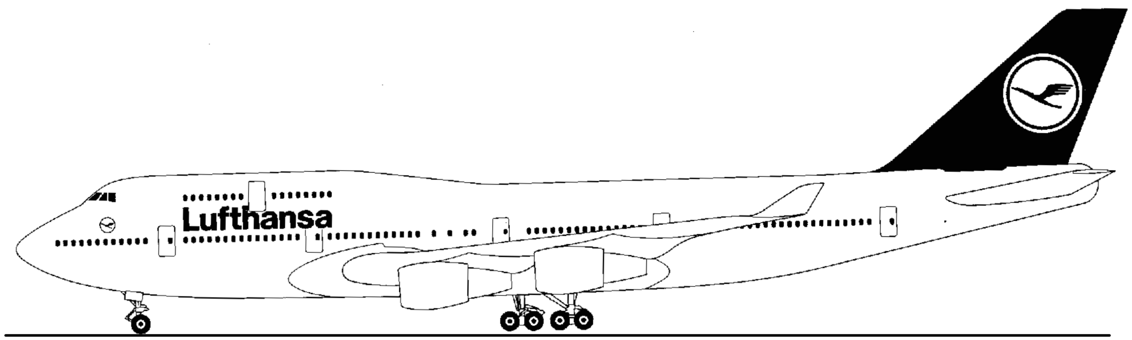
Lufthansa
Technical Training

Training Manual
B 747 - 430

ATA 27
FLIGHT CONTROLS



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ATA 27 FLIGHT CONTROLS

27-00 GENERAL

PRIMARY CONTROLS

GENERAL

WARNING: FIRE RESISTANT HYDRAULIC FLUIDS CONFORMING TO BMS 3-11 MAY CAUSE SKIN IRRITATION. AVOID PROLONGED OR REPEATED CONTACT WITH THE SKIN. IN CASE OF EYE CONTACT, FLUSH THE EYES WITH WATER AND OBTAIN MEDICAL AID. IN CASE OF INGESTION, OBTAIN MEDICAL AID.

Primary controls of airplane flight attitude are ailerons, elevators, and rudders. These primary control surfaces are positioned by hydraulic actuators powered by the airplane's four independent hydraulic systems. The surfaces are controlled from the flight compartment with aileron control wheels, elevator control columns, and rudder pedals.

AILERONS

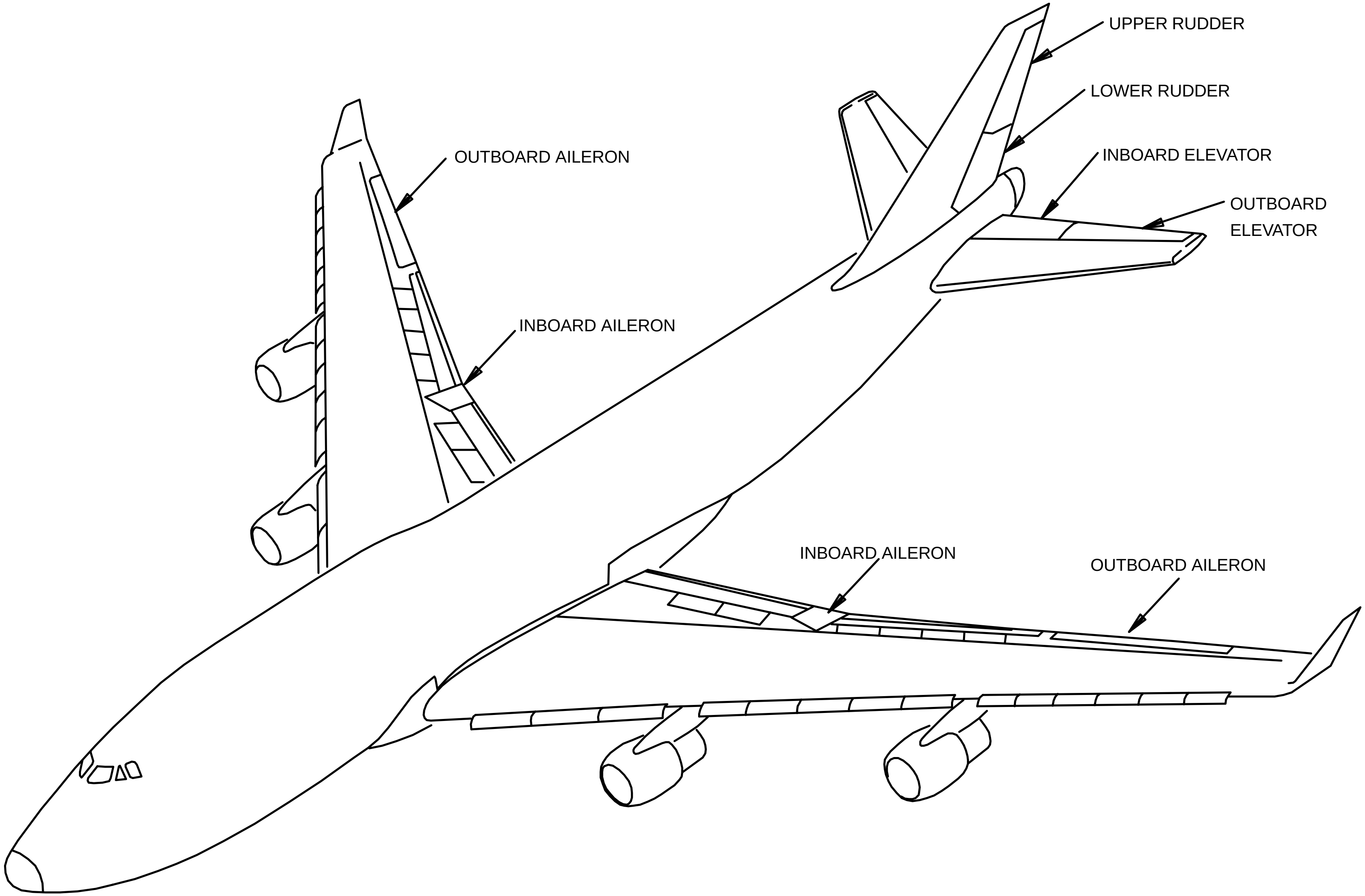
- dienen zur Quersteuerung
- 2 Inboard- und 2 Outboard Ailerons
- werden hydraulisch betätigt
- Inboard Ailerons sind immer wirksam
- Outboard Ailerons sind wirksam in Abhängigkeit von Flaps und Speed

RUDDERS

- dienen zur Seitensteuerung
- Upper- und Lower Rudder
- werden hydraulisch betätigt
- Ausschläge werden in Abhängigkeit der Speed verändert
  - Low Speed: Großer Ausschlag
  - High Speed: Kleiner Ausschlag

ELEVATORS

- dienen zur Höhensteuerung
- 2 Inboard- und 2 Outboard Elevators
- werden hydraulisch betätigt



326 432

Figure 1 PRIMARY FLIGHT CONTROL SURFACES

SECONDARY CONTROLS

GENERAL

Secondary controls consist of spoilers, trailing edge flaps, leading edge flaps, and an adjustable horizontal stabilizer.
Spoilers are hydraulically powered. When used for lateral control, the spoilers are controlled by a mechanical output from the aileron control system.
When used as speed brakes, the spoilers are controlled from the speed brake lever on the pilots' control stand.
Trailing edge flaps are normally driven by hydraulic power and leading edge flaps by pneumatic power. All flaps are controlled from the flap control lever on the pilots' control stand. All flaps may be driven by electric motors as an alternate means of power. The electric motors are controlled by the flap control lever, or may be controlled directly by switches on the pilots' center instrument panel.
The horizontal stabilizer is positioned by hydraulic motors controlled by switches mounted in the aileron control wheels. There are also switches on the pilots' control stand which override all other command signals to position the stabilizer.

HORIZONTAL STABILIZER

- dient zur Höhentrimmung
- wird hydraulisch betätigt
- Verstellgeschwindigkeit ist unterschiedlich in Abhängigkeit von Trimmart und Speed

FLAPS

- dienen zur Autriebserhöhung
- 2 Inboard- und 2 Outboard Flaps
- Betriebsarten:
  - Primary Hydraulic
  - Primary Electric
  - Alternate Electric

LIFT AUGMENTING

- dient zur Auftriebserhöhung
- 22 Variable Camber Flaps
- 6 Krueger Flaps
- Betriebsarten :
  - Primary Pneumatic
  - Primary Electric
  - Alternate Electric

SPOILERS

- dienen zur Unterstützung der Ailerons (Quersteuerung) und als Speed Brakes
- 10 Flight Spoilers und 2 Ground Spoilers
- werden hydraulisch betätigt
- Quersteuerung 10 Flight Spoilers fahren asymmetrisch
- Speed Brakes fahren symmetrisch
  - In Flight: 6 Flight Spoilers und 2 Ground Spoilers
  - On Ground: 10 Flight Spoilers und 2 Ground Spoilers

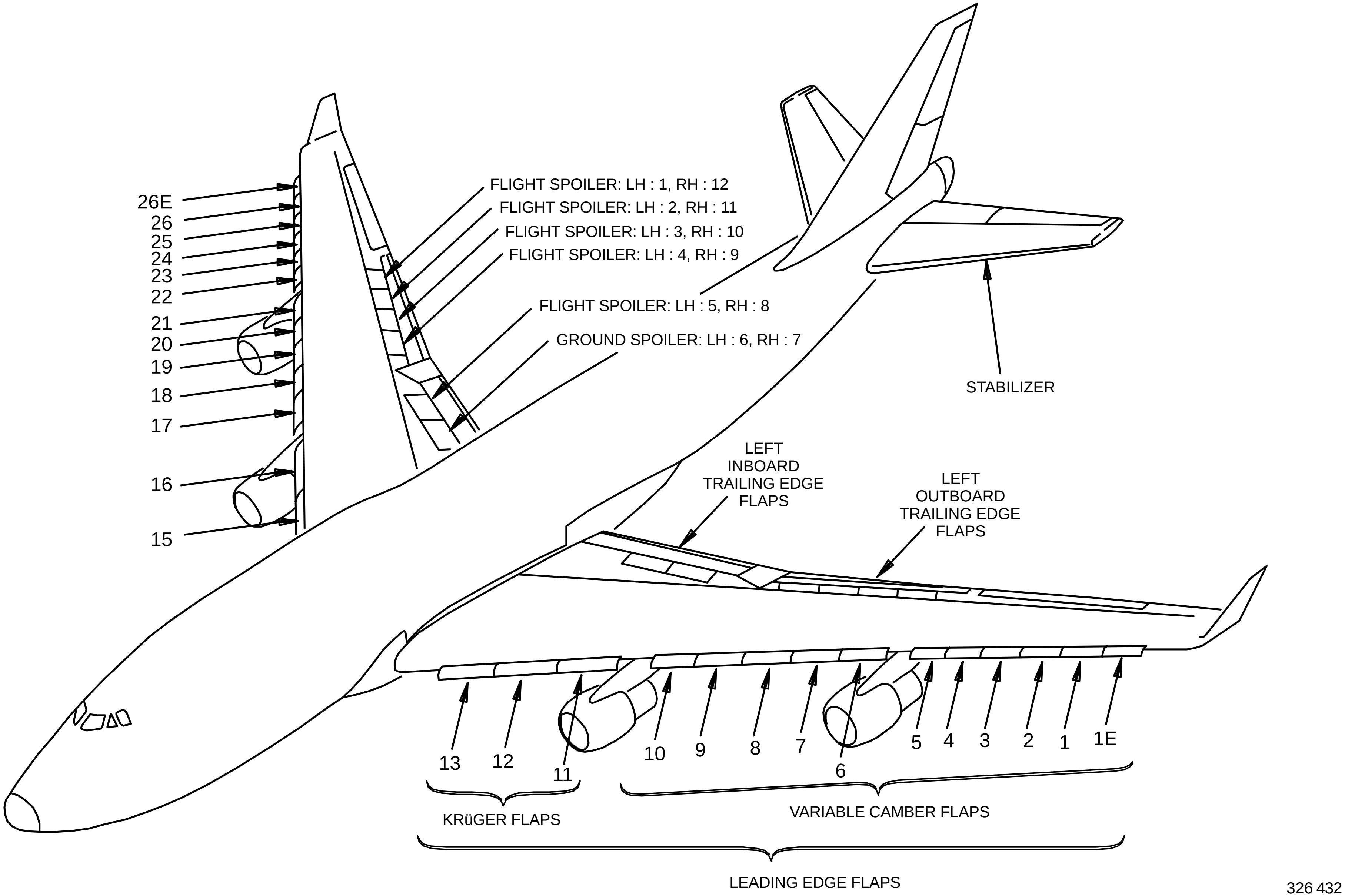


Figure 2 SECONDARY FLIGHT CONTROL SURFACES

FLIGHT CONTROL HYDRAULIC POWER

GENERAL

An aileron and spoiler hydraulic supply shutoff valve is provided in each of the four airplane hydraulic systems to shut off hydraulic pressure to the aileron and spoiler power control packages and the central lateral control packages. Each shutoff valve is controlled by a guarded switch on the pilots' overhead panel. A valve position indicator light is located below each switch. The shutoff valve switches are part of the FLT CONTROL SHUTOFF - WING VALVE on P461 Pilot's Overhead Maintenance Panel.

A rudder and elevator hydraulic supply shutoff valve is provided in each of the four airplane hydraulic systems to shut off hydraulic pressure to the rudder and elevator power control packages. Each system shutoff valve consists of a guarded switch on the pilot's overhead maintenance panel and a dc motor operated shutoff valve assembly located in the stabilizer jackscrew compartment. The four shutoff valve switches and the position indicator light are parts of the FLT CONTROL HYD POWER - TAIL VALVE on P461 Pilot's Overhead Maintenance Panel.

SUMMARY :

Die Flight Control Hydraulic Power Switches dienen zur Betätigung der TAIL- und WING shutoff valves.

NORM :

- Capped Position
- Shutoff Valve : OPEN

SHUT OFF :

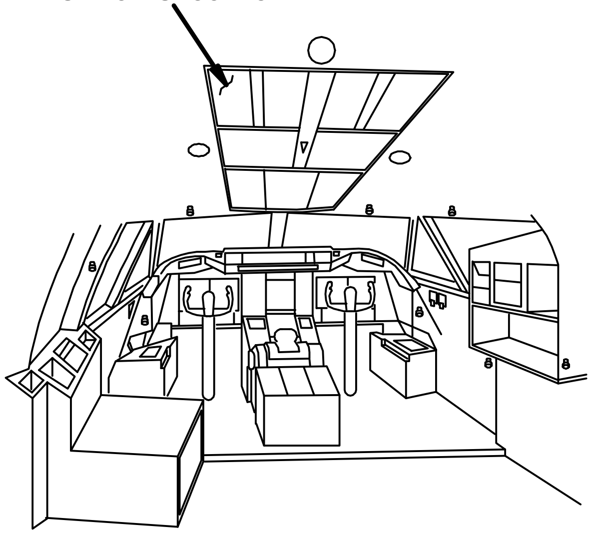
- Shutoff Valve : CLOSED

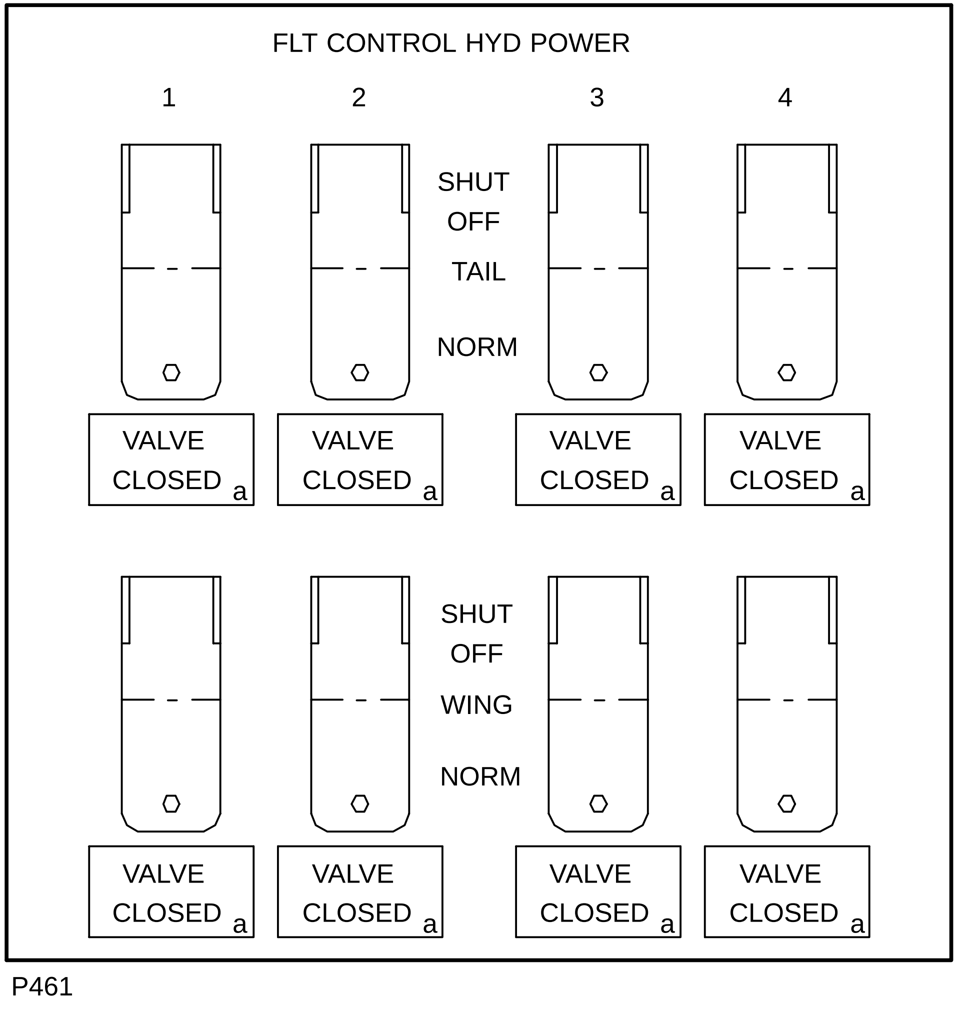
VALVE CLOSED-LIGHT :

- das VALVE CLOSED-Light leuchtet, wenn der Internal Limit Switch NOT FULLY OPEN geschaltet hat, gleichzeitig erfolgt die

Advisory Message

FLT CONT VALVES.





854 635

Figure 3 FLIGHT CONTROL HYDRAULIC POWER SWITCH PANEL

AILERON AND SPOILER HYDRAULIC SUPPLY SHUTOFF VALVES

HYDRAULIC SHUTOFF WING VALVES

The hydraulic shutoff wing valve is located on the wing rear spar and consists of a two-position valve driven by a 28-volt dc motor. A double seal isolates the oil chamber of the valve from the electrical units. A manual override and position indicator lever provides a visual indication of valve position.

Two limit switches in the shutoff wing valve electrical circuits limit motor operation. The switches operate so that regardless of valve position in the operating cycle, or whether the position has been reached manually or electrically, operation of the appropriate switch applies electrical power to the motor to drive the valve in selected position.

The shutoff wing valve also incorporates a switch to sense valve slide position. The slide operates the switch to complete an indicator light circuit when valve is not fully open. The indicator light is located adjacent to the switch.

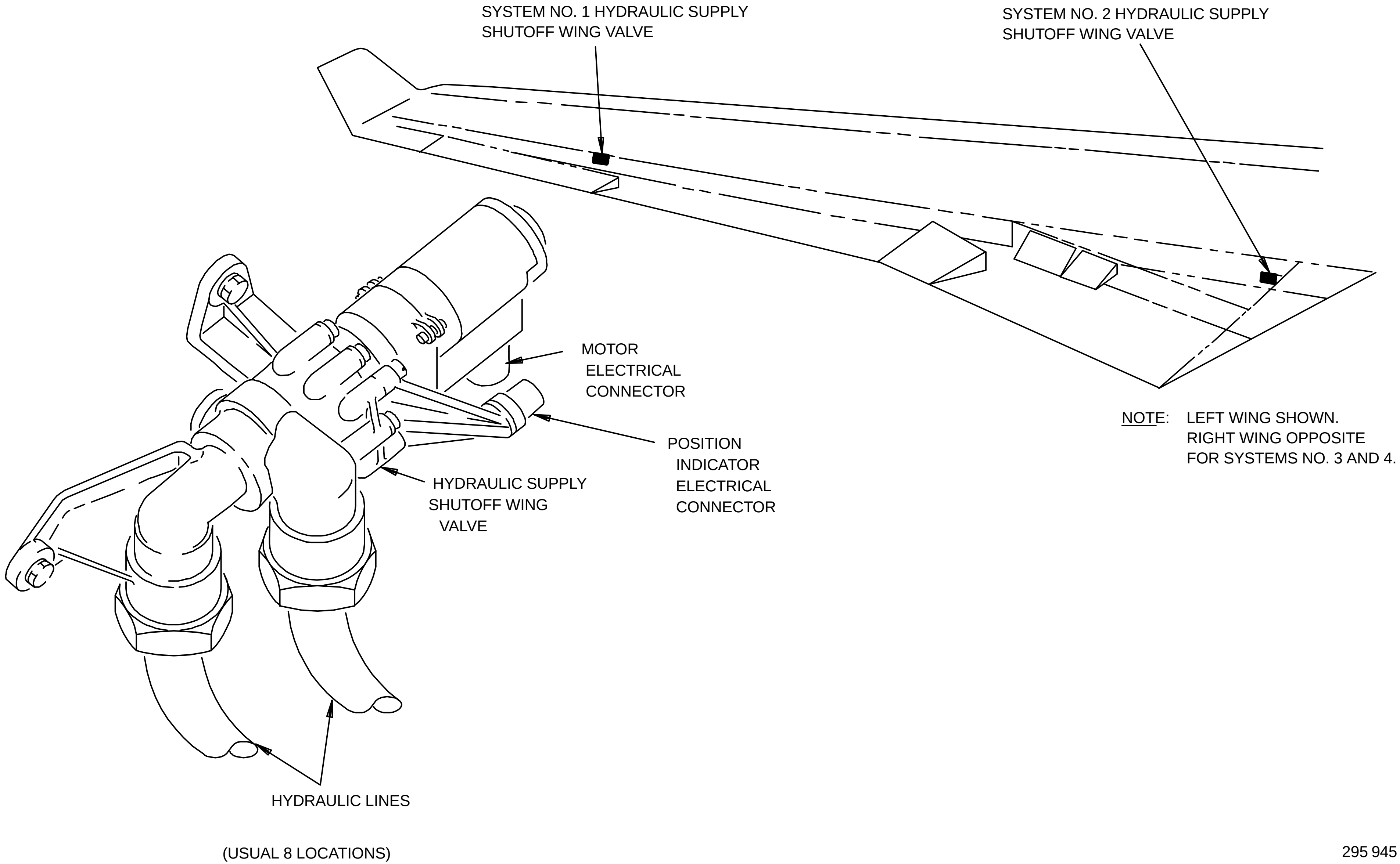


Figure 4 AILERON AND SPOILER HYDRAULIC POWER SHUTOFF VALVE LOCATION

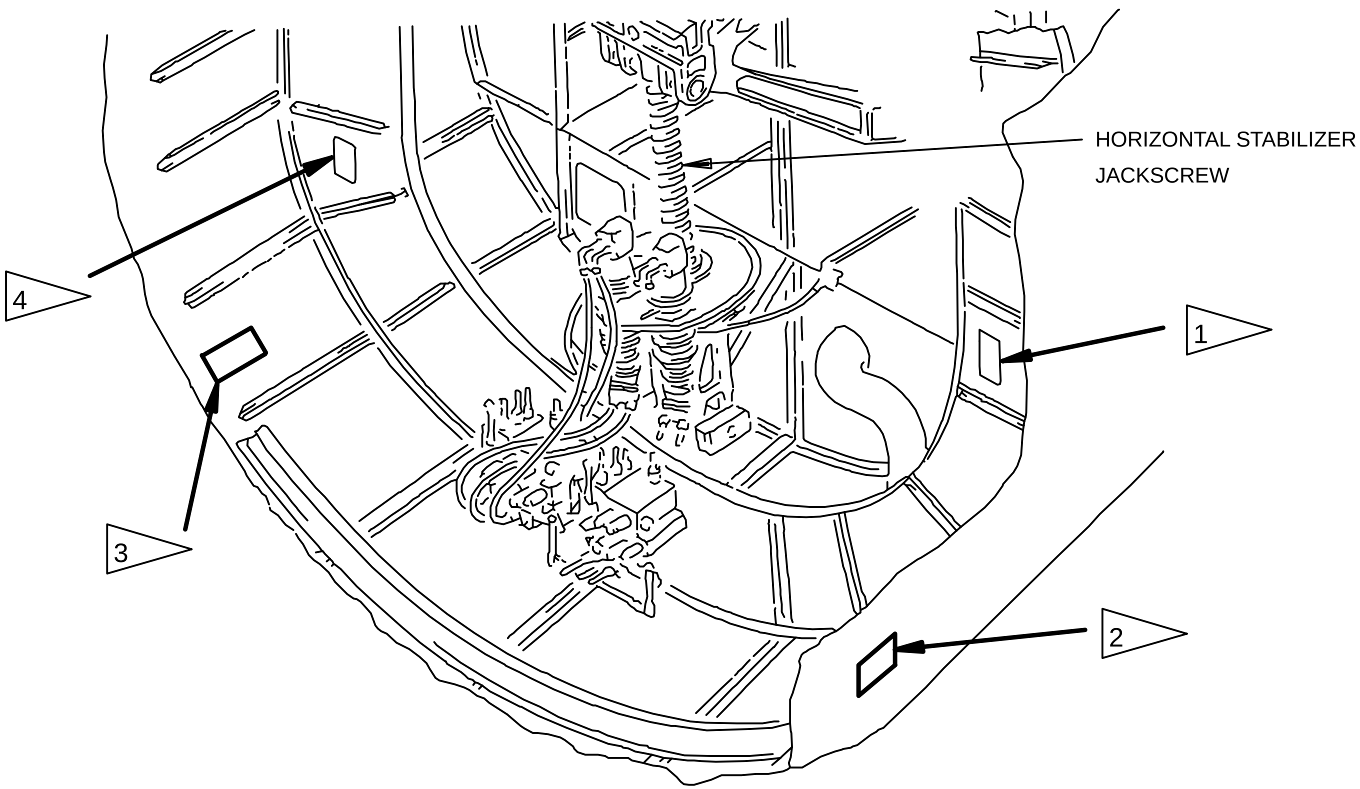
RUDDER AND ELEVATOR HYDRAULIC SUPPLY SHUTOFF VALVE

RUDDER AND ELEVATOR HYDRAULIC SUPPLY SHUTOFF VALVE

The shutoff valve assembly consists of two position valve driven by a dc motor powered by the airplane 28 volt dc electrical system. A double seal isolates the oil chamber of the valve from the electrical units. A manual override and position indicator lever provides a visual indication of valve position.

Two limit switches in the shutoff valve electrical circuits limit motor operation. The switches operate so that regardless of valve position in the operating cycle, or whether the position has been reached manually or electrically, operation of the appropriate FLT CONTROL HYD POWER - TAIL VALVE switch applies electrical power to the motor to drive the valve in selected position.

The shutoff valve also incorporates a switch to sense valve slide position. The slide operates the switch to complete an indicator light circuit when valve is not fully open. An indicator light is located on P461 Pilot’s Overhead Maintenance Panel adjacent to each FLT CONTROL HYD POWER - TAIL VALVE switch. The light is marked VALVE CLOSED.



1 DC MOTOR OPERATED SHUTOFF VALVE ASSY, FOR UPPER RUDDER, LEFT OUTBOARD ELEVATOR AND LEFT INBOARD ELEVATOR USING HYDRAULIC SYSTEM NO. 1.

2 DC MOTOR OPERATED SHUTOFF VALVE ASSY, FOR LOWER RUDDER AND LEFT INBOARD ELEVATOR USING HYDRAULIC SYSTEM NO. 2.

3 DC MOTOR OPERATED SHUTOFF VALVE ASSY, FOR UPPER RUDDER AND RIGHT INBOARD ELEVATOR USING HYDRAULIC SYSTEM NO. 3.

4 DC MOTOR OPERATED SHUTOFF VALVE ASSY, FOR LOWER RUDDER, RIGHT OUTBOARD ELEVATOR AND RIGHT INBOARD ELEVATOR USING HYDRAULIC SYSTEM NO. 4.

297 899

Figure 5 RUDDER AND ELEVATOR HYDRAULIC POWER SHUTOFF VALVE LOCATION

FLIGHT CONTROL HYDRAULIC SYSTEM SCHEMATIC

DESCRIPTION

Auf der folgenden Seite finden Sie die Flight Control Hydraulic System Schematic, auf der Sie die hydraulische Versorgung der einzelnen Flight Control Systeme ersehen können.

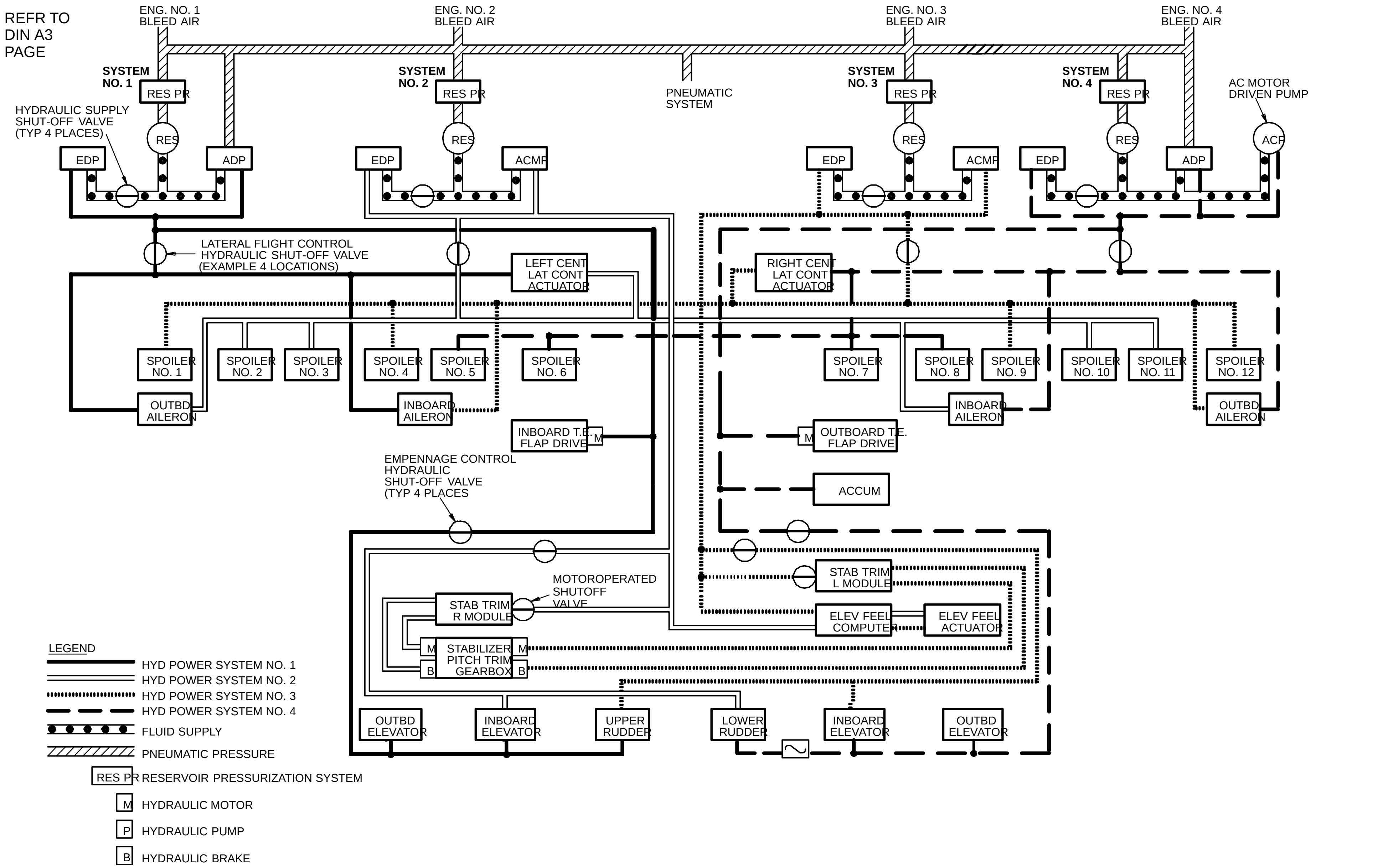


Figure 6 FLIGHT CONTROL HYDRAULIC SYSTEM SCHEMATIC

FLIGHT CONTROL HYDRAULIC SHUTOFF VALVE FUNCTION

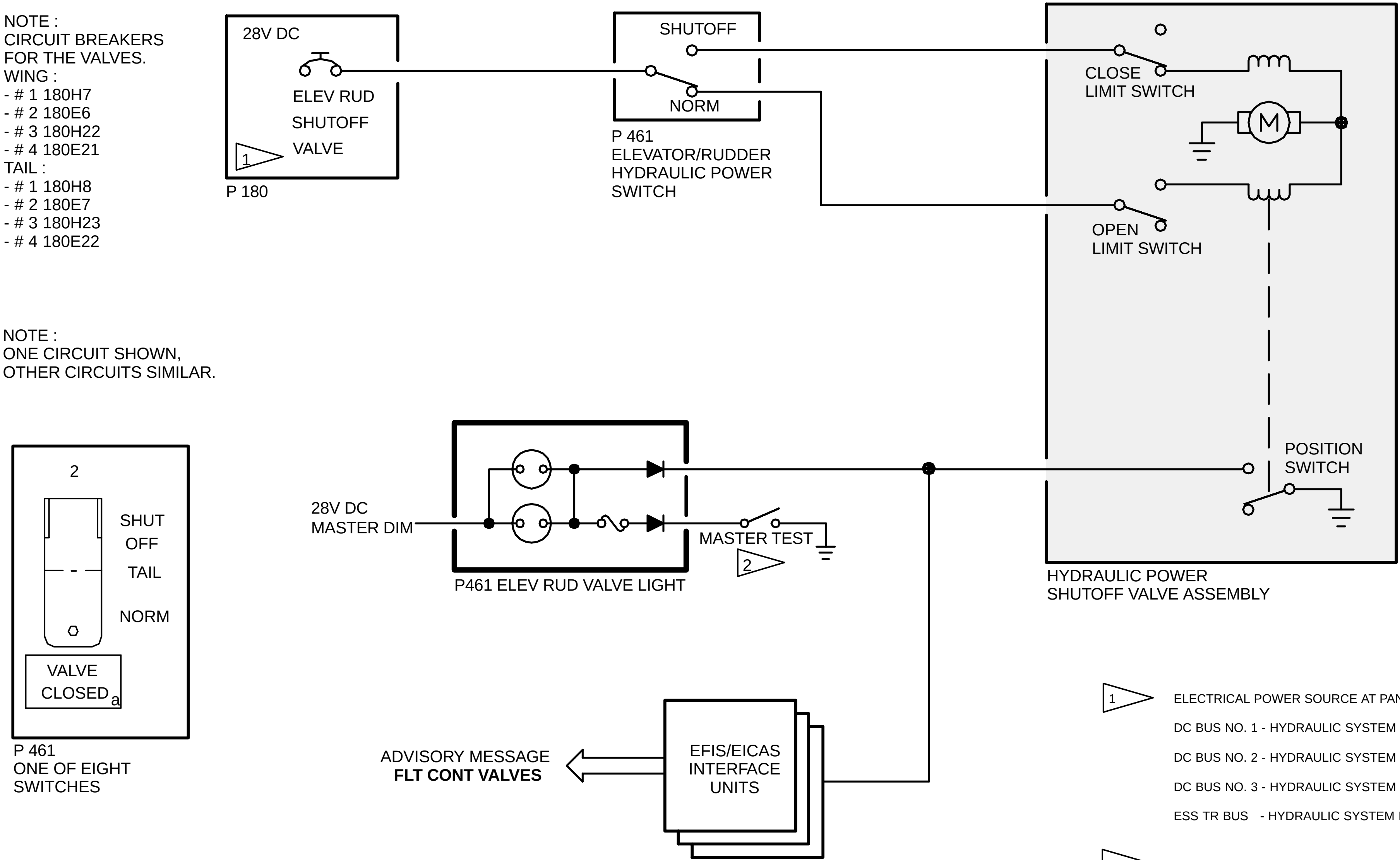
FUNCTIONAL DESCRIPTION

With electrical power on, the FLT CONTROL SHUTOFF - WING VALVE switch positions the shutoff valve according to the selected position. With the switch OFF, the valve is closed; with the switch ON, the valve is open. A guard normally shields the switch in the ON position. When valve is open, hydraulic fluid is ported to aileron and spoiler power control packages and valve indicator light (VALVE CLOSED) is off. When the valve is closed, hydraulic fluid flow to the control packages is stopped and the valve indicator light illuminates.

With electrical power on, FLT CONTROL HYD POWER - TAIL VALVE switch positions the shutoff valve according to the selected position. With the switch in SHUTOFF position, the valve is closed; with the switch in NORM position, the valve is open. A guard normally shields the switch in the NORM position. Hydraulic fluid entering the valve assembly is routed to the shutoff valve. When valve is open, hydraulic fluid is ported to rudder and elevator power control packages and the valve indicator light (VALVE CLOSED) is off. When the valve is closed, hydraulic fluid flow to the control packages is stopped and the valve indicator light illuminates.

NOTE :
CIRCUIT BREAKERS
FOR THE VALVES.
WING :
- # 1 180H7
- # 2 180E6
- # 3 180H22
- # 4 180E21
TAIL :
- # 1 180H8
- # 2 180E7
- # 3 180H23
- # 4 180E22

NOTE :
ONE CIRCUIT SHOWN,
OTHER CIRCUITS SIMILAR.



1 ELECTRICAL POWER SOURCE AT PANEL P180
DC BUS NO. 1 - HYDRAULIC SYSTEM NO. 1
DC BUS NO. 2 - HYDRAULIC SYSTEM NO. 2
DC BUS NO. 3 - HYDRAULIC SYSTEM NO. 3
ESS TR BUS - HYDRAULIC SYSTEM NO. 4

2 33-12-00, PILOTS' PANEL LIGHTS - DESCRIPTION AND OPERATION

298 919

Figure 7 FLIGHT CONTROL HYDRAULIC SHUTOFF VALVE ELECTRICAL SCHEMATIC

27 - 09 FLIGHT CONTROL ELECTRONIC COMPONENTS

FLIGHT CONTROL ELECTRONICS (FCE)

GENERAL

The Flight Controls Electronics (FCE) System is a collection of black box modules which provide control, indication, and fault detection functions for the primary and secondary flight controls. The modules are located on the E1-2 and E2-2 electronics shelves.

The FCE modules interface with airplane systems to provide indication, control, and fault detection functions for
- flap control (Ref 27-51-00, 27-81-00),
- stabilizer trim (Ref 27-41-00),
- rudder ratio control authority (Ref 27-21-00),
- aileron lockout (Ref 27-11-00), and
- yaw damping system (Ref 22-21-00).

The FCE contains four power supply modules which provide power to all FCE modules.

The FCE consists of the following modules:
(1) Flap Control Unit (FCU) - leftM7881
(2) Flap Control Unit (FCU) - center M7880
(3) Flap Control Unit (FCU) - right M7879
(4) Stabilizer Trim/Rudder Ratio Module (SRM) - left M3136
(5) Stabilizer Trim/Rudder Ratio Module (SRM) - right M3137
(6) Yaw Damper Module (YDM) - upper M7362
(7) Yaw Damper Module (YDM) - lower M7363
(8) Power Supply Module (PSM) - left No. 1 M7358
(9) Power Supply Module (PSM) - left No. 2 M7359
(10) Power Supply Module (PSM) - right No. 1 M7360
(11) Power Supply Module (PSM) - right No. 2 M7361

POWER SUPPLY MODULE

The 4 power supply modules provide the power required for operation of the FCE system. Each module supplies multiple regulated +5, +15, and -15 volts dc and unregulated 26 volts ac power sources to the FCE modules and and their sensors.

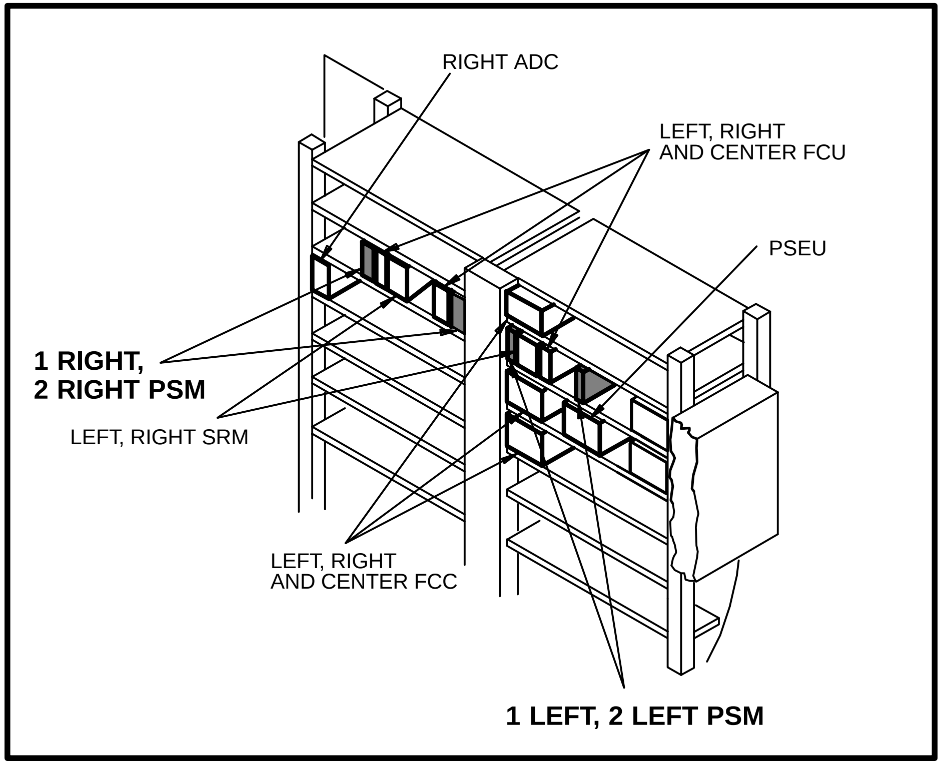
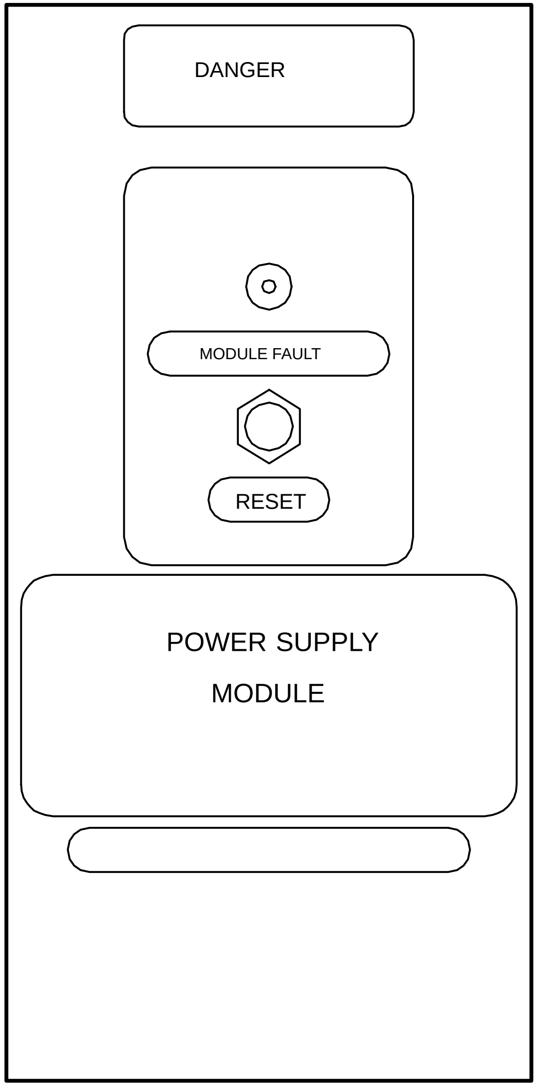
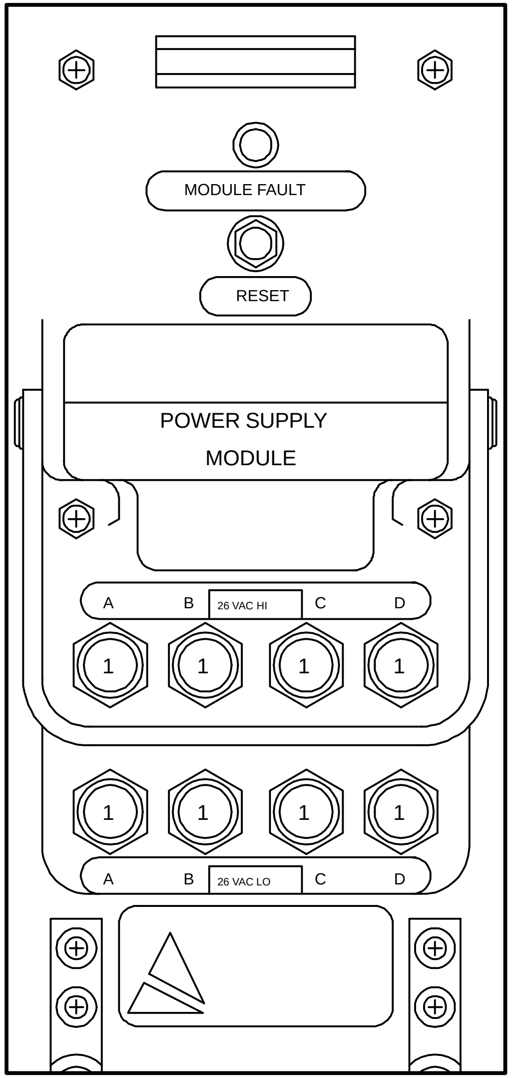


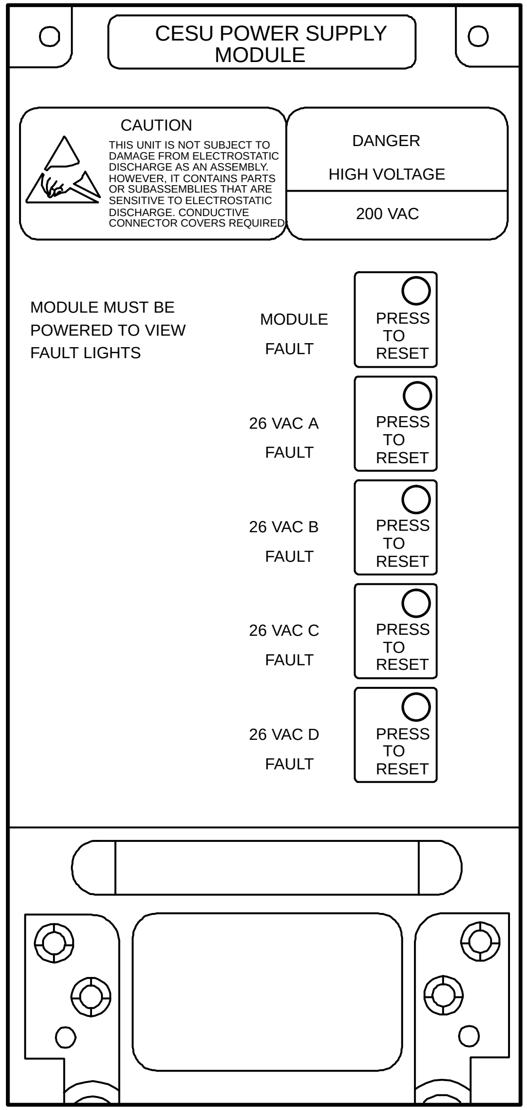
Figure 8 FLIGHT CONTROL ELECTRONIC POWER SUPPLY MODULES



POWER SUPPLY MODULE
(-103)



POWER SUPPLY MODULE
(-104)



POWER SUPPLY MODULE
(-204)

STABILIZER TRIM / RUDDER RATIO MODULE (SRM)

DESCRIPTION

The Stabilizer Trim/Rudder Ratio Module (SRM) contains a reset switch, located on the front panel. The purpose of the switch is to reset latched faults on the ground, which may have been set by airplane maintenance activity. Depressing the switch for approximately 1 second will initiate an SRM power-up and reset all faults.

The left and right SRMs are located on the E1-2 and E2-2 shelves respectivly.

The SRMs are the interface for :

- the manual electric,
- automatic stabilizer trim, and
- mach/speed trim systems.

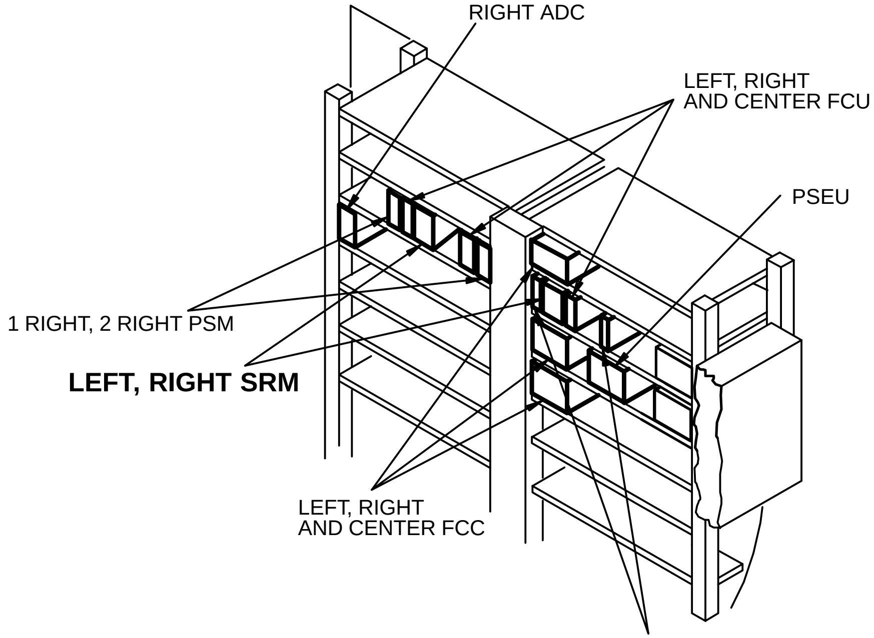
The SRMs contain logic to determine which trim system has authority under all conditions, and monitors all trim commands for proper coincidence.

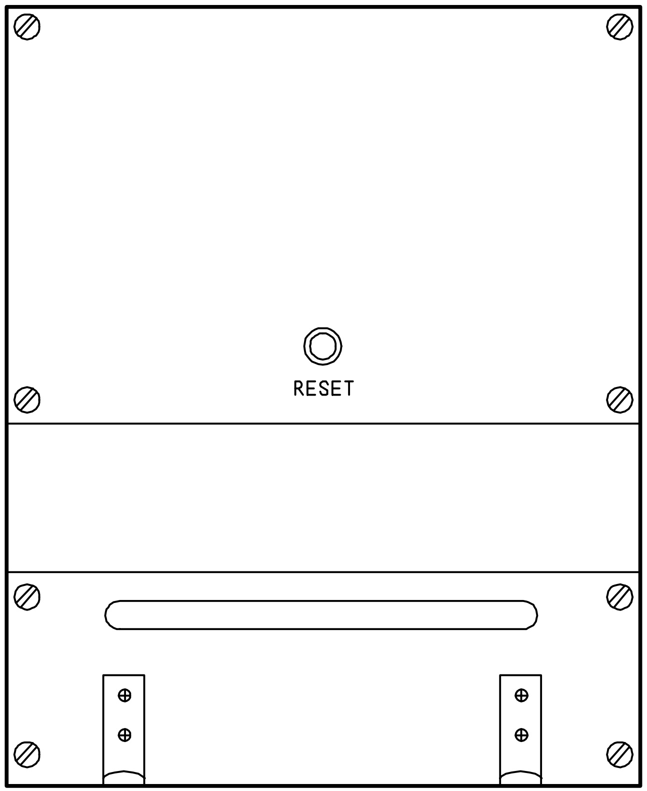
Additionally the SRM controls many other functions:

- speed trim,
- stabilizer trim limit changes,
- stabilizer trim rate control,
- automatic motor operated valve (MOV) shutdown,
- rudder ratio changer computations,
- outboard aileron lockout , and
- with interfaces to the system EIU's provide system EICAS messages.

NOTE: Unterschiedliche SRM Dash-Nummern :

- 108 : für die All Pax- und Combi Versionen und **kein Mach Trim System**
- 109 : für die Freighter Version und **kein Mach Trim System**
- 110 : ist die neue Version der -108. Diese Version hat ein Mach Trim System, welches bei den All Pax- und Combi Versionen durch Pin Programming abgeschaltet ist.





STABILIZER TRIM/

RUDDER RATIO MODULE

22/967 026

Figure 9 STABILIZER TRIM / RUDDER RATIO MODULE (SRM)

27-09 FLIGHT CONTROL ELECTRONIC COMPONENTS

FCE/PSM ELECTRICAL SCHEMATIC

FUNCTIONAL DESCRIPTION

The power supply modules provide regulated +5, +15, and -15 volts dc and unregulated 26 volts ac to the FCE modules and their sensors. Details of the operation of the individual modules are given in the references listed in the general information section above.

CONTROL

Operation of the Power Supply Modules is automatic. No control functions are exercised. Control of the FCE modules is detailed in the references listed in the general information section above.

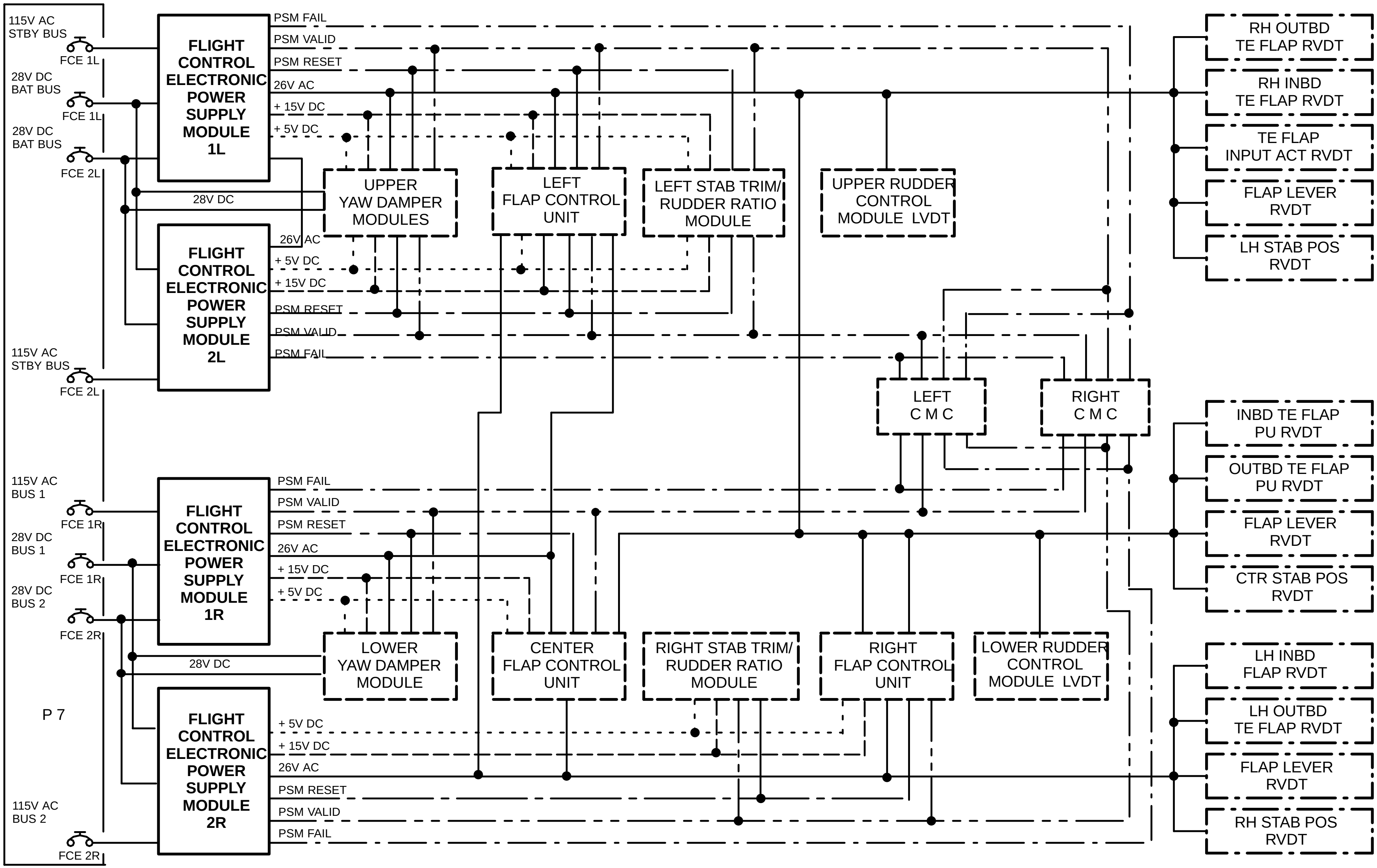


Figure 10 FCE/PSM ELECTRICAL SCHEMATIC

27 - 10 AILERON SYSTEM

FLIGHT CONTROL MAINTENANCE- AND STATUS PAGE

MAINTENANCE PAGE

Die Maintenance Page für das Flight Control System ist über das Central Maintenance Computer System (CMCS) folgendermaßen aufrufbar :

- CMC
- MENü
- MAINTENANCE PAGE
- ATA 27
- DISPLAY.

