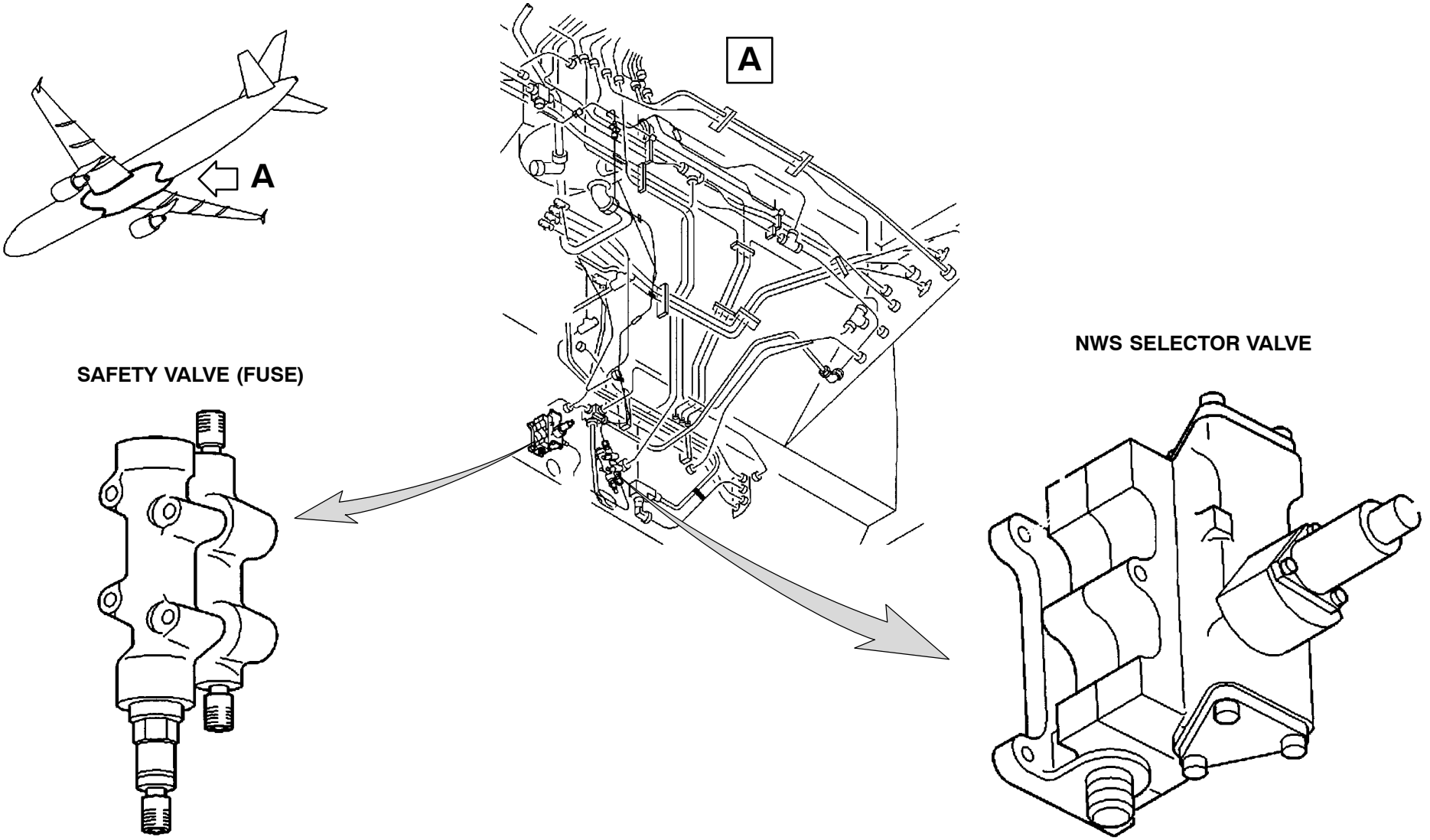


Figure 139 NW/S Components

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