Die Anzeigen:

- der Control Wheels
- des Left Outboard Ailerons
- des Left Inboard Ailerons
- des Right Inboard Ailerons
- des Right Outboard Ailerons

erfolgt in ° .

Die Anzeige erfolgt in Steps von $^{1}/_{10}$ ° .

CONTROL WHEELS:

- Control Wheel Ausschlag von 10.5° für einen Right Turn

AILERONS:

- Left Ailerons Ausschlag von 15° DOWN
- Right Ailerons Ausschlag von 15° UP

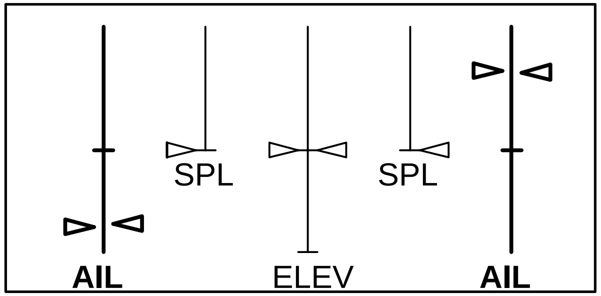
STATUS PAGE

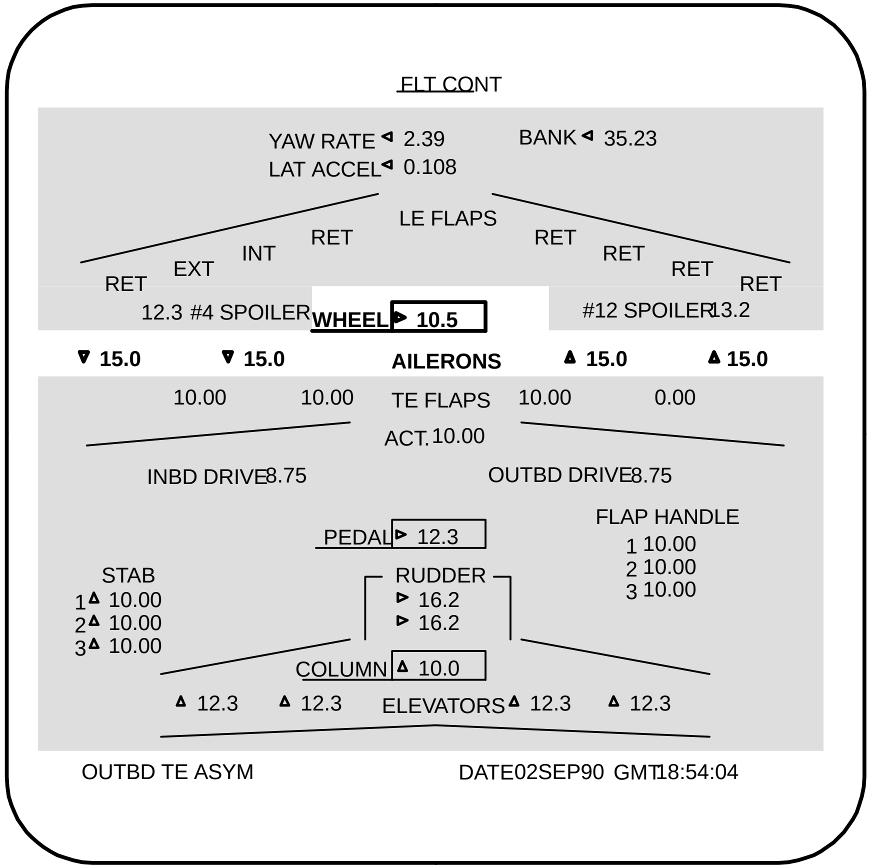
Die Status Page ist über das EICAS Data Select Panel (EDSP) auf dem Glearshild über den Select Button STATUS aufrufbar.

Auf der Status Page befindet sich in der rechten unteren Ecke die Informationen des Flight Control Systemes.

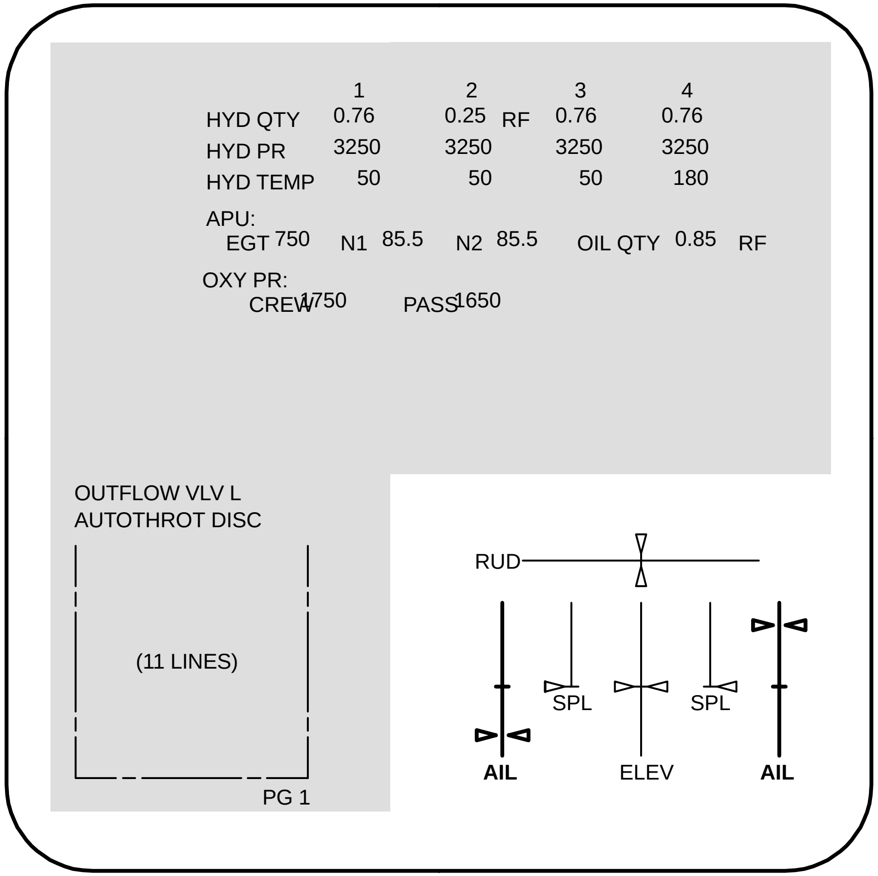
Die Anzeigen der Ailerons erfolgt unter der Bezeichnung **AIL** für :

- das Left Outboard Aileron
- das Left Inboard Aileron
- das Right Inboard Aileron
- das Right Outboard Aileron.





MAINTENANCEPAGE
FLIGHT CONTROL



STATUS PAGE

302 365
302 366

Figure 11 MAINTENANCE PAGE FLIGHT CONTROL AND STATUS PAGE

AILERON BASIC SCHEMATIC DESCRIPTION

GENERAL

Two ailerons in each wing operating with the spoilers provide lateral control of the airplane. The ailerons are hydraulically powered with the control system utilizing all four airplane hydraulic supply systems. The inboard ailerons are operable at any airspeed; the outboard ailerons are used exclusively during low speed flight. Extension of the group A LE flaps are not fully retracted activates the outboard ailerons.

The ailerons are controlled by conventional control wheels in the flight compartment as shown. The control wheels are bussed together using drums and cables below the control columns. Control cables connect the drum at the captains control column to a cable quadrant in the left wing gear wheel well. The quadrant includes a trim mechanism and also provides artificial feel to the aileron control system. Output of the trim and feel mechanism provides input to the hydraulically powered left and right central lateral control packages (CLCP's). The CLCP's also receive input from the airplane autopilot system.

The mechanical input to the CLCP's positions internal control valves which cause the CLCP's to provide a hydraulically powered output. The upper piston rod of each CLCP is connected to a spoiler differential which controls operation of the five flight spoilers in the respective wing. The lower piston rod of each CLCP is connected to an aileron programmer.

The output of each aileron programmer is transmitted to the respective wing through cables which attach to an aileron power package control quadrant at each surface. Each inboard aileron control quadrant is connected directly to the power package through control linkage. Each outboard aileron control quadrant is connected to the power package through an outboard aileron lockout mechanism. The lockout mechanism prevents the outboard ailerons from operating when the group A LE flaps are fully retracted. The lockout mechanism is actuated by an electric actuator that receives power through the Stabilizer Trim/Rudder Ratio Module (SRM).

Aileron trim is accomplished by use of the aileron arming and trim control momentary switches on the pilots' control stand. The switches control the aileron trim actuator which adjusts the trim and feel mechanism neutral position. The mechanism provides input to the CLCP (right autopilot) which, in turn, repositions the lateral control system's neutral point, thereby establishing a change in lateral trim.

AILERON DESCRIPTION

The inboard and outboard ailerons are conventional frame structures consisting of metal spars and ribs with skins of fiberglass honeycomb construction. Each aileron is positioned by a single hydraulic power package connected directly to the aileron. The inboard ailerons are designed for a full travel of 20 degrees up and 20 degrees down, available at all times. The outboard ailerons are designed to operate only during slow flight, and become operable by the group A LE flaps are not fully retracted. At a flap extension greater than 1 unit, full outboard aileron travel of 25 degrees up through 15 degrees down is available.

R E F E R T O D I N A 3 P A G E

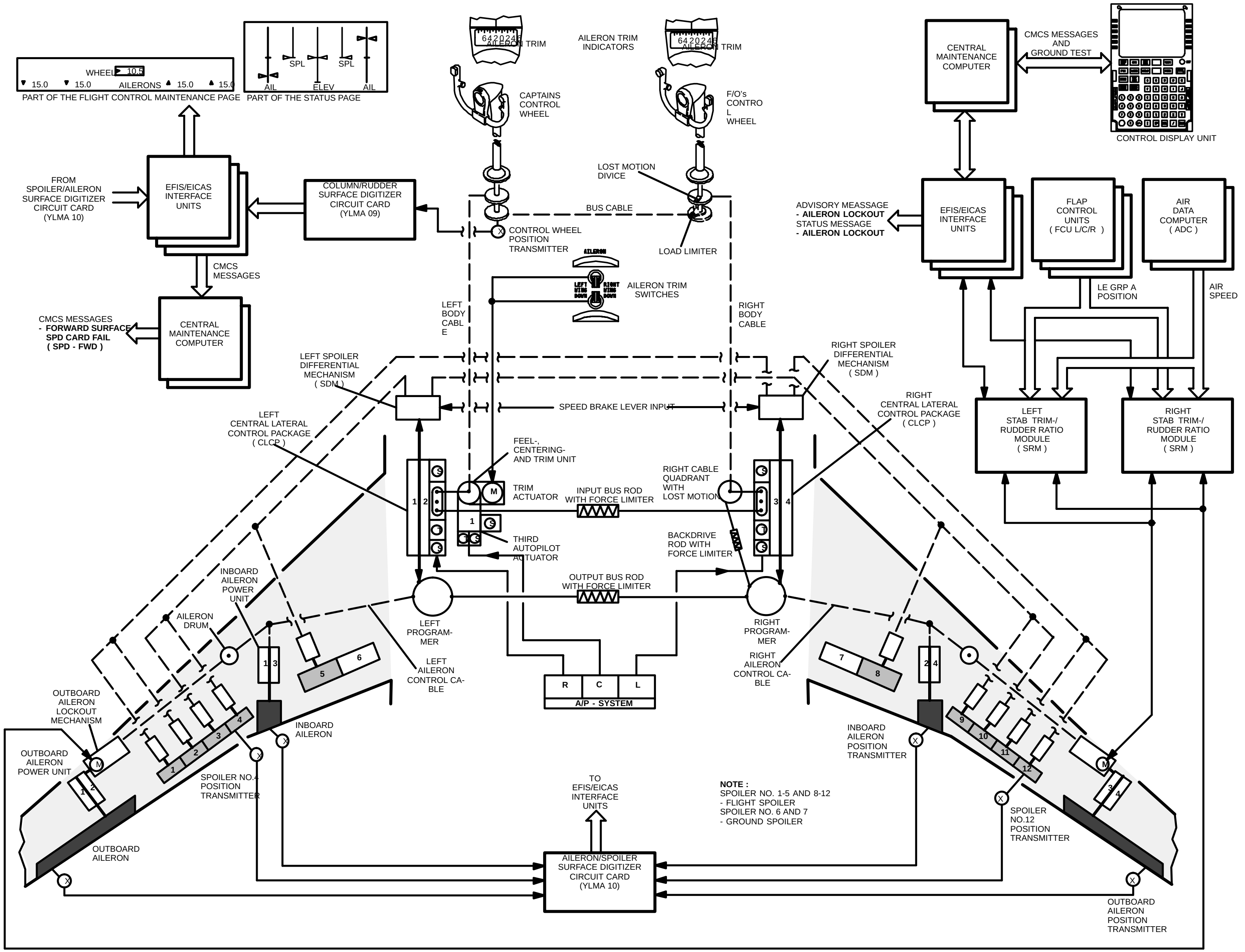


Figure 12 AILERON SYSTEM BASIC SCHEMATIC

LATERAL CONTROL

CAPTAIN's CONTROL WHEEL

- ist fest mit den Bus Cable und Left Body Cable verbunden

FO-PILOT CONTROL WHEEL

- ist über Load Limiter mit Bus Cable verbunden

CONTROL WHEELS

- geben über Left Body Cable Inputs zur Feel-, Centering and Trim Unit
- Lost Motion Devices sorgt dafür, daß dabei das Right Body Cable nicht betätigt wird

FEEL-,CENTERING- AND TRIM UNIT

- erzeugt Gegenkräfte und zentriert die Control Wheels
- gibt Inputs zum Control Valve vom Left CLCP und über Input Rod wird das Control Valve vom Right CLCP angesteuert
- Lost Motion sorgt dafür, daß dabei nicht der Right Cable Quadrant betätigt wird

CENTRAL LATERAL CONTROL PACKAGES (CLCP)

- betätigen Programmers und Spoiler Differential Mechanisms zur Ansteuerung der Flight Spoilers
- haben Internal Follow Up

PROGRAMMERS

- geben Inputs zu den Inboard Aileron Power Unit Control Valves und über die Outboard Aileron Lockout Mechanisms zu den Outboard Aileron Power Unit Control Valves. Dabei erfolgt die Control Cable Ansteuerung so, daß bei ca. 50% Control Wheel Auslenkung (CLCP Output) die Control Valves der Power Units schon für vollen Ausschlag angesteuert werden.
- Falls ein CLCP hydraulisch nicht versorgt und nicht blockiert ist, wird diese vom anderen CLCP durch die Output Rod mitgenommen.
- Zusätzlich betätigt der Right Programmer über die Backdrive Rod den Right Cable Quadrant und über das Right Body Cable wird das Lost Motion Device am Co- Pilots Control Wheel ausgeglichen.

AILERON DRUM

- ermöglicht, daß bei Cable Riß zum Lockout Mechanism die Inboard Power Units weiter angesteuert werden können.

OUTBOARD AILERON LOCKOUT MECHANISM

- bekommen Inputs von den SRM's. Bei einem Fehler erscheint die EICAS Mess. mit CMC Speicherung.
- schalten bei Group A LE Flaps NOT FULLY RETRACTED oder Speed < 232 KTS die Aileron Control Cable Bewegung auf die Outboard Aileron Power Unit Control Valves, und bei Group A LE Flaps FULLY RETRACTED und Speed > 238 KTS gelangen keine Control Cable Bewegungen auf die Control Valves.

AILERON TRIM

- erfolgt durch Betätigung der Trim Switches. Dadurch wird der Trim Actuator angesteuert.
- Actuator gibt Input über Feel-, Centering and Trim Unit auf die CLCP's und auf das Left Body Cable.
- Anzeige durch die Trim Indicators an den Control Wheels.

AUTOPILOT CONTROL

- Signals "L" gelangen zum Right CLCP und Sinals "R" gelangen zum Left CLCP. Über Solenoid- und Transfer Valves werden die Control Valves ausgelenkt und über das Left Body Cable werden die Control Wheels bewegt.
- Signals "C" gelangen über Solenoid- und Transfer Valves aif den Third Autopilot Actuator. Dieser Actuator lenkt über die Feel-, Centering and Trim Unit die CLCP Control Valves aus und über das Left Body Cable werden die Control Wheels bewegt.

REFER TO DIN A3 PAGE

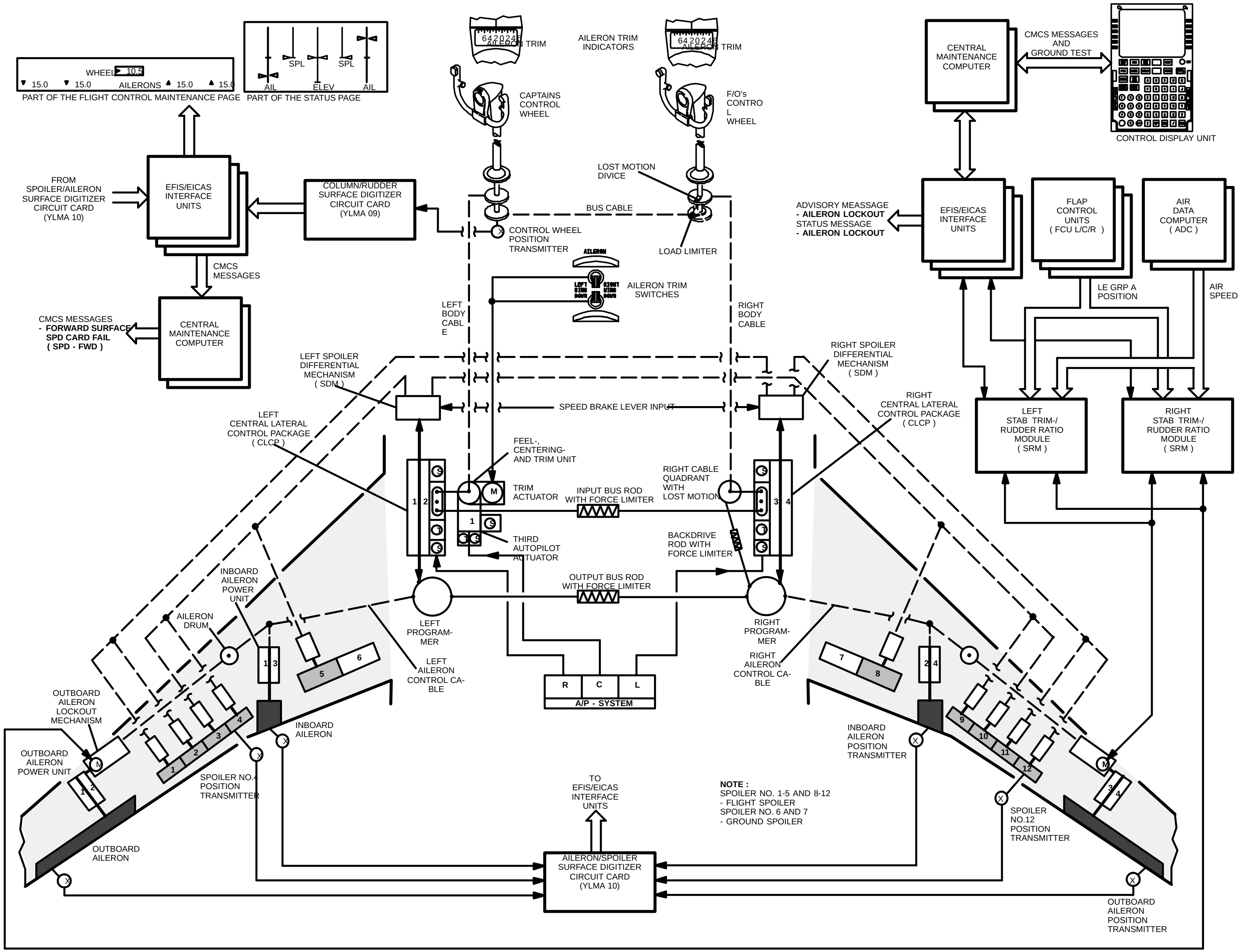


Figure 13 AILERON SYSTEM BASIC SCHEMATIC

LATERAL CONTROL MECHANICAL SCHEMATIC

FUNCTIONAL DESCRIPTION

Aileron control wheels which operate through a maximum travel range of +/- 89 degrees provide the inputs to the lateral control system . The wheels are bussed together through a load limiter at the base of the first officer's control column. Cables connected to the control drum at the base of the captain's control column are routed aft along the left side of the fuselage to the left wing gear wheel well. The cables provide the normal input to the lateral control components located in the wheel well. The cables are connected to the trim and feel mechanism which transmits the cable motion to the input lever of the CLCP-right autopilot. The CLCP-left autopilot is connected to the CLCP-right autopilot by a force limiting pushrod which normally controls the CLCP-left autopilot.Output of the CLCP's positions the two spoiler differentials and the two aileron programmers. The programmers are connected by a force limiting pushrod but both are normally positioned by the CLCP's. Output cables from the programmers provide input directly to the inboard aileron power packages, and indirectly to the outboard aileron power packages through the lockout mechanisms.

The inboard aileron power packages provide a total inboard aileron travel range of 20 degrees up and 20 degrees down. A total outboard aileron travel range of 25 degrees up to 15 degrees down is available if the group A LE flaps are not fully retracted or the airspeed is below 232 Knots. The SRM's receive speed inputs from the DADC's and flap position inputs from the FCU's. When the group A LE flaps start to extend or the airspeed gets below 232 Knots, the SRM's activate the electric actuators. The power the SRM's used to activate the electric lockout actuator is from the 7D18 AILERON LOCKOUT circuit breaker on P7 Overhead Circuit Breaker Panel. The CLCP input positions the lockout mechanism linkage to allow control wheel motion to be transmitted to the aileron power package. When the outboard flaps are retracted, the CLCP repositions the lockout mechanism allowing the aileron cables to move the outboard aileron control quadrant but without transmitting motion to the aileron power package. The right body cables are normally driven by a quadrant assembly positioned by the CLCP (left autopilot) through a force limiting pushrod. A conventional pushrod connects the CLCP (left autopilot) input to the CLCP quadrant with a lost motion slot existing at the quadrant connecting point. The right body cables are connected to the control drum in the load limiter at the base of the first

Spring detents, force limiters and lost motion features are provided to permit system operation in the event of component failure. A spring detent is provided on the input link to each CLCP. In the event of jamming within a CLCP, the link will disengage at an aileron control wheel force of approximately 35 pounds, permitting full valve travel in the alternate CLCP. In either control system, jamming occurring between an aileron control wheel and the CLCP is bypassed by the aileron control load limiter.Overcoming the spring force in the limiter permits the left body cables to operate when the right body cable system is jammed. In this condition, the system can be operated by the captain's control wheel. If the left body cable system jams, the system can be operated by the first officer's control wheel through the right body cables. The right body cables will start to move after the spring force and 6 degrees of lost motion are overcome. After another 4 degrees of lost motion at the CLCP quadrant are taken up, input is provided to the CLCP-left autopilot. The force limiting pushrod between the CLCP's prevents the left body cable system from immobilizing the CLCP-left autopilot. Force limiting pushrods between the programmers and the CLCP quadrant permit operation of the right aileron programmer.

In the event of complete hydraulic failure within one CLCP, the related programmer would not move, but with a signal into the opposite CLCP, the CLCP will respond, moving its programmer and providing the input to override the force limiting rod between the programmers, permitting aileron operation on the same side of the airplane as the operable CLCP. If there is hydraulic failure to one CLCP that does not prevent piston rod movement, the force limiting rod between the programmers, will provide operation of both programmers through the operable CLCP.

If trim is adjusted while both CLCP's have no hydraulic power, the aileron trim and feel mechanism will reposition but the control wheels will not. The drag of the unpowered CLCP's will not allow the input quadrant to rotate and will force the trim and feel mechanism cam follower out of the cam detent. Then, when hydraulic power is applied, the control wheels and ailerons will rapidly move to the newly trimmed position.

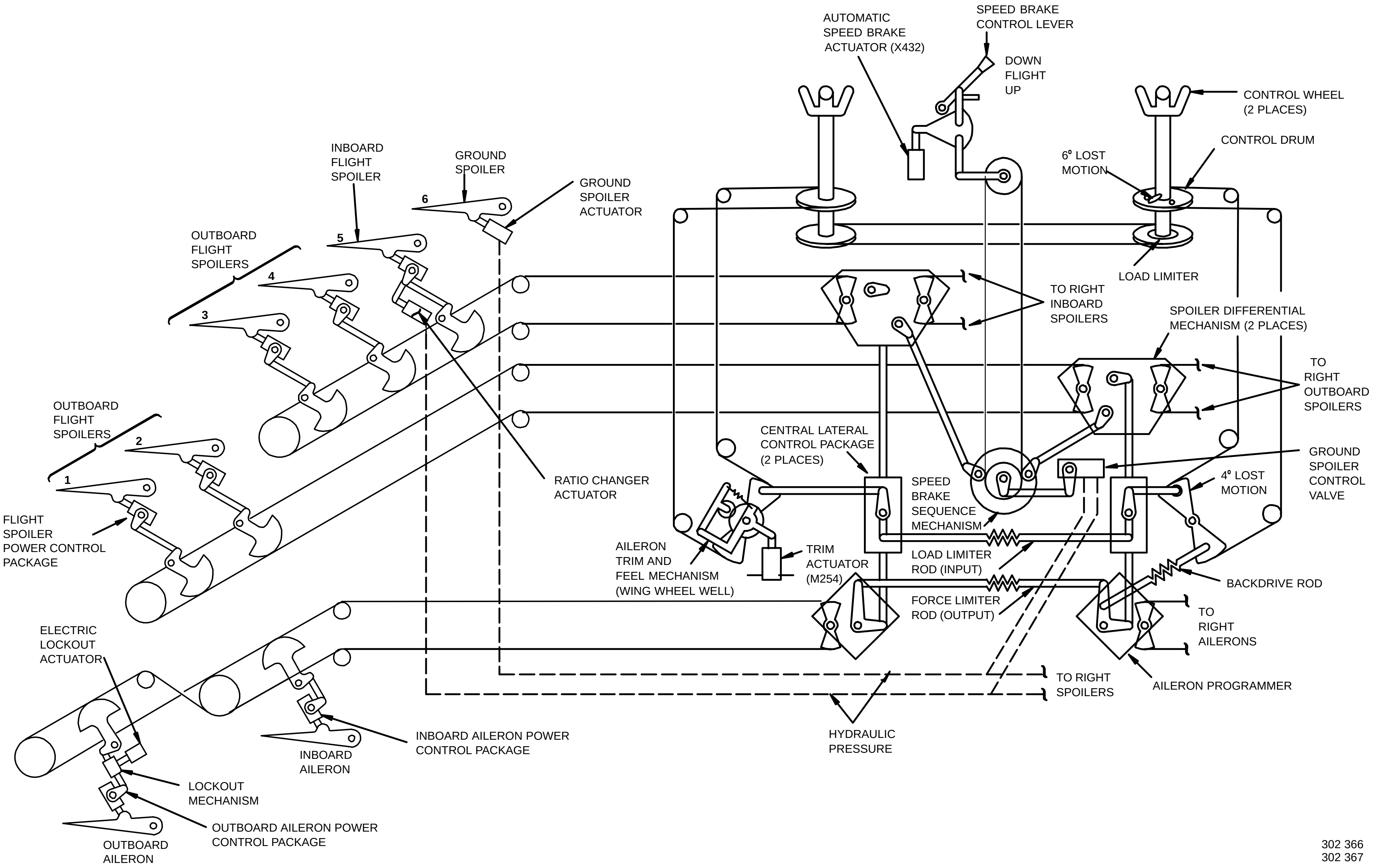


Figure 14 LATERAL CONTROL MECHANICAL SCHEMATIC

CENTRAL LATERAL CONTROL PACKAGE (CLCP) CONTROL SCHEMATIC

CONTROL ROD
- betätigt bei Normal Control den Control Crank und die Input Bus Rod
- kann justiert werden

CONTROL CRANK
- betätigt CLCP Control Valve
- ist Bestandteil vom CLCP

LEFT CLCP
- betätigt Left Spoiler Differential Mechanism und Left Programmer
- Manual Override bei Autopilot On ist möglich
- Follow Up wirkt intern

SOLENOID- AND TRANSFER VALVES
- erhalten Signale vom Autopilot "R"
- können separat gewechselt werden

INPUT BUS ROD
- verbindet Control Cranks
- ist als Force Limiter ausgelegt

RIGHT CLCP
- betätigt Right Spoiler Differential Mechanism und Right Programmer
- Manual Override bei Autopilot On ist möglich
- Follow Up wirkt intern

SOLENOID- AND TRANSFER VALVES
- erhalten Signale vom Autopilot "L"
- können separat gewechselt werden

CONTROL ROD
- steuert bei Abnormal Control das Right CLCP

RIGHT CABLE QUADRANT
- überträgt bei Normal Control Backdrive Signale zum Ausgleich von Lost Motion
- betätigt bei Abnormal Control die Control Rod

LOST MOTION
- wirkt zwischen Right Cable Quadrant und Control Rod

RIG PIN
- für Neutral von Lost Motion und CLCP

RIGHT BODY CABLE
- ist mit F/O's Control Wheel verbunden

BACKDRIVE ROD
- überträgt bei Normal Control Backdrive Signale auf Right Cable Quadrant zum Ausgleich von Lost Motion
- wird vom Right Programmer betätigt
- ist als Force Limiter ausgelegt und ermöglicht dadurch bei Abnormal Control eine Auslenkung vom Right Cable Quadrant.

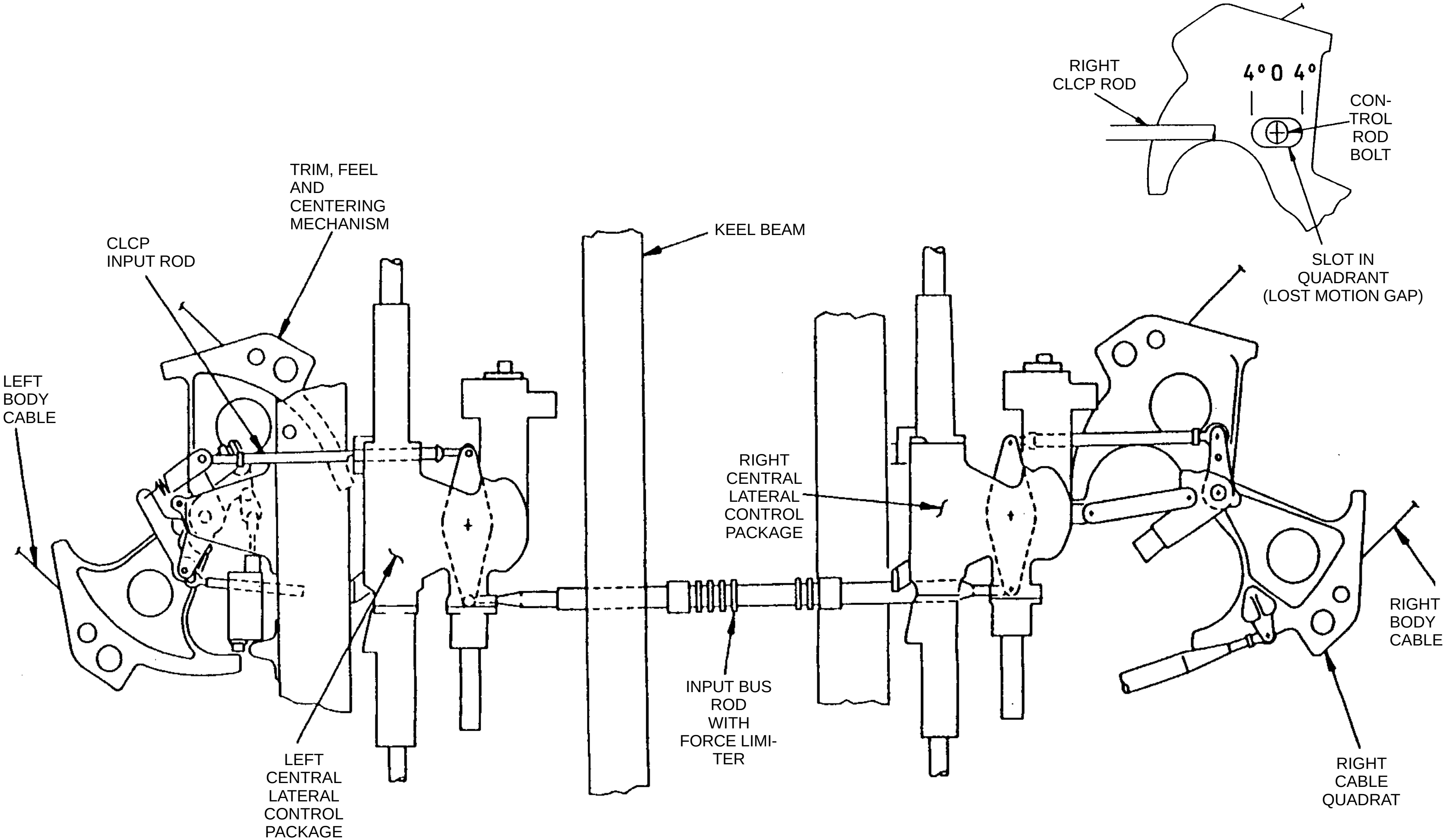


Figure 15 CENTRAL LATERAL CONTROL PACKAGE CONTROL SCHEMATIC

AUTOFLIGHT CONTROL SCHEMATIC

DESCRIPTION

Bei der manuellen Steuerung überträgt ein Seilsystem zwischen Captain's Aileron Drum und dem Left- bzw. Right CLCP das Drehen der Control Wheels. Die CLCP's betätigen über Programmer ein Seilsystem zu den Aileron Power Control Packages, die dann die Ailerons bewegen.

BEACHTE :

Das im Left Wing Gear Wheel Well eingebaute CLCP wird vom Right FCC versorgt, und
das im Right Wing Gear Wheel Well eingebaute CLCP wird vom Left FCC versorgt.

Bei A/P Betrieb übernehmen A/P Actuator innerhalb der CLCP's die Steuerung (Left/Right FCC). Center FCC liefert sein Signal zum Lateral (Third) Autopilot Servo. Er ist über das Left CLCP mit dem Steuermechanismus gekoppelt.

Jede Bewegung des Autopilot Inputs wird zu den Control Wheels übertragen.

Mechanische Camouts innerhalb der A/P Servos gleichen Signaldifferenzen bei Mehrkanalbetrieb aus.

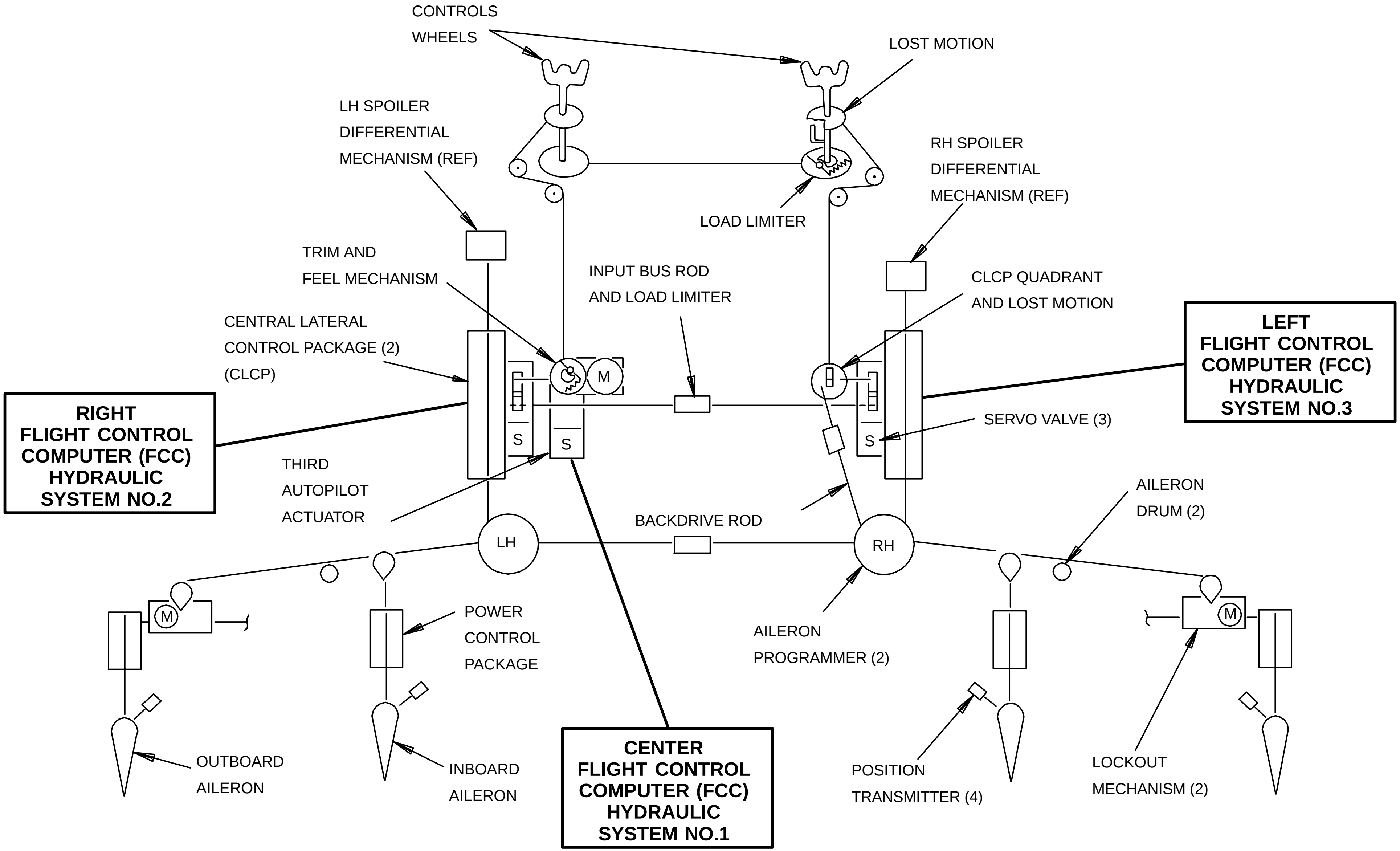


Figure 16 AUTOFLIGHT CONTROL SCHEMATIC

CAPTAIN'S AND CO-PILOTS CONTROL COMPONENTS

CONTROL WHEELS

- dienen zur Betätigung der Ailerons und der Flight Spoilers
- 45° Auslenkung entspricht bereits voller Ausschlag der Ailerons; die Flight Spoilers sind dabei ca. 20° ausgeschlagen

CAPTAINS CONTROL WHEEL

- betätigt bei Normal Control das Left Body Cable und das Bus Cable

FIRST OFFICERS CONTROL WHEEL

- betätigt bei Normal Control über den Load Limiter das Bus Cable
- betätigt bei Abnormal Control über Lost Motion Device das Right Body Cable

LOAD LIMITER

- überträgt bei Normal Control First Officer's Control Wheel Signale auf Bus Cable
- kuppelt bei Blockierung First Officer's Control Wheel ab

LOST MOTION

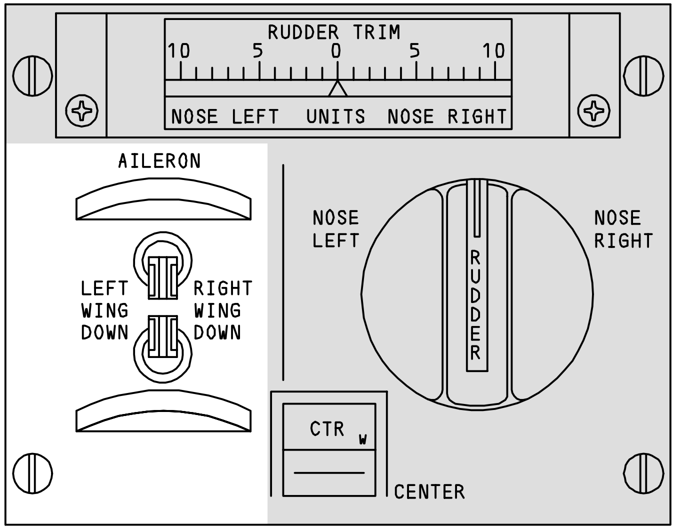
- ermöglicht bei Normal Control die Auslenkung von Control Wheels und Left Body Cable, ohne daß dabei das Right Body Cable betätigt wird
- überträgt bei Abnormal Control First Officer's Control Wheel Bewegungen auf Right Body Cable

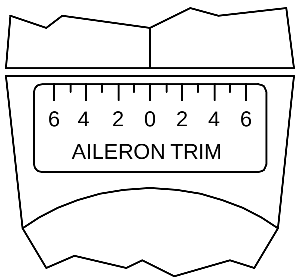
AILERON TRIM CONTROL SWITCHES

- betätigen den Trim Actuator, und die Control Wheels werden dabei ausgelenkt
- sind Toggle Type Switches

AILERON TRIM INDICATOR

- zeigt Control Wheel Positions
- Trimmbereich bis 6 Units, das entspricht 45° Control Wheel Auslenkung





AILERON TRIM INDICATOR

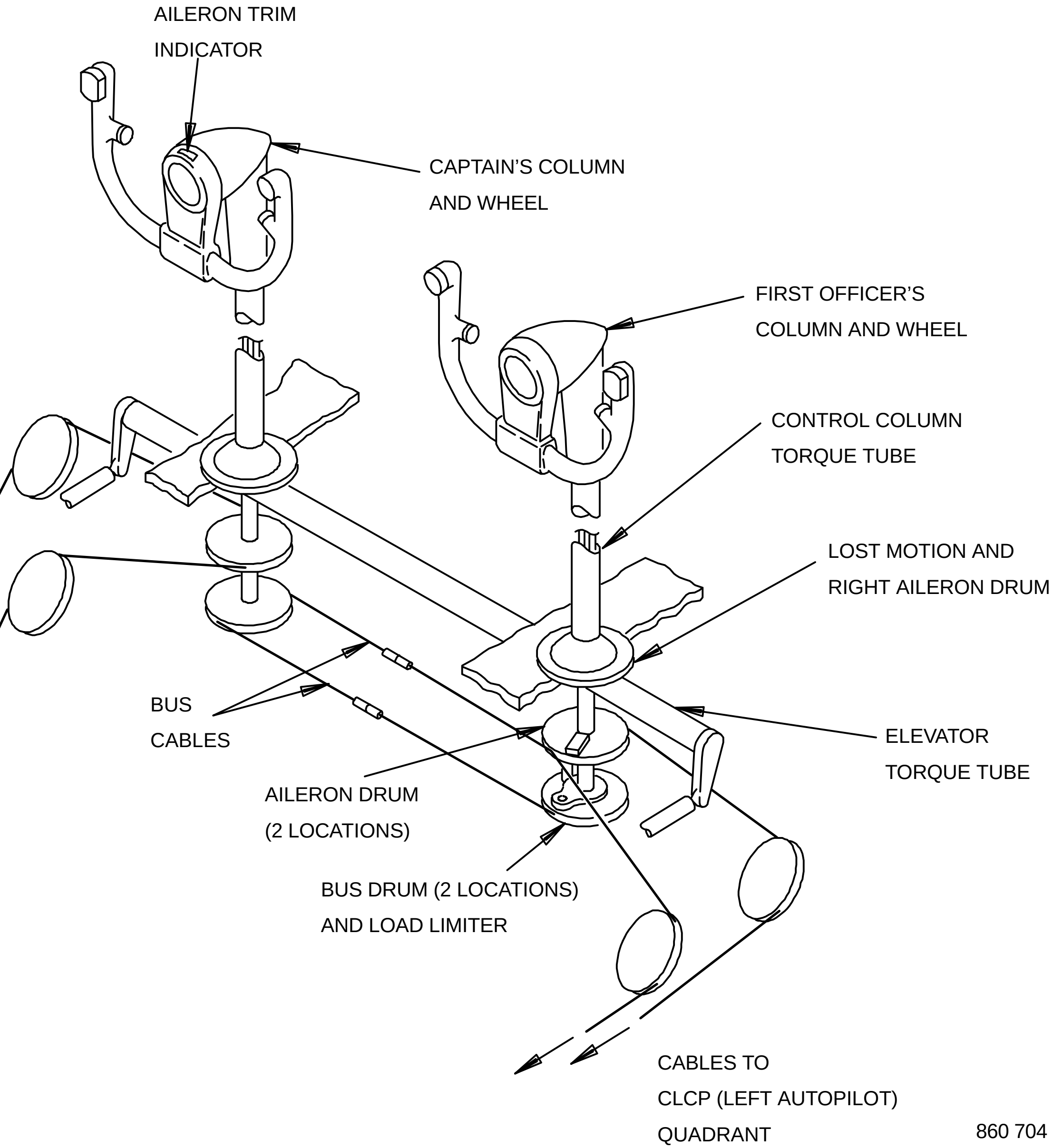


Figure 17 AILERON SYSTEM OVERVIEW

AILERON CONTROL COMPONENTS

AILERON LOAD LIMITER DESCRIPTION

The aileron control load limiter performs two functions. It provides an alternate system for moving the ailerons in the event either body cable system should jam and, it incorporates a lost motion feature which prevents undesired feedback of cable system motion into the aileron control wheels.

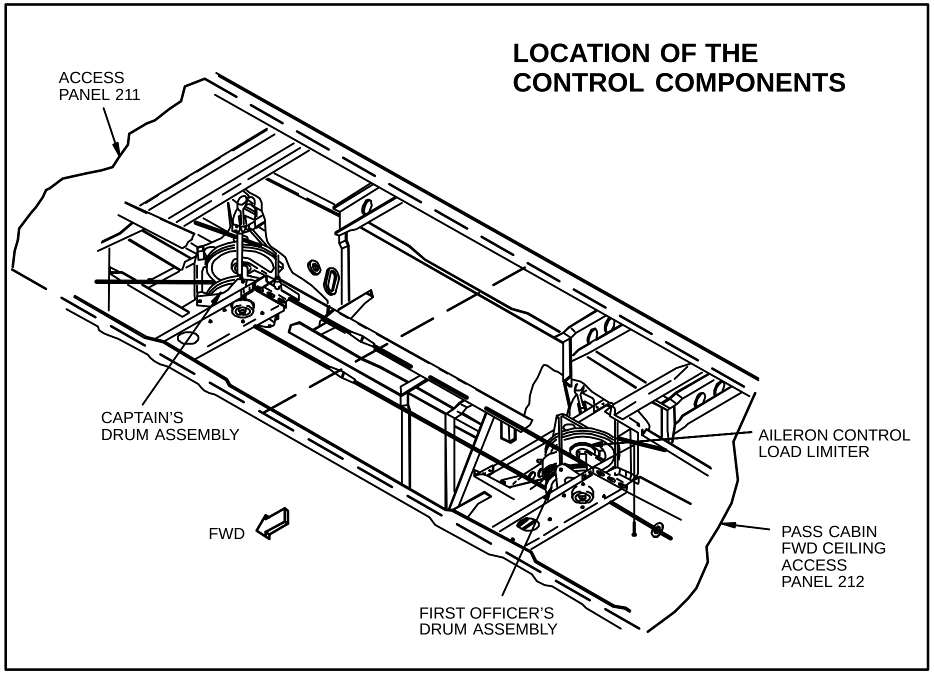
In normal operation, rotational movement of either control wheel is transmitted to the ailerons through the left body control cables. The right body control cables constitute a standby system and, normally, will not impart motion to ailerons.

The aileron control load limiter is located at the base of the first officer's control column. The load limiter consists of a bus drum, an aileron control drum, a shaft with integral cam, and a roller and preloaded torsion spring mechanism. The bus drum and aileron drum above it are bearing-mounted on the same shaft. Spring-induced compression maintains the roller in a cam surface detent on the shaft. In effect, the shaft and bus drum are locked together. Rotation of bus drum causes rotation of shaft. Shaft rotation, in turn, produces aileron movement. To free the shaft, sufficient rotational force must be applied at the first officer's control wheel to force the roller out of the cam detent.

If the left body control cables should become jammed, the captain's control wheel will become inoperable and the first officer's control wheel must be used to maintain lateral flight control. Additionally, each attempt to rotate this wheel out of its neutral position will require application of substantially greater force than normal. This force (approximately 26 pounds) will overcome the coupling of the two control wheels and allow the first officer's wheel to operate the ailerons through the right body control cables.

The lost motion feature is provided by a device in the load limiter which permits motion of the control wheel bus drum with respect to the load limiter drum within certain mechanical stop limitations. The lost motion feature is required because of system lag through the cable system and power packages which causes the right body cables to be slightly out of phase with the control wheels.

Up to Ï 6 degree system lag is permitted without causing any input to the aileron control wheels.



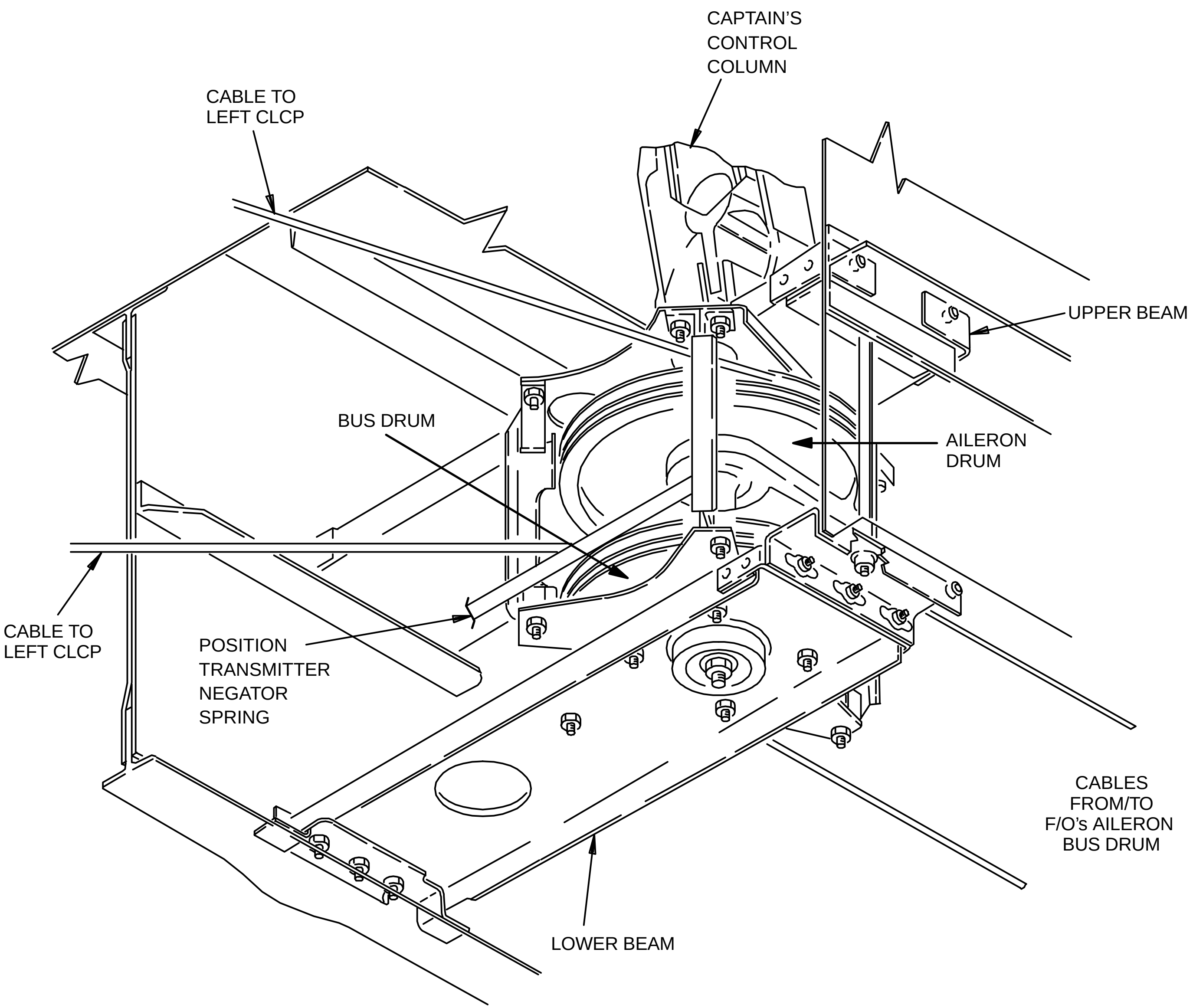


Figure 18 CAPTAINS's CONTROL COMPONENTS

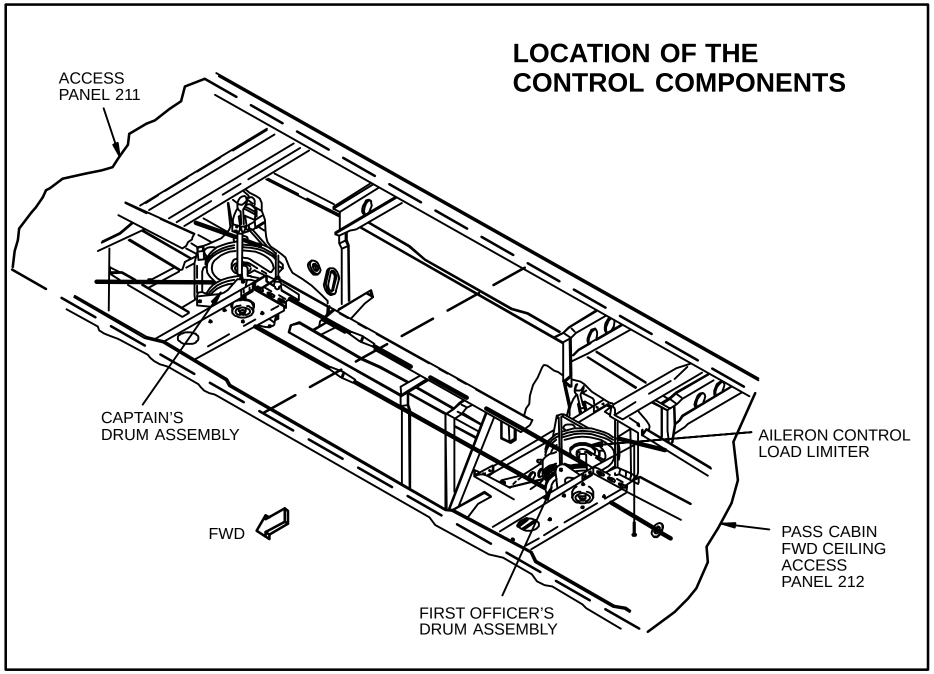
AILERON CONTROL COMPONENTS

CAPTAINS CONTROL

- Wheel Drums sind fest mit Input Shaft verbunden
- Input Shaft betätigt den Position Transmitter
- Bus Drum betätigt Bus Cable
- Aileron Drum
  - betätigt das Left Body Cable
  - Stops für maximalen Control Wheel Ausschlag

FIRST OFFICERS CONTROL

- Bus Drum
  - wird bei Normal Control über Load Limiter vom Input Shaft betätigt
  - wird bei Abnormal Control durch Load Limiter vom Input Shaft getrennt
- Load Limiter
  - besteht aus einer fest auf dem Input Shaft sitzender Cam und einem federbelastetem Roller
  - überträgt bei Normal Control die Control Wheel Bewegung auf die Bus Drum
  - trennt bei blockierter Bos Drum und ermöglicht damit Abnormal Control
- Aileron Drum
  - wird bei Normal Controlvom Right Body Cable nachgeführt
  - wird bei Abnormal Control über Lost Motion Device betätigt
  - Stops für maximalen Control Wheel Ausschlag
- Lost Motion Device
  - besteht aus einer fest auf dem Input Shaft sitzenden Cam und Stops an der Aileron Drum
  - ist bei Normal Control nicht auf Anschlag
  - überträgt bei Abnormal Control Control Wheel Bewegungen auf Aileron Drum
  - Rig Pin für Control Wheel Neutral



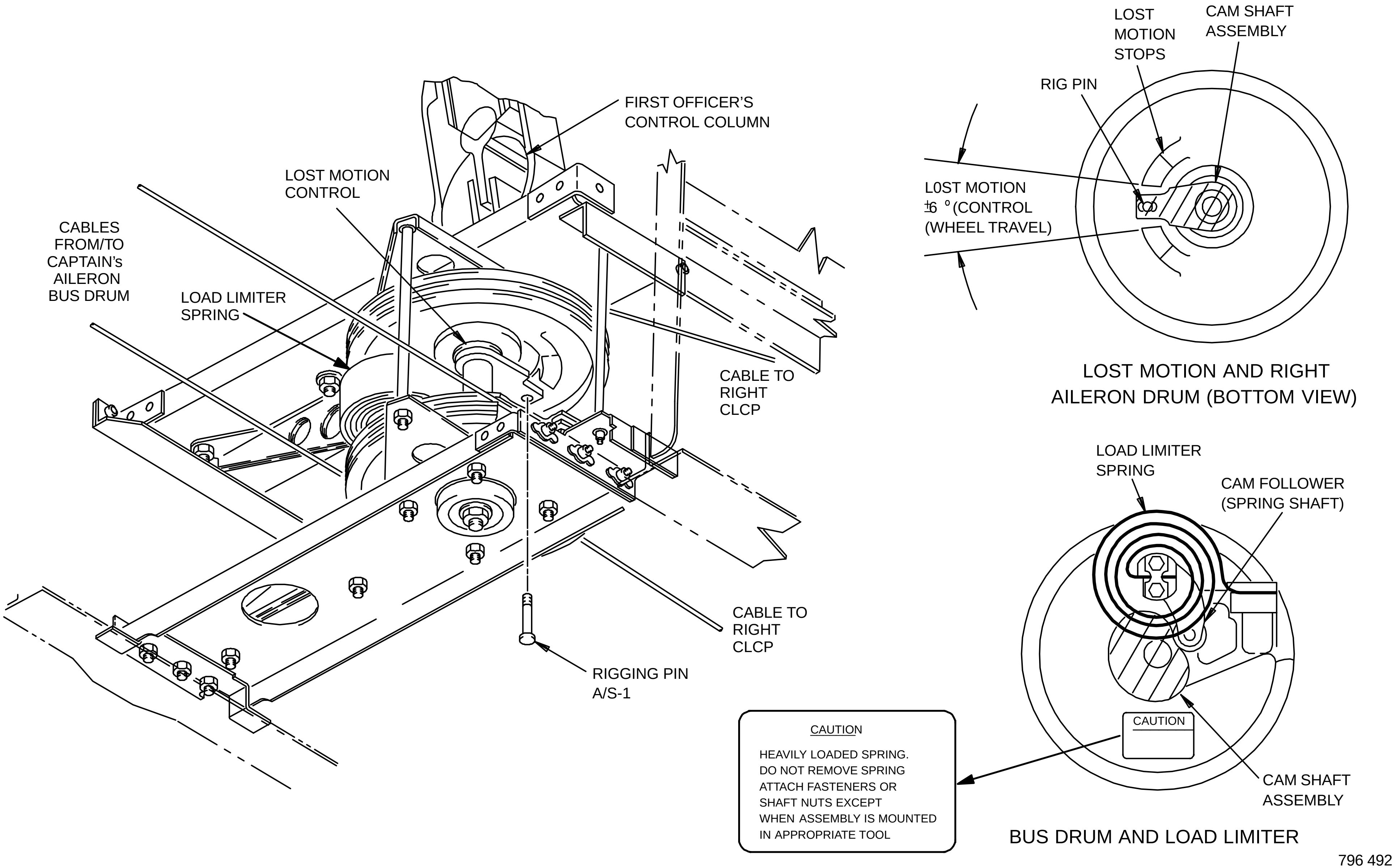


Figure 19 F/O's CONTROL COMPONENTS

AILERON COMPONENTS - WING GEAR WHEEL WELL

CONTROL WHEELS

- geben über Left Body Cable Inputs zur Feel-, Centering and Trim Unit
- Lost Motion Devices sorgt dafür, daß dabei das Right Body Cable nicht betätigt wird

FEEL-, CENTERING- AND TRIM UNIT

- erzeugt Gegenkräfte und zentriert die Control Wheels
- gibt Inputs zum Control Valve vom Left CLCP und über Input Rod wird das Control Valve vom Right CLCP angesteuert
- Lost Motion sorgt dafür, daß dabei nicht der Right Cable Quadrant betätigt wird

CENTRAL LATERAL CONTROL PACKAGE (CLCP)

- betätigen Programmers und Spoiler Differential Mechanisms zur Ansteuerung der Flight Spoilers
- haben Internal Follow Up

PROGRAMMERS

- geben Inputs zu den Inboard Aileron Power Unit Control Valves und über die Outboard Aileron Lockout Mechanisms zu den Outboard Aileron Power Unit Control Valves. Dabei erfolgt die Control Cable Ansteuerung so, daß bei ca. 50% Control Wheel Auslenkung (CLCP Output) die Control Valves der Power Units schon für vollen Ausschlag angesteuert werden.
- Falls ein CLCP hydraulisch nicht versorgt und nicht blockiert ist, wird diese vom anderen CLCP durch die Output Rod mitgenommen.
- Zusätzlich betätigt der Right Programmer über die Backdrive Rod den Right Cable Quadrant und über das Right Body Cable wird das Lost Motion Device am Co- Pilots Control Wheel ausgeglichen.

AILERON DRUM

- ermöglicht, daß bei Cable Riß zum Lockout Mechanism die Inboard Power Units weiter angesteuert werden können.

OUTBOARD AILERON LOCKOUT MECHANISM

- bekommen Inputs von den SRM's. Bei einem Fehler erscheint die EICAS Mess. mit CMC Speicherung.
- schalten bei LE Flaps Group A Not Up oder Speed <231 KTS die Aileron Control Cable Bewegung auf die Outboard Aileron Power Unit Control Valves, und bei LE Flaps Group A Up und Speed >238 KTS gelangen keine Control Cable Bewegungen auf die Control Valves.

AILERON TRIM

- erfolgt durch Betätigung der Trim Switches. Dadurch wird der Trim Actuator angesteuert.
- Actuator gibt Input über Feel-, Centering and Trim Unit auf die CLCP's und auf das Left Body Cable.
- Anzeige durch die Trim Indicators an den Control Wheels.

AUTOPILOT CONTROL

- Signals "L" gelangen zum Right CLCP und Signals "R" gelangen zum Left CLCP. Über Solenoid- und Transfer Valves werden die Control Valves ausgelenkt und über das Left Body Cable werden die Control Wheels bewegt.
- Signals "C" gelangen über Solenoid- und Transfer Valves auf den Third Autopilot Actuator. Dieser Actuator lenkt über die Feel-, Centering and Trim Unit die CLCP Control Valves aus und über das Left Body Cable werden die Control Wheels bewegt.

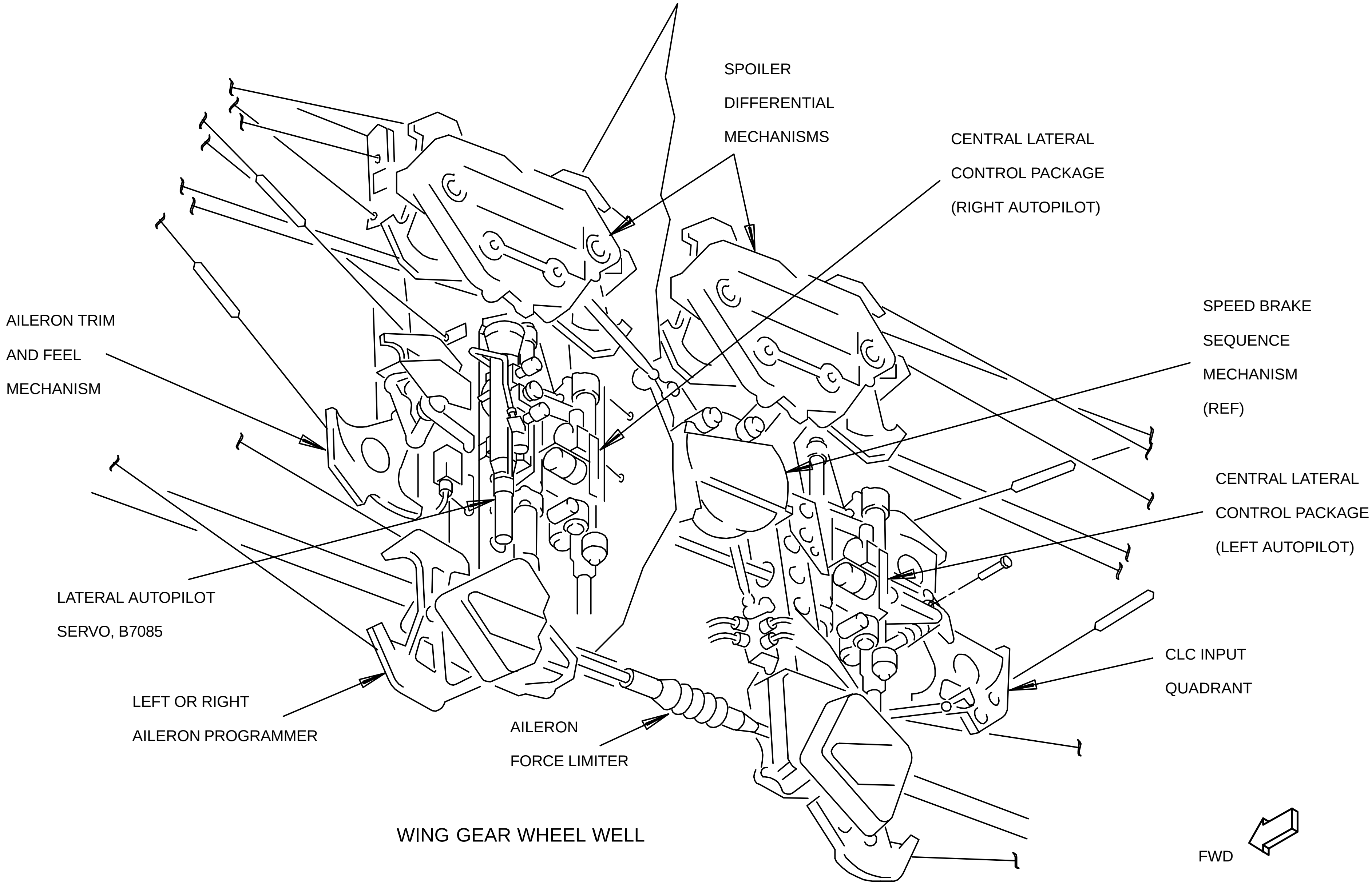


Figure 20 AILERON COMPONENTS - WING GEAR WHEEL WELL

CENTRAL LATERAL CONTROL PACKAGE (CLCP)

DESCRIPTION

Two central lateral control packages (CLCP's), mechanically connected, receive the lateral control input and provide a hydraulically powered output which operates the aileron programmers and spoiler differentials. The CLCP-right autopilot is in the left wheel well. The CLCP-left autopilot is in the right wheel well. Hydraulic pressure of 3000 psi is provided to the CLCP-right autopilot from main hydraulic supply systems No. 1 and 2. Hydraulic supply systems No. 3 and 4 provide power for the CLCP-left autopilot. The CLCP's also include provisions for input from the airplane autopilot system.

The mechanical input to each CLCP is received by an input lever and is transmitted through dual load path cranks to primary and secondary summing beams. The primary summing beam is connected directly to the spool of the main control valve. The valve is a dual tandem valve with the valve sleeve connected to the secondary summing lever. Lost motion is provided at the connection allowing the sleeve to be repositioned only after a spool motion of 50% of total travel. During normal operating conditions, the sleeve is rarely repositioned. Motion of the valve spool or sleeve ports hydraulic fluid from both supplying systems to a tandem actuator. Motion of the actuator provides the input to the spoiler differential and aileron programmer. The summing beams, connected to the actuator, provide the follow-up to close the control valve when the actuator reaches the desired position.

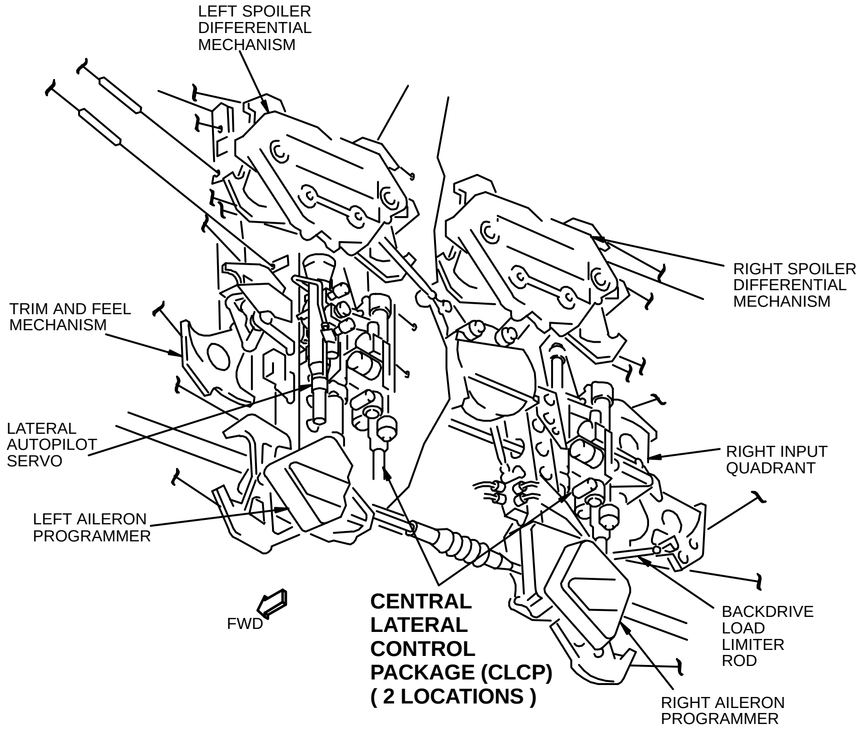
Hydraulic fluid to the main control valve and autopilot components passes through replaceable filters. Four anticavitation check valves in the package connect the pressure and return lines. The valves permit hydraulic fluid to flow from a return line to a pressure line to prevent a hydraulic lock which would occur if one hydraulic supply system was shut off.

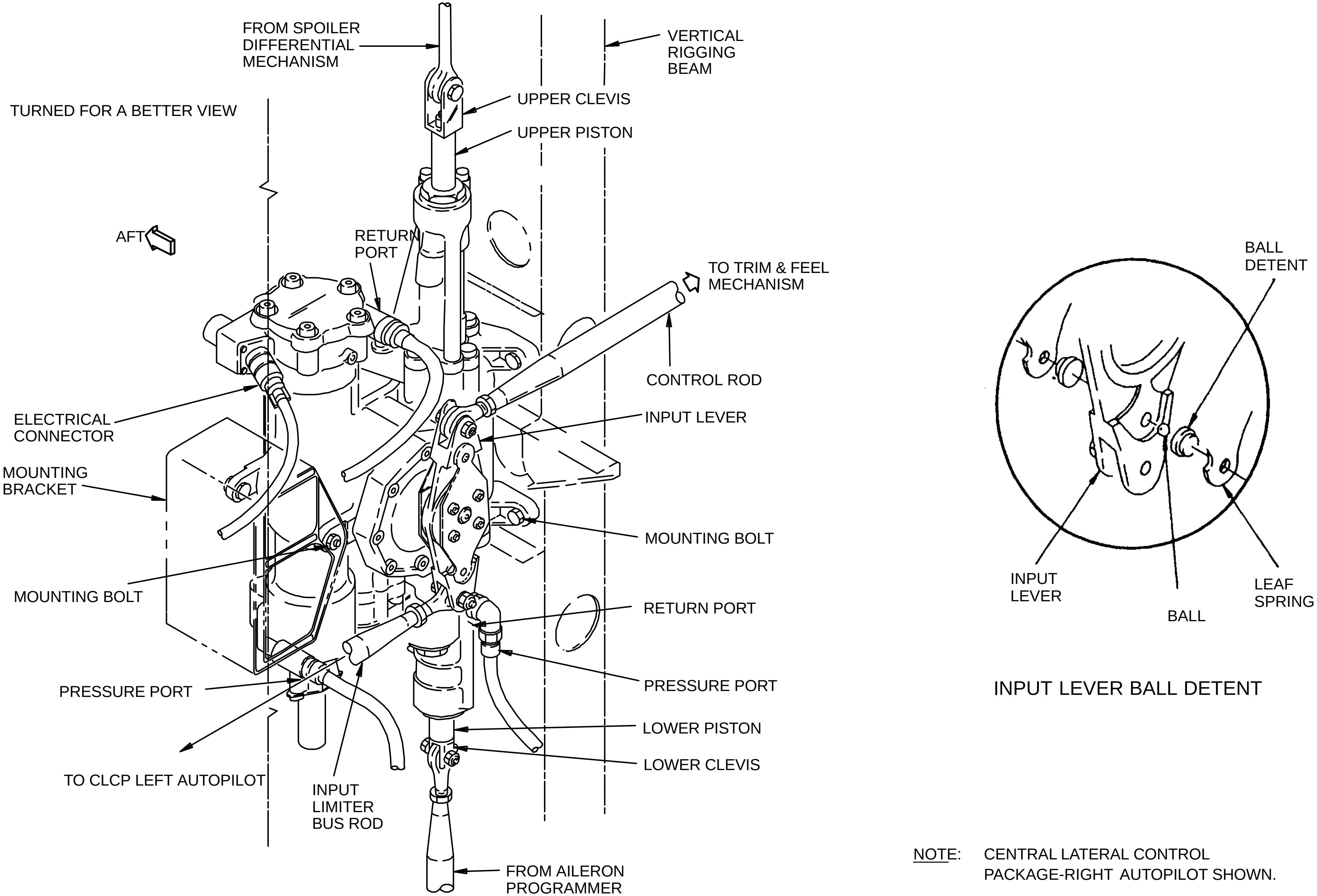
SUMMARY :

Ball Detent Mechanism

- verbindet Leaf Spring Arm mit Control Crank
- entkuppelt bei Blockierung
- Leaf Spring Arm ist fest CLCP Eingang verbunden
- hat keine Internal Limit Switches

LOCATON OF THE CENTRAL LATERAL CONTROL PACKAGES





NOTE: CENTRAL LATERAL CONTROL PACKAGE-RIGHT AUTOPILOT SHOWN.

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Figure 21 AILERON COMPONENTS - WING GEAR WHEEL WELL

LATERAL AUTOPILOT SERVO (LAS)

DESCRIPTION

Autopilot components within the CLCP include two solenoid valves, an electro-hydraulic servo valve, an autopilot pressure regulator valve, an autopilot actuator and two linear transducers.
During manual operation by the aileron control wheels, the solenoid valves are de-energized.
The autopilot actuator is not clamped to the intermediate crank and so allows free movement of the summing beams. When the autopilot system is engaged, the solenoid valves energize and allow hydraulic fluid to clamp the autopilot actuator to the output actuator through the summing beams.
Autopilot operation is accomplished by electrical signals applied to the transfer valve (electrohydraulic servo valve) which controls the flow of hydraulic fluid to the autopilot actuator. Movement of the autopilot actuator positions the main control valve through the summing beams. Thereafter, functioning is identical, irrespective of the mode of operation (manual or autopilot).
The feedback signal to the main control valve is provided by movement of the tandem actuator transmitted through the summing beams. Autopilot feedback signals are provided by linear transducers positioned by the autopilot actuator and the tandem actuator.

SUMMARY :

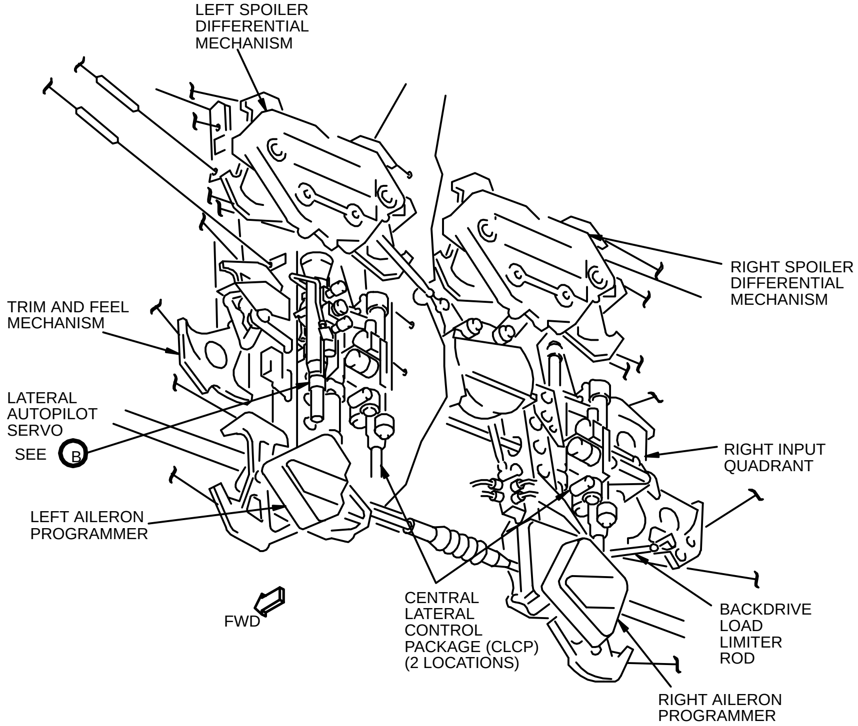
AUTOPILOT "C" ACTUATOR
(THIRD AUTOPILOT ACTUATOR)
- betätigt über Output Crank, Output Rod und Crank den Left Body Cable Quadrant
- Manual Override ist möglich

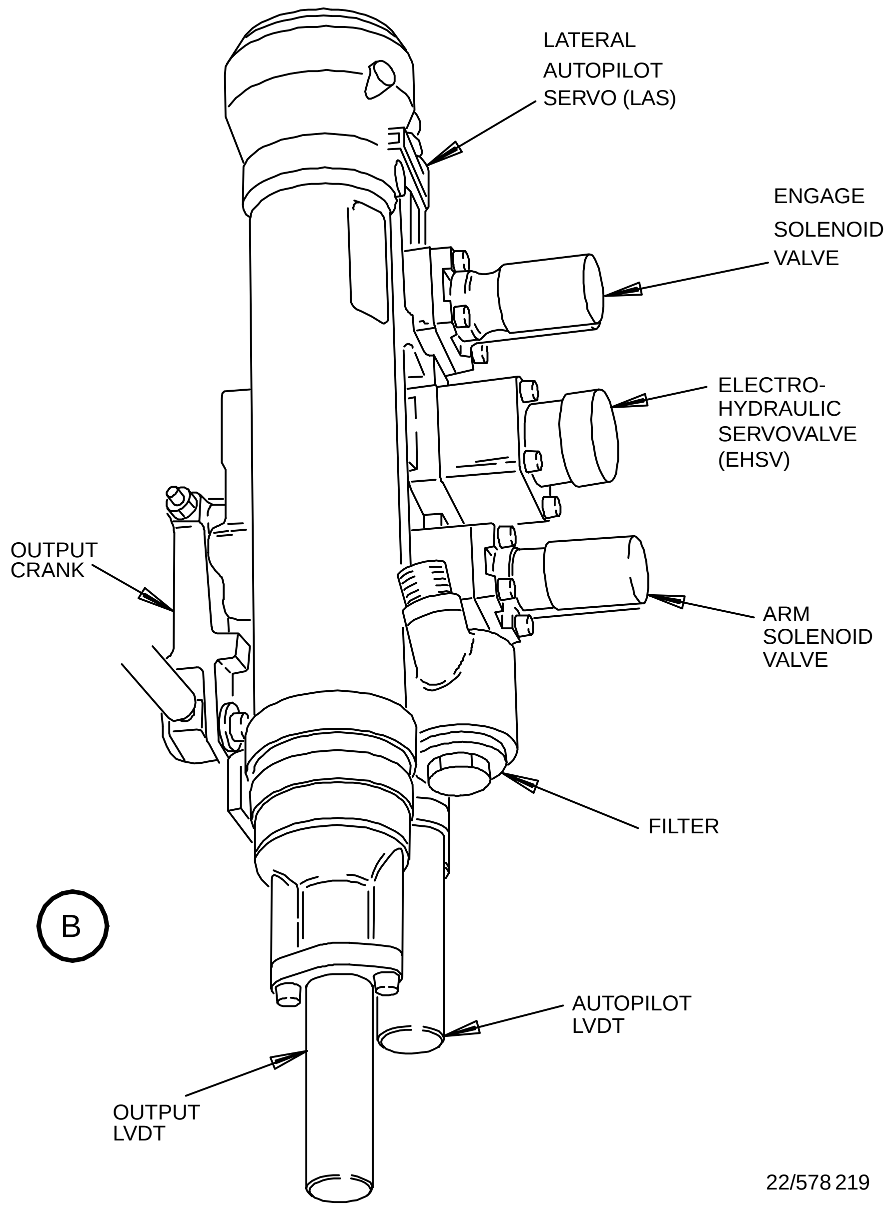
ARMING SOLENOID
- dient für Hydraulic Supply vom Transfer Valve und vom Actuator
- erhält Signale vom Autopilot System
- kann separat gewechselt gewerden

TRANSFER VALVE
- steuert Actuator
- erhält Signale vom Autopilot System
- kann separat gewechselt gewerden

ENGAGE SOLENOID
- steuert Hydraulic zur Internal Hydraulic Pressure Operated Clutch. Diese Clutch verbindet Autopilot Actuator Bewegungen mit der Output Rod.
- kann separat gewechselt gewerden

TRANSDUCER
- übertragen Autopilot Feedback Signale





THE LEFT CLCP IS THE CLCP - RIGHT AUTOPILOT;
THE RIGHT CLCP IS THE CLCP - LEFT AUTOPILOT.

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Figure 22 LATERAL AUTOPILOT SERVO (LAS)

AILERON TRIM AND FEEL MECHANISM

DESCRIPTION

The aileron trim and feel mechanism provides artificial feel at the aileron control wheels, and centering and trim of the lateral control system. The mechanism receives its input from the left body control cables and provides an output which operates the CLCP's.

Rotation of the left body input quadrant rotates a cam mounted on the same shaft as the quadrant. This motion forces a cam follower out of a neutral detent position. Two centering and feel springs connected to the cam follower extend and provide the force felt at the control wheels. When the control wheels are released, the spring force, operating through the cam follower, forces the cam back to the neutral position, centering the system. A pushrod connected to the quadrant provides the input to the CLCP's.

Trim input to the mechanism is provided by a trim actuator attached to adjacent structure. The actuator consists of an electric motor and jackscrew which provides linear motion of the output shaft. The actuator is controlled by switches on the pilots' control stand. The actuator output shaft is connected to the mechanism support assembly. Output of the actuator repositions the entire trim and feel mechanism, including the input quadrant, to establish a new control system neutral position. This rotation provides an input to the CLCP's which position the lateral flight control surfaces to give the desired trim correction. Rotation of the input quadrant due to trim input also repositions the aileron control wheels away from the normal neutral positions. Positioning of the trim actuator is not affected by reverse forces resulting from normal control of the system.

Command from the autopilot module to the mechanism is provided by a lateral autopilot servo (LAS) attached to adjecent structure. The LAS functions in response to roll command signals received from channel C autopilot. The signals cause motion of the LAS output rod. The rod is connected to the mechanism input crank which is attached to the left body input quadrant.

SUMMARY :

LEFT BODY CABLE
- betätigt Left Body Cable Quadrant

LEFT BODY CABLE QUADRANT
- betätigt Output Rod
- Control Rod für Inputs vom Autopilot C Actuator

FEEL- , CENTERING- AND TRIM UNIT
- erzeugt bei Betätigung vom Left Body Cable Quadrant Gegenkräfte für die Control Wheels
- stellt nach Auslenkung Left Body Cable Quadrant auf Neutral
- überträgt Actuator Trimbewegungen auf den Left Body Cable Quadrant

TRIM ACTUATOR
- verstellt bei Trimmung über die Feel-. Centering and Trim Unit den Left Body Cable Quadrant

OUTPUT ROD
- Steuert Left Centeral Lateral Control Packages (CLCP) control Valve
- ist an Left Body Cable Quadrant angelenkt

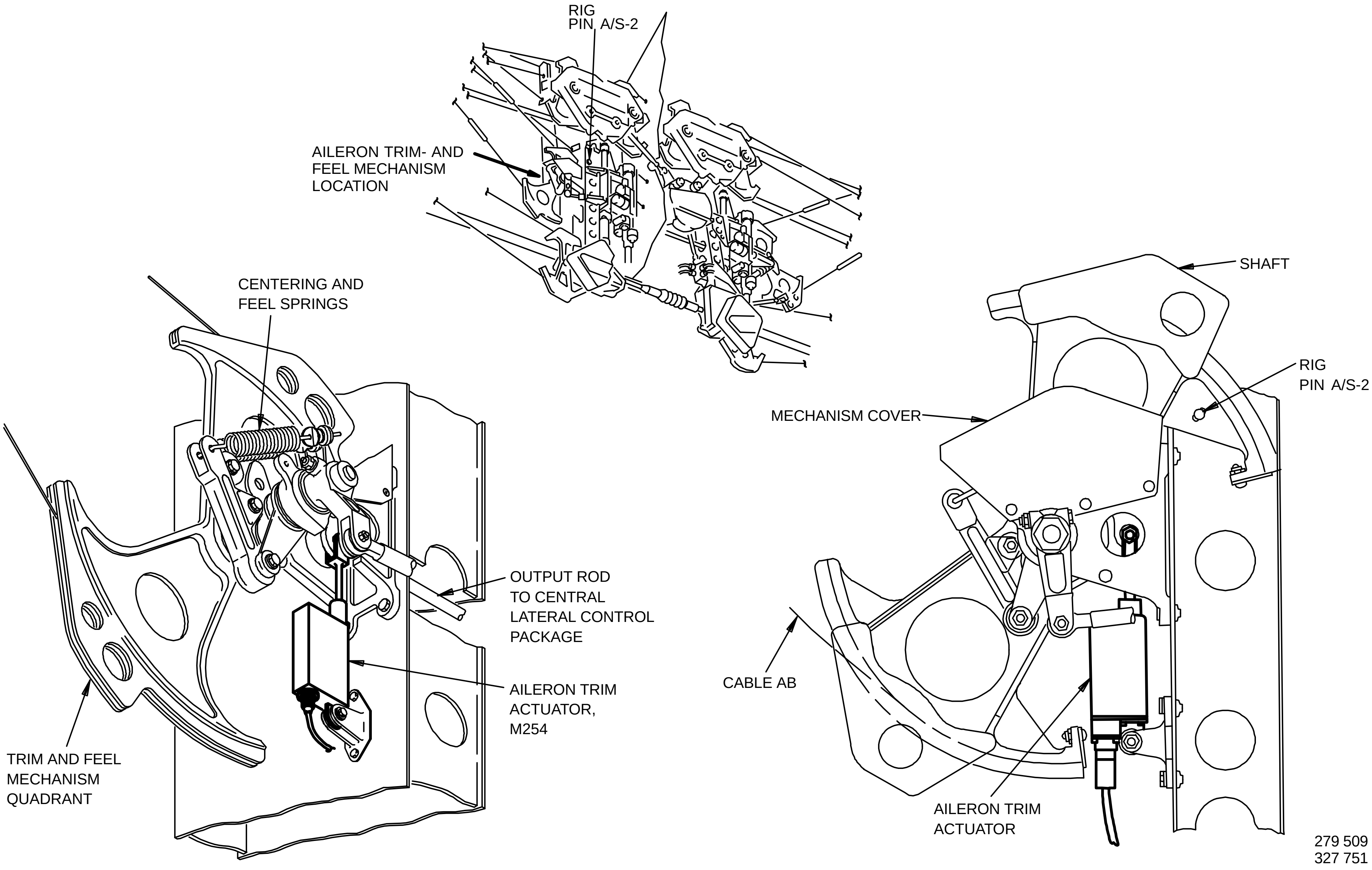


Figure 23 AILERON TRIM AND FEEL MECHANISM

AILERON TRIM ACTUATOR ELECTRICAL SCHEMATIC

DESCRIPTION

The aileron trim system includes the following components :

- Trim positon decals on both control wheels
- Arming- and control switches on the P-8 pilots control stand
- Electric trim actuator located in the left wing gear wheel well
- Circuit breaker on P-7 overhead circuit breaker panel.

OPERATION :

Actuate both arming and control switches to provide 28V DC power to the trim actuator. Switch position determines extension or retraction of the actuator. Note movement of control wheel.

When trimming beyond 20° of control wheel rotation manual assist to the control may be required to keep the cam follower centered.

Maximum trim travel is 47 +/- 3° of control wheel rotation. The corresponds to six units on the aileron trim indicator.

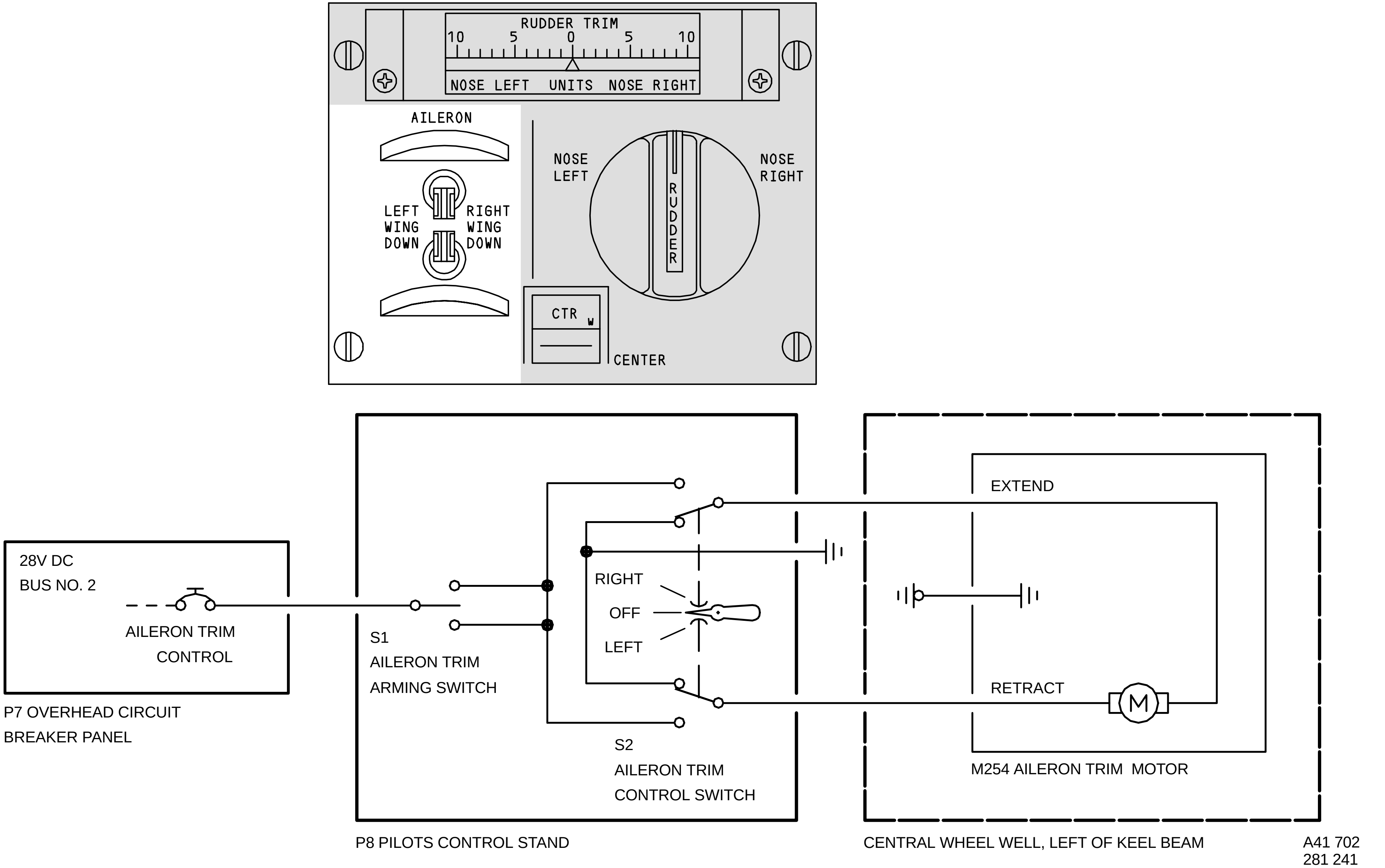


Figure 24 AILERON TRIM ACTUATOR SCHEMATIC

AILERON PROGRAMMER

DESCRIPTION

The aileron programmers control the motion of the ailerons relative to aileron control wheel movement. Two programmers are installed with each programmer providing the output for a respective wing. The programmers are so designed that initial control wheel rotation away from neutral produces a relatively large amount of aileron travel. The aileron response rate decreases as control wheel rotation increases.

Input to the programmer is provided by the CLCP which causes rotation of an input lever. The input lever operates a cam assembly which is connected to an output quadrant. The cam assembly provides the aileron response rate variation.

Basically, the cam assembly consists of two cranks separated by three rollers. The roller location is such that the radius of input crank rotation is large compared with the radius of output crank rotation when the system is in the neutral position. As the cranks rotate, the radius remains constant for the input crank while the radius increases for the output crank. As a result, the ratio of output to input decreases as the cam moves away from neutral. Backlash at the rollers is eliminated by a preloaded compression spring connecting the two halves of the output crank.

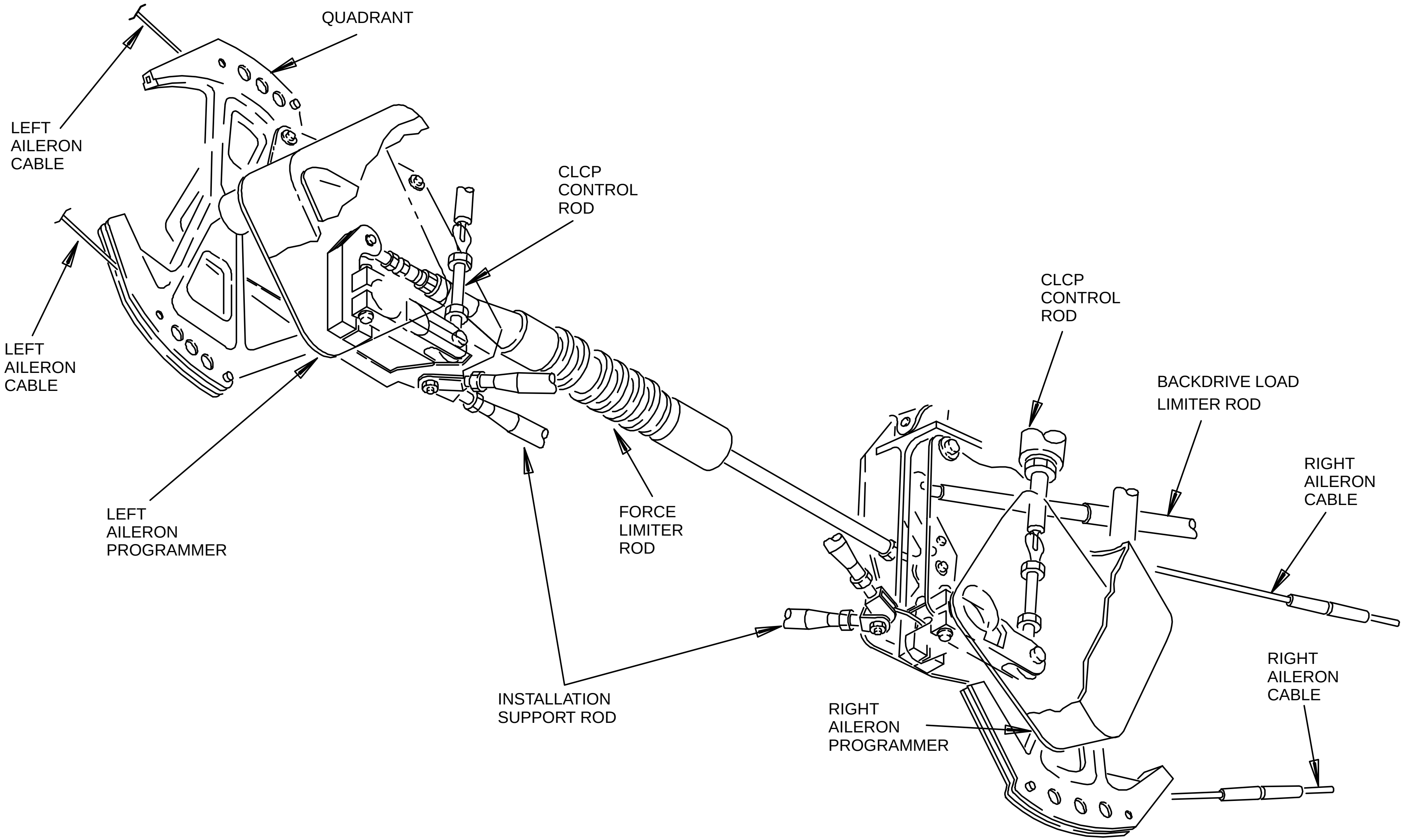


Figure 25 AILERON PROGRAMMER OVERVIEW

AILERON PROGRAMMER

SUMMARY :

SHEAR RIVITS :

- dienen zur Befestigung und als Verbindungselemente von Cable Quadrant und Spli Yoke Assembly

INPUT CRANK

- überträgt die Control Rod Bewegung auf die Rollers

SLIT YOKE ASSEMBLY

- ist mit dem Cable Quadrant verbunden
- wird durch eine Spring gehalten

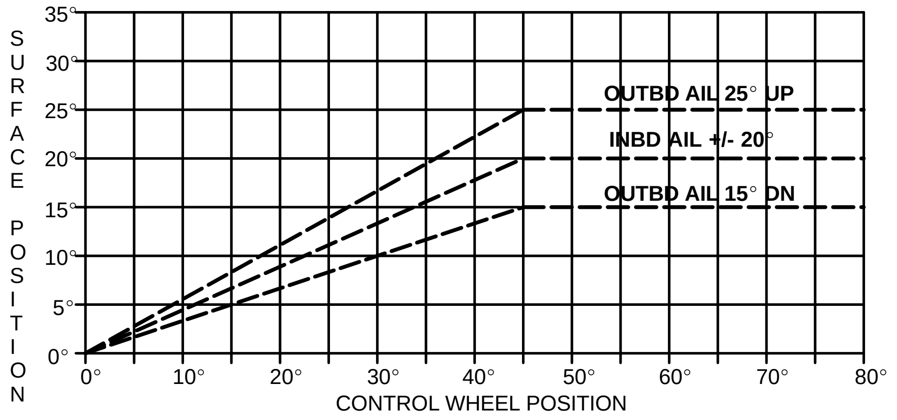
OUTPUT CRANK

- ist mit der Output Bus Rod verbunden

OUTPUT BUS ROD

- verbindet den rechten und linken Force Limiter miteinander
- kann justiert werden

AILERON PROGRAMMER FUNCTION



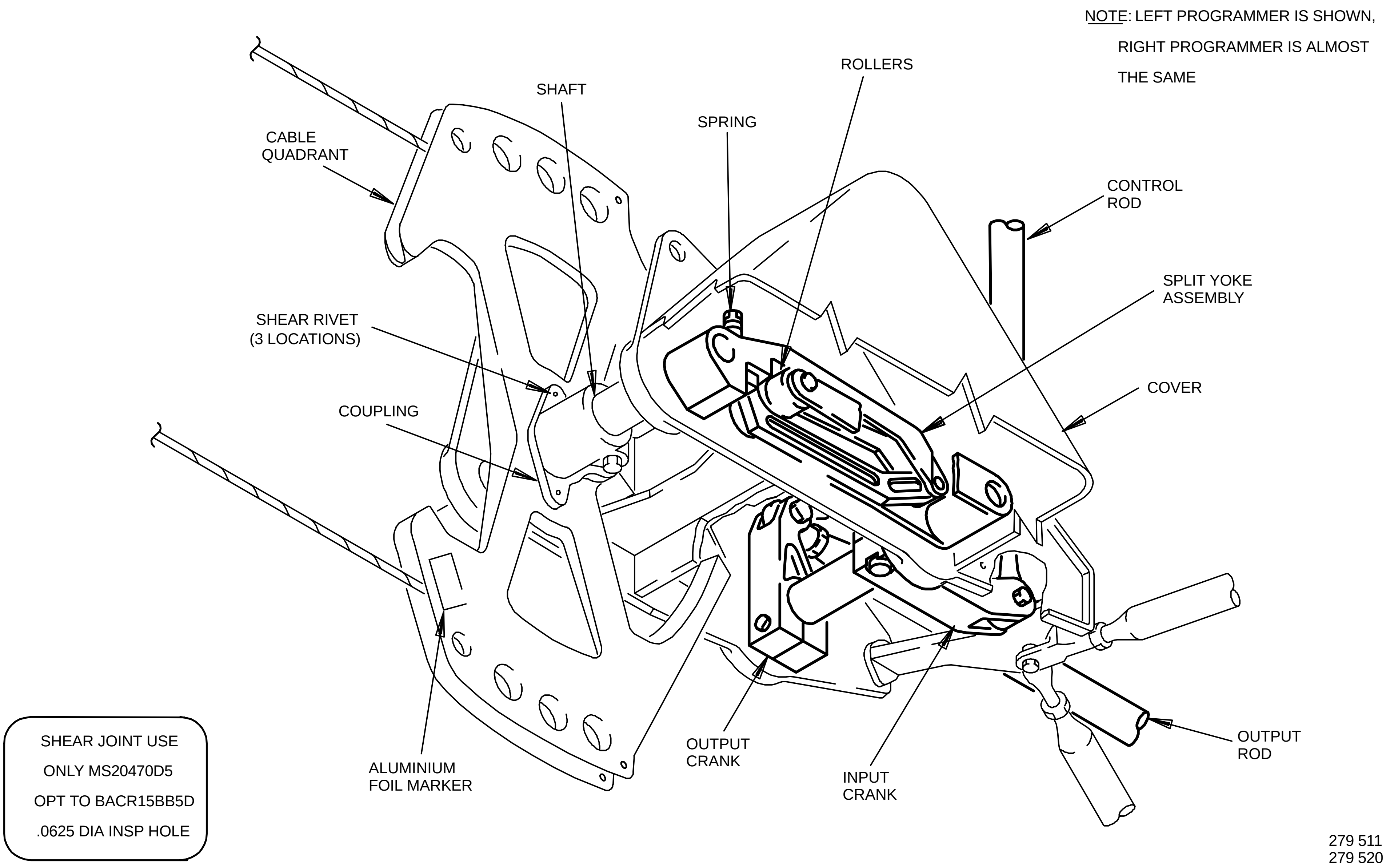


Figure 26 AILERON PROGRAMMER

INBOARD AILERON POWER CONTROL PACKAGE

DESCRIPTION

Each of the four ailerons is positioned by a single aileron power package. Two independent hydraulic supply systems provide hydraulic fluid at 3000 psi to each package with distribution as shown. The two hydraulic systems are isolated within the package so that loss of one hydraulic system cannot cause loss of the second system. Thus, the package will continue to operate with only one hydraulic source available at the package.

Input to each power package is provided by cable runs and control linkage positioned by one of the CLCP's. The input operates through an overtravel mechanism to position a single spool tandem control valve. The overtravel mechanism compensates for additional input after the valve spool has reached full travel.

Hydraulic fluid from the supply systems is provided to the control valve through filters and check valves which prevent reverse flow in the pressure lines. Positioning of the control valve ports both hydraulic systems to a tandem actuator. As the CLCP moves to position the aileron, it also repositions the input linkage to the power package. This follow-up closes the control valve when the aileron reaches the desired position as determined by the initial input. In the event of linkage failure, a bias spring will position the control valve spool to the aileron full down position.

A compensator is installed in the package for each hydraulic return system. Each compensator stores a small quantity of hydraulic fluid at return pressure. With the package inoperative, a spring within the compensator forces fluid into the package to compensate for loss from temperature change or leakage.

The pressure and return lines of each hydraulic system within the package are connected with two anticavitation check valves. The check valves permit hydraulic fluid to flow from the extend to return side of a piston to prevent a hydraulic lock which would occur with one hydraulic supply system shut off.

CONTROL QUADRANT

- betätigt über Control Rod, Summing Lever und Control Linkage das Control Valve
- Rig Pin für Neutral Position

CONTROL ROD

- zum Justieren vom Control Valve

SUMMING LEVER

- dient zur Control Valve Auslenkung bei Ansteuerung und Follow Up
- ist an durchgehender Piston Rod angelenkt

CONTROL VALVE

- steuert Hydraulic
- Internal Overtravel Mechanism
  - dient bei einer Störung zur Trennung (zum Auskuppeln) von Linkage Assembly und Control Valve
  - kuppelt aus, wenn das Control Valve nach einer Auslenkung fehlerhaft hängen bleibt. Dadurch können die anderen Power Units weiterhin angesteuert werden.
- Internal Bias Spring betätigt bei Linkage Fehler (z.B. Bruch) das Control Valve nach Aileron Full Down.

COMPENSATORS

- verschließen bei Hydraulic Off die Return Ports und halten die eingeschlossene Flüssigkeit unter einer Vorspannung von 65 psi.

ANTICAVITATION CHECK VALVES

- versorgen bei Hydraulic Off die jeweilige Kolbenseite mit Hydraulic zur Vermeidung von Unterdruck.

INBOARD AILERON

- Max. Ausschlag ca. 20° nach beiden Seiten
- ist statisch nicht ausgewogen

REACTION LINKS

- zum Abfangen der Kräfte.

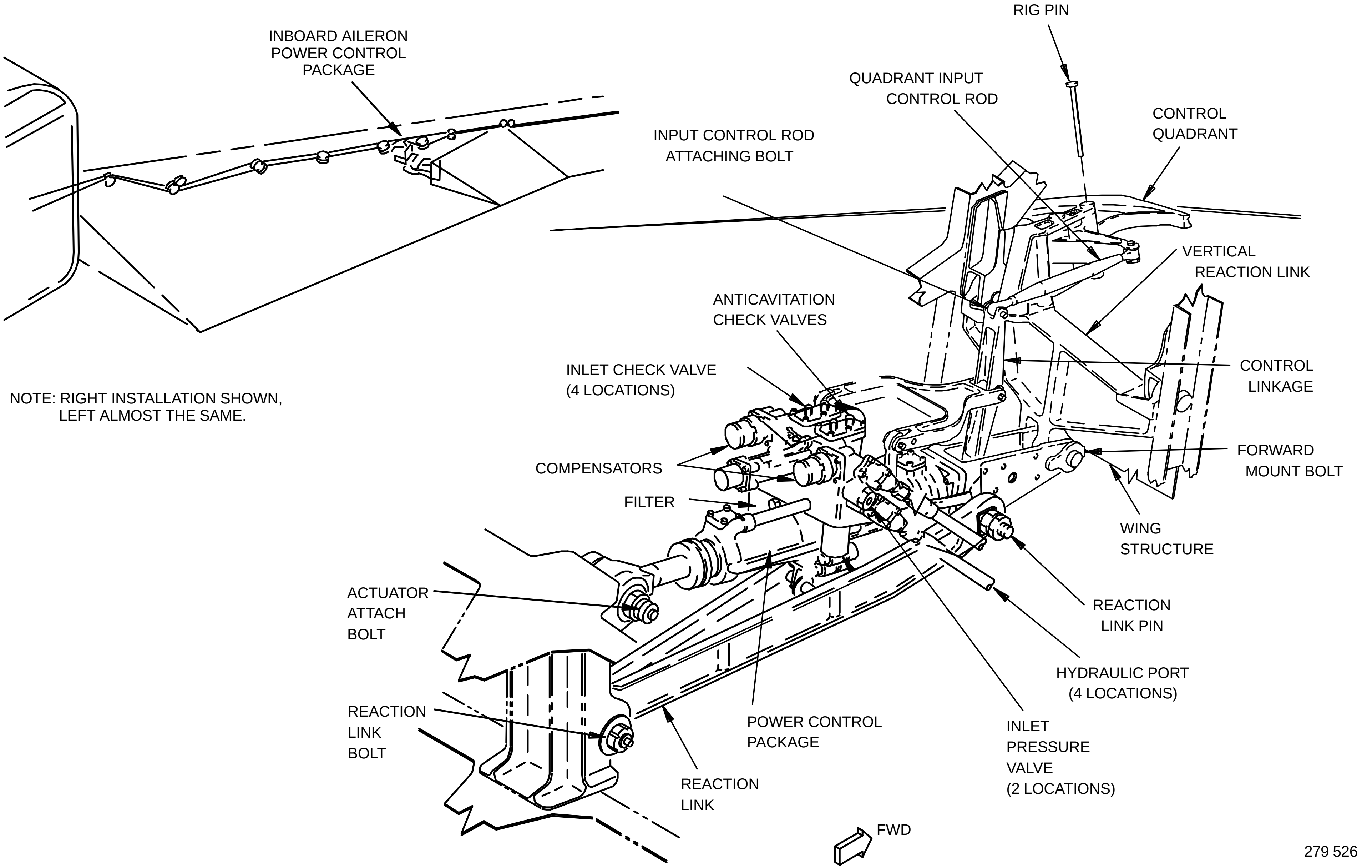


Figure 27 **INBOARD AILERON POWER CONTROL PACKAGE**

OUTBOARD AILERON CONTROL PACKAGE AND LOCKOUT MECHANISM

DESCRIPTION

Each of the four ailerons is positioned by a single aileron power package. Two independent hydraulic supply systems provide hydraulic fluid at 3000 psi to each package with distribution as shown. The two hydraulic systems are isolated within the package so that loss of one hydraulic system cannot cause loss of the second system. Thus, the package will continue to operate with only one hydraulic source available at the package.

Input to each power package is provided by cable runs and control linkage positioned by one of the CLCP's. The input operates through an overtravel mechanism to position a single spool tandem control valve. The overtravel mechanism compensates for additional input after the valve spool has reached full travel.

Hydraulic fluid from the supply systems is provided to the control valve through filters and check valves which prevent reverse flow in the pressure lines. Positioning of the control valve ports both hydraulic systems to a tandem actuator. As the CLCP moves to position the aileron, it also repositions the input linkage to the power package. This follow-up closes the control valve when the aileron reaches the desired position as determined by the initial input. In the event of linkage failure, a bias spring will position the control valve spool to the aileron full down position.

A compensator is installed in the package for each hydraulic return system. Each compensator stores a small quantity of hydraulic fluid at return pressure. With the package inoperative, a spring within the compensator forces fluid into the package to compensate for loss from temperature change or leakage.

The pressure and return lines of each hydraulic system within the package are connected with two anticavitation check valves. The check valves permit hydraulic fluid to flow from the extend to return side of a piston to prevent a hydraulic lock which would occur with one hydraulic supply system shut off.

SUMMARY :

AILERON QUADRANT

- betätigt über Lockout Mechanism, Output Linkage, Input Linkage den Summing Lever.

LOCKOUT MECHANISM

- wird vom Lockout Actuator verstellt.

LOCKOUT ACTUATOR

- wird von den SRM's gesteuert
- Rod Retracted bei LE Flaps Group A Up und Speed >238 KTS (0.53 M)
  - keine Output Linkage Bewegung
- Rod Extend bei LE Flaps Group A Not Up oder Speed <232 KTS (0.51 M)
  - Output Linkage betätigt Input Linkage.

OUTPUT LINKAGE

- bewirkt Differentialansteuerung.

INPUT LINKAGE

- kann justiert werden.

SUMMING LEVER

- ist an Piston Rod angelenkt.

OUTBOARD AILERON POWER CONTROL PACKAGE

- (siehe Inboard Aileron Power Package)

OUTBOARD AILERON

- Max. Ausschläge ca. 25° nach oben und ca. 15° nach unten
- ist statisch ausgewogen.

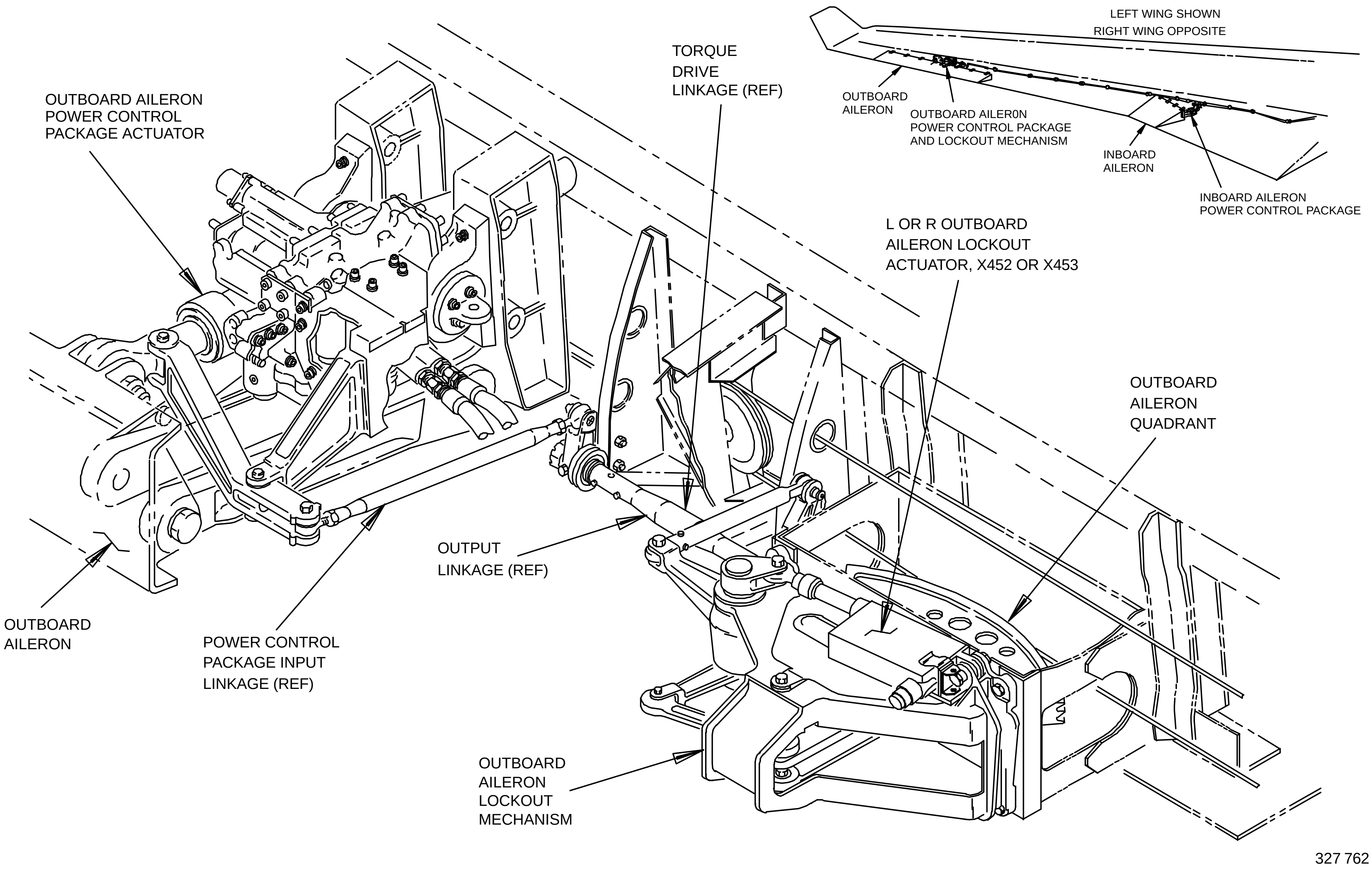


Figure 28 OUTBOARD AILERON CONTROL PACKAGE AND LOCKOUT MECHANISM

OUTBOARD AILERON LOCKOUT MECHANISM

DESCRIPTION

OUTBOARD AILERON LOCKOUT MECHANISM

An outboard aileron lockout mechanism is located in each wing to isolate the outboard ailerons from the lateral control system during high speed flight. The mechanism consists of a housing, cable quadrant, input crank, output crank and a series of levers and links, that, when in certain positions, will either transmit or prevent the transmission of motion from the control wheel to the aileron power package. The lockout mechanism is electrically controlled by an actuator installed on the mechanism housing.

With the group A LE flaps fully retracted, the pivot point of the mechanism is aligned with the center of rotation of the aileron control quadrant, point A. In this configuration the quadrant cannot transmit motion. When the flaps leave the full up position the electric actuator repositions the lockout mechanism to separate the pivot points. With these points separated the mechanism will then transmit motion to the aileron power package.

OUTBOARD AILERON ELECTRIC LOCKOUT ACTUATOR

The outboard aileron electric lockout actuator provides the input to the aileron lockout mechanism. The actuator consists of a 28-volt dc reversible motor controlled by limit switches within the actuator, and an actuator shaft. During operation the actuator shaft will travel 2 inches between limit switch actuations. The shaft cannot be adjusted. Electrical power to the actuator is provided from the AILERON LOCKOUT circuit breaker on P7 Overhead Circuit Breaker Panel through the SRM's, which located in the main equipment center. The lockout command is computed using the speed inputs from the Digital Air Data Computers (DADC's) and flap position inputs from the Flap Control Units (FCU's).

FAILURE INDICATION OF A COMPONENT OF THE AILERON LOCKOUT ACTUATOR

For example :

Whenever a fault is detected for the aileron lockout actuator the advisory massage

AILERON LOCKOUT 27 10 01 00

and / or

status message :

AILERON LOCKOUT 27 10 02 00

appears

and on the MCDU is shown the reason for the EICAS message

CMC message :

R AILERON LOCKOUT ACTUATOR ”NO RESPONSE” (SRM-L) 27 122

or

L AILERON LOCKOUT ACTUATOR POSITION SW FAIL (SRM-R) 27 323

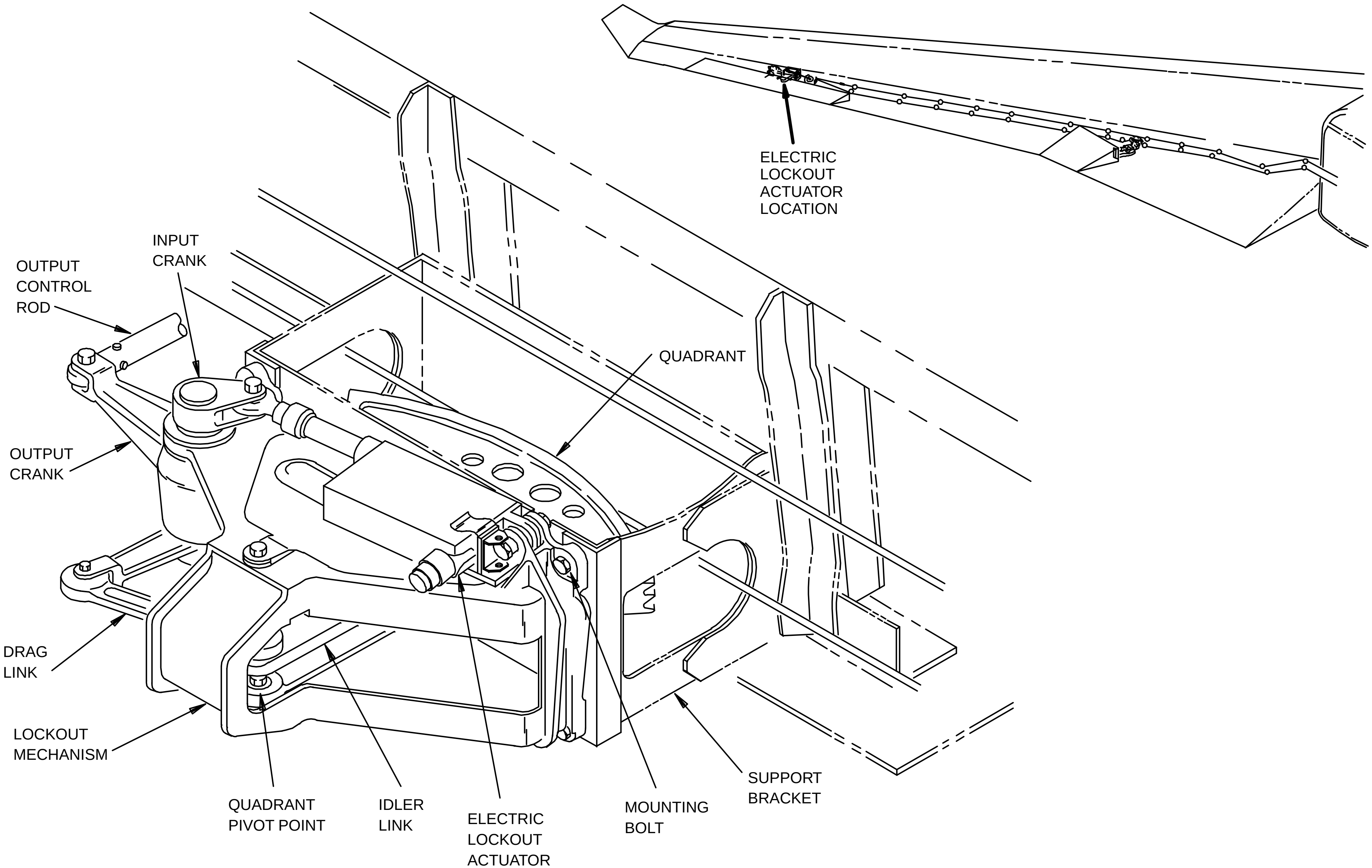


Figure 29 OUTBOARD AILERON LOCKOUT MECHANISM

OUTBOARD AILERON LOCKOUT ELECTRICAL SCHEMATIC

DESCRIPTION

Beide SRM's sind so auf die Lockout Actuators geschaltet, daß bei Ausfall von einem SRM das andere die Ansteuerung der beiden Lockout Actuators weiterhin durchführen kann.

Die Actuator Retract- und Extend Abschaltung erfolgt durch Internal Limit Switches und dient als Feedback für die SRM's. Actuator Extend bedeutet Lockout Mechanism Unlocked, d.h. Outboard Aileron wird betätigt; Actuator Retract bedeutet Lockout Mechanism ist Locked, d.h. Outboard Aileron ist abgeschaltet.

Die Aileron Lock Actuator werden von der aktiven SRM angesteuert nach :

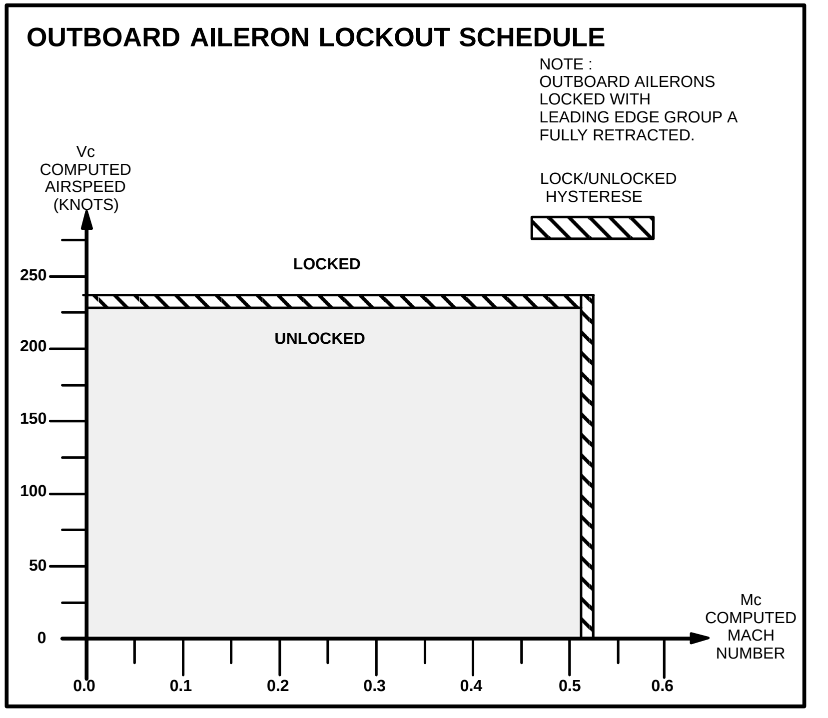
<u>**LOCKED :**</u>

- Computed Airspeed (Vc) **> 238 Kts**
  oder
- Computed Mach Number (Mc) **> 0.53 M**
  und
- Group A LE Flaps **FULLY RETRACTED**

<u>**UN-LOCKED :**</u>

- Computed Airspeed (Vc) **< 232 Kts**
  oder
- Computed Mach Number (Mc) **< 0.51 M**
  oder
- Group A LE Flaps **NOT FULLY RETRACTED**

NOTE: Das erste Speed - Signal (Kts oder M) von den ADC's zu den SRM's wird durchgeschaltet und steuert das LOCKED- bzw. UN-LOCKED - Signal .



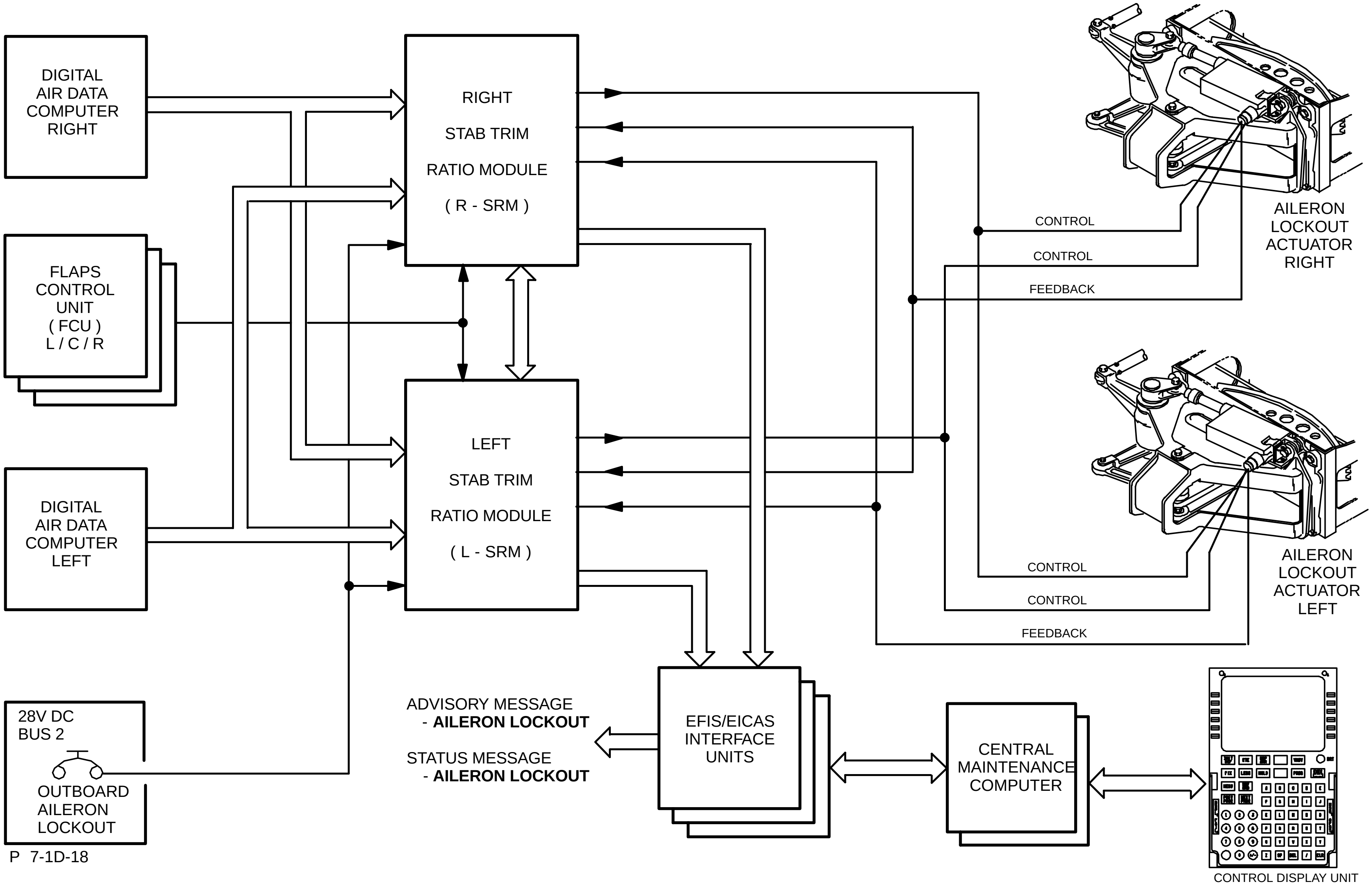


Figure 30 OUTBOARD AILERON LOCKOUT ELECTRICAL SCHEMATIC

GROUND TEST - AILERON LOCKOUT ACTUATORS

GENERAL

(1) This task is a check to make sure there are no failures with the left or right stabilizer trim/rudder ratio module (SRM) on the CMCS. Use one of the two procedures that follow to do a check for existing faults in the aileron lockout system.

REFERENCES

(1) 24-22-00/201, Manual Control

(2) 45-27-00/201, CMS - Flight Controls

PROCEDURE 1 :
Airplanes with Two SRM's P/N 285U0015-108 or later)

NOTE: This is a test of the aileron lockout system. This procedure is applicable for the left and right aileron lockout actuators. The aileron lockout actuators will be operated during this test. If a check of the mechanical operation of the lockout system is necessary, hydraulic power and the movement of the ailerons will be necessary. Hydraulic power and aileron movement will not be necessary to do a test of the electrical part of the system.

(1) Supply electrical power (Ref 24-22-00/201).

(2) If the mechanical operational test is to be done, supply hydraulic power (Ref 29-11-00/201).

(3) Set the GND TEST switch on the overhead maintenance panel, P461, to the ENABLE position.

(4) Open and close these circuit breakers on the P7 panel:

NOTE: This is to make sure the left SRM controls the actuators.

(a) FLT CONT ELEC 2R AC (C10265)

(b) FLT CONT ELEC 2R DC (C10266)

(5) Prepare the CDU for the test:

(a) Push the MENU key on the CDU to show the MENU.

(b) Push the line select key (LSK) that is adjacent to <CMC to show the CMC MENU.

(c) If <RETURN shows after you push the LSK, push the LSK that is adjacent to <RETURN until you see the CMC MENU.

(d) Push the LSK that is adjacent to <GROUND TESTS to show the GROUND TESTS menu.

(e) Push the NEXT PAGE key until you find <27 AILERON LOCKOUT.

(f) Push the LSK that is adjacent to <27 AILERON LOCKOUT to show the GROUND TESTS menu for the aileron lockout actuators.

(g) Find the <AIL LO ACTUATORS prompt.

NOTE: If INHIBITED shows above <AIL LO ACTUATORS, the test will not operate.

(h) If INHIBITED shows above <AIL LO ACTUATORS:

1) Push the LSK that is adjacent to the test prompt.

2) Do the steps shown on the CDU.

3) Push the LSK that is adjacent to <RETURN to show the ground test menu again.

(6) Push the LSK that is adjacent to the <AIL LO ACTUATORS prompt.

(a) When the TEST PRECONDITIONS page shows, make sure each instruction on the page is completed. (Push the NEXT PAGE key to see the subsequent pages.)

WARNING: MAKE SURE THAT PERSONS AND EQUIPMENT ARE CLEAR OF THE RUDDER AND AILERONS. THE RUDDER AND AILERONS CAN MOVE DURING THIS TEST IF HYDRAULIC POWER IS SUPPLIED. THIS CAN CAUSE INJURY TO PERSONS OR DAMAGE TO EQUIPMENT.

(b) If you are to do the mechanical operational test, do the steps that follow:

1) Turn the captain's or the first officer's control wheel fully clockwise.

2) Make sure the outboard ailerons move fully.

a) Use the flight controls maintenance page (on the lower EICAS) to make sure that the left outboard aileron position is between 12.5 and 17.5 degrees down.

b) Use the flight controls maintenance page (on the lower EICAS) to make sure the right outboard aileron position is between 22.5 and 27.5 degrees up.

3) Push the LSK that is adjacent to START TEST>.

NOTE: IN PROGRESS shows during the test.

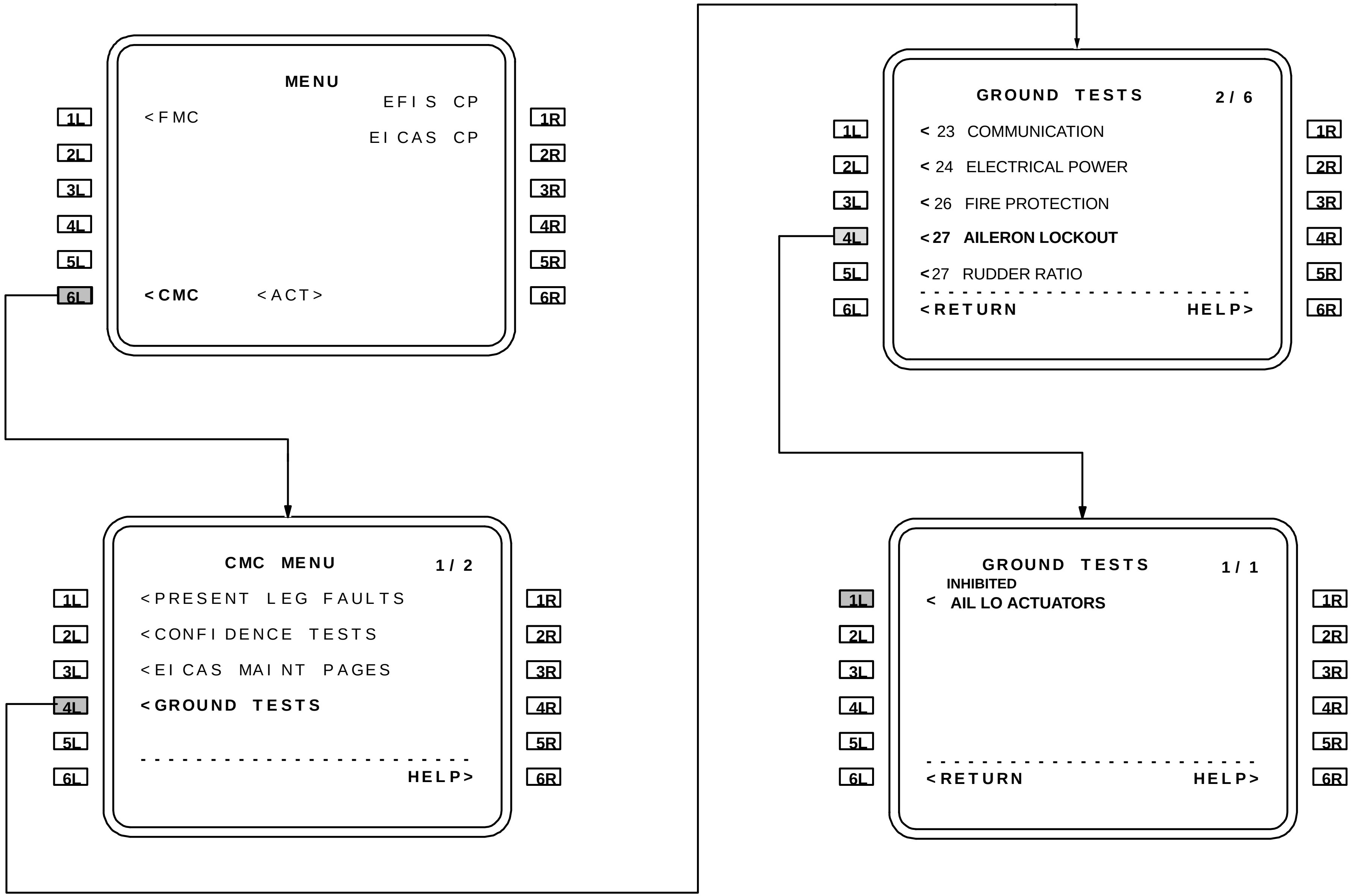


Figure 31 AILERON LOCKOUT ACTUATOR GROUND TEST

4) Make sure the outboard ailerons go back to the neutral position in approximately 30 seconds.

NOTE: Approximately 1 minute after you start the test, the actuators will unlock and return the outboard ailerons to full travel.

a) Use the flight controls maintenance page on the lower EICAS to make sure the two outboard aileron's positions are between 0.1 and 1.1 degrees down.

5) Return the control wheel to the neutral position.

(c) Push the LSK that is adjacent to START TEST>.

NOTE: IN PROGRESS shows during the test.

(7) When IN PROGRESS goes out of view, look for PASS or FAIL> adjacent to <AIL LO ACTUATORS.

NOTE: If a PASS indication shows, no failures occurred during the test.

(a) If FAIL> shows:

1) Push the LSK that is adjacent to FAIL> to see the GROUND TEST MSG pages for the failure.

2) Push the NEXT PAGE key until you find all the GROUND TEST MSG pages.

3) Make a list of all CMCS messages, CMCS message numbers, and ATA numbers that show on the GROUND TEST MSG pages.

4) Open and close these circuit breakers on the P7 panel:

NOTE: This is to make sure the right SRM controls the actuators.

a) FLT CONT ELEC 2L AC (C10263)

b) FLT CONT ELEC 2L DC (C10264)

c) FLT CONT ELEC 1L AC (C8782)

d) FLT CONT ELEC 1L DC (C8783)

5) Do the aileron lockout ground test a second time.

NOTE: Do not open and close FLT CONT ELEC 2R AC and FLT CONT ELEC 2R DC circuit breakers when you do the ground test a second time.

6) Go to the CMCS message index of the Fault Isolation Manual (FIM) to find the corrective action for each CMCS message.

NOTE: For CMC messages 27121, 27122, 27221 and 27222 the information that follows applies: If both SRM's show a failed actuator, use the FIM corrective action. However, if only the right SRM shows a failed actuator (27221 or 27222), repair the applicable aileron lockout command wiring from the right SRM to the Left SRM.

PROCEDURE 2 :
Airplanes with Any Combination of SRM Part Numbers Installed

(1) Supply elecrical power (Ref 24-22-00/201).

(2) Look for existing faults in the aileron lockout system (Ref 45-27-00/201).

(a) Select <EXISTING FAULTS from the CMC main menu.

(b) Select <27 AILERON LOCKOUT from the existing faults menu.

(c) Make sure there are no existing faults on the CDU.

(d) Select <27 STABILIZER TRIM from the existing faults menu.

NOTE: If 27 AILERON LOCKOUT and 27 STABILIZER TRIM do not come into view, there are no existing faults with the aileron lockout system.

Put the Airplane Back to Its Usual Condition

(1) Set the GND TEST switch to the NORM position.

(2) Remove electrical power (Ref 24-22-00/201).

(3) If the mechanical operational test was done, remove hydraulic power (Ref 29-11-00/201).

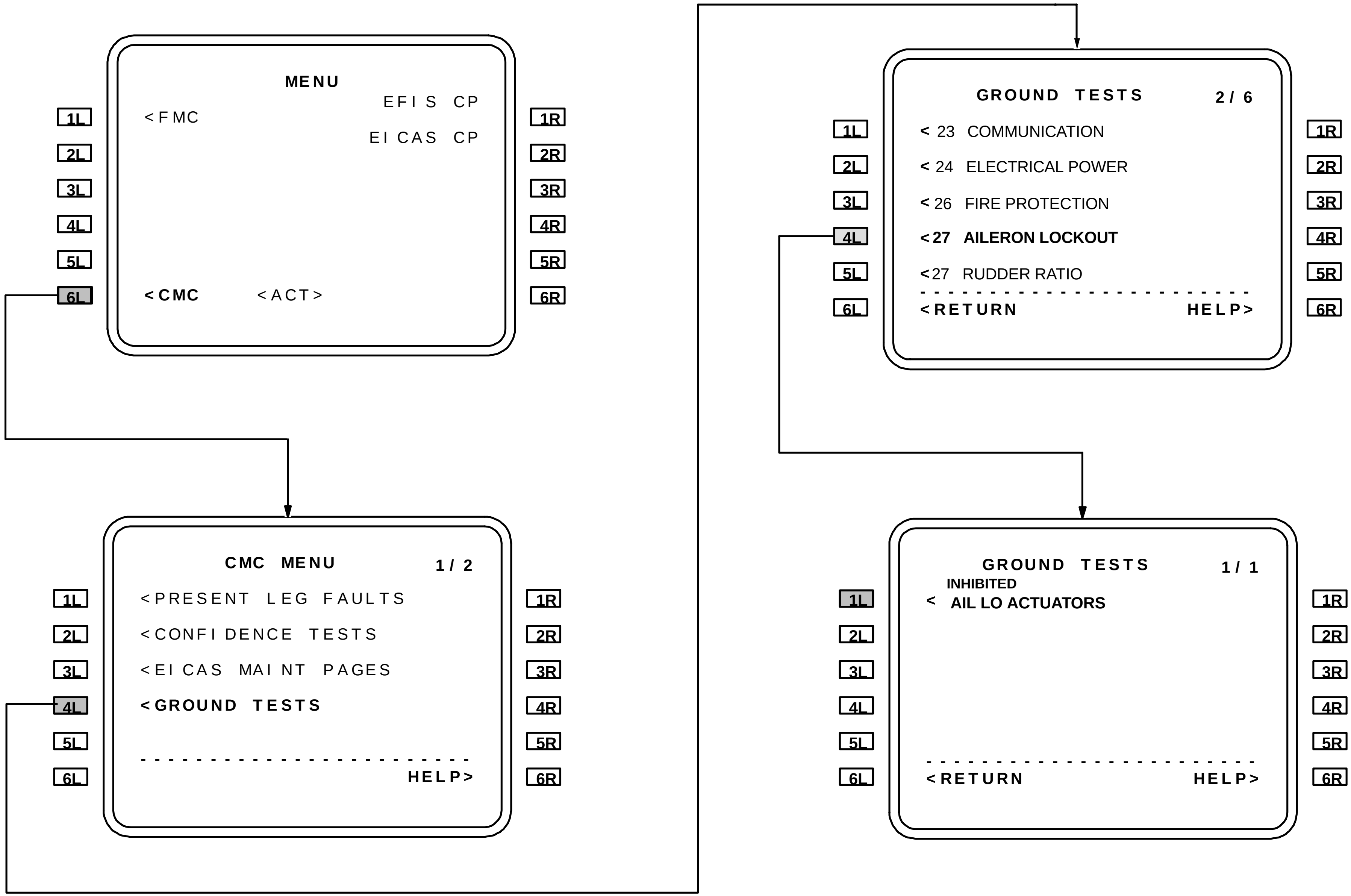


Figure 32 AILERON LOCKOUT ACTUATORS GROUND TEST

AILERON POSITION INDICATION COMPONENTS

GENERAL

The aileron position indicating system provides visual indication on the flight deck of the angular displacement of each aileron. The aileron position indicators appear on the EICAS status page as part of the surface position display.

Components used by the aileron position indicating system are the four aileron position transmitters, the spoiler/aileron surface position digitizer circuit card, and the EIU's and EICAS display. The system is powered by 28 volts dc from the 28 vdc bus 4 and by 28 volts ac from the 28 vac bus 4 through circuit breakers on the P6 panel.

CONTROL WHEEL POSITION TRANSMITTER

Control Wheel Position Transmitter with Direct Drive Design;
The control wheel position transmitter is located below the captain's aileron drum assembly. The transmitter contains a synchro transducer. Rotation of the aileron drum is transferred to the position transmitter shaft. The transmitter is adjusted to zero the **WHEEL** readout on the EICAS flight controls maintenance page when the control wheel is in the neutral position.

Control Wheel Position Transmitter with Negator Spring Design;
The control wheel position transmitter is located next to the captain's aileron drum assembly below the flight deck. The transmitter contains a synchro transducer. Rotation of the aileron drum is transferred to the position transmitter shaft through a flat negator spring. The transmitter is adjusted to zero the **WHEEL** readout on the EICAS flight controls maintenance page when the control wheel is in the neutral position.

SUMMARY :

Der Control Wheel Position Transmitter überträgt den gemessenen Wert zur Surface Position Digitizer (SPD) Card YLMA 10 und über die EFIS/EICAS Interface Units (EIU's) als **WHEEL**-Indication aif die Maintenance Page FLIGHT CONTROL.

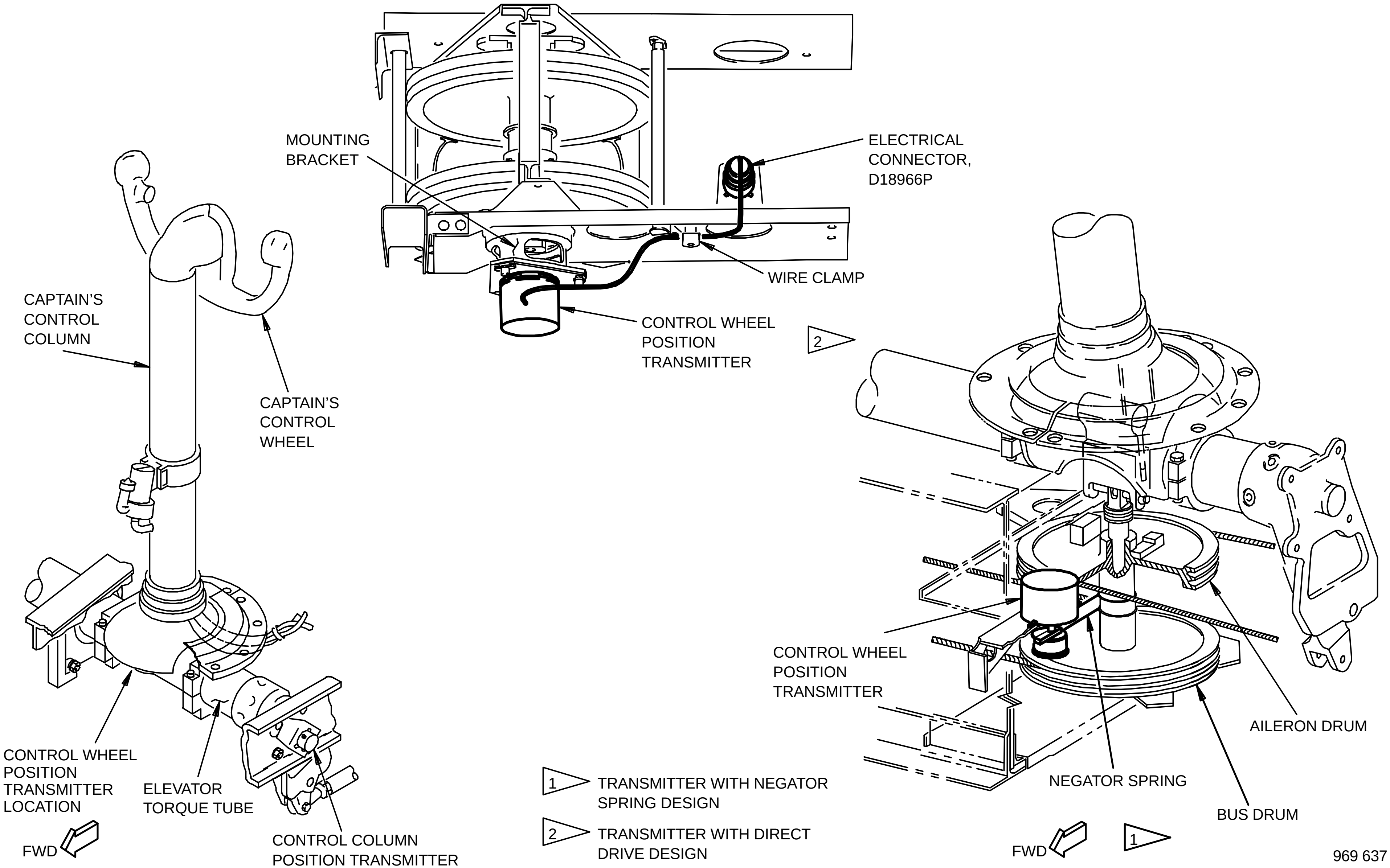


Figure 33 CONTROL WHEEL POSITION TRANSMITTER

AILERON POSITION INDICATION COMPONENTS

DESCRIPTION

AILERON POSITION TRANSMITTER

The aileron position transmitters are located between each aileron and the wing rear spar. An adjustable control rod attaches the transmitter crank to the aileron. With the aileron in the neutral position, the control rod can be adjusted to set the aileron position readout at zero degree for inboard ailerons or 0.6 degrees down for outboard ailerons on the EICAS flight controls maintenance page.

ADJUSTMENT OF THE AILERON POSITION TRANSMITTER

(1) Do this task: "Supply Electrical Power" (Ref 24-22-00/201).

(2) Remove the DO-NOT-CLOSE tags and close these circuit breakers:

(a) P6 Main Power Distribution Panel

1) 6J21 SPLR/ALRN IND

2) 6J20 SPLR/ALRN SENSOR

(3) Make sure that the ailerons are in the neutral position.

(4) Install the rig pin through the crank and the outer hole of the bracket.

NOTE: You may have to adjust the control rod to install the rig pin.

(5) Adjust the aileron position transmitter:

(a) Loosen the transmitter clamping screws.

(b) For the outboard aileron, adjust the transmitter body.

1) Make sure you get an indication of 0.6+/-0.1 degree down on the EICAS flight controls maintenance page.

(c) For the inboard aileron, adjust the transmitter body.

1) Make sure you get an indication of 0 +/-0.2 degree on the EICAS flight controls maintenance page.

(d) Tighten the transmitter clamping screws to 5-10 pound-inches.

(6) If the indication is not in the tolerance, adjust the control rod:

(a) Move the rig pin to the inner hole.

(b) Adjust the control rod.

(c) Install the lockwire on the thumb nut of the control rod.

(7) Remove the rig pin from the transmitter assembly.

(8) Close the access panel.

(9) Remove the DO-NOT-CLOSE tags and close these circuit breakers:

(a) P180 DC Power Distribution Panel

1) 180H7 LATERAL CONT VLV SYS 1

2) 180E6 LATERAL CONT VLV SYS 2

3) 180H22 LATERAL CONT VLV SYS 3

4) 180E21 LATERAL CONT VLV SYS 4

(10) Set all FLT CONTROL HYD POWER WING switches on the P461 Pilots' Overhead Maintenance Panel to NORM.

(11) Do this task: "Trailing Edge Flap Activation" (Ref 27-51-00/201).

(12) If electrical power is not necessary, do this task: "Remove Electrical Power" (Ref 24-22-00/201).

FAILURE INDICATION OF THE AILERON POSITION TRANSMITTER :

For example :

Whenever a fault is detected for the aileron position transmitter on the MCDU is shown the

CMC message :

LEFT OUTBOARD AILERON SYNCHRO FAIL (SPD-FWD) 27 952.

only.

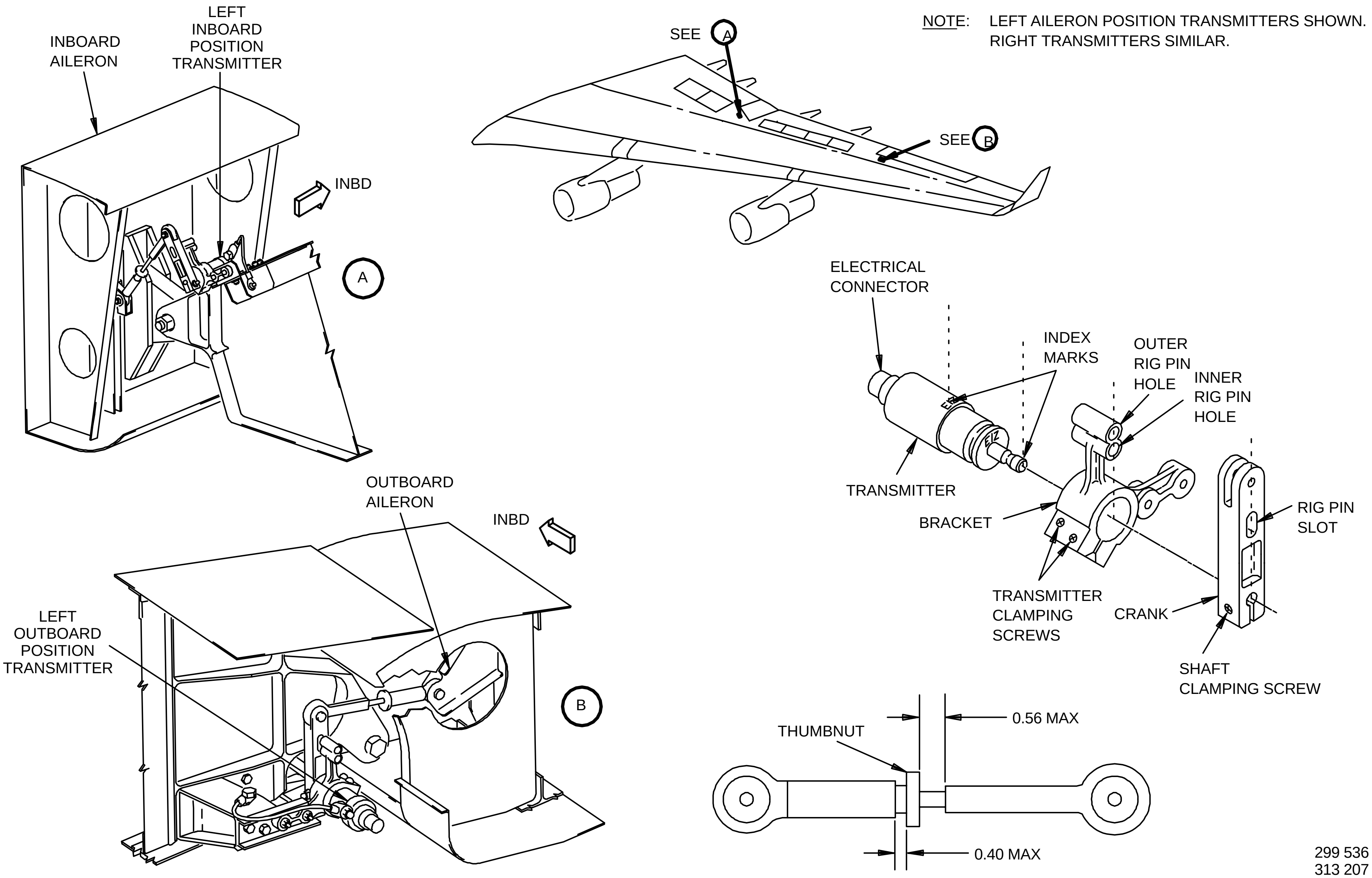


Figure 34 AILERONS POSITION TRANSMITTER

AILERON POSITION INDICATION COMPONENTS

DESCRIPTION

SURFACE POSITION DIGITIZER (SPD) CARD

The forward surface position digitizer circuit card YMLA09 receives the signals from the aileron position transmitters and converts the signals to a serial digital format for transmission to the EIU's on an ARINC 429 bus. The card is installed in the forward electrical systems card file M7603 in the main electrical equipment center.

SUMMARY :

Die Surface Position Digitizer (SPD) Card **YLMA 09** in der Forward Electrical System Card File ist für die Indication über die EFIS/EICAS Interface Units (EIU's) für

- der **AILERONS (4x)**
  und
- der **SPOILER (#4 und #12)**

zuständig,

die Surface Position Digitize (SPD) Card **YLMA 10** ist für die Indication der Bedienelemente

- der **AILERONS**
  - Control Wheel Position Transmitter
- der **RUDDER**
  - Rudder Pedal Position Transmitter

zuständig, d.h. sie setzt die von den Transmittern erhaltenen, analogen Signale in digitale um und leitet diese über die EIU's auf

- die FLIGHT CONTROL Maintenance Page
  und
- die Status Page.

FAILURE INDICATION OF THE SURFACE POSITION DIGITIZER CARD

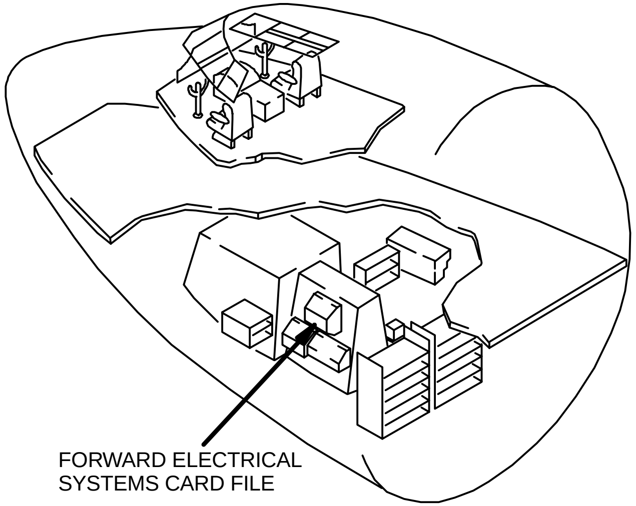
For a excample :

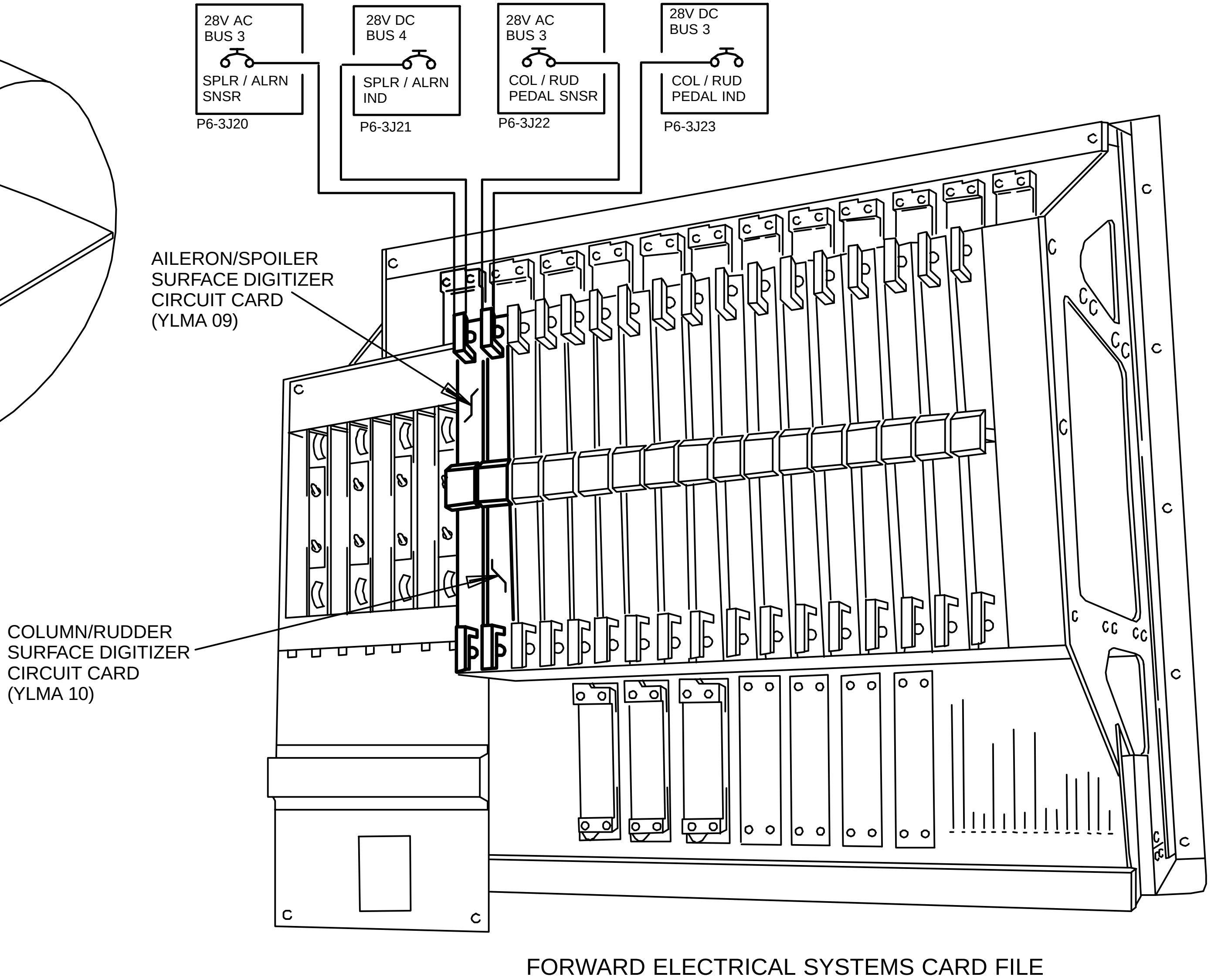
Whenever a fault is detected for the forward surface position digitizer card on the CMC is shown the

CMC message :

FORWARD SURFACE SPD CARD FAIL (SPD-FWD) 27 951

only.





322 362

Figure 35 AILERON/SPOILER SURFACE DIGITIZER CARD LOCATION

AILERON POSITION INDICATING SYSTEM

OPERATION

Functional Description

As the aileron is deflected from the neutral position, the attached control rod drives the transmitter crank which pivots the transmitter shaft. The transmitter electrical output varies as the shaft pivots. The output signal passes to the surface position digitizer which processes the signal and routes it to the EIU's for display on EICAS.

Control

Operation of the aileron position indicating system is automatic. The EICAS surface position display appears when the EICAS status page is invoked.

The flight controls maintenance page may be called up on the auxiliary EICAS display. This page displays the values of aileron angular displacement as numeric readouts for system adjustment and trouble shooting.

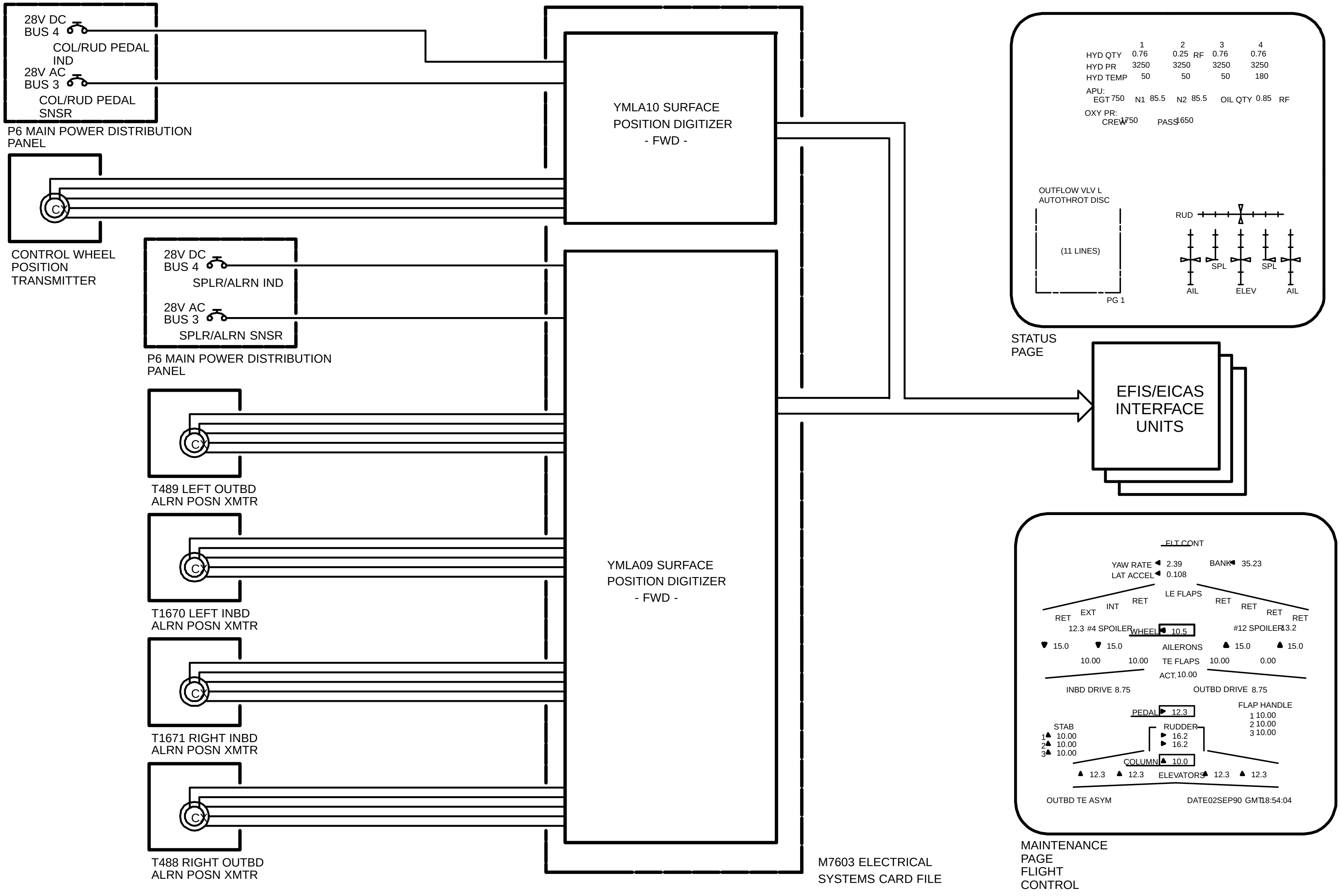


Figure 36 AILERON POSITION INDICATING SYSTEM SCHEMATIC

27-60 SPOILER AND DRAG DIVICES

FLIGHT CONTROL MAINTENANCE- AND STATUS PAGE

DESCRIPTION

DESCRIPTION MAINTENANCE PAGE

Die Maintenance Page für das Flight Control System ist über das Central Maintenance Computer System (CMCS) folgendermaßen aufrufbar :

- CMC
- MENü
- MAINTENANCE PAGE
- ATA 27
- DISPLAY.

Die Anzeigen der Spoiler #4 und #12 erfolgt in ° .

Die Anzeige erfolgt in Steps von $^{1}/_{10}$ ° .

Die Anzeige des Spoilers #4 erfolgt bei :

20.0 #4 SPOILER

- Spoilerbetätigung nach
  - FLIGHT DETENT

    und
  - UP
- Aileronbetätigung
  - nur bei einem LEFT TURN

Die Anzeige des Spoilers #12 erfolgt bei :

#12 SPOILER 0.0

- Spoilerbetätigung nach
  - UP ONLY
- Aileronbetätigung
  - nur bei einem RIGHT TURN.

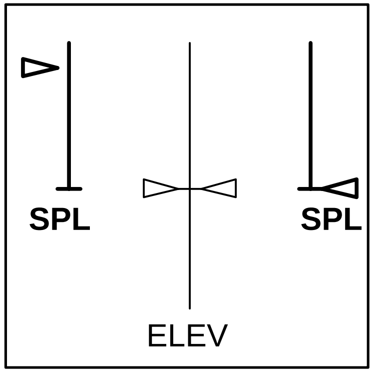
DESCRIPTION STATUS PAGE

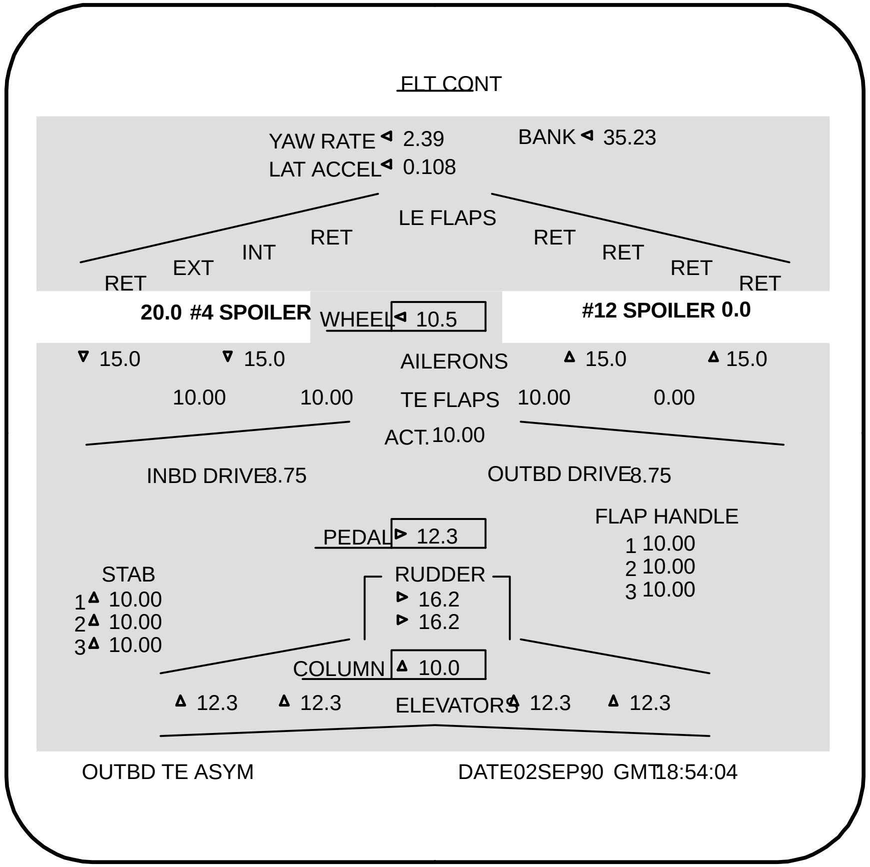
Die Status Page ist über das EICAS Data Select Panel (EDSP) auf dem Glearshild über den Select Button STATUS aufrufbar.

Auf der Status Page befindet sich in der rechten unteren Ecke die Informationen des Flight Control Systemes.

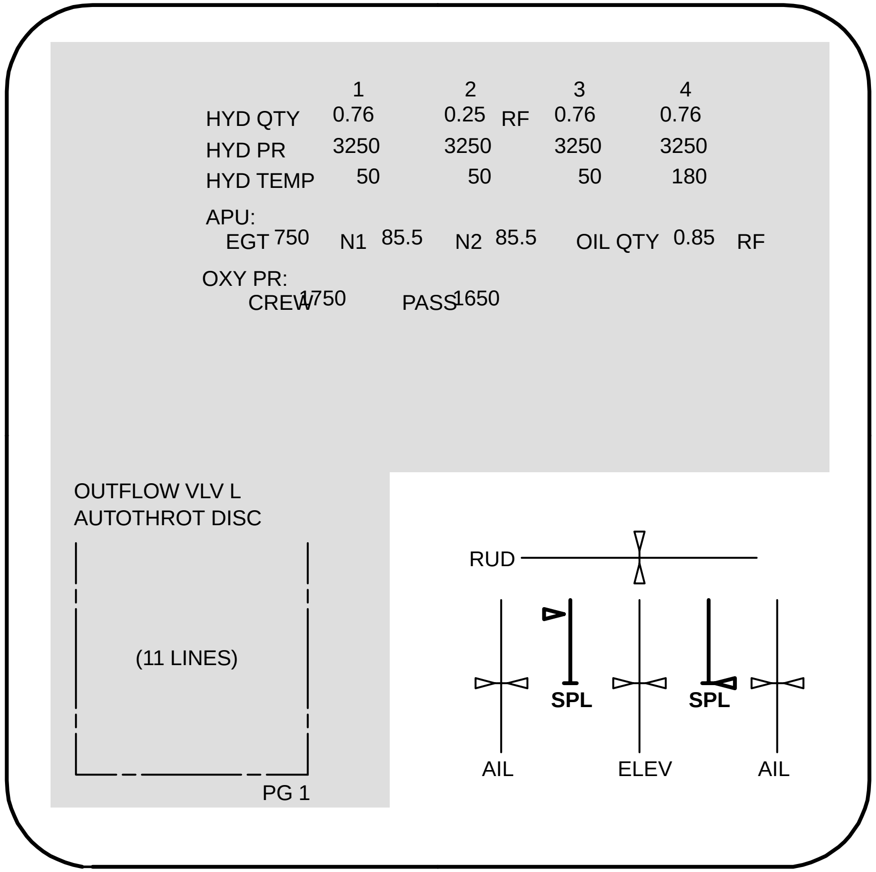
Die Anzeigen der Ailerons erfolgt unter der Bezeichnung **SPL** für :

- Spoiler No.4 (linke Indication)
- Spoiler No.12 (rechte Indication)





MAINTENANCE PAGE
FLIGHT CONTROL



STATUS PAGE

Figure 37 MAINTENANCE PAGE FLIGHT CONTROL AND STATUS PAGE

SPOILER CONTROL SYSTEM OVERVIEW

DESCRIPTION

GENERAL

The spoiler control system supplements the ailerons in providing lateral control of the airplane about the roll axis. There is a total of 12 spoilers of which 10 are flight spoilers and 2 are ground spoilers. Only the flight spoilers are used with the spoiler control system. However, the flight spoilers are used with the ground spoilers in the speed brake control system for speed brake operation. The spoilers are numbered 1 thru 12 from left to right . The four outermost spoilers on each wing are identified as outboard flight spoilers. The next spoiler on each side, No. 5 and 8, are identified as inboard flight spoilers. The two remaining spoilers, No. 6 and 7, are ground spoilers.

The flight spoilers are positioned hydraulically and controlled directly by the aileron control system. Actuation of the spoilers is accomplished by a flight spoiler control package for each spoiler. The airplane main hydraulic systems No. 2, 3, and 4 supply pressure to the flight spoiler control packages. The hydraulic pressure for operation of spoilers No. 2, 3, 10, and 11 comes from hydraulic system No. 2. Hydraulic pressure for operation of spoilers No. 1, 4, 9, and 12 comes from hydraulic system No. 3. Pressure for operation of spoilers 5 and 8 comes from hydraulic system No. 4.

The control input for operation of the flight spoilers comes from the central lateral control packages through the spoiler control differential mechanisms and then by cables to the control valves of the flight spoiler control packages. The central lateral control packages are part of the lateral control system operated by the aileron control system.

SPOILERS

The spoilers are located on the upper surface of each wing trailing edge. In the retracted position, the spoilers are flush with the wing surface. The spoiler panels are hinged from the rear spar of the wing box, and are monocoque structures with four hinges used for each panel. The spoilers are composed of an aluminum alloy honeycomb bonded structure with aluminum alloy fittings and spar. The maximum extension and retraction limits for each spoiler are controlled by the main actuator of the spoiler control package. Spoiler extension is limited by aerodynamic forces in proportion to airspeed. Flight spoiler panels No. 1 thru 4 and 9 thru 12 are interchangeable. Flight spoiler panels No. 5 and 8 are also interchangeable.

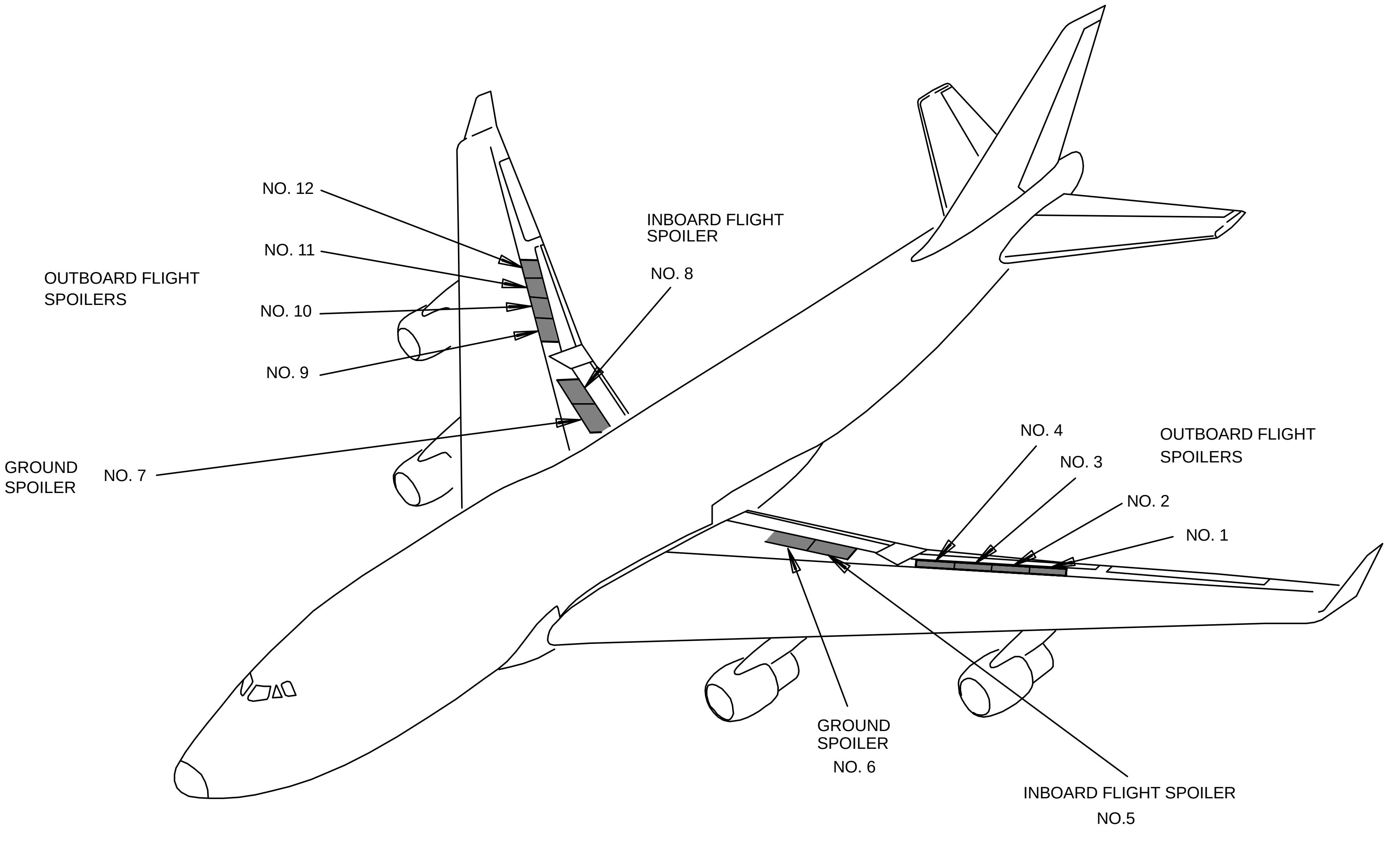


Figure 38 SPOILER CONTROL SYSTEM OVERVIEW

SPOILER AND DRAG DIVICES BASIC SCHEMATIC

FUNCTIONAL DESCRIPTION

Rotation of the aileron control wheels provides a manual input which is transferred by the lateral control cable system to the central control actuators. The actuators are dual tandem with a through piston rod having connections on both ends. One end of the piston rod of the actuator connects to a spoiler control differential mechanism. The other end of the piston rod connects to an aileron programmer. The input cranks to the central control actuators are connected together by a force limiting pushrod. The flight spoilers assist the ailerons in providing lateral control. A given control wheel deflection modulates deflection of the appropriate spoilers.

The left central control actuator provides input to the spoiler control differential mechanism controlling spoilers No. 3, 4, 5, 8, 9 and 10. The right central control actuator provides input to the spoiler control differential mechanism controlling spoilers No. 1, 2, 11 and 12. The output from each spoiler control differential mechanism is directed by control cables and quandrants to the control valves on the various flight spoiler control package. Each flight spoiler control package installation includes a cable quadrant and linkage for conveying the control input to the control package valve. Certain spoilers are grouped together for simultaneous operation by common cable runs from the differential mechanisms. One cable quadrant of the left differential mechanism controls spoilers No. 3, 4 and 5 by the associated cable run. The other cable quadrant of the left differential mechanism controls spoilers No. 8, 9 and 10. One cable quadrant of the right differential mechanism controls spoilers No. 1 and 2 and the other cable quadrant controls spoilers No. 11 and 12. The speed brake control lever on the pilots' control stand drives the speed brake sequence mechanism by means of cables and quadrants. Levers on the speed brake sequence mechanism provide for use of spoilers No. 3 thru 10 as flight speed brakes, and for use of all spoilers No. 1 thru 12, as ground speed brakes.

Hydraulic systems No. 2, 3, and 4 supply power used in operating the spoilers. Control for spoiler operation is provided by normally open (guarded) switches located on the pilots' FLT CONTROL HYD POWER overhead panel . A decal above the switches shows the hydraulic supply system for each spoiler. Surface position transmitters are installed at spoiler No. 4 on the left side and spoiler No.12 on the right side. The two transmitters provide electrical signals to the computers to display the relative displacement and position of the two spoilers on the EICAS status display. The maximum up position for flight spoilers No. 1 thru 4 and 9 thru 12 is 45 degrees. When the speed brake control lever is in the DOWN or FLIGHT position, the maximum up position for spoilers No. 5 thru 8 is 20 degrees. When the speed brake control lever is in the UP position, spoilers No. 5 thru 8 have a maximum up position of 45 degrees.

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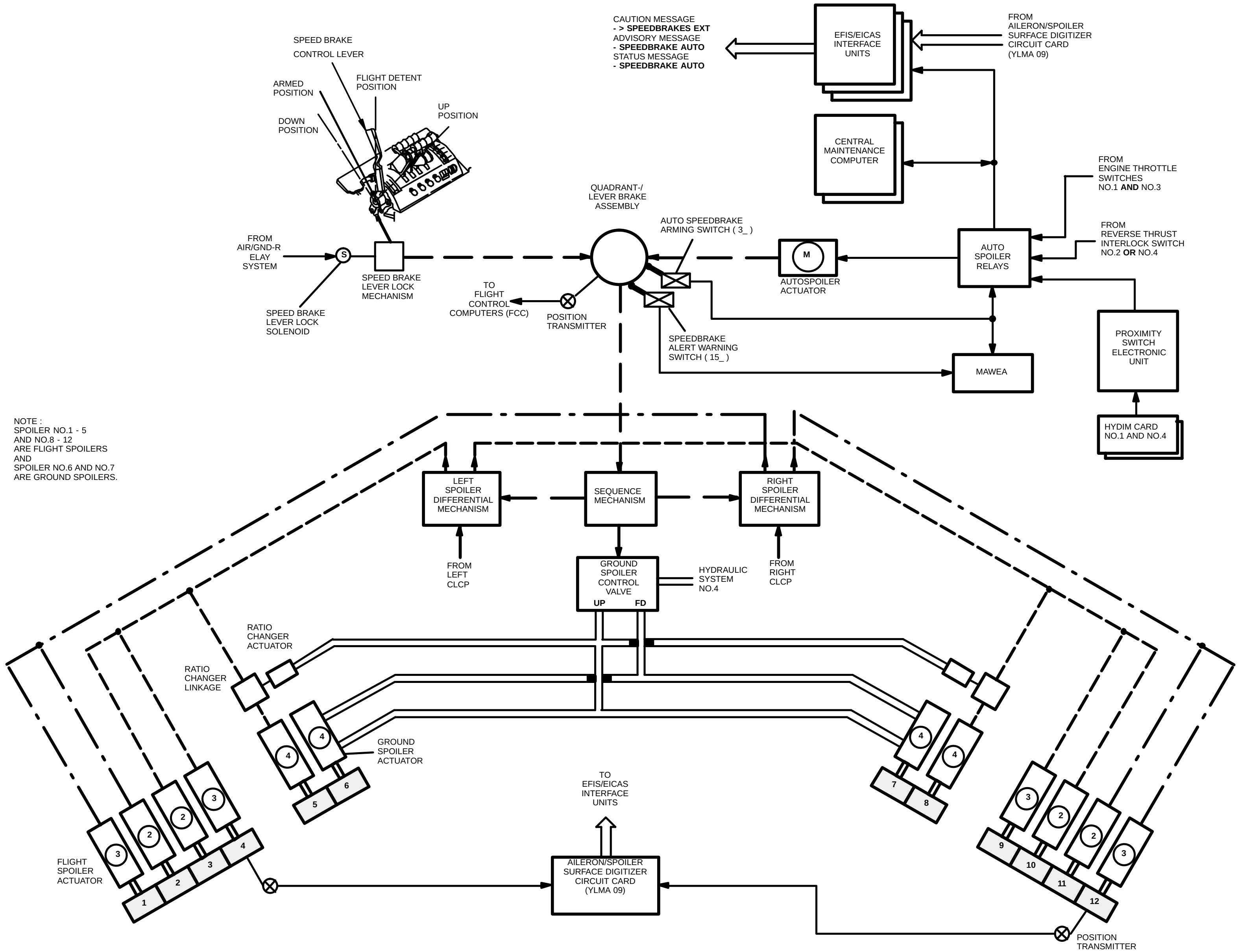

Figure 39 BASIC SCHEMATIC SPOILER AND DRAG DIVICES

FUNCTION SCHEMATIC

SPEED BRAKE LEVER

- betätigt Quadrant/Lever Brake Assy
- Lock Mechanism
  - sorgt dafür, daß der Lever im Fluge nur bis zur Flight Detent Position betätigt werden kann
  - wird durch Solenoid betätigt
- Positions werden über Transmitter für Autoflight zu den Flight Control Computers übertragen

SPEED BRAKE LEVER: DOWN

- alle Spoilers Down
- Position Switch meldet Lever Down

SPEED BRAKE LEVER: ARMED

- alle Spoilers Down
- Position Switch gibt Armed Signal zum Auto Spoiler System und zur MAWEA

SPEED BRAKE LEVER: >15°

- Speed Brake Alert Warning Switch gibt Signal in MAWEA

SPEED BRAKE LEVER: FLIGHT DETENT

- Sequence Mechanism
  - gibt Input zum Left Spoiler Diff. Mechanism
  - gibt Input zum Ground Spoiler Control Valve
- Left Spoiler Diff. Mechanism gibt 45° Input zu den Flight Spoiler Actuators. Die Control Valves der Spoilers 3, 4, 9, 10 werden maximal ausgelenkt, so daß diese Spoiler auf 45° ausfahren. Das Control Valve der Spoiler 5 und 8 werden durch die Ratio Changer nur teilweise ausgelenkt,so daß diese Spoilers nur bis 20° ausfahren.
- Ground Spoiler Control Valve wird in Flight Detent Position betätigt, Flight Detent Pressure wird durchgeschaltet und die Ground Spoilers fahren auf 20°.

SPEED BRAKE LEVER: UP

- Sequence Mechanism
  - gibt Input zum Right Spoiler Diff. Mechanism
  - gibt Input zum Ground Spoiler Control Valve
- Right Spoiler Diff. Mechanism gigt 45° Input zu den Control Valves der Spoiler 1, 2, 11, 12 und die Spoilers fahren auf 45°
- Ground Spoiler Control Valve wird in die Up Position betätigt, Up Pressure wird durchgeschaltet
  - die Ground Spoilers fahren auf 45°
  - die Ratio Changer Actuators lenken über die Ratio Changer Linkages die Control Valves der Spoilers 5 und 8 maximal aus, so daß diese Spoilers auf 45° ausfahren.

AUTO SPOILER

- Actuator
  - betätigt über Lever Brake Assy den Quadrant. Dadurch wird der Speed Brake Lever und der Sequence Mechanism angesteuert. Durch die Lever Brake kann die Auto Spoiler Actuator Bewegung vom Speed Brake Lever übersteuert werden (Manual Override).
- Relays
  - steuern Actuator
  - Fehler werden durch EICAS Message angezeigt, mit CMC Speicherung.

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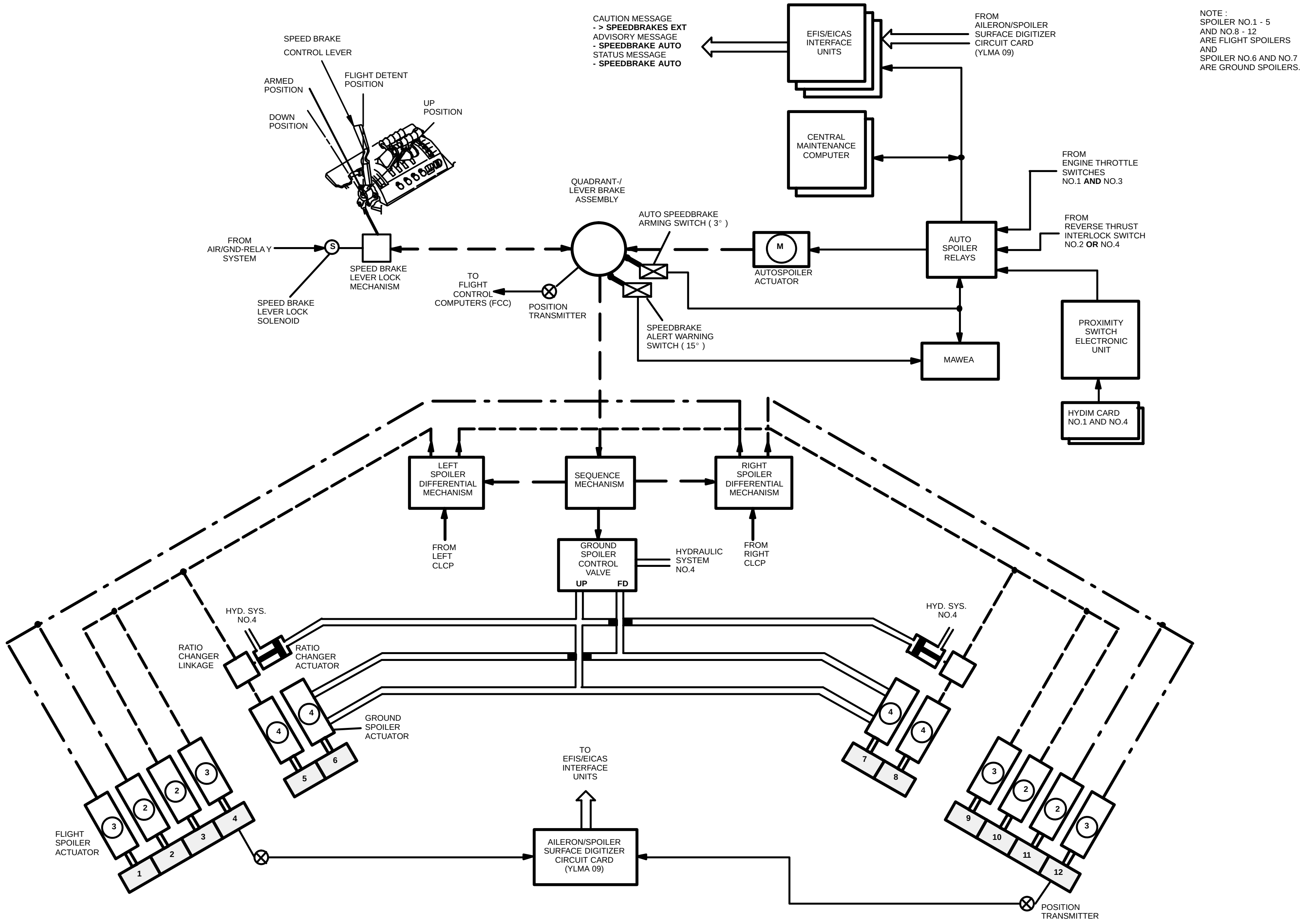

Figure 40 BASIC SCHEMATIC SPOILER AND DRAG DIVICES

SPOILER MECHANICAL SCHEMATIC

DESCRIPTION

- **Speed Brake Lever Down**
  (Lever verrastet).

- **Speed Brake Lever Arm**,
  Position Switch ist betätigt, d.h. Auto Spoilers armiert.

- **Speed Brake Lever Flight Detent**.
  Bei Betätigung vom Lever nach Flight Detent (im Fluge begrenzt durch den Lever Lock Mechanism) wird über den Sequence Mechanism nur der Left Spoiler Diff. Mechanism angesteuert und das Ground Spoiler Control Valve nach Flight Detent betätigt. Dadurch fahren die Flight Spoiler 3 bis 5 und 8 bis 10 proportional zur Lever Stellung aus (Spoiler 3, 4, 9, 10 von Null auf 45°, Spoiler 5 und 8 von Null auf 20°). Die Ground Spoilers 6 und 7 fahren direkt in die Flight Detent Stellung auf 20°.

- **Speed Brake Lever Up**.
  Bei Betätigung vom Lever nach Up (nur am Boden) wird über den Sequence Mechanism nur der Right Spoiler Diff. Mechanism angesteuert und das Ground Spoiler Control Valve nach Up betätigt.Dadurch fahren die Flight Spoilers 1, 2, 11, 12 proportional zur Lever Stellung aus (von Null bis 45°). Durch die erneute Ansteuerung vom Ground Spoiler Control Valve eralten die Ground Spoiler Actuators eine weitere hydraulische Beaufschlagung und die Ground Spoilers 6 und 7 fahren auf 45°. Gleichzeitig werden die Flight Spoilers 5 und 8 Ratio Changer Actuators hydraulisch beaufschlagt, es erfolgt eine erneute Ansteuerung der beiden Ground Spoiler Actuators, diese Spoilers fahren von 20° auf 45° aus.

- **Auto Spoiler System**:
  Der Auto Spoiler Actuator betätigt über Quadrant/Lever Brake Assy und Sequence Mechanism die Spoiler Diff. Mechanisms und das Ground Spoiler Control Valve und den Speed Brake Lever. Das Quadrant/Lever Brake Assy erlaubt Speed Brake Lever Manual Override.

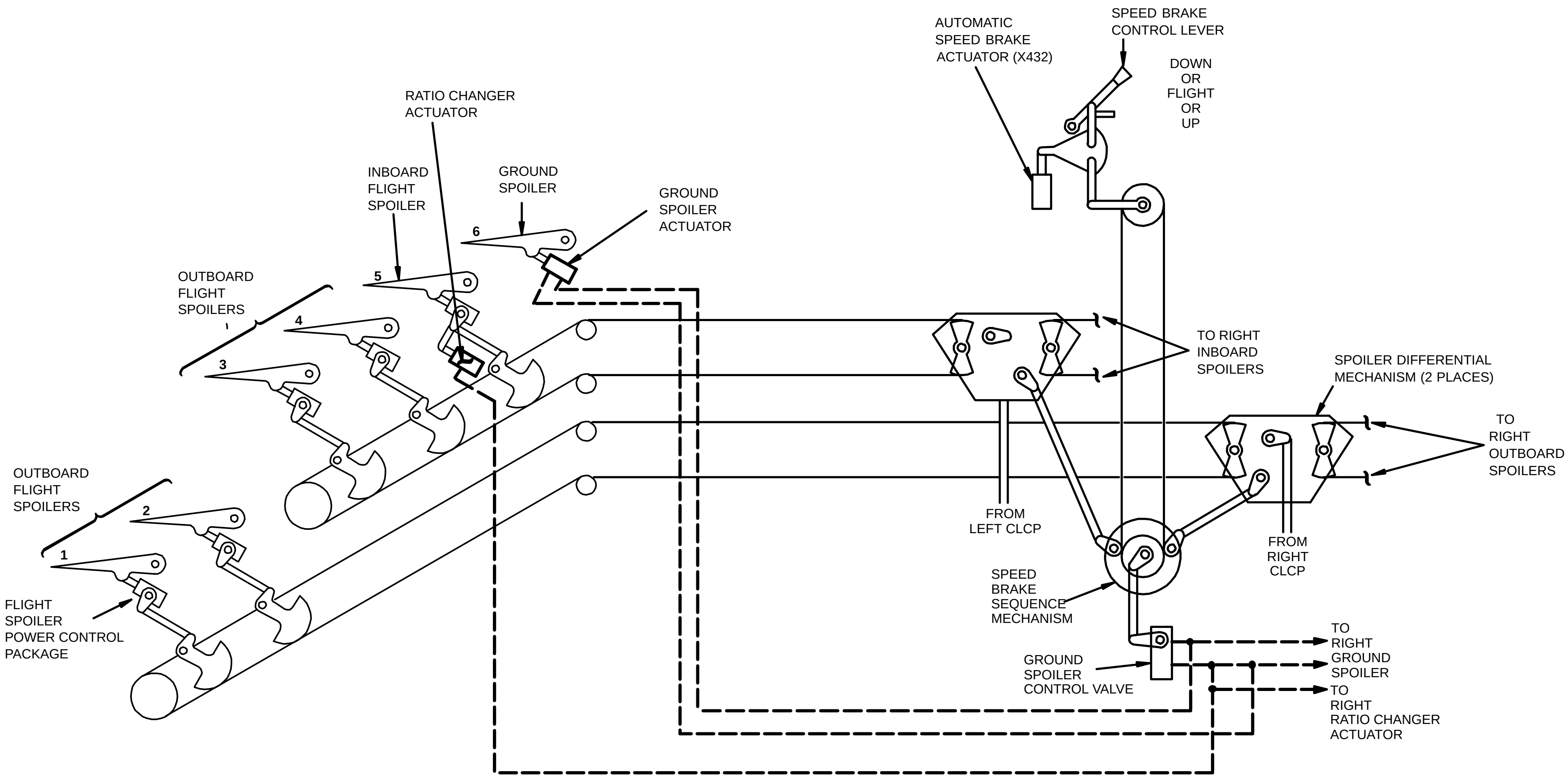

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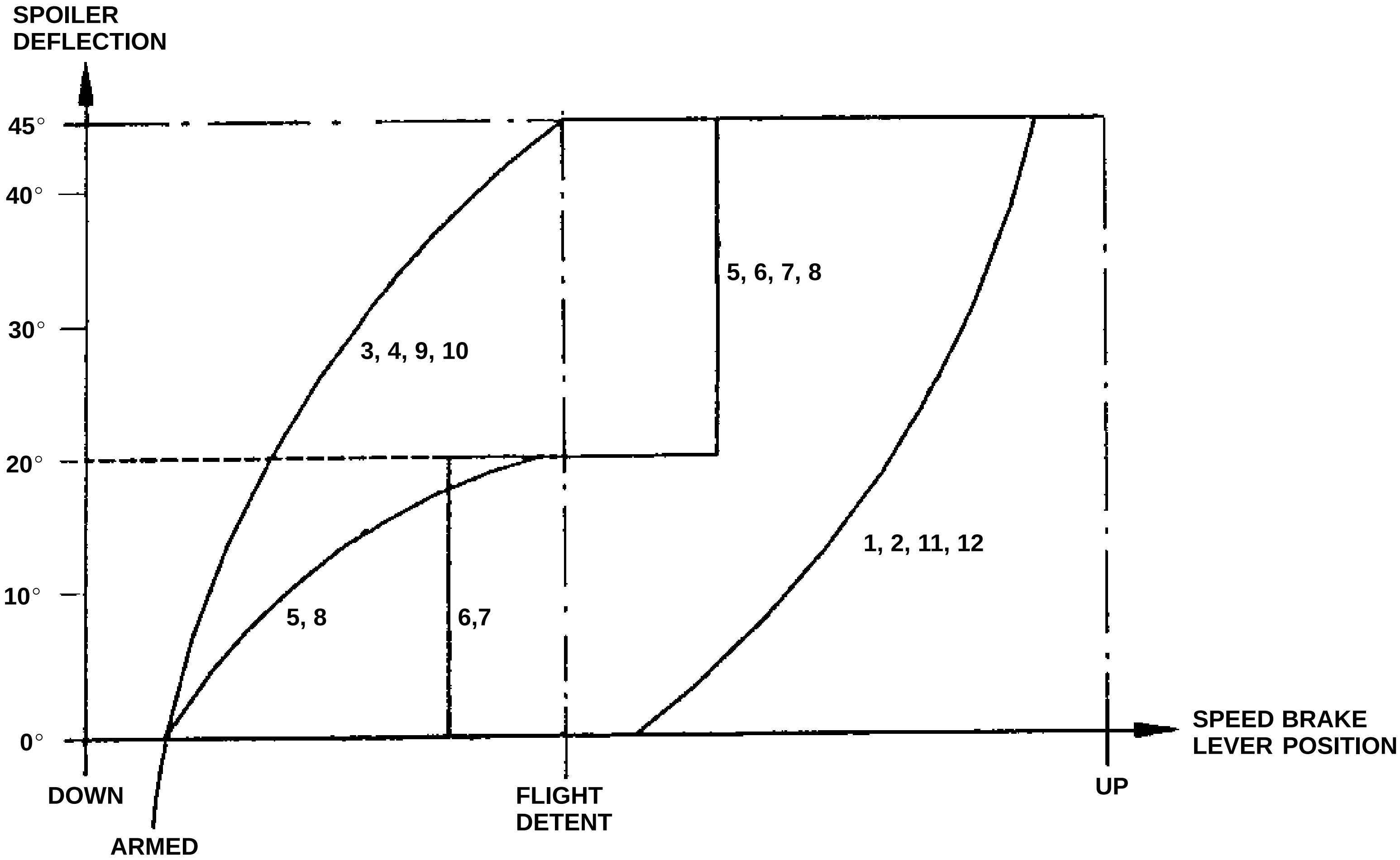
Figure 41 SPOILER MECHANICAL SCHEMATIC



SPOILER DEFLECTION
WITH SPEED BRAKE SYSTEM
(SYMEMTRICAL)

Figure 42 SPOILER DEFLECTION SCHEMATIC

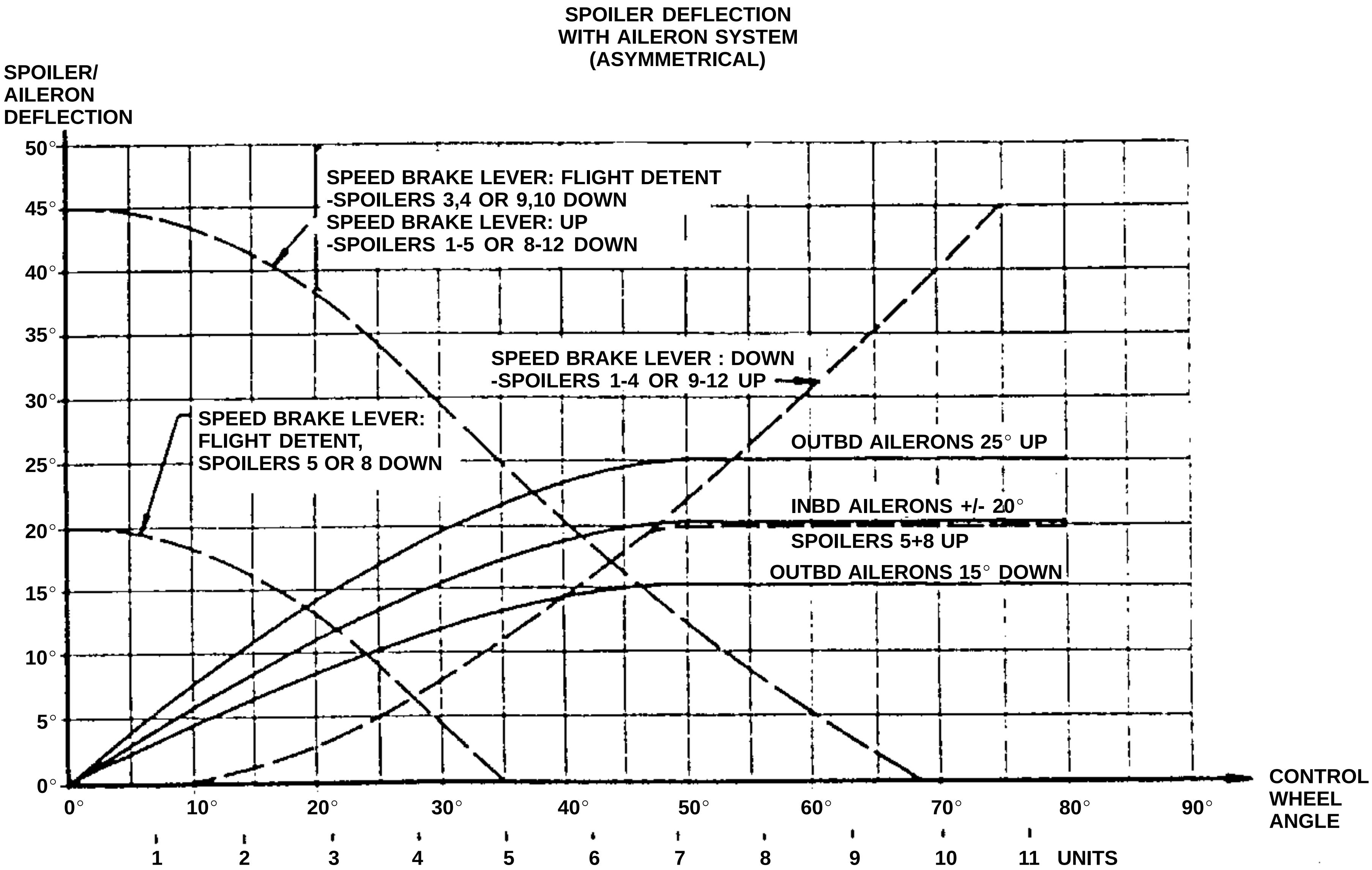


Figure 43 SPOILER / AILERON DEFLECTION SCHEMATIC

SPEED BRAKE CONTROL SYSTEM OVERVIEW

SPEED BRAKE LEVER

- steuert die Flight- und Ground Spoilers
  - im Fluge als Speed Brakes
  - am Boden als Ground Spoilers

- **DOWN**
  - verrastete Position
  - alle Spoiler DOWN
  - kann durch den Reverse Thrust Lever No.2 oder No.4 entriegelt werden

- **ARMED**
  - Auto Spoiler System ist ARMED
  - Keine Spoiler Reaction

- **FLIGHT DETENT**
  - maximale Position im Fluge
  - Spoiler 3,4,9,10 auf Position 45°
  - Spoiler 5,6,7,8 auf Position 20°
  - Spoiler 1,2,11,12 auf Position 0°

- **UP**
  - alle Spoiler auf Position 45°

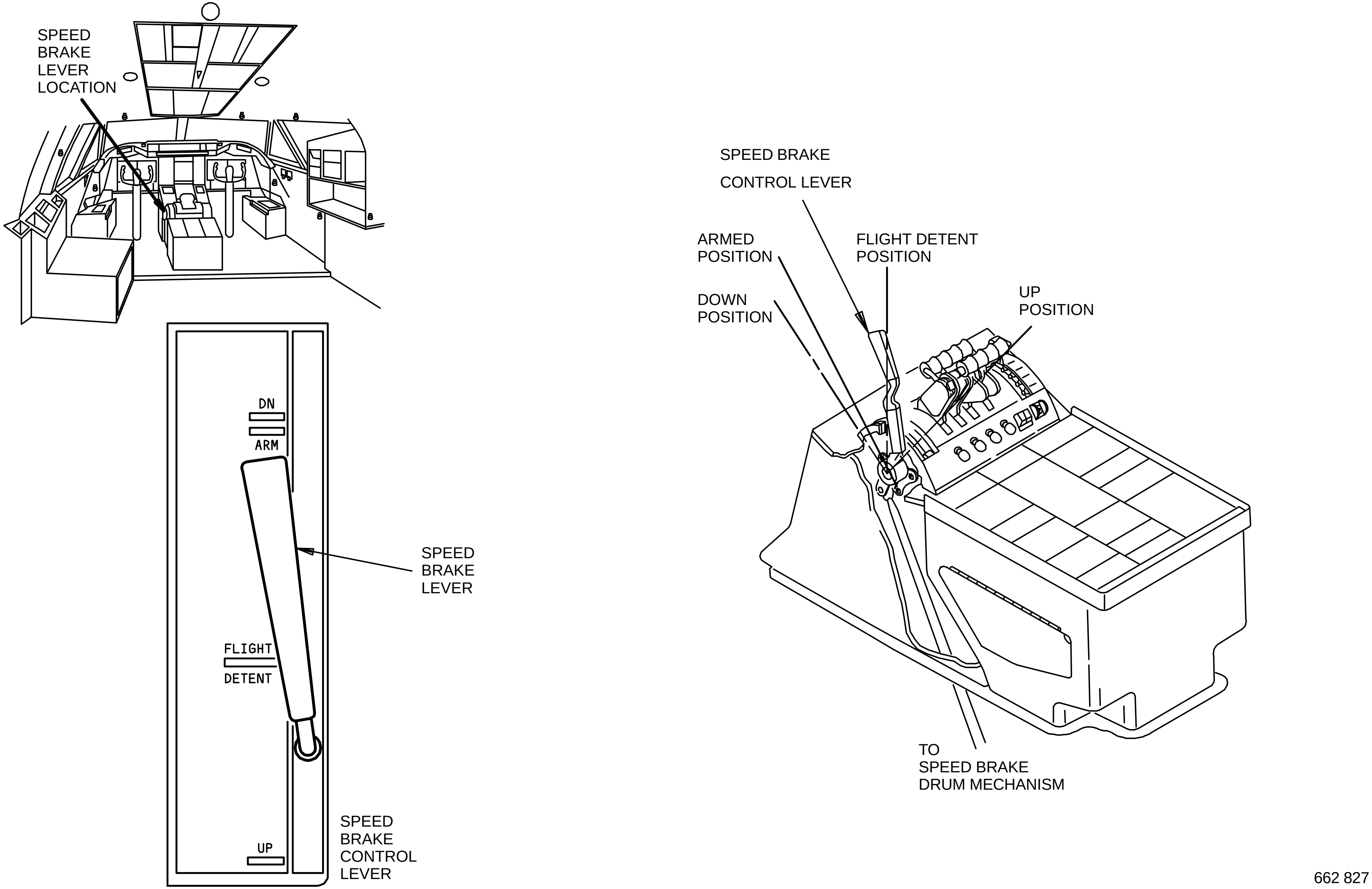


Figure 44 SPEED BRAKE CONTROL SYSTEM COMPONENTS OVERVIEW

SPEED BRAKE CONTROL SYSTEM OVERVIEW

SPEED BRAKE MECHANISM

CONTROL ROD
- betätigt Quadrant
- Bewegung löst Lever Brake

QUADRANT
- betätigt Position Switch
- mit Rig Pin für Flight Detent
- Control Cable überträgt Lever Signals zum Sequence Mechanism

POSITION SWITCH 3°
- armiert das Auto Spoiler System

POSITION SWITCH 15°
- gibt Signale zum Auto Spoiler System und zur MAWEA für Take Off Warning

LEVER BRAKE
- verhindert selbständiges Verstellen des Levers
- Drum ist mit Auto Spoiler Actuator verbunden

AUTO SPOILER ACTUATOR
- betätigt bei Auto Spoiler Condition über die Lever Brake den Quadrant und die Control Rod (Lever).

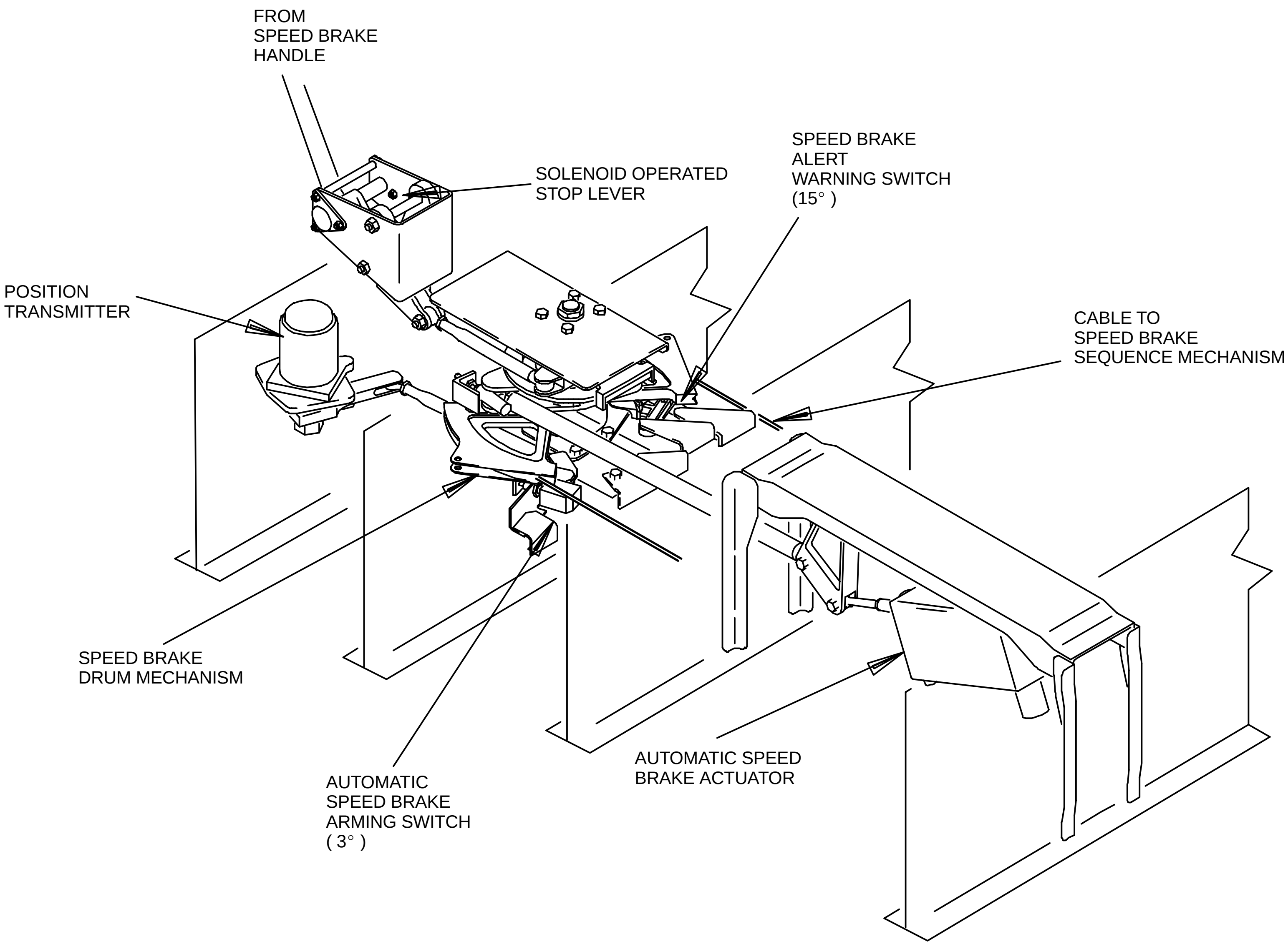


Figure 45 SPEED BRAKE CONTROL SYSTEM COMPONENTS OVERVIEW

AUTOMATIC SPEED BRAKE ARMING SWITCH

DESCRIPTION

Normally, the auto speed brake system is ARMAD by placing the auto speed brake lever in the ARMED position while performing the landing gear check list, the reverse thrust system will activate the auto speed brakes on the ground.

SUMMARY :

- Der Automatic Speed Brake Arming Switch wird durch die Arming Switch Striker Plate betätigt, wenn der Speed Brake Lever in die Position ARMED betätigt wurde und armiert dadurch das Auto Spoiler System.

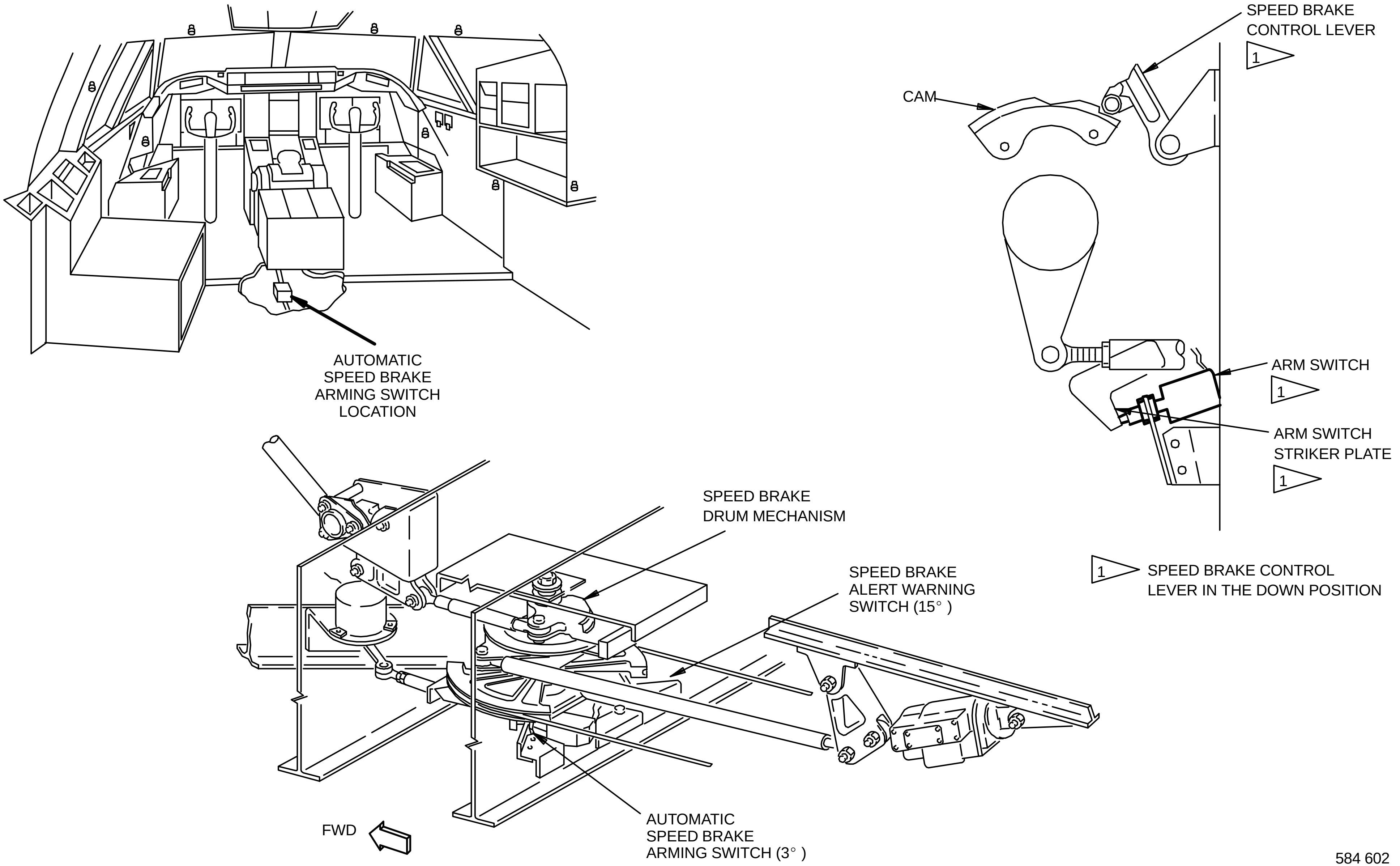


Figure 46 AUTOMATIC SPEED BRAKE ARMING SWITCH

REVERSE THRUST LEVER OPERATED ARMING SWITCH

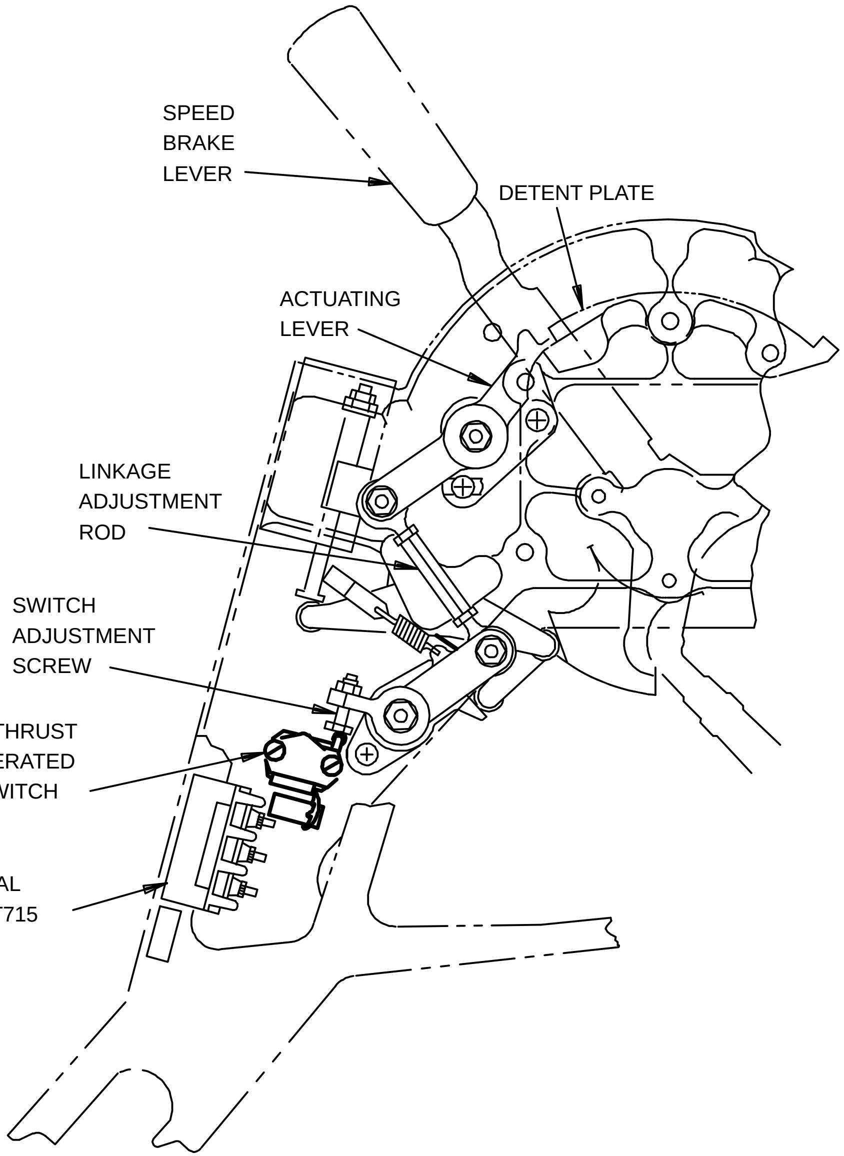
DESCRIPTION

During reverse thrust operation on the ground, reverse thrust lever no.2 and/or no.4 rotate the autothrottle (A/T) clutch pack. The outer rims of these pack function as cams which engage auto speed brake linkage cranks that rotate an auto speed brake shaft. The end of this shaft drives a crank that is connected to the auto speed brake lever unlock actuator (rocker arm) by an adjustable rod. The rocker arm operates the auot speed brake / reverse thrust interlock switch and lifts the auto speed brake lever out of the down and lock detent. The interlock switch bypasses the ARMING switch and energizes the auto speed brake actuator.

The rod interconnecting the auto speed brake shaft and crank and the unlock actuator rocker arm is adjustable to rig the system to the reverse thrust lever.

SUMMARY :

- Der Reverse Thrust Lever Operated Arming Switch armiert dann das Auto Spoiler Sytem, wenn der Speed Lever NICHT in die Position ARMED gestellt wurde durch das Betätigen des Reverse Thrust Levers No.2 oder No.4.



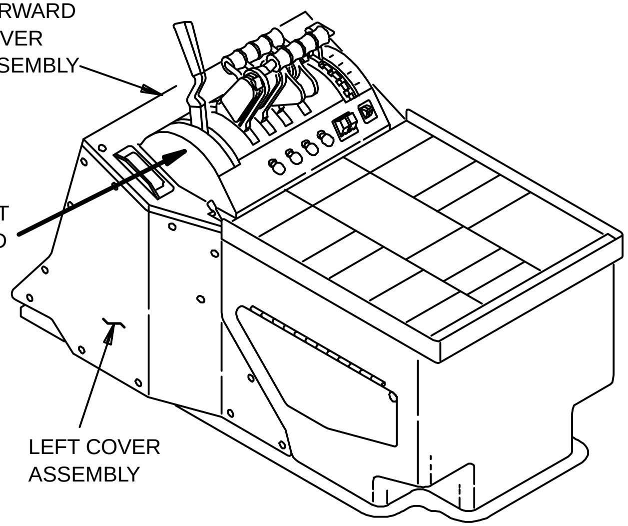


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Figure 47 REVERSE THRUST LEVER OPERATED ARMING SWITCH

SPEED BRAKE CONTROL LEVER LOCK

DESCRIPTION

SPEED BRAKE LEVER LOCK

The speed brake lever lock prevents the speed brake control lever from being moved aft of the FLIGHT DETENT position during flight. The lever lock mechanism is located below the control stand in the speed brake lever linkage. A solenoid in the lever lock is energized when the airplane is in the air. The solenoid moves a mechanical stop into the lever linkage.

Der Speed Brake Control Lever Lock sorgt dafür, daß der Speed Brake Control Lever im AIR-Zustand nur bis zu der Position FLIGHT DETENT bewegt werden kann.

Das Lever Lock Solenoid :

- betätigt den Stop Lever
- wird von dem Alternate AIR/GND-Relay System geschaltet

- **AIR-Zustand :**
  - Flight Detent ONLY
  - Solenoid erregt
  - Stop Lever gesetzt

- **GND-Zustand :**
  - UP Position
  - Solenoid nicht erregt
  - Stop Lever nicht gesetzt

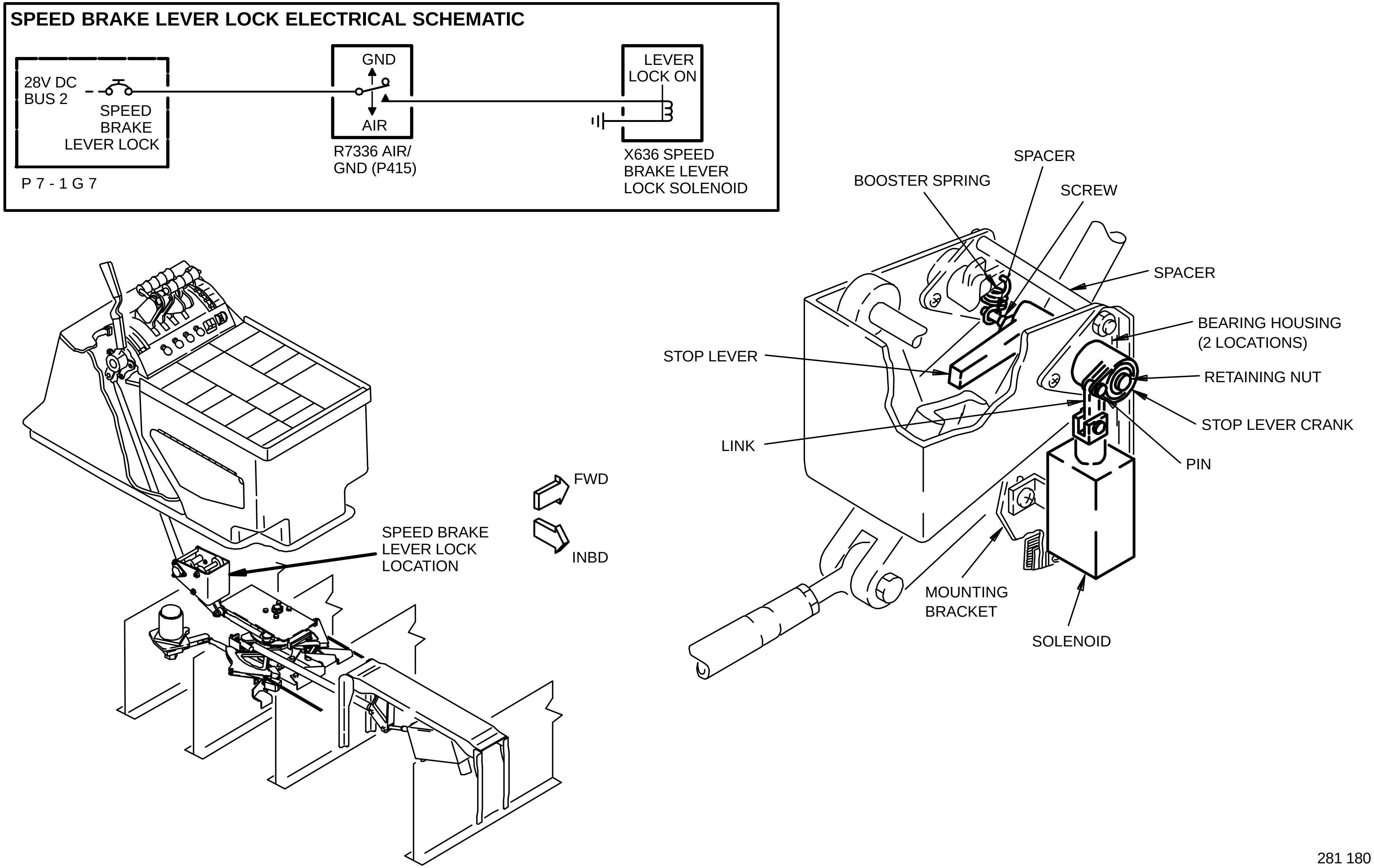

Figure 48 SPEED BRAKE CONTROL LEVER LOCK

SPEED BRAKE QUADRANT

SPEED BRAKE DRUM MECHANISM

The speed brake drum mechanism is located below and aft of the control stand. The drum mechanism consists of a quadrant assembly and a no-back brake. The linkage from the speed brake control lever attaches to the quadrant through the no-back brake. The quadrant assembly moves the control cables which connect to the speed brake sequence mechanism in the right wing gear wheel well. The no-back brake prevents torque applied through the control cables from passing back to the control lever and allows the lever to have a manual override of the automatic speed brake actuator.

SUMMARY :

INPUT CONTROL ROD

- betätigt den Forward Quadrant
- ist mit der Control Rod Plate verbunden, die lose auf den Quadrantshaft gelagert ist
- der Input löst die Lever Brake

FORWARD QUADRANT

- mit Rig Pin für Flight Detent
- betätigt die Position Switches
- Control Cable überträgt die Speed Brake Signale zum Speed Brake Quadranten

LEVER BRAKE

- verhindert selbsttätiges Verstellen des Levers
- die Drum ist mit dem Auto Speed Brake Actuator verbunden

SPRING

- drückt die Brake Pin Arms auseinander und erzeugt dadurch eine Bremswirkung

BRAKE DRUM

- betätigt bei Auto Speed Brake Operation über die Brake Pins und den Arms Quadrant Shaft die Control Rod Plate

DETENT

- für Brake Release
- für Quadrant Betätigung

AUTO SPEED BRAKE ACTUATOR INPUT

- betätigt bei Auto Speed Brake Conditions über die Lever Brake den Quadrant und den Speed Brake Lever

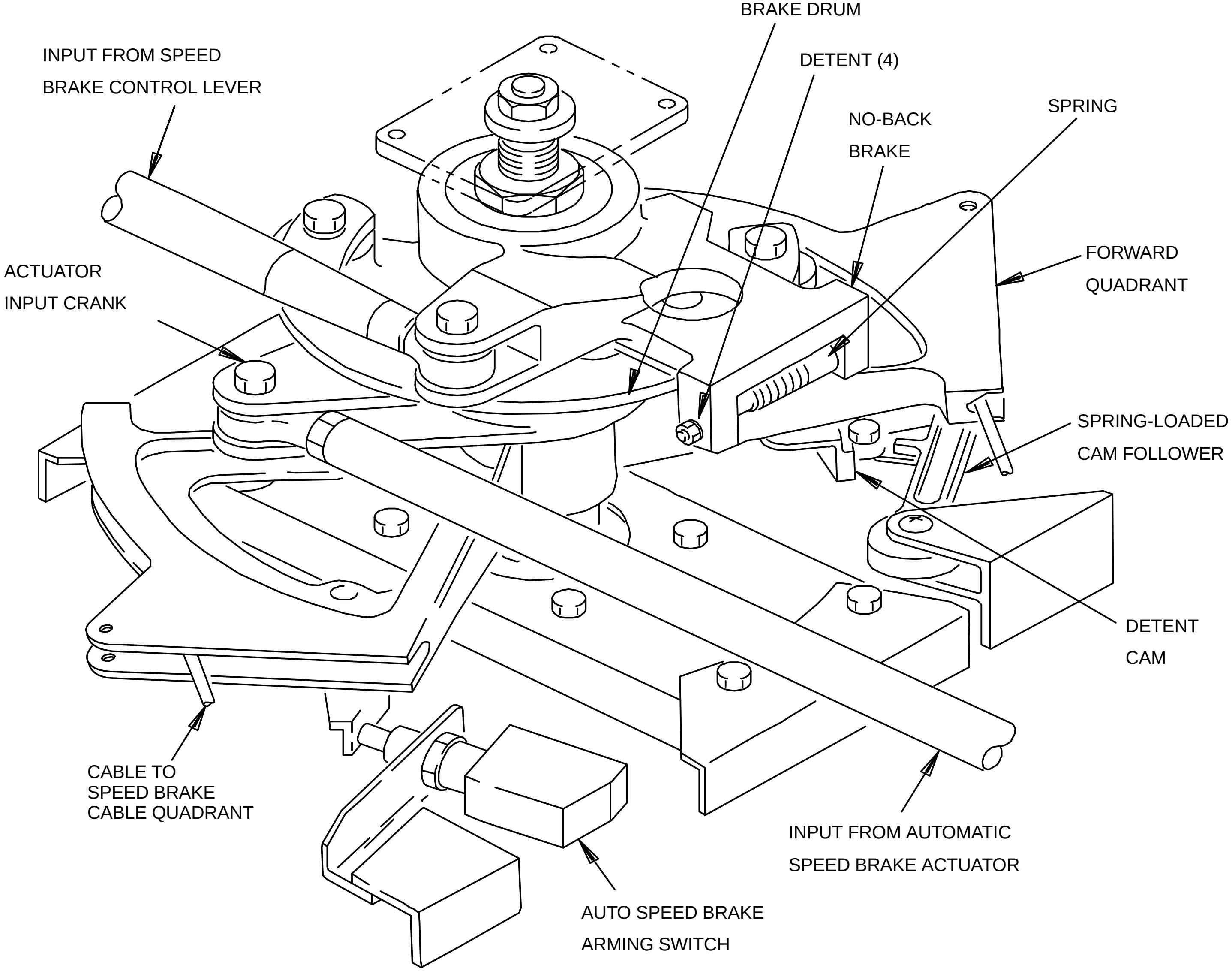

Figure 49 SPEED BRAKE QUADRANT

AUTOMATIC SPEED BRAKE ACTUATOR

DESCRIPTION

AUTOMATIC SPEED BRAKE ACTUATOR

The automatic speed brake actuator contains a 28v dc motor, gearset, and limit switches. The actuator is attached to structure just aft of the speed brake drum mechanism. The actuator is connected to the no-back brake ring on the speed brake drum mechanism through a linkage. When the actuator is energized to extend, it moves the forward quadrant to extend all flight and ground spoiler panels.

The actuator extends when the speed brake control lever is out of the DN position, both air/ground relays systems are in ground mode, hydraulic system 1 or 4 is pressurized, and thrust levers are retarded. The actuator also extends if the control lever is in the DN position when the thrust reversers are deployed.

SUMMARY :

ACTUATOR

- betätigt über Lever Brake Assy den Quadrant. Dadurch wird der Speed Brake Lever und der Sequence Mechanism angesteuert. Durch die Lever Brake kann die Auto Spoiler Actuator Bewegung vom Speed Brake Lever übersteuert werden (Manual Override).

RELAYS

- steuern Actuator
- Fehler werden durch EICAS Message angezeigt, mit CMC Speicherung.

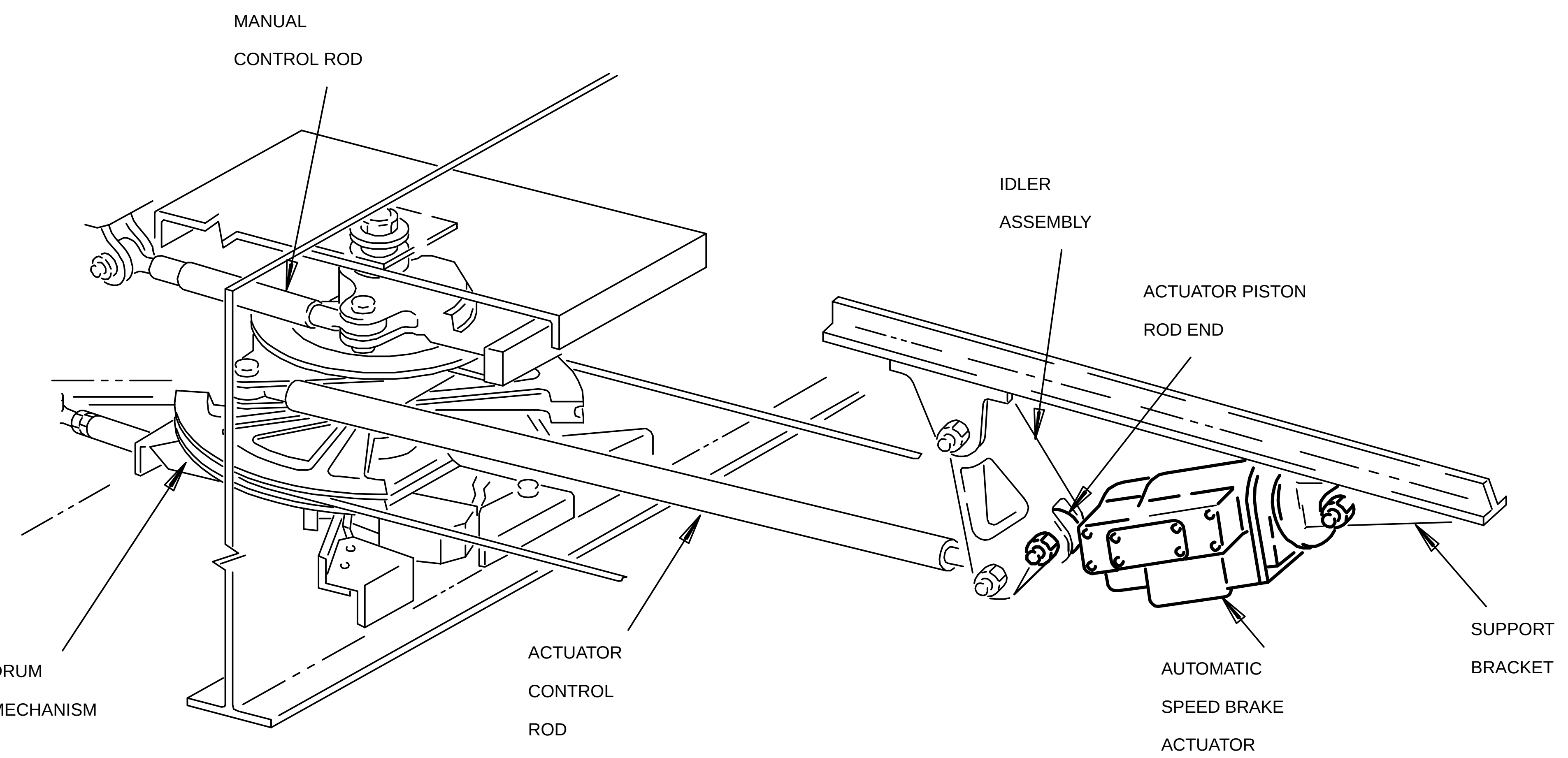

Figure 50 AUTOMATIC SPEED BRAKE ACTUATOR

AUTOMATIC SPEED BRAKE SCHEMATIC

MERKE :

Eine Überprüfung des Auto Spoiler Systemes darf nur mit Hydraulic Pressure erfolgen.

AUTOMATIC SPEED BRAKE OPERATION

The speed brake control system automatically extends all spoilers to 45° after touchdown if the speed brake control lever is in the ARM position. The automatic speed brake actuator moves the quadrant of the speed brake drum mechanism to the position corresponding to control lever UP. The actuator is energized to extend when the speed brake control lever is out of the DN detent, both air/ground relay systems are in ground mode, hydraulic system 1 or 4 is pressurized, and thrust levers 1 and 3 are at idle.

If the speed brake control lever is in the DN position at touchdown or during a refused takeoff, the spoilers will automatically extend when reverse thrust levers 2 and 4 are moved to the deployed position. When moved to the deployed position, reverse thrust levers 2 and 4 rotate a shaft with a linkage which lifts the speed brake control lever out of the DN detent. The linkage also operates the reverse thrust lever switch. This switch bypasses the auto speedbrake arm switch and extends the auto speed brake actuator.

During a go-around, all spoilers will automatically retract when either thrust lever 1 or 3 is advanced to the takeoff range.

INDICATION :

The EICAS advisory message **SPEEDBRAKE AUTO** is displayed along with the status message **SPEEDBRAKE AUTO** if one or more of the following conditions exist:

(a) Auto speed brake arming switch is not in armed position when the auto speedbrake actuator is not retracted.
(b) 28v dc power to automatic speed brake control circuit is lost.
(c) There is a disagreement between primary and alternate air/ground relay systems.

The EICAS caution message
>SPEEDBRAKES EXT
is displayed if the speed brake control lever is aft of the ARM position and one or more of the following conditions exist:

(a) Flaps are in landing position (trailing edge flaps at 25 or 30 units).
(b) Airplane radio altitude is between 15 feet and 800 feet.
(c) Two or more thrust levers are beyond 7.5 degrees TLA when airplane radio altitude is valid and is above 15 feet.

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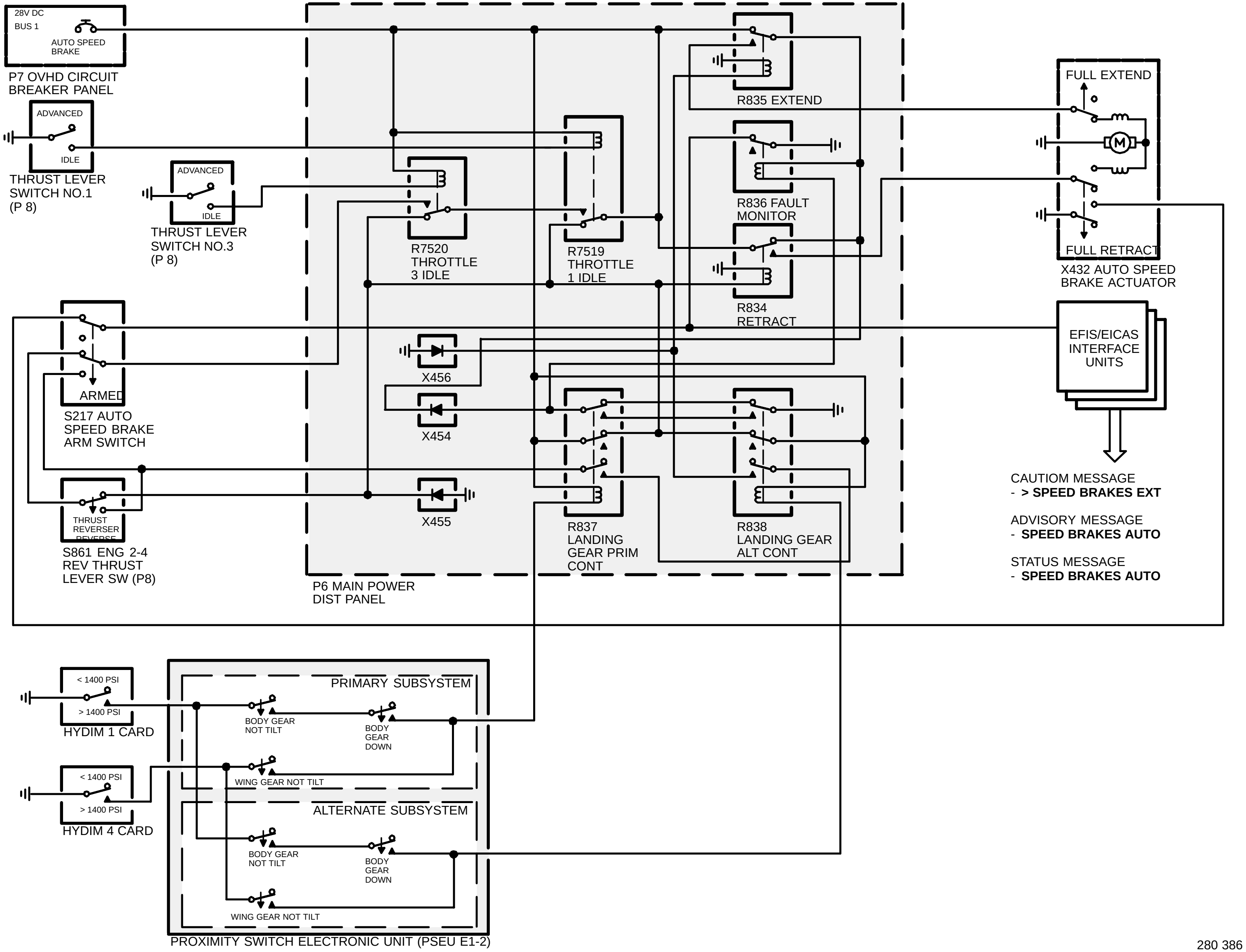


Figure 51 AUTOMATIC SPEED BRAKE OPERATION SCHEMATIC

AUTOMATIC SPEED BRAKE ACTUATOR EXTEND (SPOILER UP)

- Speed Brake Control Lever : ARMED
  oder
- Speed Brake Control Lever : NOT ARMED
  und
- Reverse Thrust Lever NO.2 : REVERSE
  oder
- Reverse Thrust Lever NO.4 : REVERSE
  und
- Hydraulic Pressure System NO.1 (HYDIM) : > 1600PSI
  und
- Body Gear : NOT TILT (Prim.System)
  und
- Body Gear : DOWN (Prim.System)
  und
- Body Gear : NOT TILT (Alt.System)
  und
- Body Gear : DOWN (Alt.System)
  und
- Thrust Lever No.1 : IDLE
  und
- Thrust Lever No.3 : IDLE

ODER

- Speed Brake Control Lever : ARMED
  oder
- Speed Brake Control Lever : NOT ARMED
  und
- Reverse Thrust Lever NO.2 : REVERSE
  oder
- Reverse Thrust Lever NO.4 : REVERSE
  und
- Hydraulic Pressure System NO.4 (HYDIM) : > 1600PSI
  und
- Wing Gear : NOT TILT (Prim.System)
  und
- Wing Gear : NOT TILT (Alt.System)
  und
- Thrust Lever No.1 : IDLE
  und
- Thrust Lever No.3 : IDLE

AUTOMATIC SPEED BRAKE ACTUATOR RETRACT (SPOILER DOWN)

Ist eine der Bedingungen für Auto Spoiler EXTEND (Spoiler UP) nicht vorhanden oder entfällt, so fahren die Spoiler ein (DOWN).

REFER TO DIN A3 PAGE

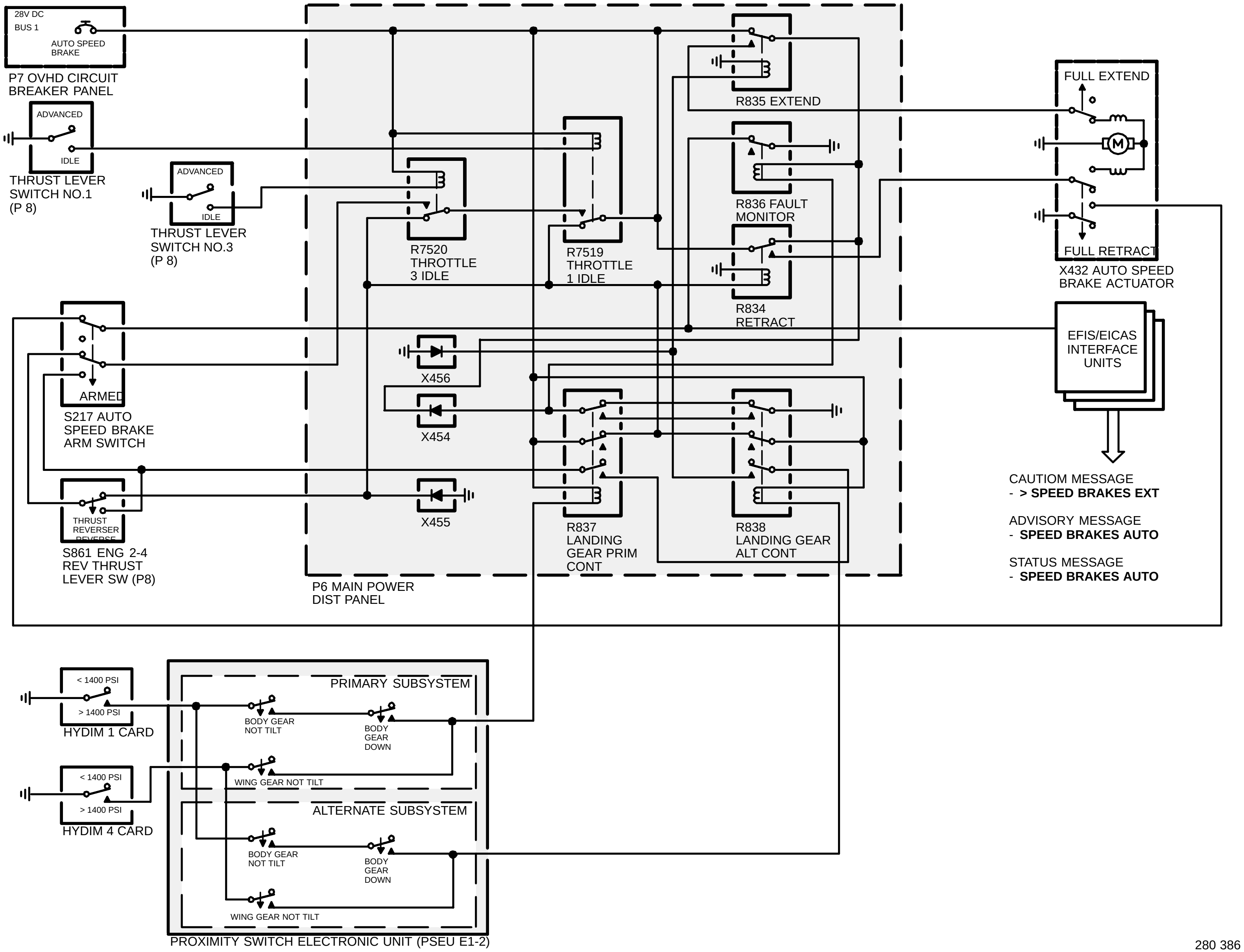


Figure 52 AUTOMATIC SPEED BRAKE OPERATION SCHEMATIC

WING GEAR WHEEL WELL SPOILER COMPONENTS OVERVIEW

SEQUENCE MECHANISM

- steuert Spoiler Differential Mechanisms (SDM) und Ground Spoiler Control Valve
- Flight Detent
  - nur Left SDM ist maximal angesteuert. Flight Spoilers 3, 4, 9, 10 sind 45°, 5 und 8 sind 20°
  - Ground Spoiler Control Valve ist angesteuert, Ground Spoilers 6 und 7 sind 20°
  - Rig Position
- UP
  - Left- und Right SDM's sind maximal angesteuert, Spoilers 1 bis 4 und 9 bis 12 sind 45°
  - Ground Spoiler Control Valve ist nach Up angesteuert, d.h. Flight Spoilers 5 und 8 sind 45°, Ground Spoilers 6 und 7 sind 45°.

GROUND SPOILER CONTROL VALVE

- steuert Hydraulic zu den Spoilers 6 und 7 und zu den Ratio Changers an Spoilers 5 und 8
- Down ist Rig Position

LEFT- AND RIGHT SPOILER DIFFERENTIAL MECHANISM

- betätigt Spoiler Cable Quadrants
- erhält CLCP und Sequence Mechanism Inputs
- Rig Pins für
  - CLCP Input
  - Sequence Mechanism Input
- Rig Positions
  - Control Wheel Neutral
  - Speed Brake Lever Down

SPOILER CABLE QUADRANT

- steuert über Cable die Flight Spoilers
- Rig Positions
  - Control Wheel Neutral
  - Speed Brake Lever Down

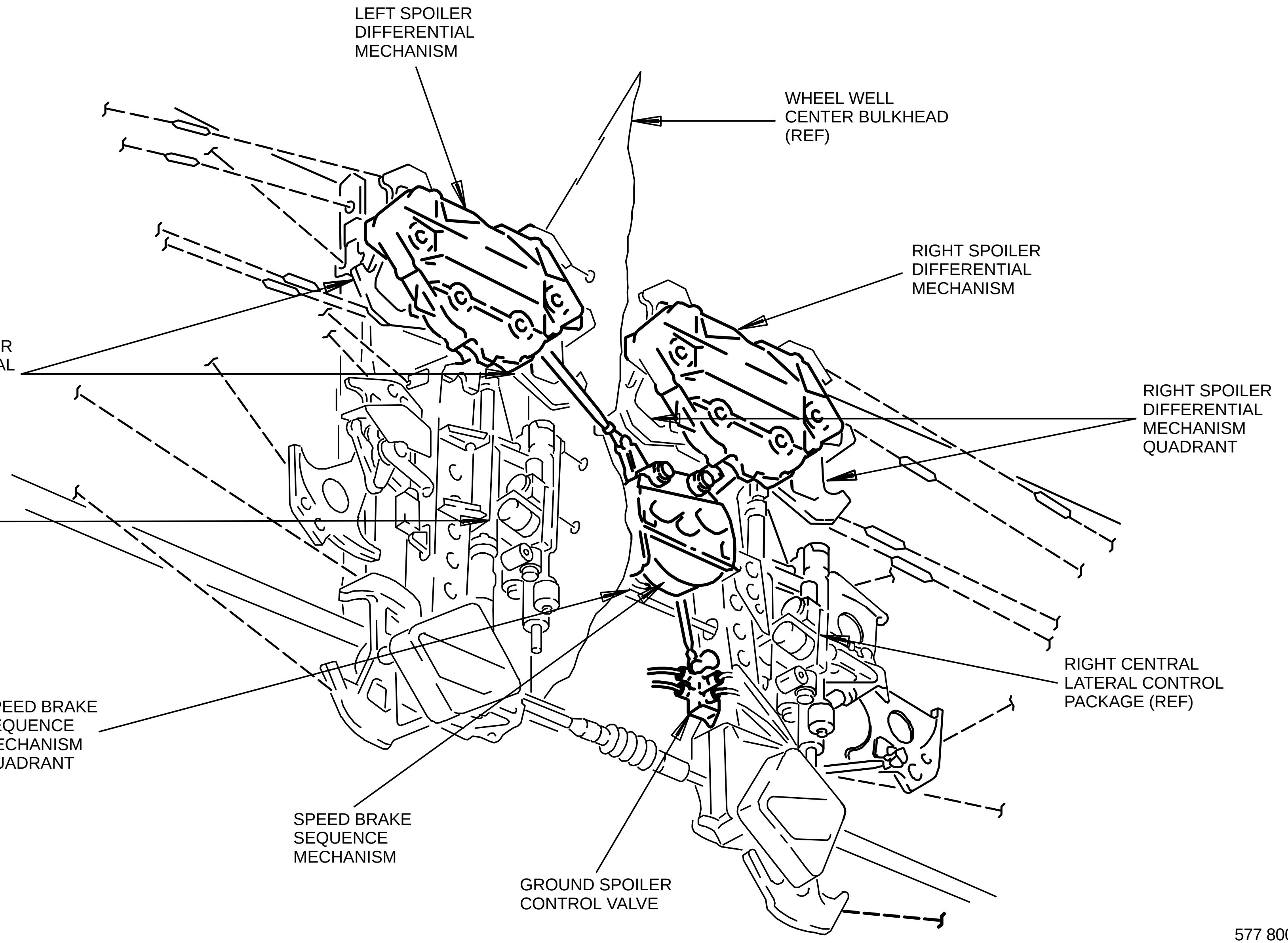


Figure 53 WING GEAR WHEEL WELL COMPONENTS OVERVIEW

SPEED BRAKE CABLE QUADRANT AND SEQUENCE MECHANISM

DESCRIPTION

SPEED BRAKE SEQUENCE MECHANISM

The speed brake sequence mechanism receives input through the speed brake control cables and programs outputs to the ground spoiler control valve and the spoiler differential mechanisms. The sequence mechanism is located in the right wing gear well.

The speed brake sequence mechanism consists of a cable quadrant, two output cranks which connect control rods to the spoiler differential mechanisms, an output crank which connects a control rod to the ground spoiler control valve, and a housing assembly with a mechanism which programs the spoiler panels to function as speed brakes.

The output from the sequence mechanism operates in two stages. With the speed brake control lever in the ARM to FLIGHT DETENT range, the control rod to the left spoiler differential mechanism moves. With the control lever in the FLIGHT DETENT to UP range, the control rod to the right spoiler differential mechanism also moves.

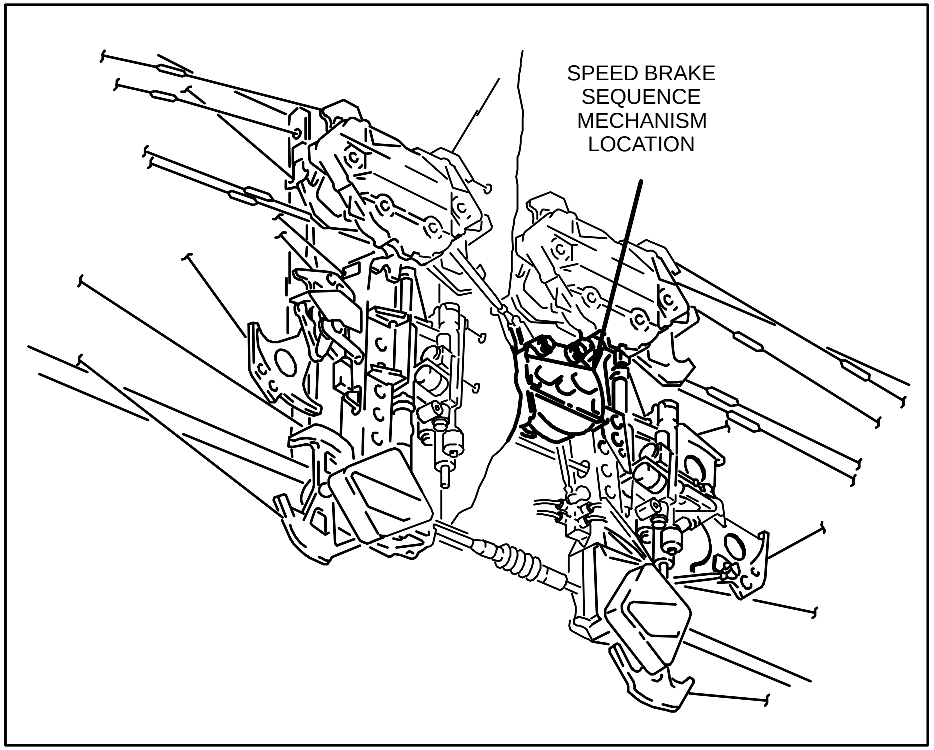
SUMMARY :

SPOILER CABLE QUADRANT

- steuert über Cable die Flight Spoilers
- Rig Positions
  - Control Wheel : NEUTRAL
  - Speed Brake Lever : DOWN

SEQUENCE MECHANISM

- steuert Spoiler Differential Mechanisms (SDM) und Ground Spoiler Control Valve
- Flight Detent
  - nur Left SDM ist maximal angesteuert. Flight Spoilers 3, 4, 9, 10 sind 45°, 5 und 8 sind 20°
  - Ground Spoiler Control Valve ist angesteuert, Ground Spoilers 6 und 7 sind 20°
  - Rig Position
- UP
  - Left- und Right SDM's sind maximal angesteuert, Spoilers 1 bis 4 und 9 bis 12 sind 45°
  - Ground Spoiler Control Valve ist nach Up angesteuert, d.h. Flight Spoilers 5 und 8 sind 45°, Ground Spoilers 6 und 7 sind 45°.



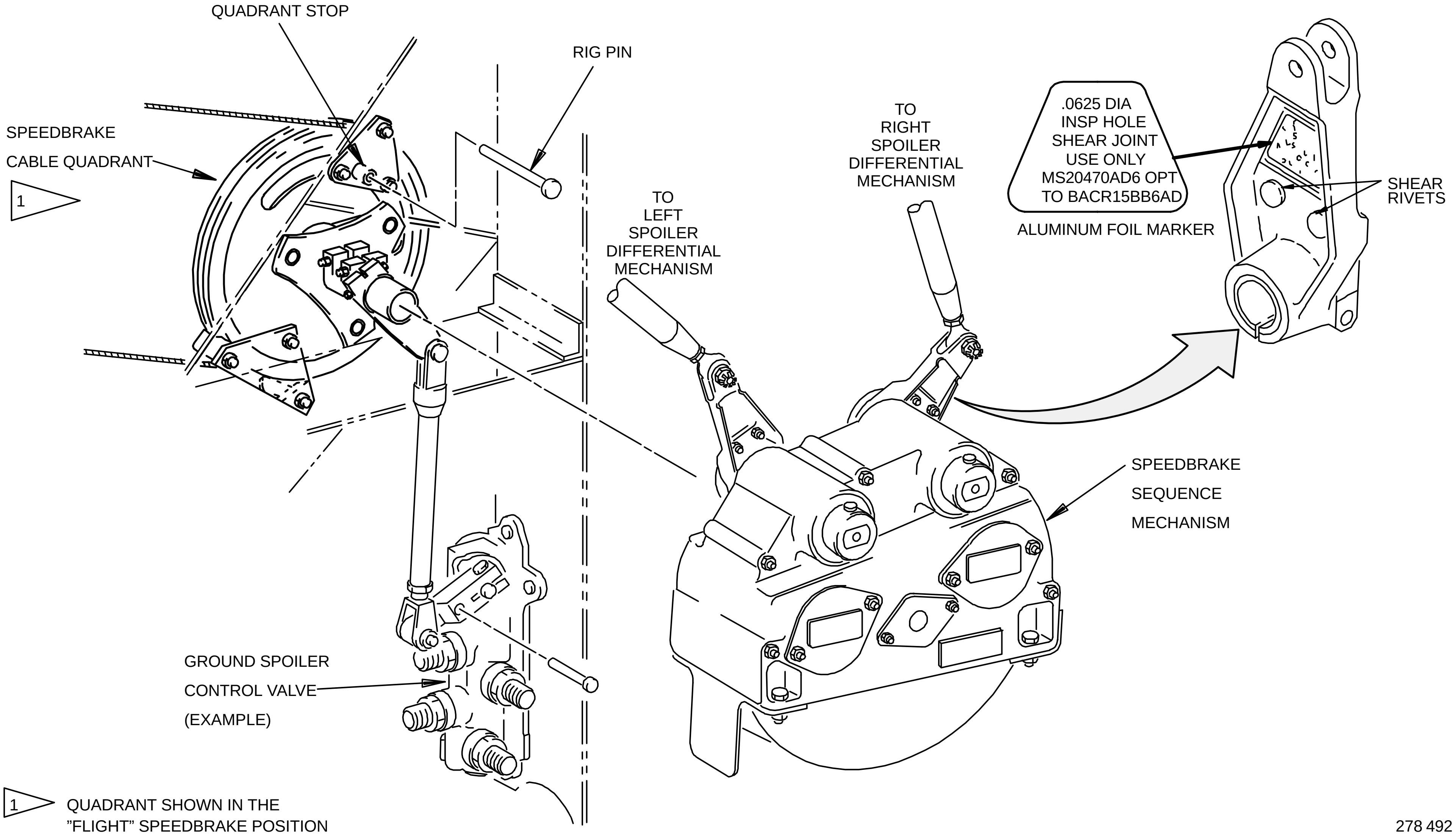


Figure 54 SPEED BRAKE SEQUENCE MECHANISM

SPOILER DIFFERENTIAL MECHANISM (SDM)

DESCRIPTION

The differential mechanisms combine the inputs from the central control actuators and the speed brake sequence mechanism to position the flight spoilers. The differential mechanisms allow the flight spoilers to be used to augment lateral control of the airplane, even when simultaneously being used as speed brakes. Two differential mechanisms are used for controlling operation of the flight spoilers and are located on the forward wheel well bulkhead above the central lateral control packages. Inputs to each differential mechanism includes a lateral input shaft and a speed brake input shaft. Output consists of a right and left output shaft with cable quadrants for cable control inputs to the spoilers.

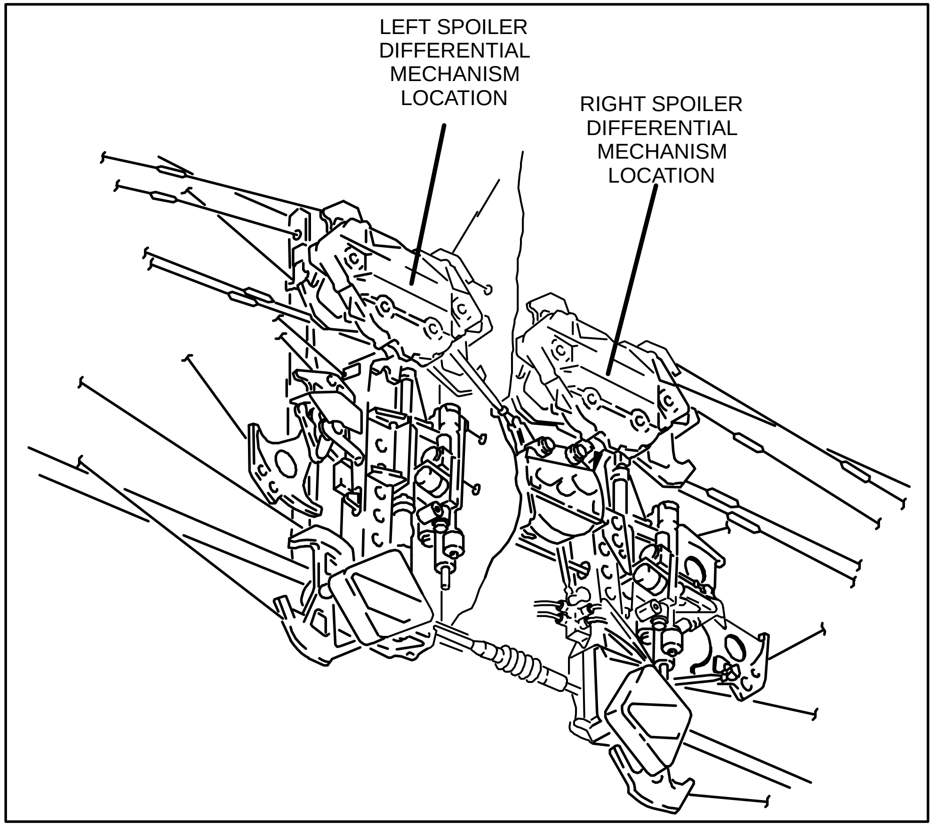
The housing of the differential mechanism contains the spoiler programming cam and related levers and linkages. The cam is mounted on the lateral input shaft contained in the differential mechanism. Rotating the cam programs the lateral control to the spoilers by causing the output cable quadrants to be rotated differentially. The cables then transfer motion along the left or right wings to rotate the spoiler package quadrants and thus position the spoilers. Rotation of the cam creates an up signal to the spoilers on one wing and a down signal to the spoilers on the other wing.

A speed brake input only, to the differential mechanism, will cause the flight spoilers on both wings to rise in proportion to actual speed brake input. Simultaneous inputs from aileron and speed brake systems will cause motion of the output quadrants in a combined manner, providing lateral control from flight spoilers with speed brakes on.

SUMMARY :

LEFT- AND RIGHT SPOILER DIFFERENTIAL MECHANISM

- betätigt Spoiler Cable Quadrants
- erhält CLCP Inputs :
  - asymmetrischer Ausschlag der Spoiler
- erhält Sequence Mechanism Inputs :
  - symmetrischer Ausschalg der Spoiler
- Rig Pins für
  - CLCP Input
  - Sequence Mechanism Input
- Rig Positions
  - Control Wheel Neutral
  - Speed Brake Lever Down



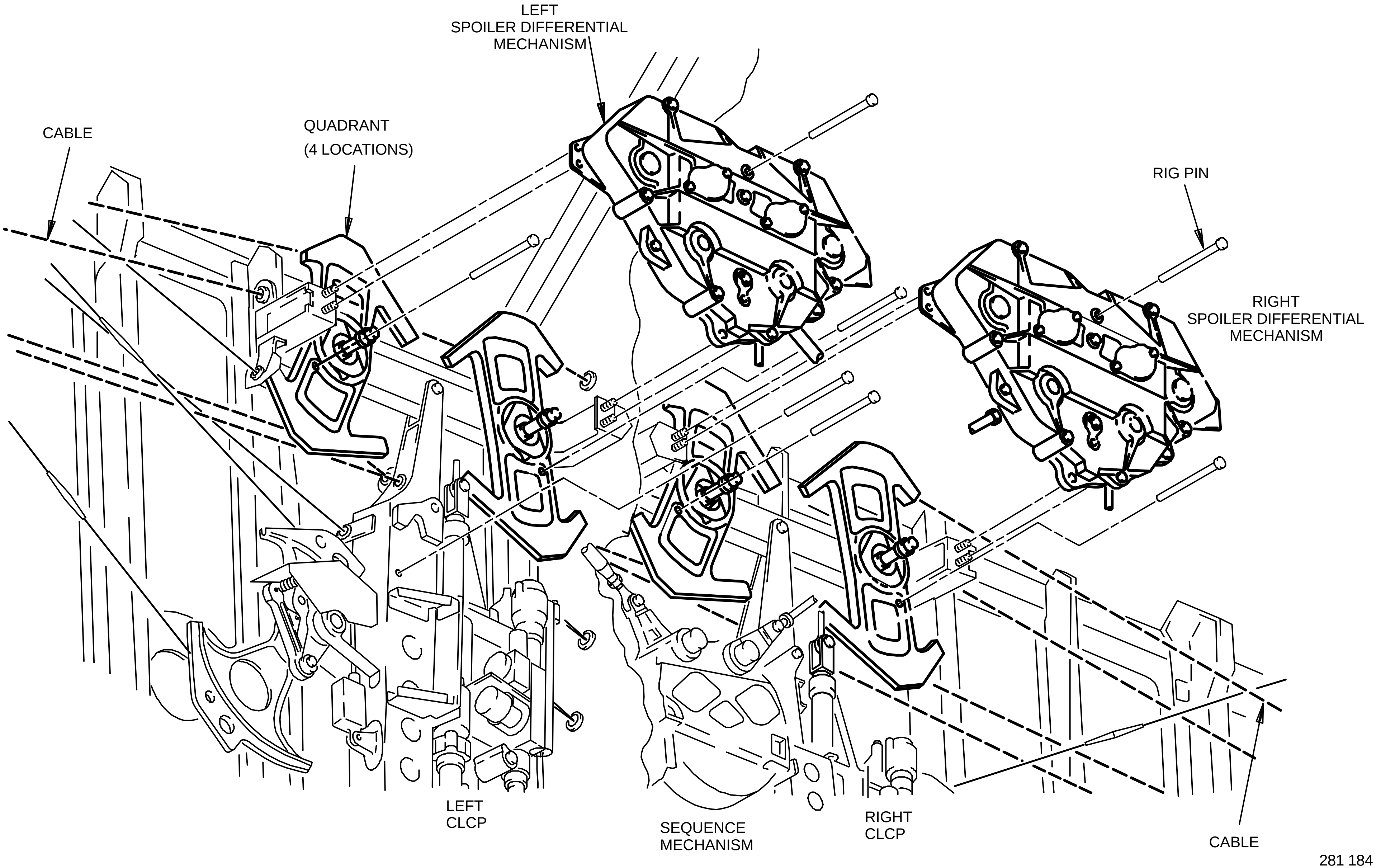


Figure 55 SPOILER DIFFERENTIAL MECHANISM

GROUND SPOILER CONTROL VALVE

DESCRIPTION

GROUND SPOILER CONTROL VALVE

The ground spoiler control valve receives mechanical input from a control rod connected to the speed brake sequence mechanism. Depending on the rod position, the control valve directs hydraulic pressure through two output ports to operate the ground spoiler control packages and the flight spoiler 5 and 8 ratio changer actuators. The control valve is located below the sequence mechanism.

SUMMARY :

GROUND SPOILER CONTROL VALVE

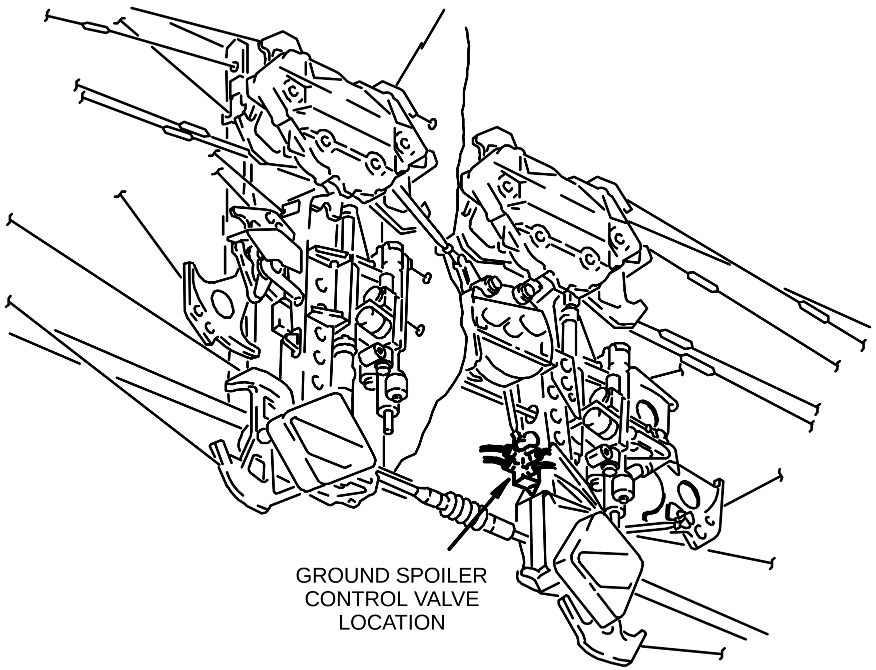
- steuert Hydraulic zu den Spoilers 6 und 7 und zu den Ratio Changers an Spoilers 5 und 8
- Down ist Rig Position

GROUND SPOILER CONTROL VALVE FUNCTION

- **DOWN**
  - Pressure Line liefert Down Pressure
  - Up 1 und Up 2 Lines sind mit Return verbunden

- **FLIGHT DETENT**
  - Pressure Line liefert Down Pressure
  - Up 1 Line erhält Pressure
  - Up 1 Pressure schaltet Switching Valve um; dadurch wird Down Pressure weggeschaltet und intern auf Return umgeschaltet
  - Up 1 Pressure fährt Actuator nach Position 20°

- **UP**
  - Flight Detent Condition bleibt
  - Up 2 erhält Pressure
  - Up 2 Pressure fährt Actuator nach Position 45°.



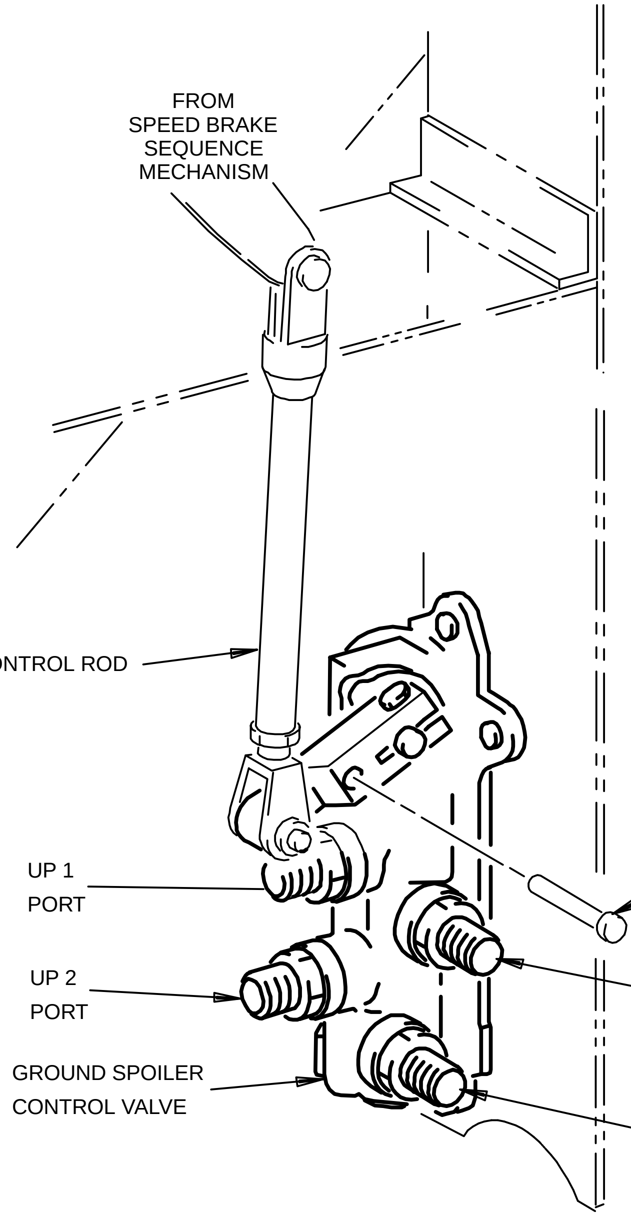


Figure 56 GROUND SPOILER CONTROL VALVE

FLIGHT SPOILER NO.1 - 4 AND NO.9 - 12

DESCRIPTION

The outboard flight spoiler control package is basically a hydraulically driven actuator. An identical control package is used for each of the four outermost spoiler panels on each wing (No. 1, 2, 3, 4, 9, 10, 11, and 12). The control packages respond to mechanical inputs to the control valves from the captain’s control wheel or speed brake control lever. Each control package is trunnion mounted to a support fitting on the wing rear spar. A control package linkage provides control inputs to the control package from a spoiler control quadrant which is also mounted on the support fitting. Hydraulic power is directed to the control package through trunnion fittings. The piston rod end of the control package is attached to the spoiler. Rotation of the spoiler control quadrant displaces an control package input lever and control valve, allowing hydraulic fluid at 3000 psi to be ported to one side of the piston and rod assembly. The input lever provides initial valve displacement, but the control package rotates on its trunnion as it positions the spoiler. Rotation of the control package returns the control valve to the neutral position, stopping hydraulic fluid flow at the desired spoiler position.

SUMMARY :

SPOILER ACTUATOR

(1 bis 4 und 9 bis 12)

- betätigt Spoiler Panels
- Control Quadrant
  - betätigt über Adjustment Rod das Control Valve
  - Rig Pin für Spoiler Down
- Follow Up wird durch die Actuator Schwenkbewegung erreicht
- Blow Down Check Valves ermöglicht Spoiler Down bei Hydraulic Off
- Hold Down Check Valve verhindert Spoiler Up bei Hydraulic Off
- Thermal Relief Valve verhindert Internal Overpressure bei Erwärmung
- hat Endlagendämpfung
- sind baugleich.

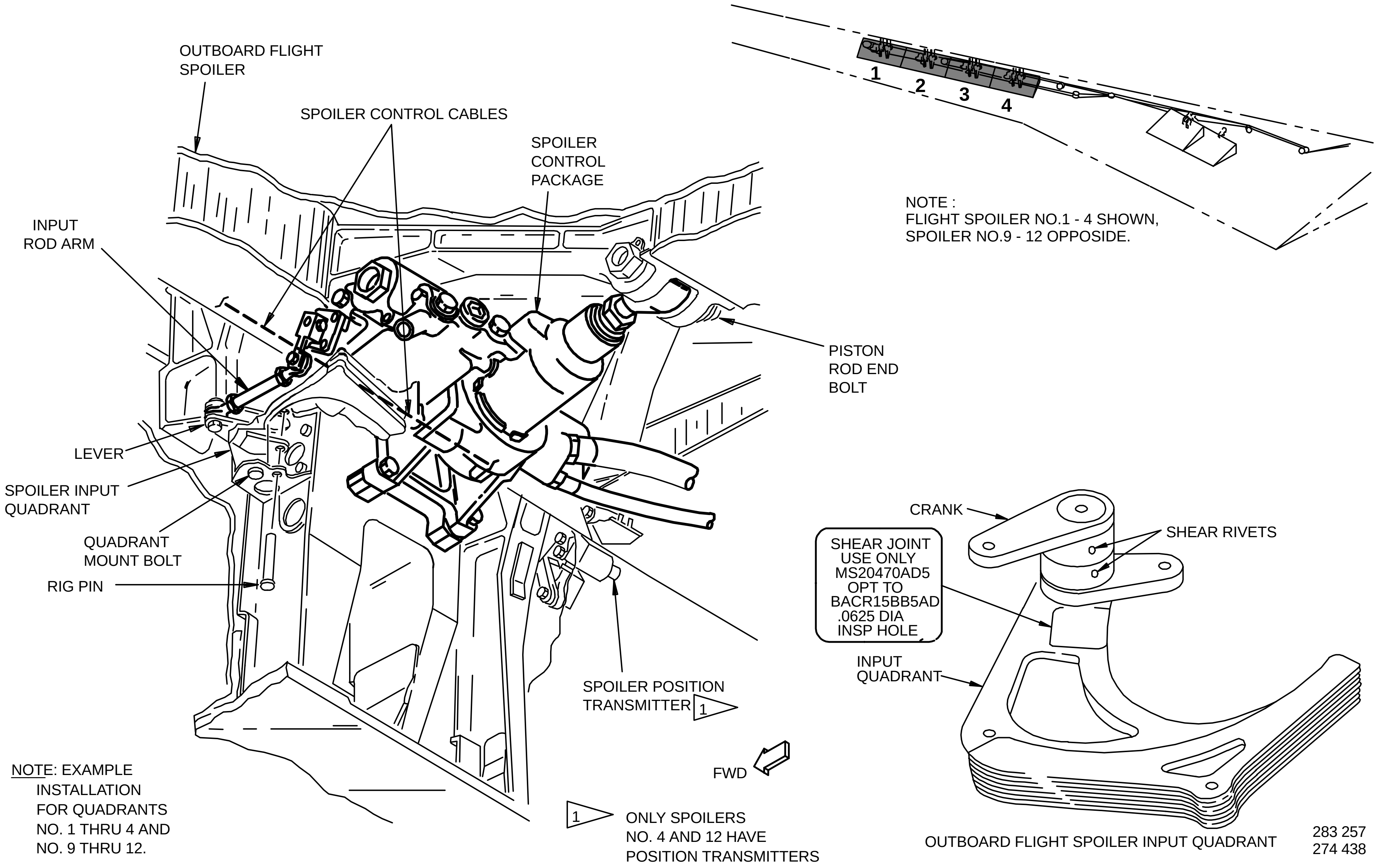
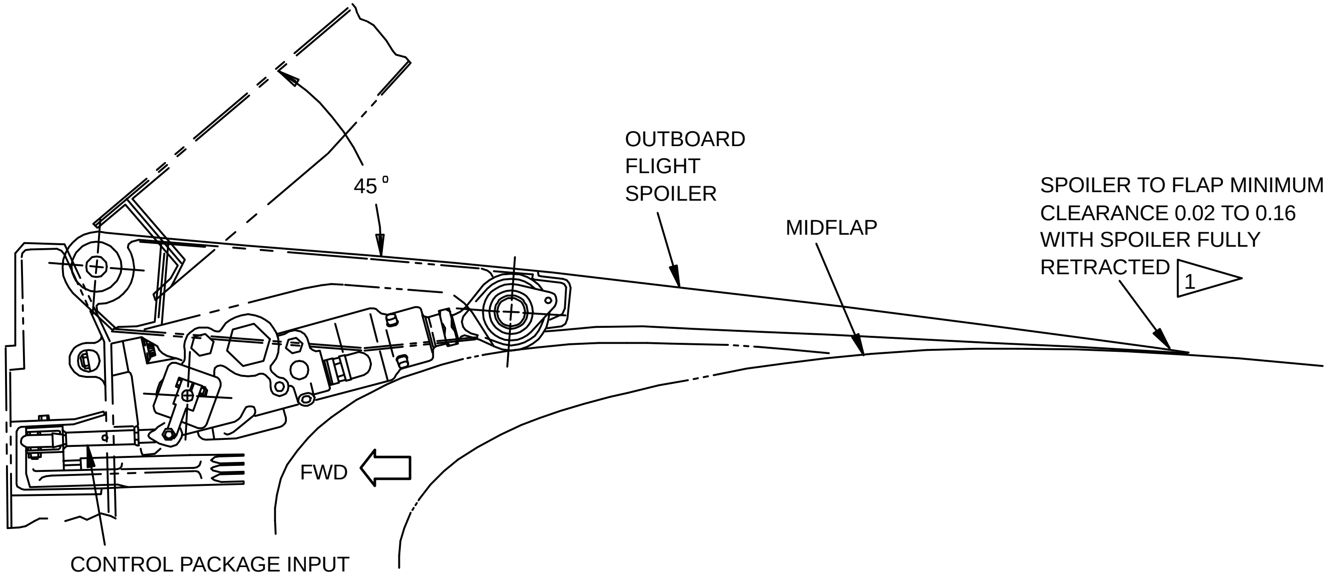
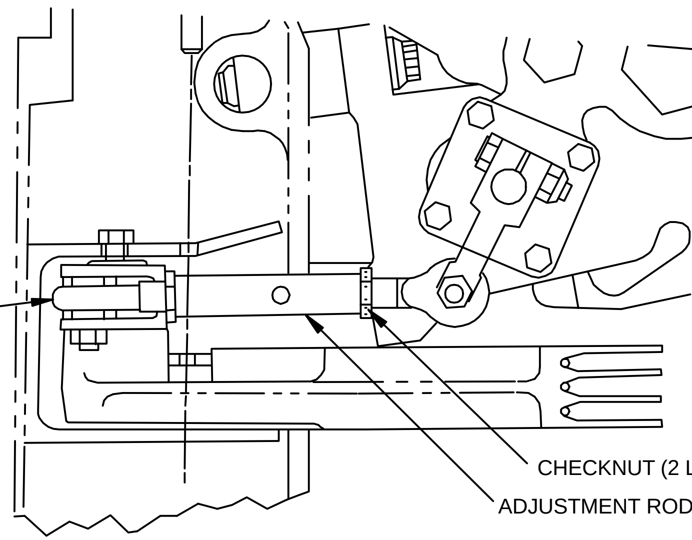


Figure 57 FLIGHT SPOILER NO.1 - 4 AND NO.9 - 12



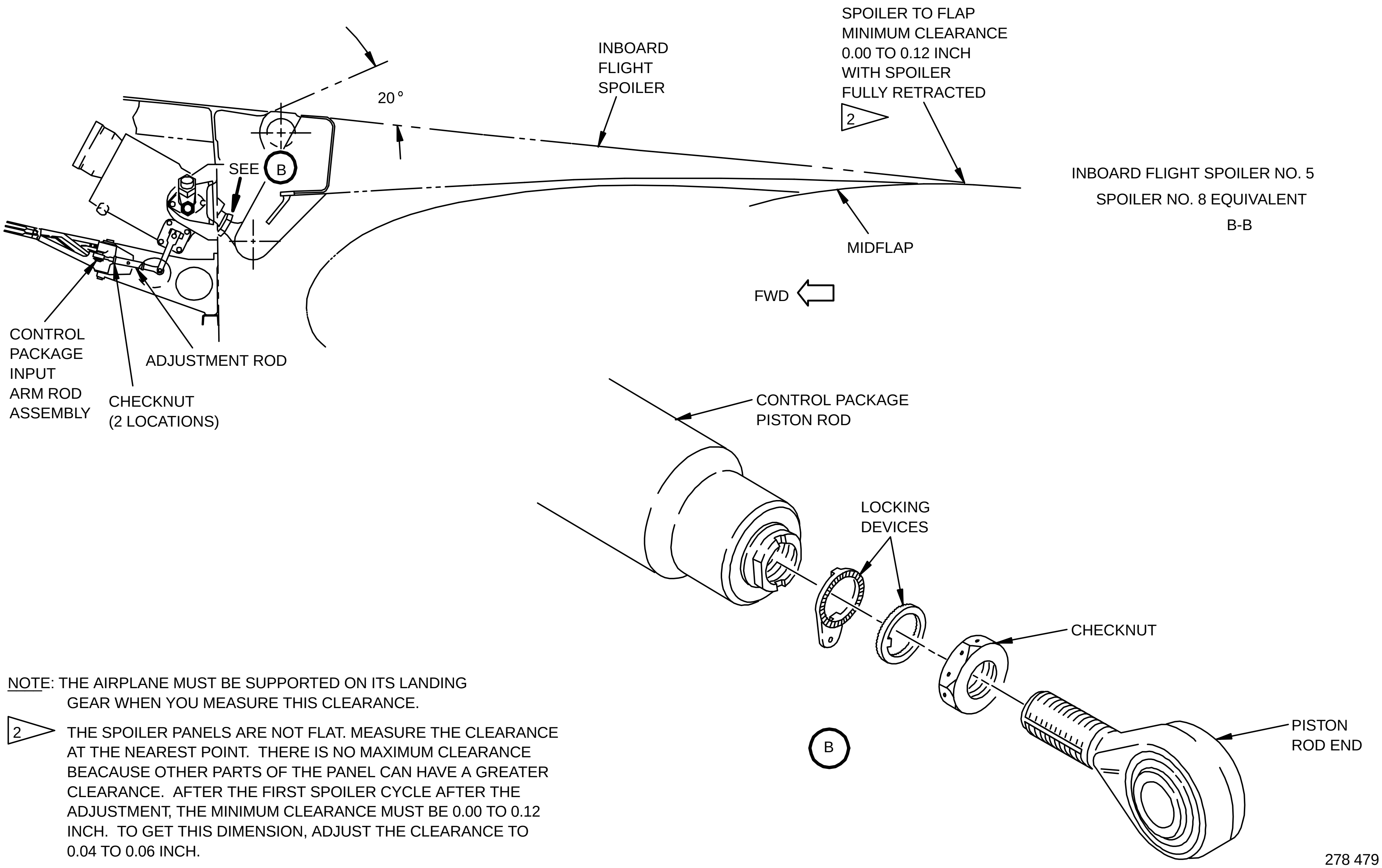
EXAMPLE OF OUTBOARD FLIGHT SPOILERS
NO. 1,2,3,4,9,10,11 AND 12



NOTE: THE AIRPLANE MUST BE SUPPORTED ON ITS LANDING GEAR WHEN YOU MEASURE THIS CLEARANCE.

1 THE SPOILER PANELS ARE NOT FLAT. MEASURE THE CLEARANCE AT THE NEAREST POINT. THERE IS NO MAXIMUM CLEARANCE BECAUSE OTHER PARTS OF THE PANEL CAN HAVE A GREATER CLEARANCE. AFTER THE FIRST SPOILER CYCLE AFTER THE ADJUSTMENT, THE MINIMUM CLEARANCE MUST BE 0.02 TO 0.16 INCH. TO GET THIS DIMENSION, ADJUST THE CLEARANCE TO 0.08 TO 0.10 INCH.

Figure 58 FLIGHT SPOILER NO.1 - 4 AND NO.9 - 12



NOTE: THE AIRPLANE MUST BE SUPPORTED ON ITS LANDING GEAR WHEN YOU MEASURE THIS CLEARANCE.

2 THE SPOILER PANELS ARE NOT FLAT. MEASURE THE CLEARANCE AT THE NEAREST POINT. THERE IS NO MAXIMUM CLEARANCE BEACAUSE OTHER PARTS OF THE PANEL CAN HAVE A GREATER CLEARANCE. AFTER THE FIRST SPOILER CYCLE AFTER THE ADJUSTMENT, THE MINIMUM CLEARANCE MUST BE 0.00 TO 0.12 INCH. TO GET THIS DIMENSION, ADJUST THE CLEARANCE TO 0.04 TO 0.06 INCH.

Figure 59 FLIGHT SPOILER NO.1 - 4 AND NO.9 - 12

FLIGHT SPOILER NO.5 AND NO.8

DESCRIPTION

INBOARD FLIGHT SPOILER CONTROL PACKAGE

The inboard and outboard flight spoiler control packages are functionally identical. The inboard flight spoiler control package is used for the No. 5 and 8 flight spoilers. Mechanical inputs for the inboard flight spoilers are by the same methods as for the other flight spoilers. Hydraulic system No. 4 supplies pressure for inboard spoiler operation.

INBOARD FLIGHT SPOILER RATIO CHANGER

The inboard flight spoiler ratio changer actuator is a two-position, hydraulically driven piston actuator. It allows the No. 5 and 8 flight spoilers to extend to 45 degrees when used as ground speed brakes. An identical actuator is installed in the control package input linkage for the No. 5 and 8 flight spoilers. When the speed brake control lever is in the DOWN or FLIGHT position, the actuator is retracted, with hydraulic system No. 4 pressure on one side of the piston. In this position, spoiler up travel is restricted to 20 degrees. When the lever is in the UP position, the ground spoiler control valve provides hydraulic pressure to the other side of the piston. Due to unequal areas, hydraulic force extends the actuator. This extension provides an additional input to the flight spoiler control package, enabling it to rise 45 degrees.

SUMMARY :

SPOILER ACTUATOR NO.5 AND NO.8

- betätigt Spoiler Panels
- der Control Quadrant betätigt über Control Crank und Adjustment Rod den Control Valve Crank
- Rig Pin für Spoiler Down
- Follow Up durch Actuator Schwenkbewegung
- hat Blow Down Check Valve
- hat Hold Down Check Valve
- hat Thermal Relief Valve
- hat Endlagendämpfung

RATIO CHANGER

- Linkage
  - betätigt Control Crank
  - wird vom Ratio Changer Actuator betätigt
  - Actuator wird hydraulisch gesteuert vom Ground Spoiler Control Valve

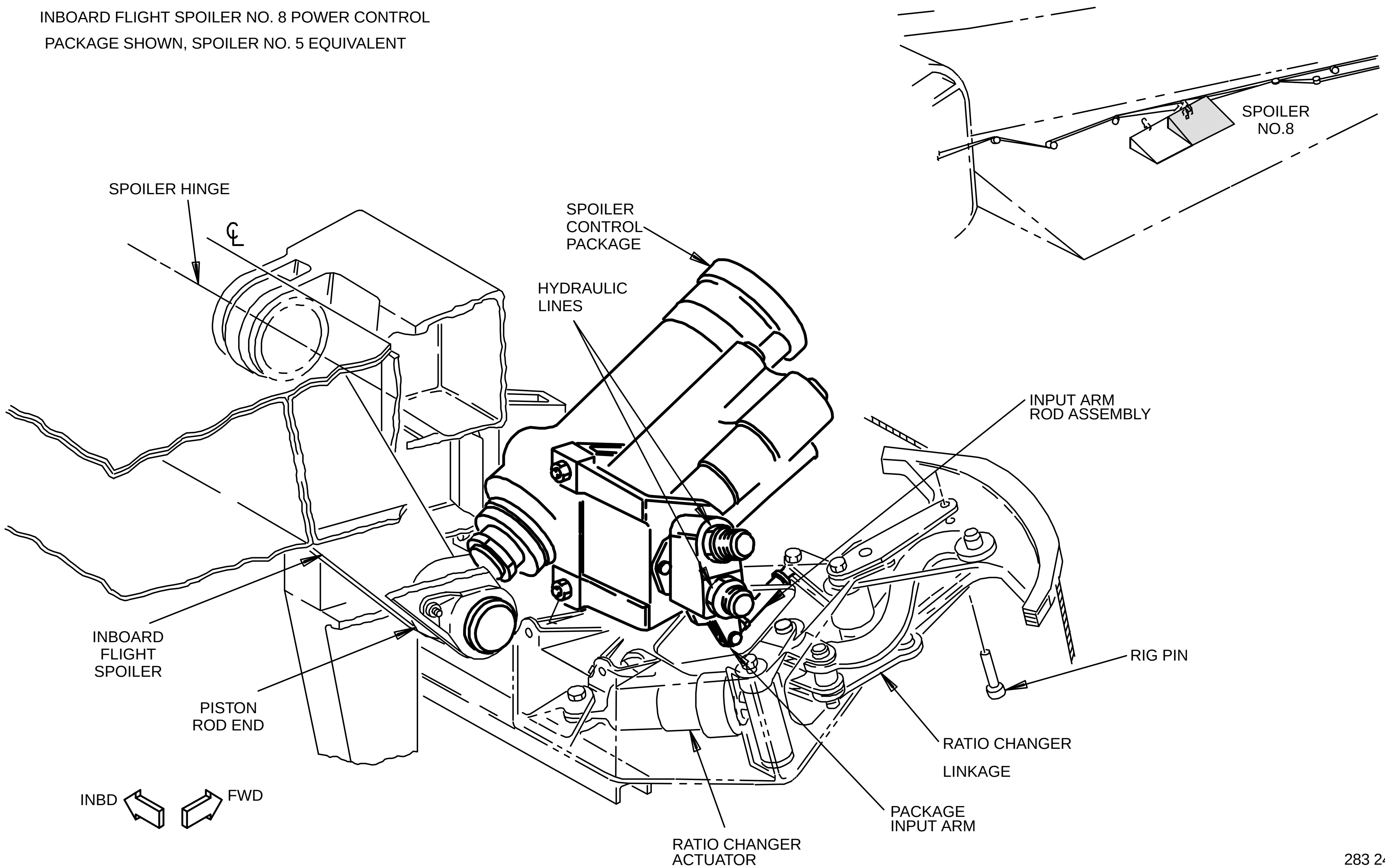


Figure 60 FLIGHT SPOILER NO.5 AND NO.8

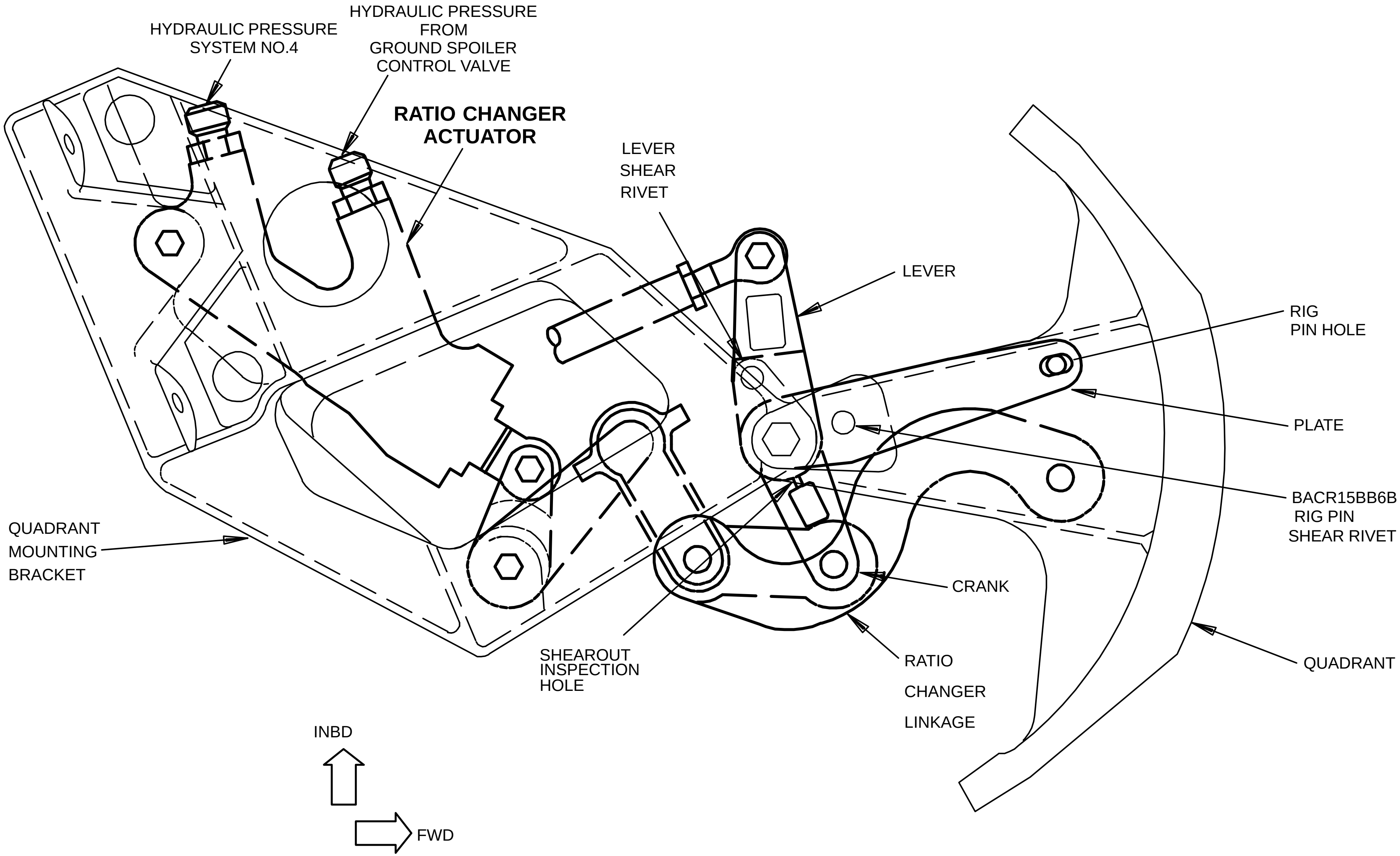


Figure 61 FLIGHT SPOILER NO.5 AND NO.8 MECHANICAL SCHEMATIC

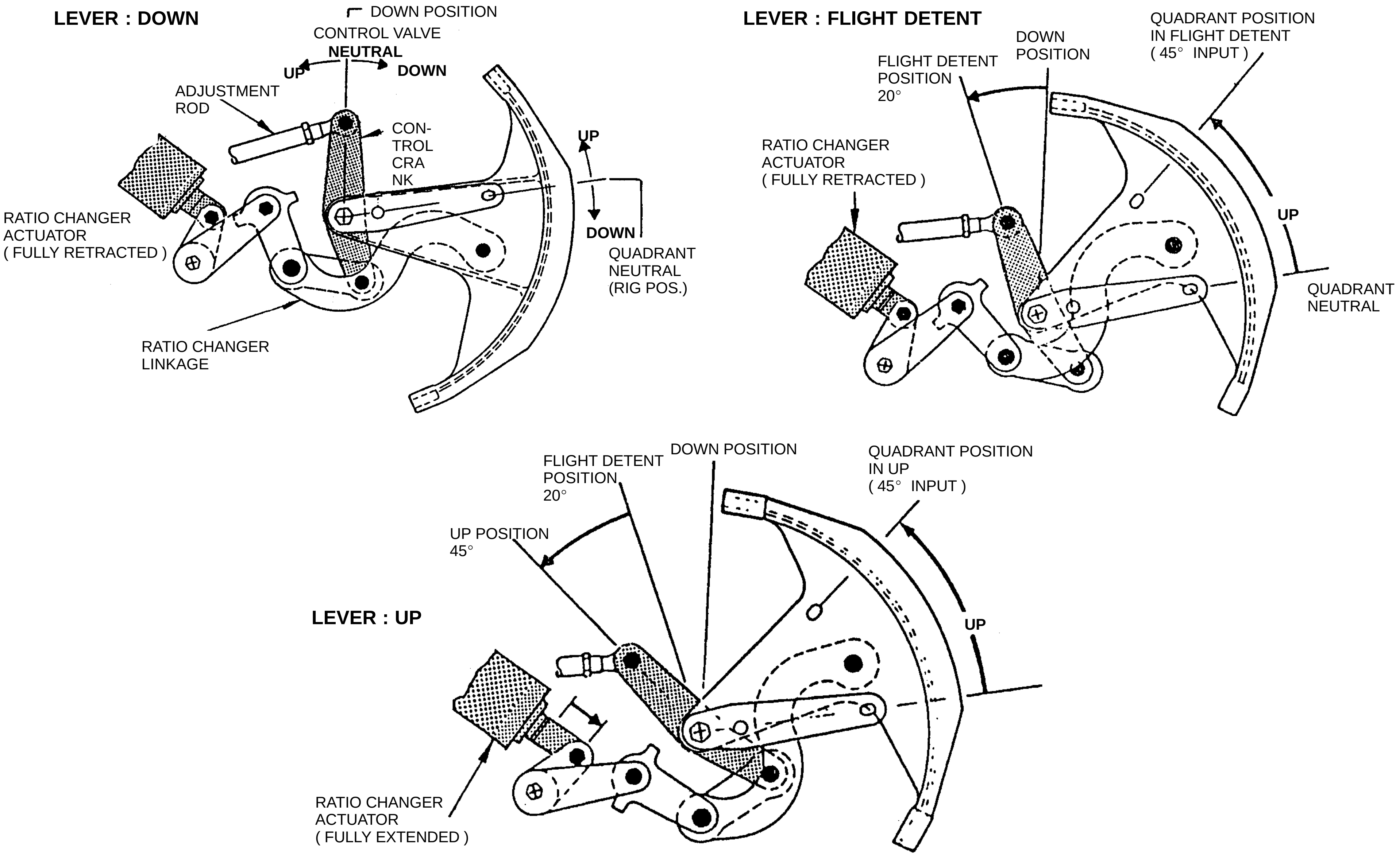


Figure 62 SPEED BRAKE CONTROL HANDLE OPERATION

GROUND SPOILER NO.6 AND NO.7

DESCRIPTION

GROUND SPOILER CONTROL PACKAGE

Each ground spoiler control package has three output positions controlled through two hydraulic pressure inputs. The control package is a piston type actuator with the piston end attached to the spoiler and the cylinder end attached to a trunnion pivot on the trailing edge beam. A thermal relief valve prevents damage to the control package due to thermal expansion of hydraulic fluid inside the actuator. The control packages are located below ground spoilers 6 and 7.

With the speed brake control lever at FLIGHT DETENT, the ground spoiler control packages extend the ground spoilers to 20° . With the control lever at UP, the ground spoilers are extended to 45° .

GROUND SPOILER SUMMARY :

- betätigt Ground Spoiler Panel
- Rig Pin für Spoiler Down
- Follow Up durch Actuator Schwenkbewegung
- hat Blow Down Check Valve
- hat Hold Down Check Valve
- hat Thermal Relief Valve
- hat Endlagendämpfung
- Positions :
  - Down 0°
  - Flight Detent 20°
  - UP 45°
- ist ein Telescope Actuator
- wird vom Ground Spoiler Control Valve gesteuert
- Switching Valve schaltet bei Spoiler Up den Down Pressure weg

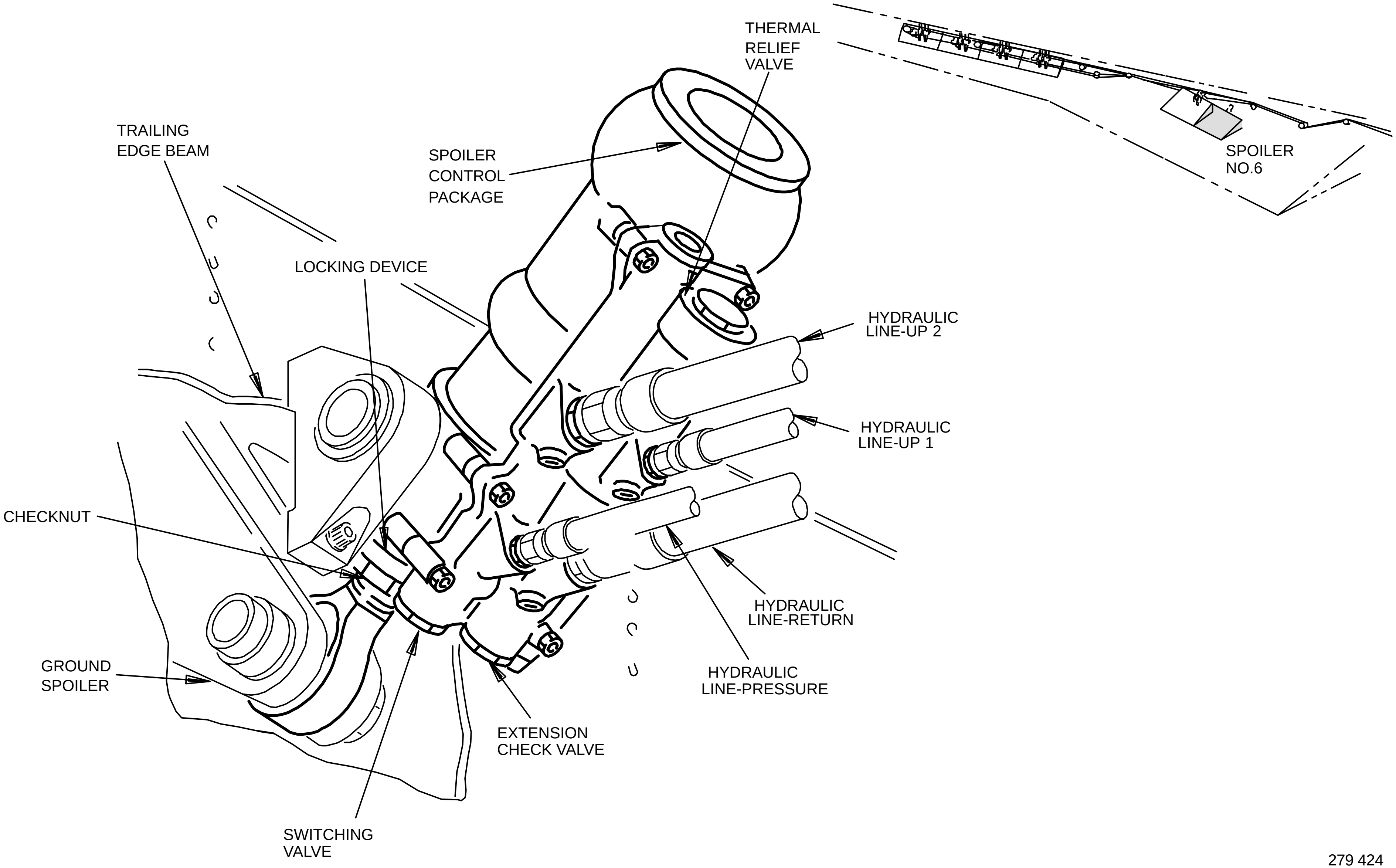


Figure 63 GROUND SPOILER NO.6 AND NO.7

SPEED BRAKE LEVER POSITION TRANSMITTER

GENERAL

The position of the speed brake control lever is sensed by a triple RVDT transmitter for use by the autopilot/flight director system, which also sends the position information to the flight data recorder system. The electrical outputs of the position transmitter are processed by the three flight control computers.

SPEED BRAKE LEVER POSITION TRANSMITTER

The speed brake lever position transmitter is located under the pilots' control stand forward of the speed brake drum mechanism. The transmitter contains three rotary variable differential transformers (RVDT) which are driven by the same input shaft. Movement of the speed brake control lever is transferred to the position transmitter shaft through a crank and a control rod attached to the speed brake drum mechanism. The control rod is adjusted to allow a rig pin to be inserted through the transmitter housing and the crank.

SUMMARY :

Der Speed Brake Lever Position Transmitter dient ausschließlich für

- das Autopilot/Flight Director System
  und
- Flight Data Recorder System.

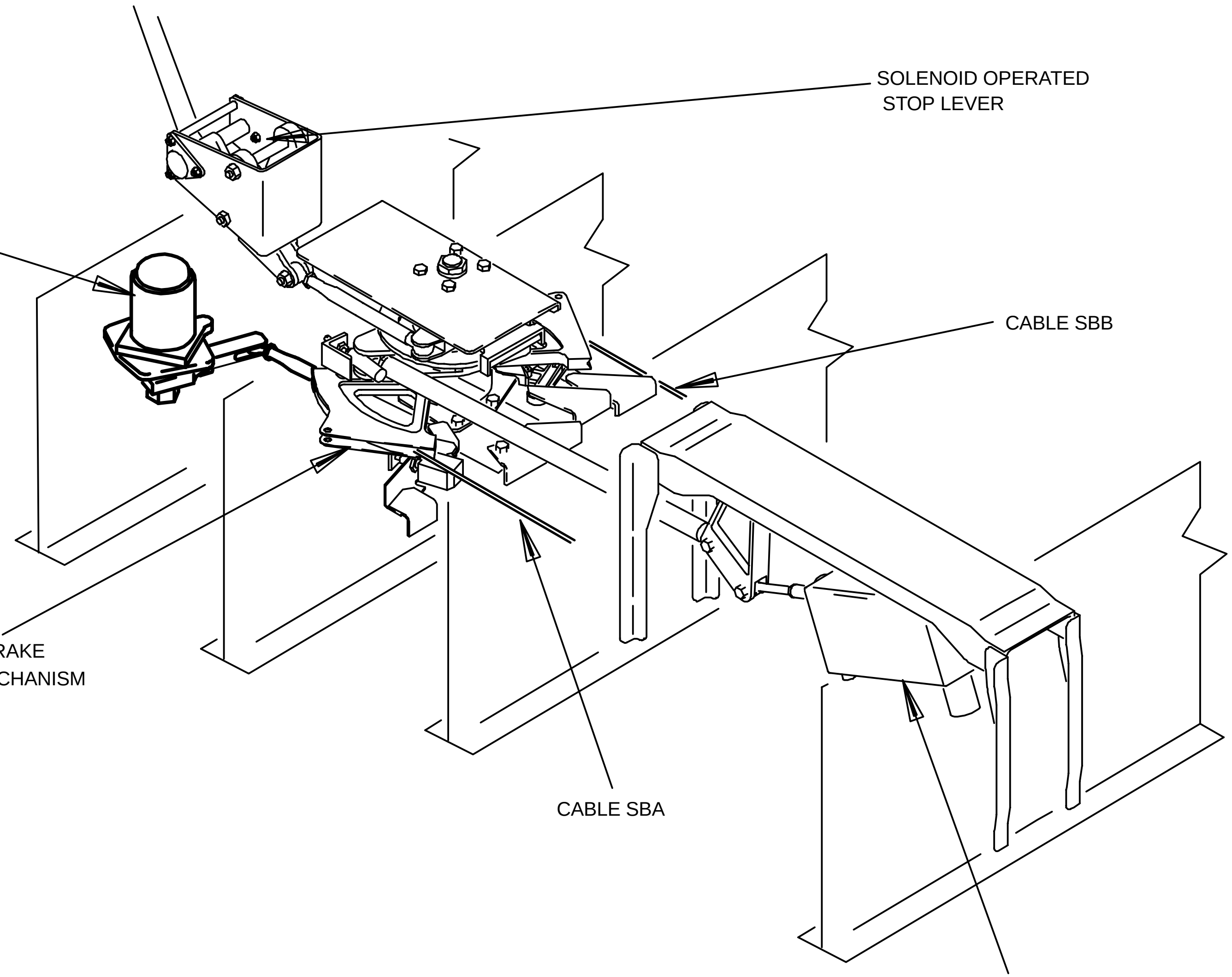


Figure 64 SPEED BRAKE LEVER POSITION TRANSMITTER

SPOILER POSITION INDICATING COMPONENTS

DESCRIPTION

GENERAL

The spoiler position indicating system provides visual indication on the flight deck of the angular position of the No. 4 and No. 12 spoilers. The spoiler position indicators appear on the EICAS status page as part of the surface position display.

Components used by the spoiler position indicating system are the two spoiler position transmitters, the spoiler/aileron surface position digitizer card, and the EIU's and EICAS display. The system is powered by 28 volts dc from the 28 vdc bus 4 and by 28 volts ac from the 28 vac bus 4 through circuit breakers on the P6 panel.

SPOILER POSITION TRANSMITTER

The spoiler position transmitters are located on the wing rear spar at the No. 4 and No. 12 spoilers. An adjustable control rod attaches each transmitter crank to the spoiler. With the spoiler in the down position, the control rod can be adjusted to set the spoiler position readout on the EICAS flight controls maintenance page to zero.

SURFACE POSITION DIGITIZER CARD

The forward surface position digitizer card YMLA09 receives the signals from the spoiler position transmitters and converts the signals to a serial digital format for transmission to the EIU's on an ARINC 429 bus.

See description of the surface position digitizer card at aileron system.

FAILURE INDICATION OF THE SPOILER POSITION TRANSMITTER :

For example :

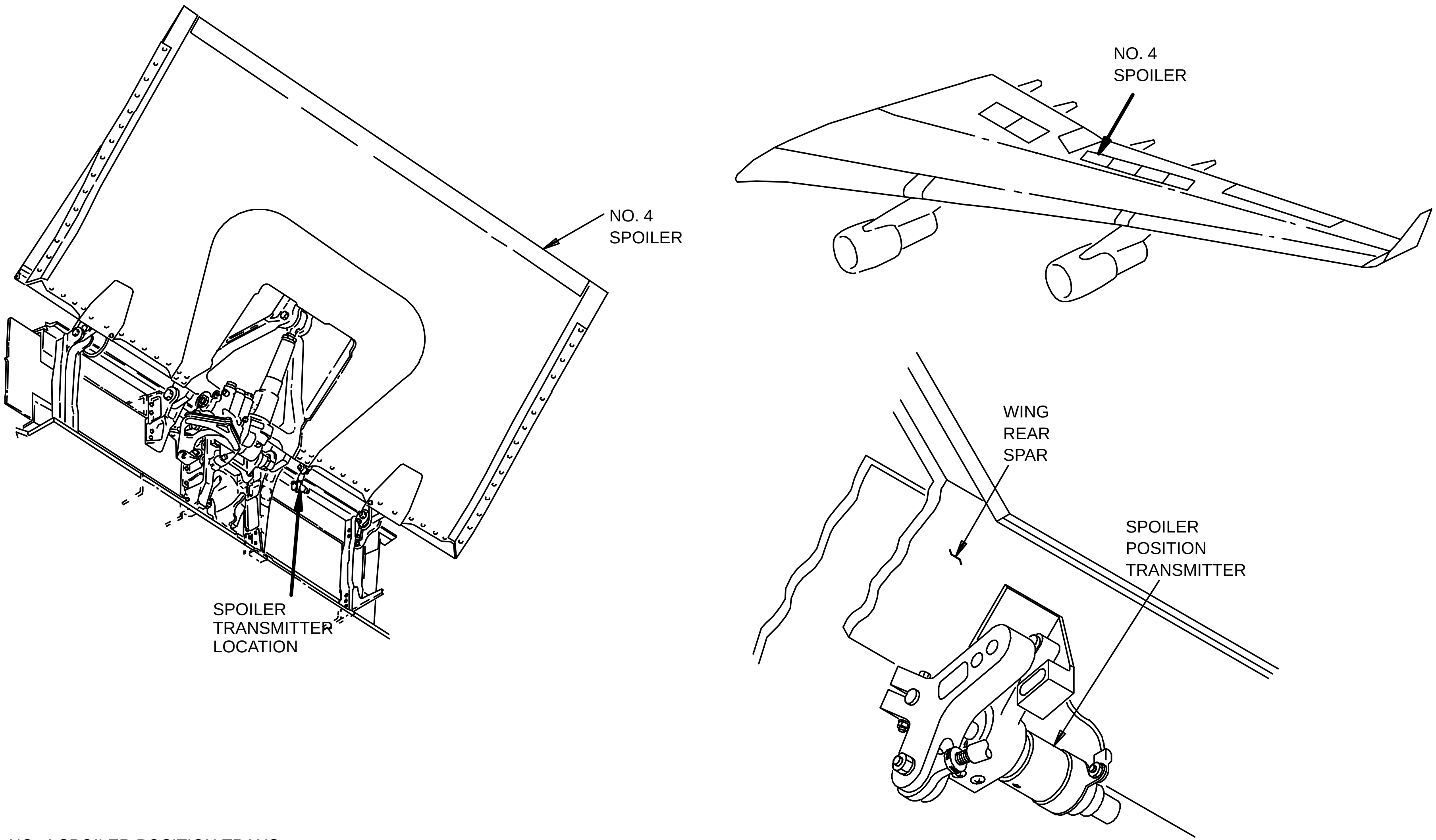
Whenever a fault is detected for the aileron position transmitter on the MCDU is shown the

CMC message :

 # 4 SPOILER SYNCHRO FAIL (SPD - FWD) 27 956

 # 12 SPOILER SYNCHRO FAIL (SPD - FWD) 27 957.

only.



NOTE: NO. 4 SPOILER POSITION TRANSMITTER SHOWN. NO. 12 SPOILER TRANSMITTER SIMILAR.

299 310

Figure 65 SPOILER POSITION INDICATING COMPONENTS

SPOILER POSITION INDICATING SYSTEM SCHEMATIC

DESCRIPTION

FUNCTIONAL DESCRIPTION

As the spoiler is deflected upwards from its down position, the attached control rod drives the transmitter crank which pivots the transmitter shaft. The transmitter electrical output varies as the shaft pivots. The output signal passes to the surface position digitizer which processes the signal and routes it to the EIU's for display on EICAS.

CONTROL

Operation of the spoiler position indicating system is automatic. The EICAS surface position display appears when the EICAS status page is invoked.

The flight controls maintenance page may be called up on the auxiliary EICAS display. This page displays the values of spoiler angular displacement as numeric readouts for system adjustment and trouble shooting.

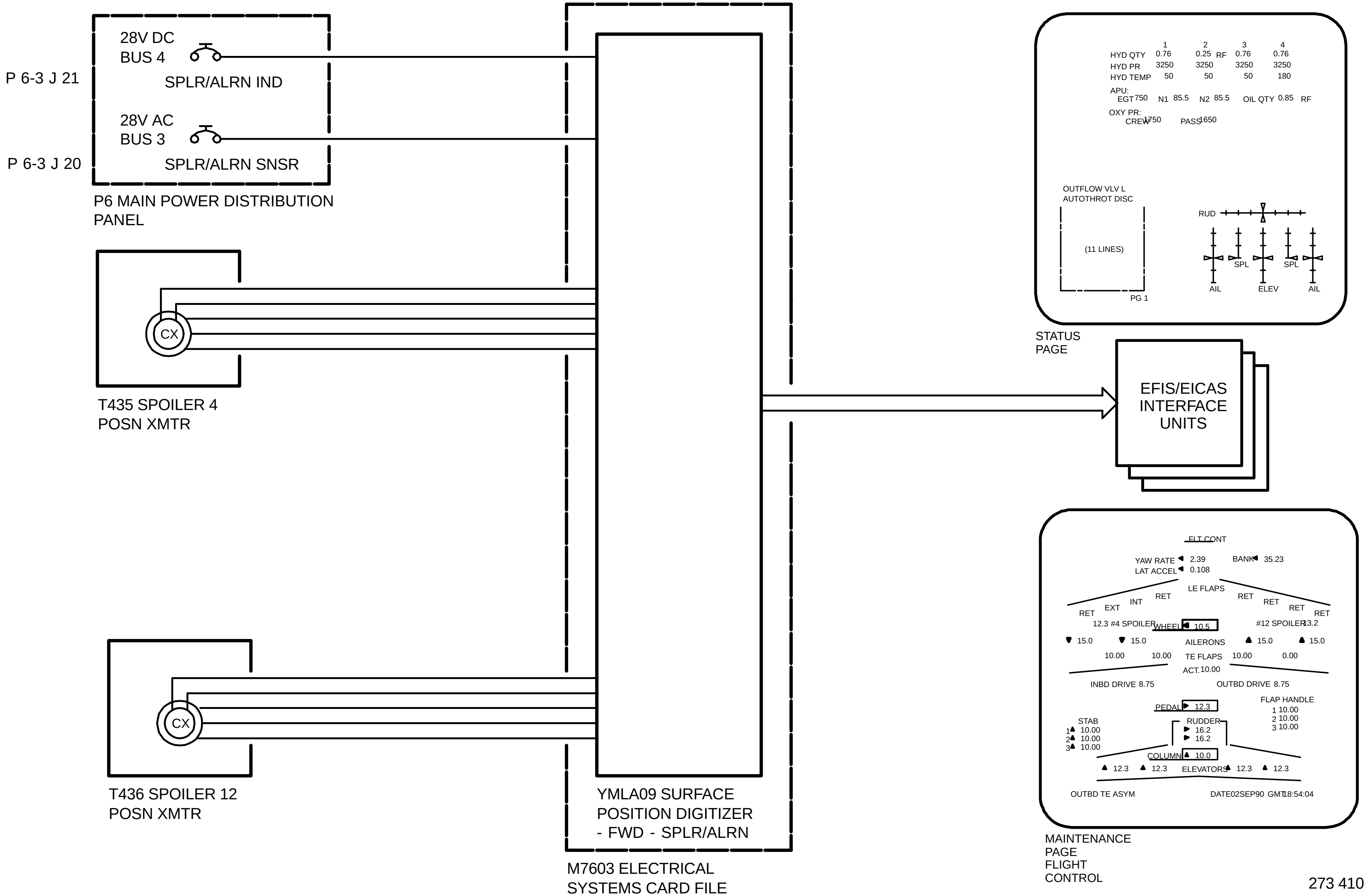


Figure 66 SPOILER POSITION INDICATING SYSTEM SCHEMATIC

27-20 RUDDER

FLIGHT CONTROL MAINTENANCE- AND STATUS PAGE

DESCRIPTION MAINTENANCE PAGE

Die Maintenance Page für das Flight Control System ist über das Central Maintenance Computer System (CMCS) folgendermaßen aufrufbar :

- CMC
- MENü
- MAINTENANCE PAGE
- ATA 27
- DISPLAY.

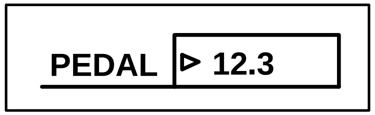
Die Anzeigen:

- der Rudder Pedals
- des Lower Rudders
- des Upper Rudders

erfolgt in ° .

Die Anzeige erfolgt in Steps von $^{1}/_{10}$ ° .

PEDALS :

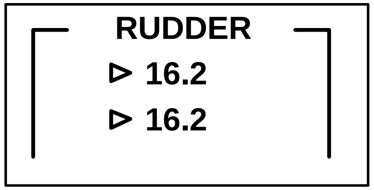


- Pedal Ausschlag von 12,3° für einen Right Turn

UPPER- AND LOWER RUDDER

Upper Rudder = obere Indication

Lower Rudder = untere Indication



- Rudder Ausschlag von 16,2° nach rechts.

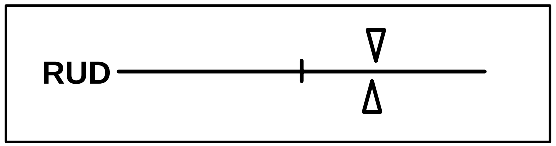
DESCRIPTION STATUS PAGE

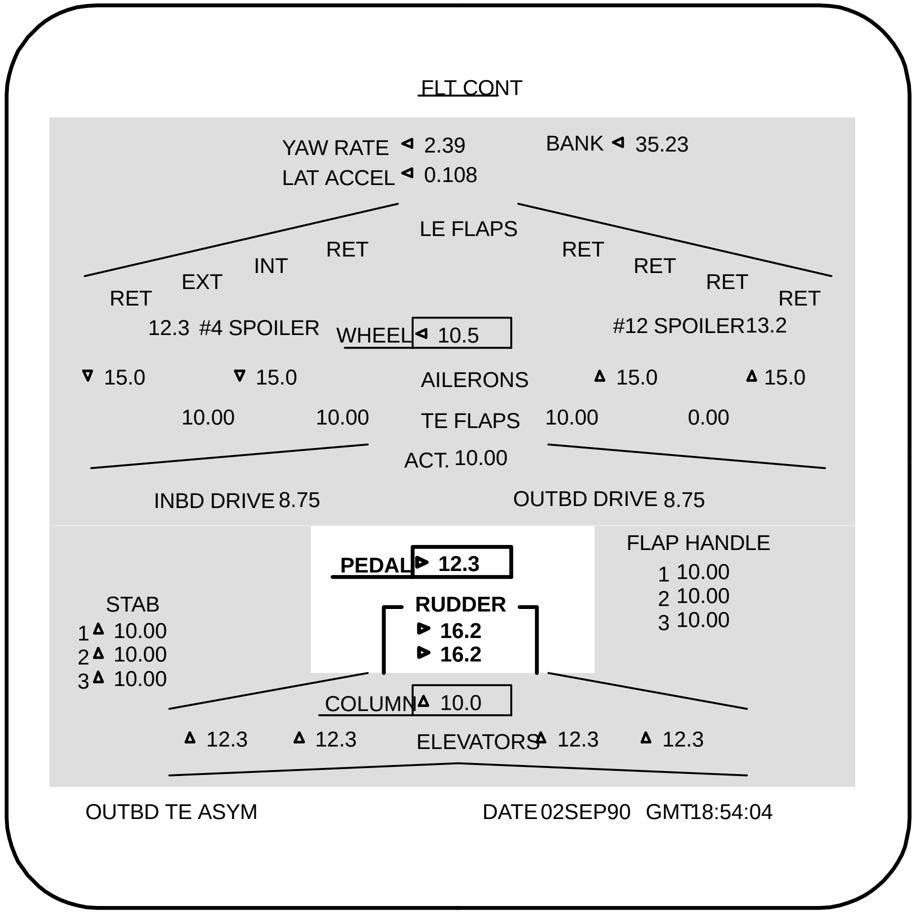
Die Status Page ist über das EICAS Data Select Panel (EDSP) auf dem Glearshild über den Select Button STATUS aufrufbar.

Auf der Status Page befindet sich in der rechten unteren Ecke die Informationen des Flight Control Systemes.

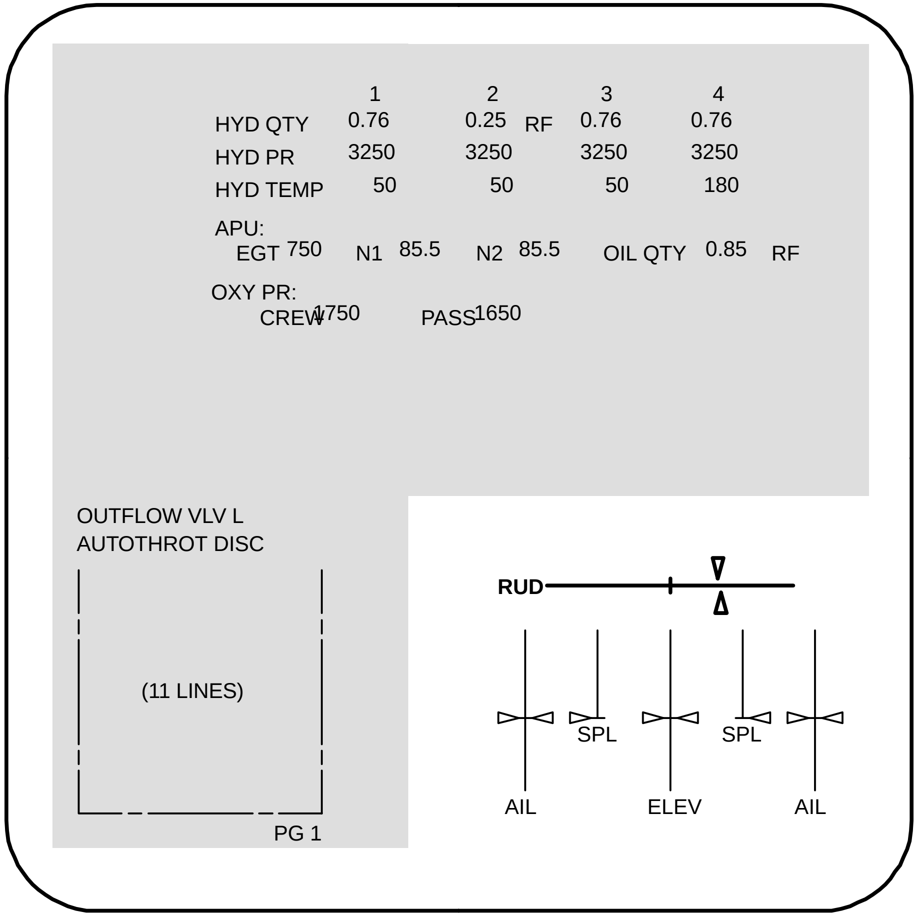
Die Anzeigen der Rudder erfolgt unter der Bezeichnung **RUD** für :

- das Upper Rudder
- das Lower Rudder





MAINTENANCE PAGE
FLIGHT CONTROLS



STATUS PAGE

Figure 67 FLIGHT CONTROL MAINTENANCE PAGE AND STATUS PAGE

BASIC SCHEMATIC DESCRIPTION

CAPTAINS PEDALS

- betätigen über Push Rods, Captain's Yoke und Forward Quadrant das Control Cable.

F/O'S PEDALS

- sind über Push Rods, Co- Pilot's Yoke und Bus Rod mit Captain's Yoke verbunden.

CAPTAINS- AND F/O'S PEDALS

- sind mit Bus Rod verbunden.
- geben über Forward Quadrant, Control Cable und Aft Quadrant Inputs zur Feel-, Centering and Trim Unit.

PEDAL ADJUSTMENT

- dienen zur Verstellung der Pedals
- verstellen die Yokes

CONTROL CABLES

- betätigt über Aft Quadrant und Input Rod die Feel-, Centering and Trim Unit.

FEEL-, CENTERING- AND TRIM UNIT

- erzeugt Gegenkräfte für die Pedals
- verstellt Pedals Auslenkung nach Neutral
- überträgt Trimmbewegung auf das System
- Stops
  - für maximale Pedalbetätigung
  - können justiert werden
- Rig Pin für Rudder Neutral
- Trim Position Switches schalten bei Trim Centering den Trim Actuator ab.

RUDDER TRIM

- erfolgt durch Betätigen vom Trim Switch bzw. vom CTR Push Button. Der Trim Actuator wird angesteuert und verstellt die Feel-, Centering and Trim Unit. Dadurch erfolgt Ansteuerung der Control Modules und das Pedal System wird betätigt.
- Centering Fehler erscheint als EICAS Mess. mit CMC Speicherung.

TRIM ACTUATOR

- stützt Feel-, Centering and Trim Unit ab
- betätigt bei Trim die Push Rods
- wird durch Trim Switch/CTR Push Button angesteuert
- die Position werden durch Internal Position Transmitter auf den Trim Indicator übertragen.

ROLLOUT POWER CONTROL UNITS

- geben bei Autoland während Rollout Inputs zur Feel-, Centering and Trim Unit. Dadurch erfolgt Ansteuerung der Control Modules und das Pedal System wird betätigt.
- Override Mechanism ermöglicht Pedal Override.

RATIO CHANGERS

- verändern Verhältnis von Push Rod Bewegung zu Control Rod Bewegung in Abhängigkeit der Speed.
- werden durch Motors (Linear Actuators) verstellt
- Linear Actuators erhalten Signale von den Stabilizer Trim/Rudder Ratio Modules (SRM's). Bei einem Fehler erfolgt EICAS Mess. mit CMC Speicherung
- Low Speed 32° Rudder Ausschlag
- High Speed ca. 5° Rudder Ausschlag.

CONTROL MODULES

- steuern Hydraulic zu den Actuators
- mit Control Valve Follow Up.
- erhalten über Solenoid- und Transfer Valves Signale vom Yaw Damping System, um Dutch Roll zu verhindern; das Pedal System wird dabei nicht betätigt.

RUDDER ACTUATORS

- betätigen die Rudders.

REFER TO DIN A3 PAGE

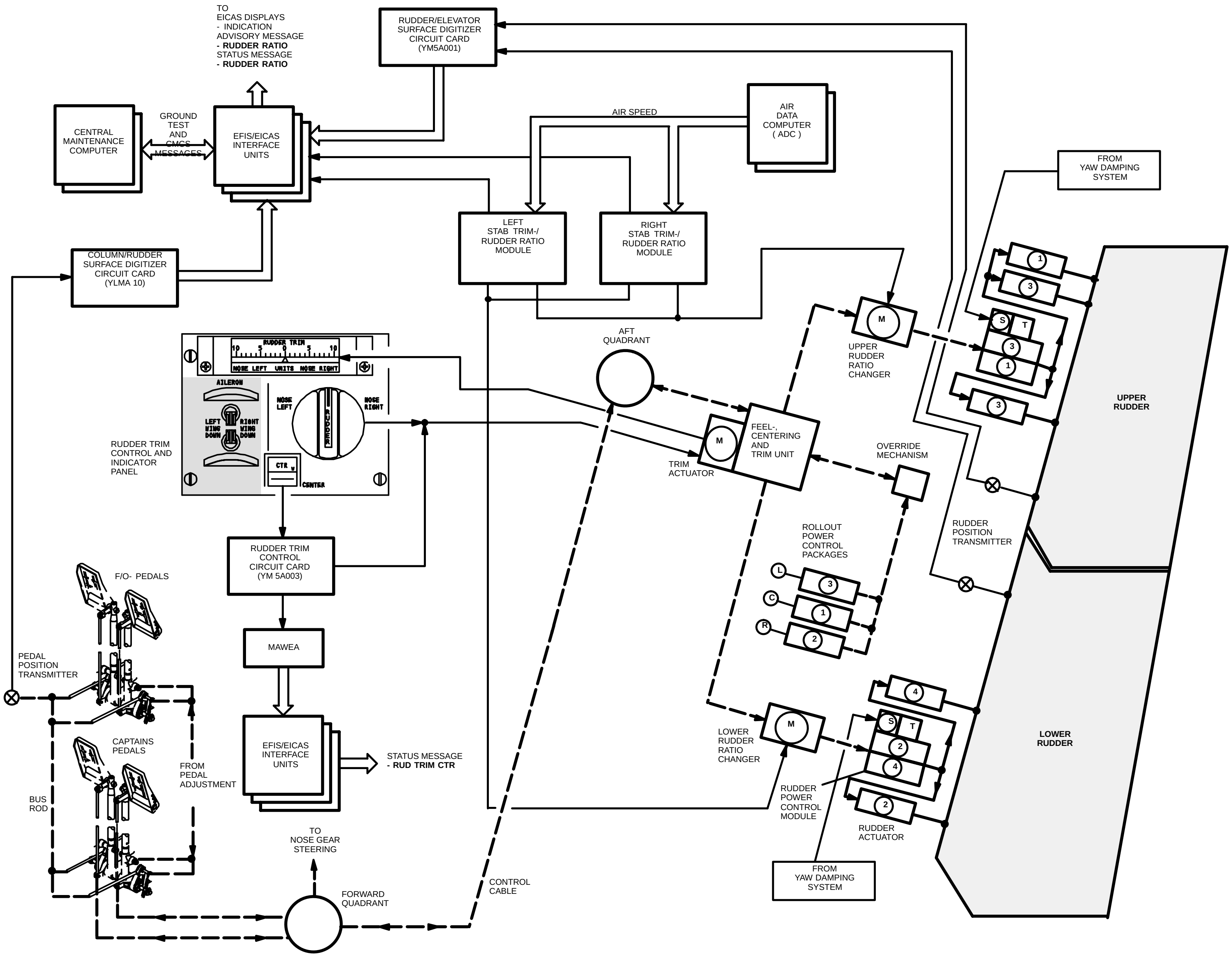


Figure 68 BASIC SCHEMATIC

RUDDER CONTROL SYSTEM SCHEMATIC

FUNCTIONAL DESCRIPTION

Airplane hydraulic systems No. 1, 2, 3 and 4 operate the rudders in response to mechanical, electromechanical, or electrical control inputs. The pilots apply mechanical inputs to either set of rudde pedals; electromechanical inputs through the rudder trim control system; or electrical inputs directly from the autoflight system. The autoflight system provides inputs directly to the upper and lower rudder PCPs.

In the rudder pedal control mode, fore and aft movement of rudder pedals transmits motion to jackshaft yoke of the forward quadrant by means of two pushrods. Rotary motion of jackshaft yoke is passed to the forward quadrant by means of the jackshaft. The forward quadrant transmits motion to the aft quadrant through a pair of cables. Rotation of the aft quadrant in turn causes rotation of the rudder control torque tube in feel and centering mechanism. As the pedals are displaced progressively from neutral, the rudder feel and centering mechanism imparts a progressively increasing centering force to the control system. When pedal force is removed, the centering mechanism returns the pedals and rudder to their neutral position. The feel and centering mechanism translates the fore and aft cable movement into lateral control rod movement to transmit motion to the lower and upper RRCs. The RRC conveys the controlled input to the main control valve linkage on each PCM. The RRC limits the rudder travel by changing the effective length of the output lever arm in proportion to air speed. For a given condition of airspeed and altitude, the servo unit will hold a fixed moment arm for the RRC output crank. Any movement then will be limited to the restrictions imposed by the servo unit.

In the ratio changer control system, the SRM receives variable air data input and sends electrical signals to the servo units in the ratio changer. Mechanical input and output linkages connect the servo unit to the feel and centering unit and to the rudder PCP. Servo unit travel is limited by mechanical stops. Intermediate servo unit positions are related to the air data input so that each position within the stroke corresponds to a specific airspeed. The positional potentiometer provides a signal proportional to the servo unit stroke.

In the rudder trim control mode, rotating the rudder trim control switch provides electrical inputs to the rudder trim actuator. The coordination crank of the feel and centering mechanism is connected to the actuator rod end. Linear movement of actuator rod end, causes the rudder feel and centering mechanism to rotate about its shaft. This provides a new neutral position for pedal and the feel and centering mechanism. This motion is transmitted to the rudders by the feel and centering mechanism control rods and the RRCs to provide the indicated trim.

Stops limit the travel of the rudder pedals at the end of the forward quadrant. There are adjustable stops also at the rig pin bracket in feel and centering mechanism. These stops constrain rudder travel to 32 degrees maximum in either direction. Surface position transmitters connected to rudders provide electrical signals to the aft surface position digitizer circuit card. This is then displayed on EICAS to show relative displacement and position of the rudders.

In manual operation, the lower and upper rudder PCPs function similarly. On each PCP, pressure from both associated hydraulic systems is applied to two separate pressure ports. The lower rudder PCA installation has two hydraulic supplies driving two PCAs from a dual tandem valve. The upper rudder PCA installation has two hydraulic supplies driving three PCAs from a triple tandem valve to give hydraulic isolation. The functions performed by both systems are identical but complete hydraulic isolation is maintained between the two systems.

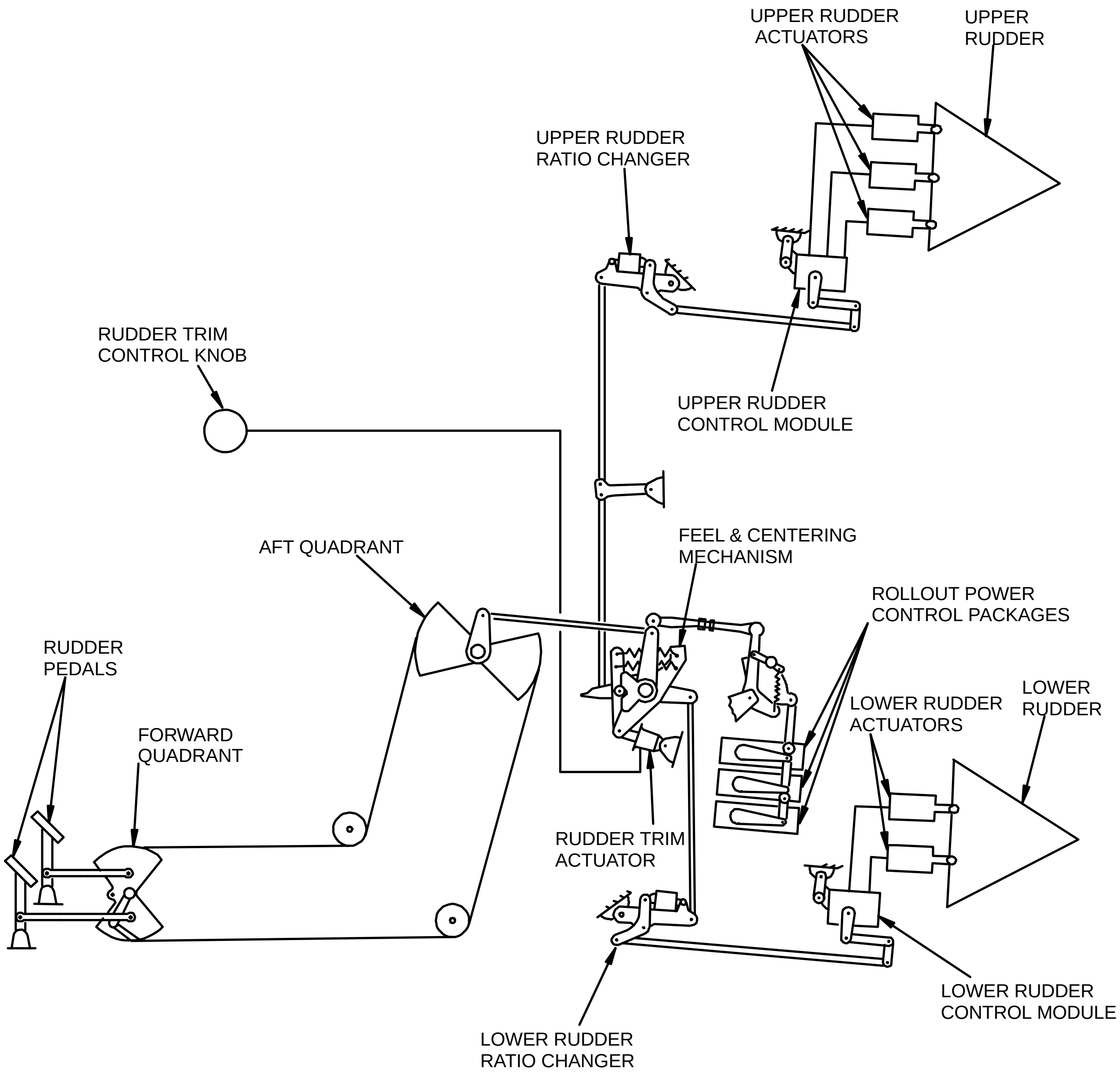


Figure 69 RUDDER CONTROL SYSTEM SCHEMATIC

ROLLOUT- AND YAW DAMPING CONTROL SYSTEM

DESCRIPTION

AUTOPILOT SYSTEM

Drei separate Rollout Power Control Packages (RPCP's) sind mit der Seitenruder- und Bugradsteuerung verbunden. Bei einem automatischen Rollout (nur möglich während A/P Mehrkanalbetrieb), führt der Autopilot das Flugzeug solange, bis dieser ausgeschaltet wird.

Ein Control Rod System überträgt die Kommandos von den RPCP's zu den Rudder Power Control Modules.

Die Pedale bewegen sich mit, und nach dem Aufsetzen des Bugfahrwerks wird die Bugradsteuerung aktiviert.

Mechanisch Camnuts innerhalb der RPCP's gleichen Signaldifferenzen bei Mehrkanalbetrieb aus.

YAW DAMPING SYSTEM

Die Upper- and Lower Yaw Damper Modules liefern ihre Signale für das Yaw Damping, die Turn Coordination und das Structural Modal Suppression auf die Upper- and Lower Rudder Power Control Modules (RPCM's).

Die RPCM's steuern ihrerseits die dazugehörigen Rudder Actuators hydraulisch an.

Eine Rückführung auf die Pedale erfolgt nicht.

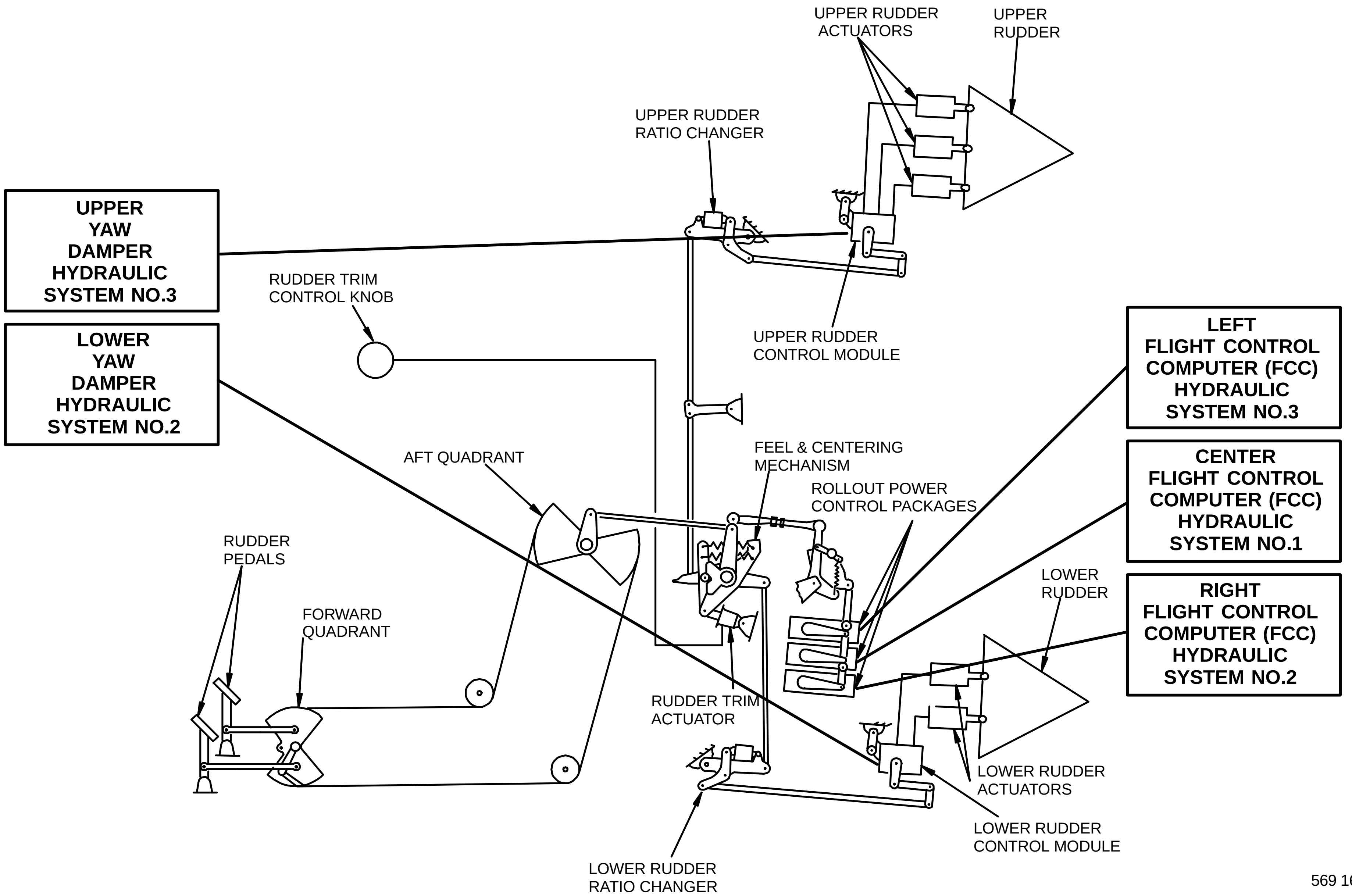


Figure 70 ROLLOUT- AND YAW DAMPING CONTROL SCHEMATIC

RUDDER TRIM CONTROL- AND INDICATOR PANEL

DESCRIPTION

RUDDER TRIM CONTROL COMPONENTS

The rudder trim control mechanism provides a means for controlling the directional trim of the airplane and indicates the units of rudder trim. The control mechanism consists of rudder trim switch and indicator on the aft end of the control stand.

The rudder trim switch is connected electrically to the rudder trim actuator located in the rudder feel and centering mechanism. Rotation of the trim switch sends a signal to the actuator to extend or retract to provide the indicated trim. Available rudder trim travel is 25 degrees in both directions. The indicator scale is divided into 10 divisions in both directions.

DLH 001-199; the rudder trim system also has a PRESS-TO-CENTER switch. This switch sends an electrical signal to the rudder trim control (RTC) card to automatically center the rudder. The switch is overridden if the rudder trim switch is turned during the automatic rudder centering.

FAILURE INDICATION OF THE RUDDER TRIM CONTROL SYSTEM :

For example :

Whenever a fault is detected at the rudder trim control system, on the EICAS display following is indicated :

the status message :

RUD TRIM CTR

and on the MCDU is shown the reason for the EICAS message :

CMC message :

RUDDER TRIM CONTROL SYSTEM FAIL ”PRESS TO CENTER” 27 107.

SUMMARY :

RUDDER TRIM CONTROL KNOB

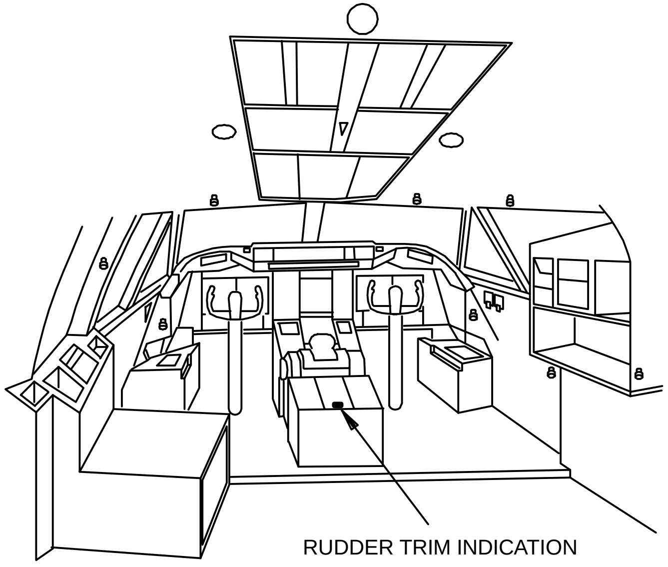
- steuert den Trim Actuator
- Toggle Type Switch
- Maximaler Trimbereich entspricht 25° Rudder Ausschlag

TRIM CTR BUTTON

- steuert den Trim Actuator nach erfolgter Auslenkung in Richtung Rudder NEUTRAL an
- CTR Light leuchtet, solange der Trim Actuator in Richtung Neutral angesteuert ist
- bei Centering Failures erscheint die EICAS Status Mess. **”RUD TRIM CTR”** und Speicherung im CMC

RUDDER TRIM INDICATOR

- zeigt Trim Actuator Positions in Units
- der Rudder Trim Indicator kann auch alleine gewechselt werden, sollte die Indication nicht stimmen, kann über eine Adjustment Srew an dem Indicator-Gehäuse, diese nachgestellt werden (bei ausgebautem Inducator).



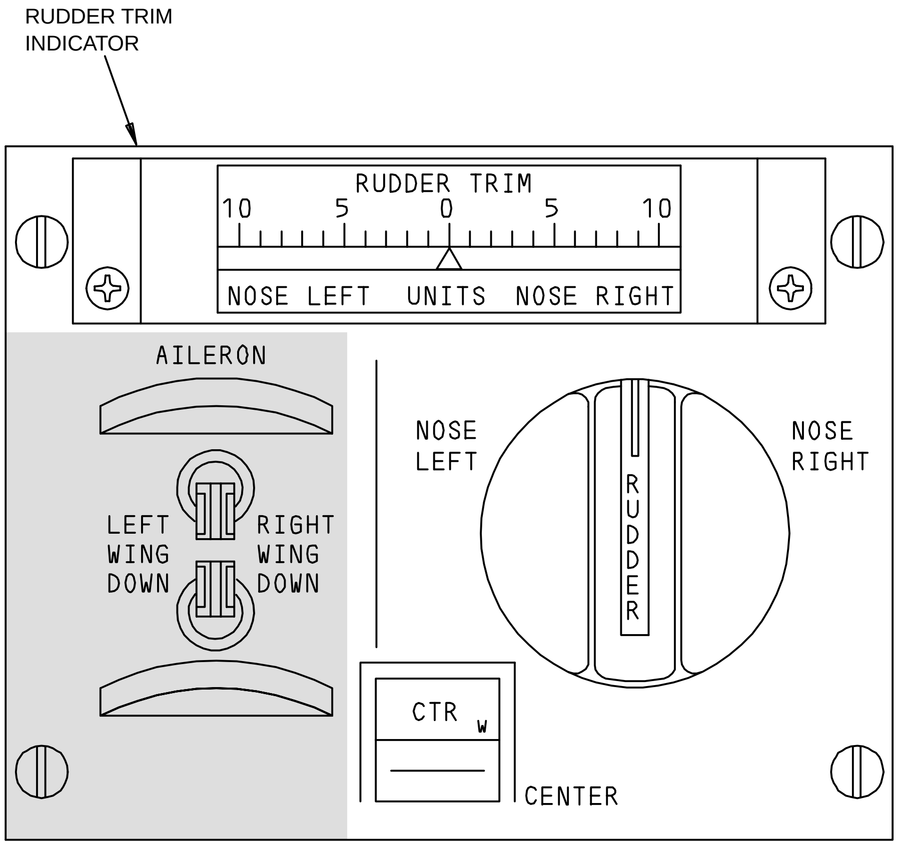


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Figure 71 RUDDER TRIM CONTROL- AND INDICATOR PANEL

RUDDER PEDAL COMPONENTS

DESCRIPTION

RUDDER PEDALS

The captain and first officer are each provided with a pair of rudder pedals for controlling the airplane about its vertical axis. The rudder pedals are located below the captain's and first officer's instrument panel. Each pair of pedals consist of right and left pedals mounted on a shaft. The pedal shaft is attached to the upper end of the pedal arm assembly. The lower end of the pedal arm assembly is mounted on a support shaft which is attached to the structure below the floor. The rudder pedal support and quadrant assemblies are accessible through ceiling panels in the maindeck passenger compartment.

The two sets of rudder pedals are bussed together by means of a bus pushrod connecting the two jackshaft assemblies. Toe pressure on the rudder pedals causes the pedals to rotate about their shafts and initiate braking action.

SUMMARY :

CAPTAINS PEDALS

- betätigen über Push Rods und Quadrant das Control Cable
- Nose Wheel Steering Rod überträgt Pedal Bewegungen zum Nose Wheel Steering System

F/O'S PEDALS

- sind über Push Rods und Bus Rod mit Captain's Quadrant verbunden

MAXIMAL PEDAL DEFLECTION

- entspricht 32° Rudder Ausschlag

RUDDER PEDAL ADJUSTMENT MECHANISM

The two pairs of rudder pedals can be adjusted independently to suit the captain and the first officer by means of the rudder pedal adjustment mechanism. The rudder pedal adjustment mechanism consists of an adjustment crank, adjustment shaft, a jackscrew, and pedal adjustment nut attached to the jackshaft assembly.

The adjustment crank is located on the instrument panel forward of the control wheel. It is connected to a flexshaft routed forward under the instrument panel, then down under the floor, to the rudder control jackshaft assembly. Rotation of the rudder pedal adjustment crank, actuates the jackscrew containing the pedal adjustment nut, which causes the yoke to move fore and aft.

RUDDER FORWARD QUADRANT

The forward quadrant transmits motion from the captain's and first officer's rudder pedals to the rudder control cables. Captain's and first officer's forward quadrants are linked together at the forward end by a bus rod.

SUMMARY :

- Captains und F/O's Pedals sind über eine Bus Rod miteinander verbunden
- von dem Captains Forward Quadrant gehen die Seile zu dem Aft Quadrant

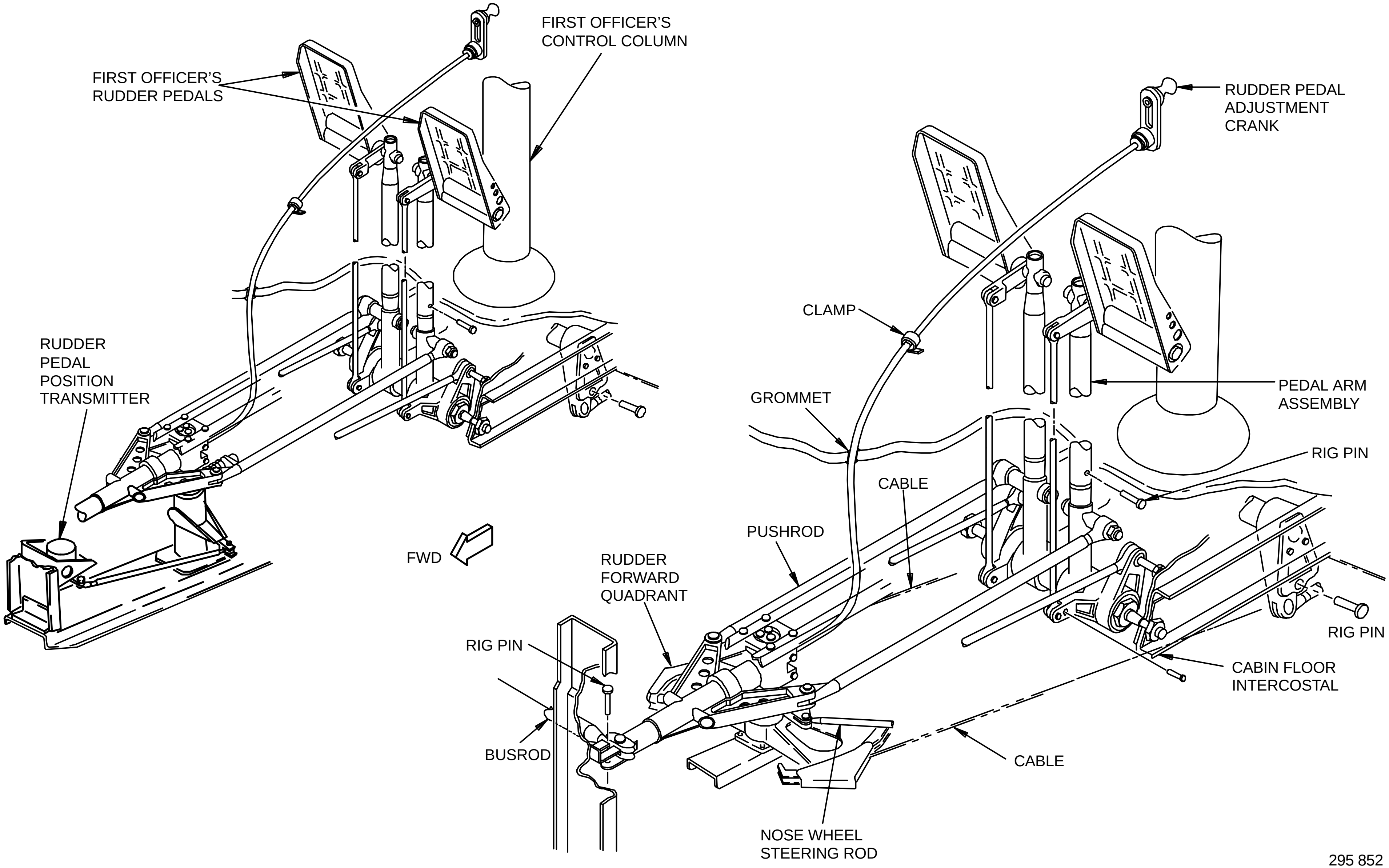

Figure 72 RUDDER PEDAL COMPONENTS

LOWER RUDDER HYDRAULIC FUSES

DESCRIPTION

HYDRAULIC FUSE

A pressure reset - type fuse located on the aft side of the torque box forward bulkhead in section 48, senses flow rate in hydraulic system 4 pressure line upstream of the rudder actuator. The fuse will close to prevent loss of hydraulic fluid in the event of hydraulic line rupture downstream, and thus maintains hydraulic pressure in the system. The fuse automatically resets by spring action once the pressure in the line is equal on both sides of the fuse. The fuse incorporates a time delay to prevent inadvertent fuse setting from pressure surges when the hydraulic system is first activated.

SUMMARY :

- Die Hydraulic Fuse schließt bei einer Hydraulic Leckage in der Lower Rudder Control Module Pressure Line, wenn die Flow Rate > 14 - 16 GPM für > 2 sec ist und wird wieder geöffnet, wenn auf beiden Seiten annähernd der gleiche Druck herrscht.
- Das Check Valve sperrt bei einer Leckage den Hydraulic System No.4 Return Flow ab.

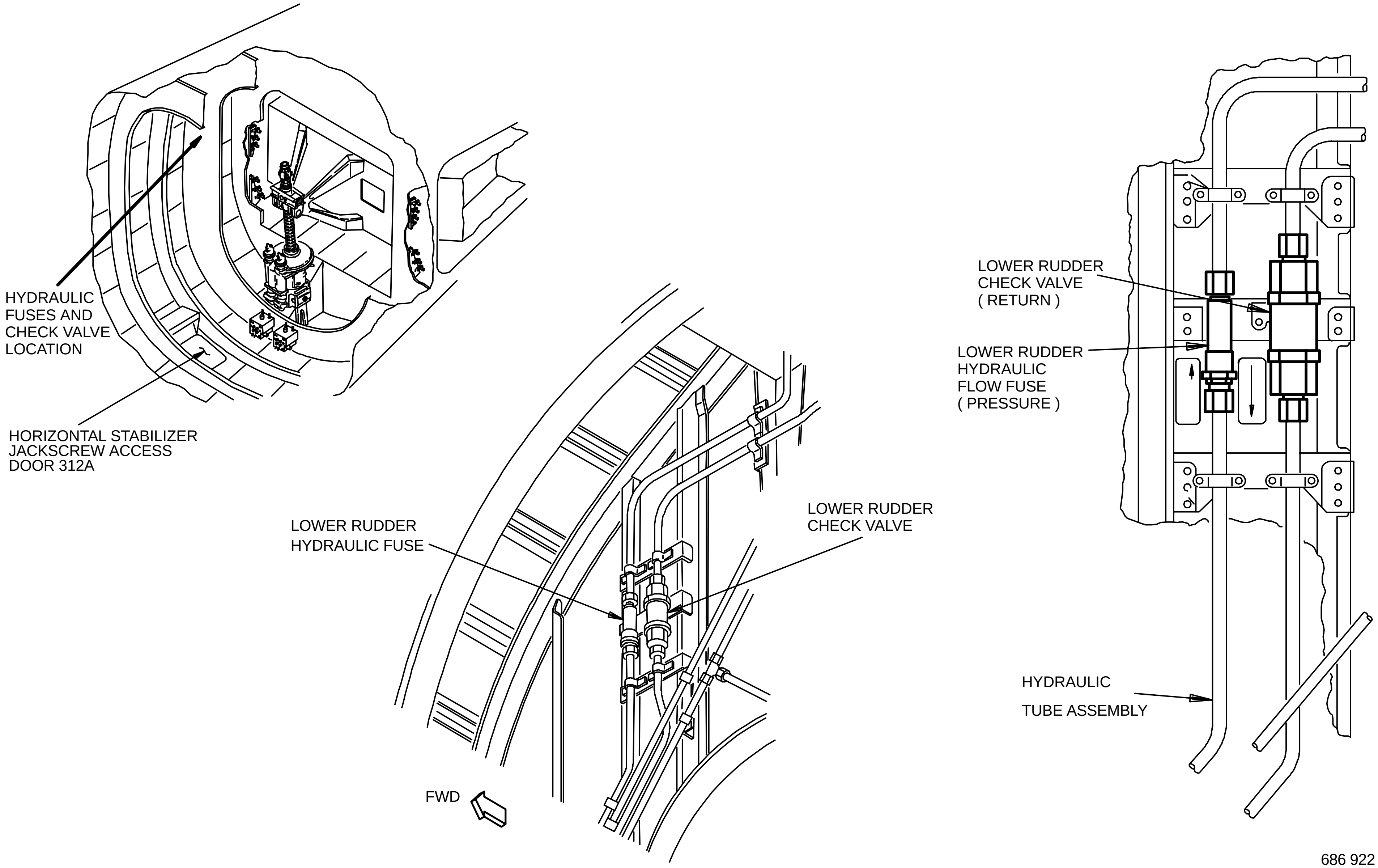

Figure 73 LOWER RUDDER HYDRAULIC FUSES

RUDDER CONTROL SYSTEM COMPONENTS

DESCRIPTION

RUDDER

The rudders are conventional frame structures consisting of aluminium spars and ribs with skins of fiberglass honeycomb construction. The upper and lower rudders are located on the aft side of the vertical stabilizer. Both the upper and lower rudders have no trim tabs and are moved by the triple and dual hydraulic actuators respectively.
The upper and lower rudder are designed for a 31.5 degrees full travel left or right at low speed (below 150 knots) and a 5 degrees maximum travel left or right at high speed (above 450 knots). The lower rudder is attached to the vertical stabilizer by four hinges. The upper rudder is attached with seven hinges. Each of these hinges requires periodic lubrication.

RUDDER AFT CONTROL QUADRANT

The rudder aft control quadrant conveys the motion of the rudder control cables to the feel and centering mechanism. The assembly consists of a quadrant and control crank which are bolted to a shaft. The shaft is mounted horizontally in the vertical stabilizer.

Quadrant shaft rotation transmits motion to the control crank. The control crank pushes or pulls the input rod to the feel and centering mechanism. The centering springs, attached to the rudder centering and feel assembly, positions the quadrant back to the trimmed position when there is no pressure on the rudder pedal.

SUMMARY :

UPPER- AND LOWER RUDDER ACTUATORS CONTROL

- Push Rod Bewegungen gelangen über Ratio Changer, Control Rod, Summing Lever und Control Valve Rod zum Control Module. Durch die Auslenkung vom Control Valve gelangt Hydraulic Pressure zu den Actuators. Der Follow Up wird durch den an der Center Actuator Rod angelenkten Summing Lever über die Control Valve Rod erreicht.

- Bei einer Control Valve Blockierung ist durch einen Internal Override Mechanism die weitere Betätigung des anderen Control Modules möglich. Solenoid Valve, Transfer Valve und Linear Transducer dienen für Yaw Damping Control (Not Shown).

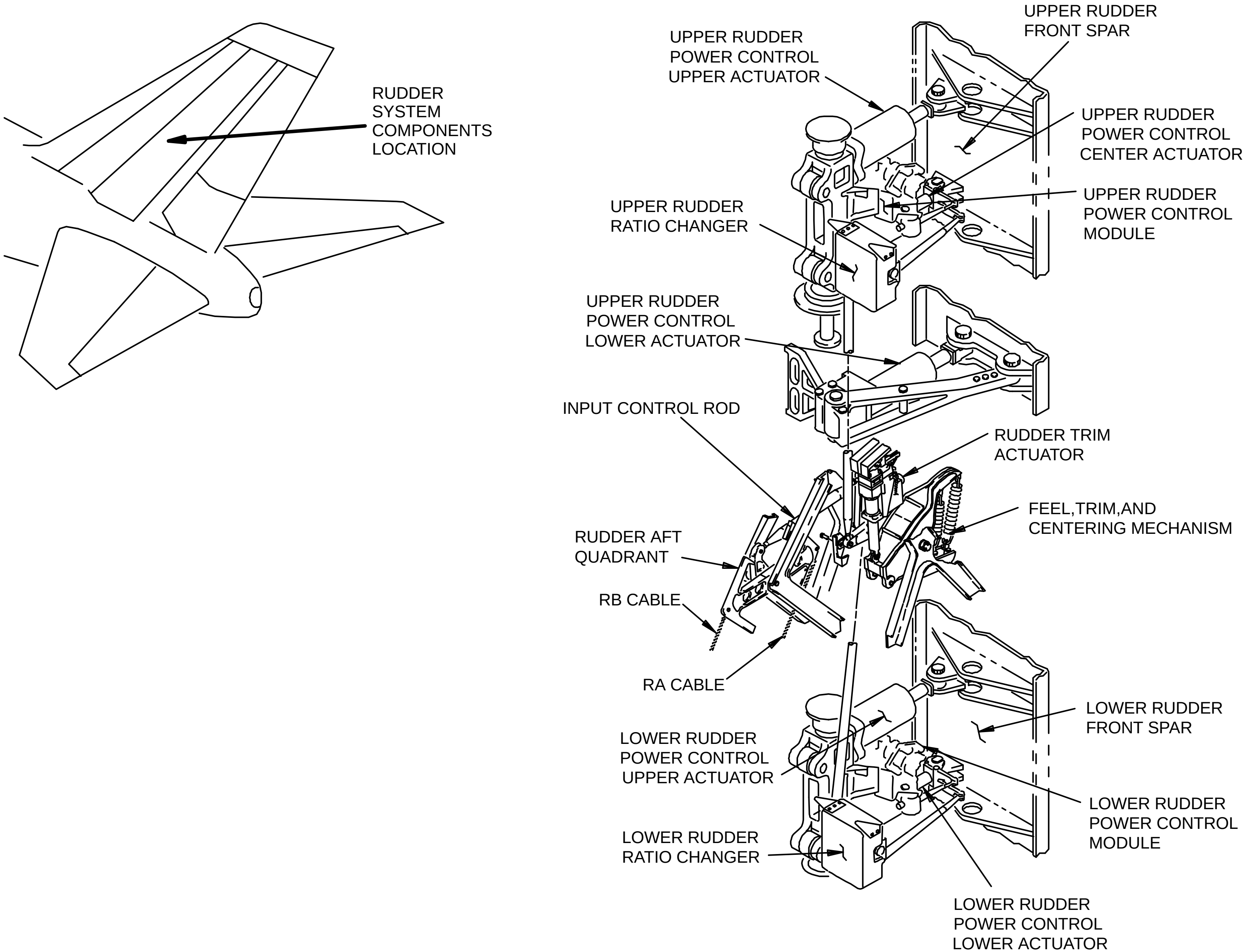

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Figure 74 RUDDER CONTROL SYSTEM COMPONENTS

FEEL-, CENTERING- AND TRIM UNIT COMPONENTS

DESCRIPTION

RUDDER TRIM ACTUATOR

The rudder trim actuator converts electrical inputs into linear force which is applied to the rudder feel and centering mechanism. The actuator and mechanism are installed in the vertical fin. The actuator assembly is connected to the airplane structure and the rod end is connected to the feel and centering mechanism crank assembly.

FEEL- CENTERING MECHANISM

The rudder feel and centering mechanism transfers rudder pedal or rudder trim input through linkage rods to the upper and lower rudder PCMs, through the RRCs. Rudder pedal feel is provided by a centering cam and roller mechanism. The centering and feel assembly consists of a shaft, torque tube, centering cam, input crank, two output cranks, rudder trim coordinating crank, two springs, and cam roller arm. The shaft is connected to the vertical stabilizer structure and the rudder trim coordinator rotates about it. The torque tube, with the input, output, and centering cam attached to it, rotates about the shaft independent of the trim coordinators. The trim coordination crank and cam-roller arm are attached. The cam roller is spring-held to ride on the centering cam providing a pedal feel force. The rudder trim coordination crank is normally held stationary by the trim actuator.

SUMMARY :

FEEL-, CENTERING- AND TRIM UNIT

- Pedal Bewegung gelangt über Aft Quadrant und Input Rod auf die Unit
- Output Crank
  - Stops (adjustable) für maximale Pedalbewegung
  - Rig Pin für Pedal Neutral
- Trim Actuator verstellt Unit
- Push Rods übertragen Pedal- bzw. Trim Signale zu den Control Module Control Valves
- Trim Position Switches
  - dienen für Trim Centering
  - werden durch Cam betätigt

RUDDER TRIM CONTROL COMPONENTS

The rudder trim control mechanism provides a means for controlling the directional trim of the airplane and indicates the units of rudder trim. The control mechanism consists of rudder trim switch and indicator on the aft end of the control stand.

The rudder trim switch is connected electrically to the rudder trim actuator located in the rudder feel and centering mechanism. Rotation of the trim switch sends a signal to the actuator to extend or retract to provide the indicated trim. Available rudder trim travel is 25 degrees in both directions. The indicator scale is divided into 10 divisions in both directions.

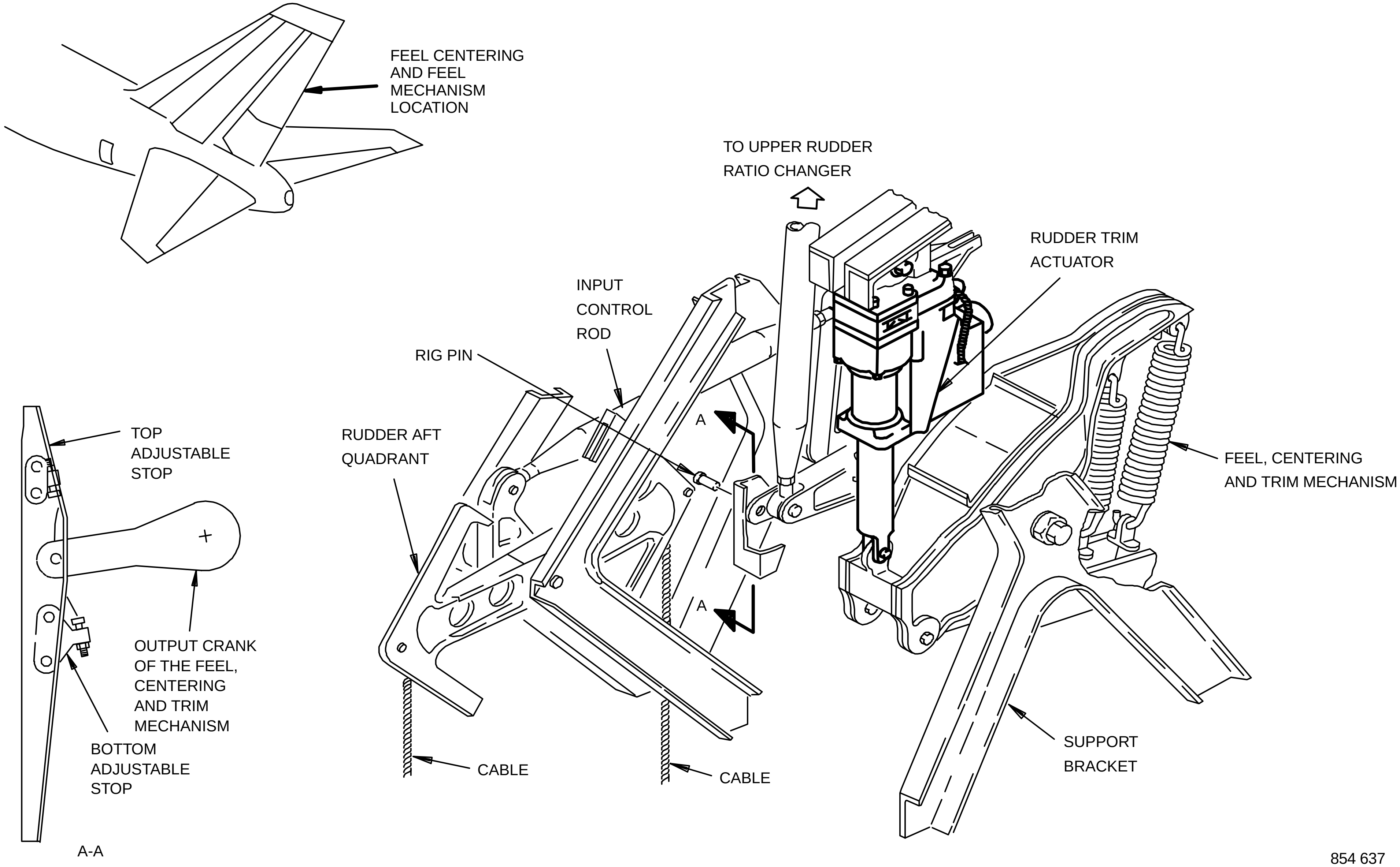


Figure 75 FEEL-, CENTERING- AND TRIM UNIT COMPONENTS

RUDDER TRIM SWITCH PACK COMPONENTS

DESCRIPTION

DLH 001-199; the rudder trim system also has a PRESS-TO-CENTER switch. This switch sends an electrical signal to the rudder trim control (RTC) card to automatically center the rudder.

The switch is overridden if the rudder trim switch is turned during the automatic rudder centering.

RUDDER TRIM CENTERING POSITION SWITCHES

A rudder control switch pack assembly is connected to the feel-, trim- and centering mechanism. Extension and retraction of the rudder trim actuator pivots the feel-, trim- and centering mechanism which opens one of the two switches in the pack assembly through a control rod and cam.

With the trim actuator centered neither switch is operated by the cam and both switches are closed

FAILURE INDICATION OF THE RUDDER TRIM SWITCH PACK ASSEMBLY:

For example :

Whenever a fault is detected at the rudder trim centering system, on the EICAS display following is indicated :

the status message :

RUD TRIM CTR

and on the MCDU is shown the reason for the EICAS message :

CMC message :

RUDDER TRIM CENTER SYSTEM FAIL 27 969.

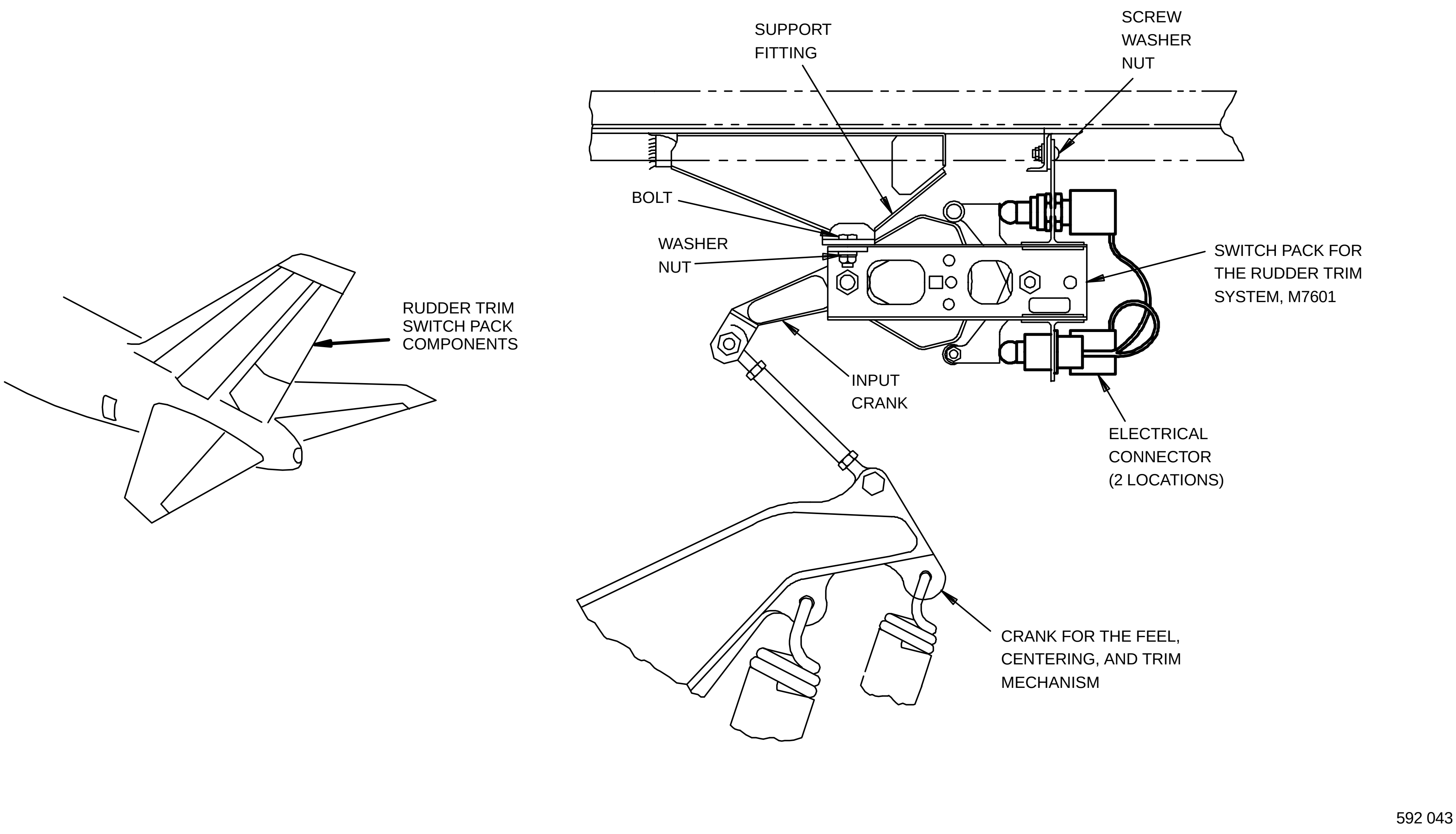


Figure 76 RUDDER TRIM SWITCH PACK COMPONENTS

RUDDER TRIM ELECTRICAL SCHEMATIC

DESCRIPTION

Durch Betätigen vom Trim Switch wird über das abgefallenen Control Relay der Trim Actuator angesteuert.

Der Input in die Control Card dient für Control Relay deenergized.

Nach Verlassen der Rudder Trim Null Position schaltet der jeweilige Trim Position Switch nach Open. Dadurch ist die Control Card für Centering armiert.

Die Trim Actuator Position wird mittels RVDT auf den Indicator übertragen.

Durch Betätigen vom Trim CTR Switch steuert die Control Card das Control Relay und den Trim Actuator in Richtung Centering an und das CTR Light leuchtet. Die Null Position ist dann erreicht, wenn der betreffende Position Switch Not Open meldet, d.h. der Trim Actuator wird stromlos, das Control Relay fällt ab und das CTR Light verlöscht.

Der RUDDER TRIM CENTER - Switch wird übersteuert, wenn der RUDDER TRIM KNOB betätigt wird, d.h.

- **1. Priorität : RUDDER TRIM KNOB**
- **2. Priorität : RUDDER TRIM CENTER Switch.**

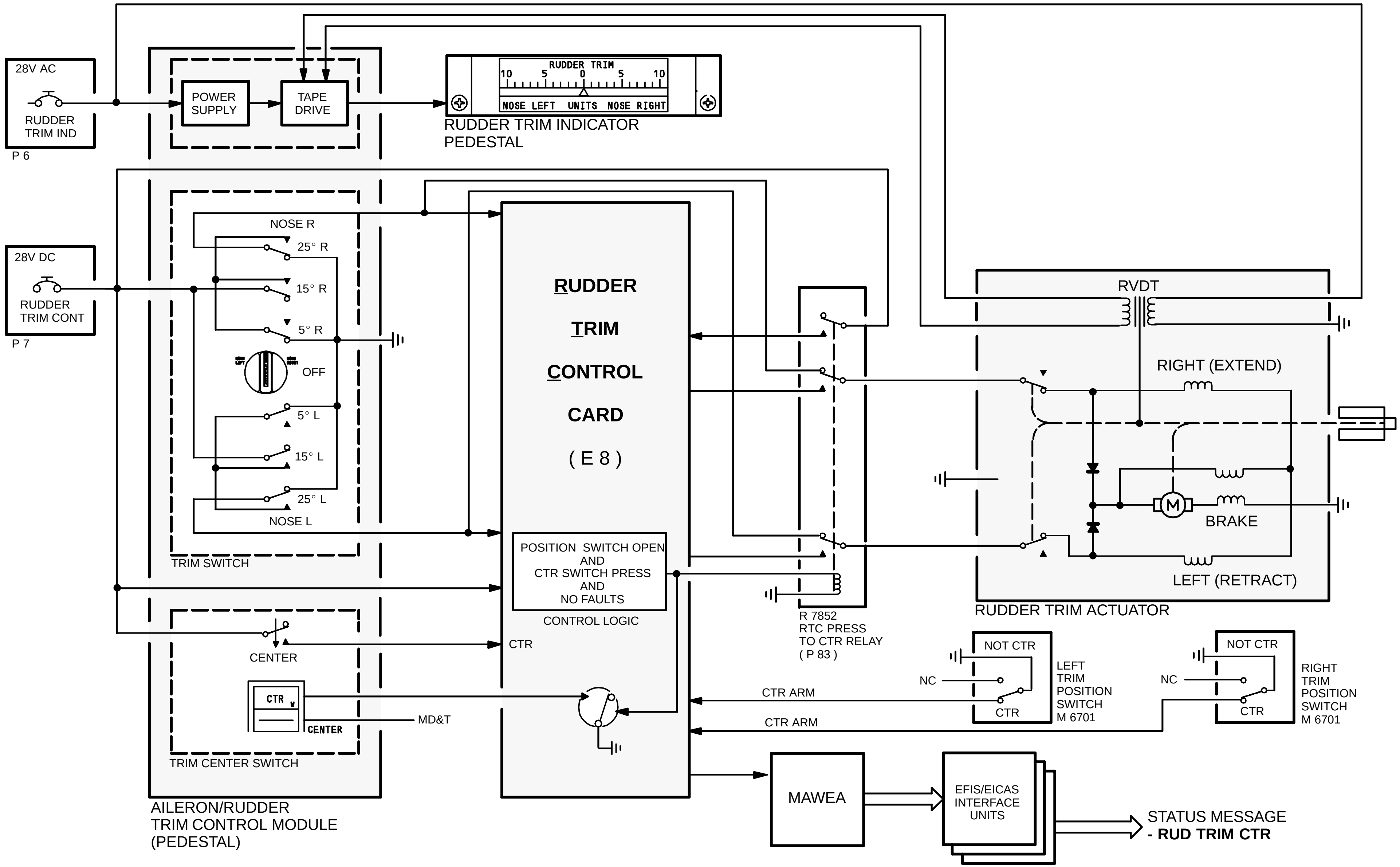


Figure 77 RUDDER TRIM ELECTRICAL SCHEMATIC

ROLLOUT POWER CONTROL PACKAGE (RPCP)

DESCRIPTION

ADJUSTABLE ROD
- überträgt PCU Outputs zur Feel-, Centering and Trim Unit

OVERRIDE MECHANISM
- ermöglicht Pedal Control bei Auto Rollout On oder bei blockierten PCU's.

ARM SOLENOID VALVE
- schaltet Hydraulic On - Off
- bekommt Engage Signal bei ca. 1150 ft

ELECTROHYDRAULIC SERVOVALVE (EHSV)
- wird vom Solenoid Valve A hydraulisch versorgt
- bekommt Signals vom Autopilot System
- steuert PCU Actuator

ENGAGE SOLENOID VALVE
- schaltet Hydraulic zu einem Internal Engage Mechanism für Output
- bekommt Engage Signal bei ca. 5 ft

LVDT's
- übertragen Feedback Signals zum Autopilot System.

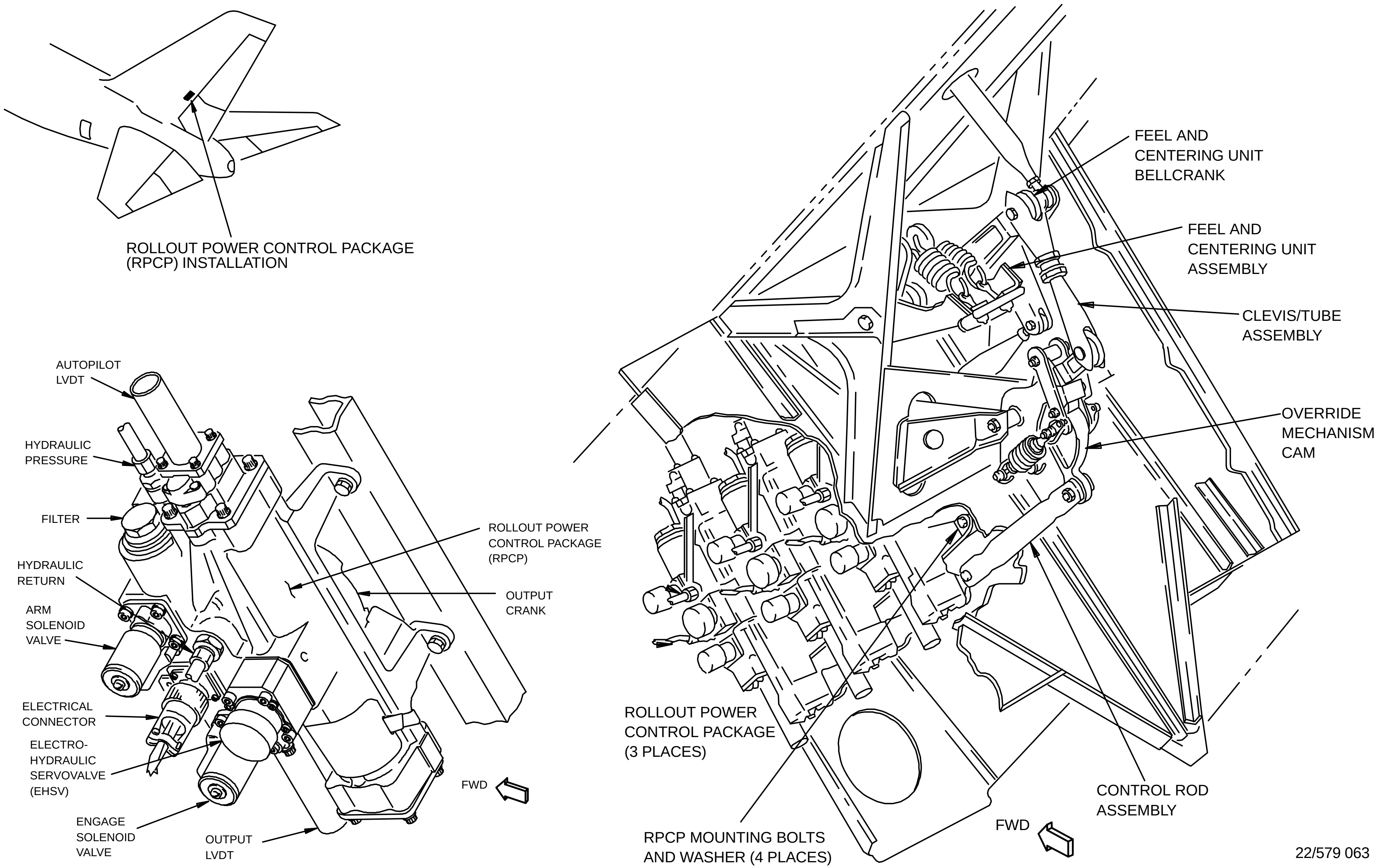


Figure 78 ROLLOUT POWER CONTROL PACKAGE (RPCP)

RATIO CHANGER ACTUATORS

DESCRIPTION

The upper and lower rudder ratio changer systems are each composed of two separate units, SRM in the E/E rack and a servo unit, interconnected electrically to form an electromechanical closed servo loop. Each servo unit contains a jackscrew, a gear train, an electric motor and two positional potentiometers.

Both ratio changer control systems are installed in the vertical fin close to their associated PCP. The RRC control system consists of an input crank, a trunnion, output crank, and a servo unit. The input crank is fixed to the trunnion. The trunnion is mounted with bearings in brackets attached to the fin. The bearings serve as axis of rotation for input and output of the ratio changer. The output crank is mounted in a yoke of the trunnion. The mounting in the yoke of the trunnion permits movement of the output crank for changing the effective moment arm to the lever leading to the main valve of the PCP. The output crank has two arms. One arm connects by a swivel joint to the servo unit and the other arm connects by a linkage to the summing lever on the PCM.

The servo unit receives electrical inputs from the stabilizer trim/rudder ratio module (SRM) to produce changes in the overall length of the servo unit through the electric actuator. The change in length is proportional to the airspeed input (Vc) at the SRM module. The electrical inputs from the SRM limit rudder travel from 31.5 degrees with no load, to approximately 7 degrees above 367 knots.

FAILURE INDICATION OF A COMPONENT OF THE RUDDER RATIO CHANGER SYSTEM

For example :

Whenever a fault is detected for the rudder ratio changer system the advisory massage

RUD RATIO SNGL

or

advisory massage

RUD RATIO DUAL

status message :

RUDDER RATIO 27 20 04 00

appears

and on the MCDU is shown the reason for the EICAS message

CMC message :

UPR RUDDER RATIO CHANGER 115 VAC FAIL (SRM-R) 27 312

or

UPR RUDDER RATIO ACTUATOR FEEDBACK FAIL (SRM-R) 27 308.

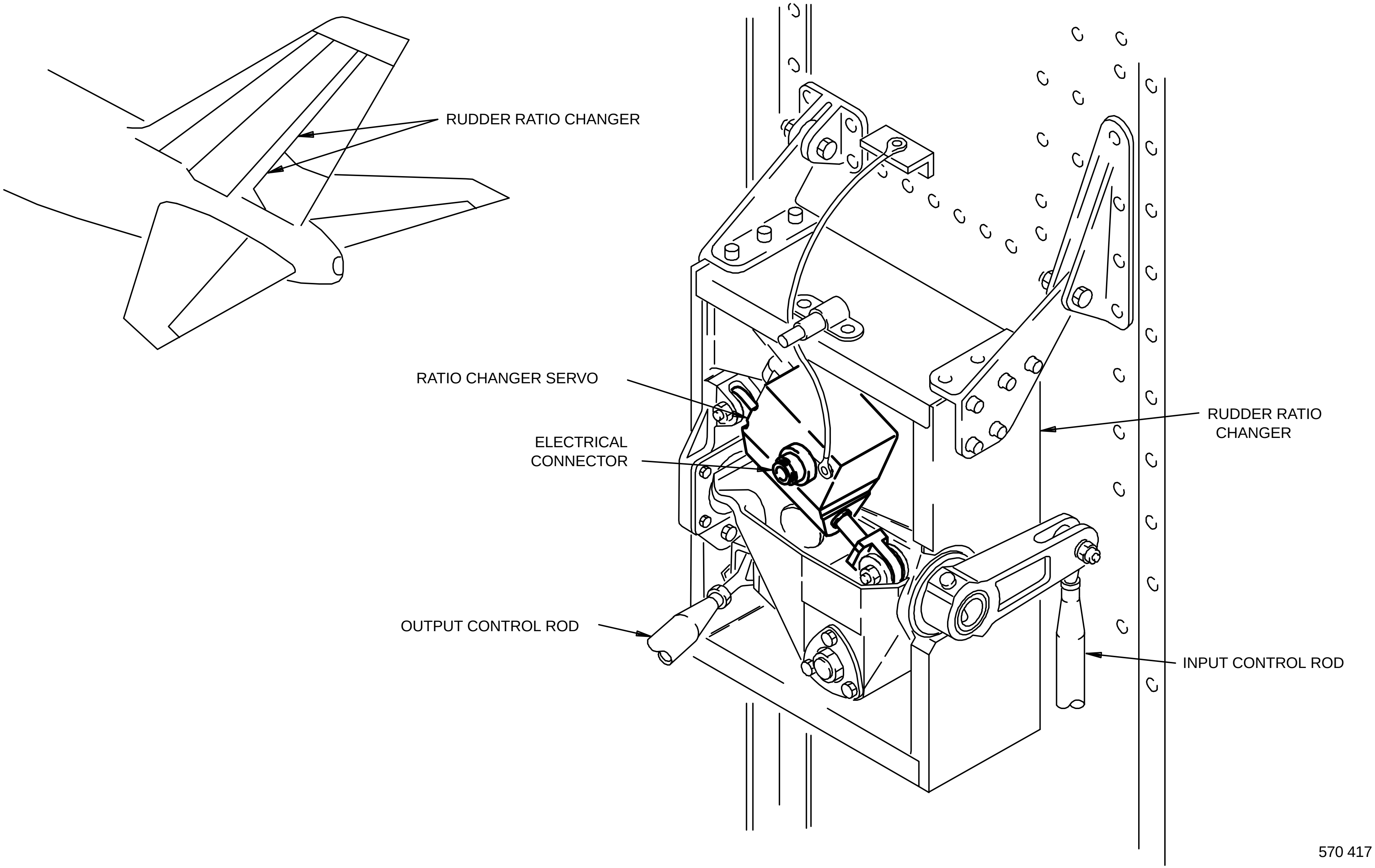


Figure 79 RATIO CHANGER ACTUATORS

RUDDER RATIO CHANGER ACTUATOR OPERATION

DESCRIPTION

LOW SPEED POSITION

Kleiner 150KTS erfolgt kein Eingriff durch das Rudder Ratio Changer System auf die das Rudder System.

MODULATION POSITIONS

Zwischen 150 KTS und 450 KTS werden die Ratio Changer Actuators so von der aktiven SRM angesteuert, daß der Pedalausschlag durch die Rudder Ratio Changer proportional verändert wird, daß mit zunehmender Fluggeschwindigkeit, der Rudderausschlag verkleinert wird.

HIGH SPEED POSITION

Über 450KTS ist die maximale Begrenzung erreicht, d.h. bei maximalen Pedalausschlag werden die Rudder nur noch 5° ausgeschlagen, bei maximaler Trim Betätigung nur noch 80% von dem maximaler Pedalausschlag (ca. 25°).

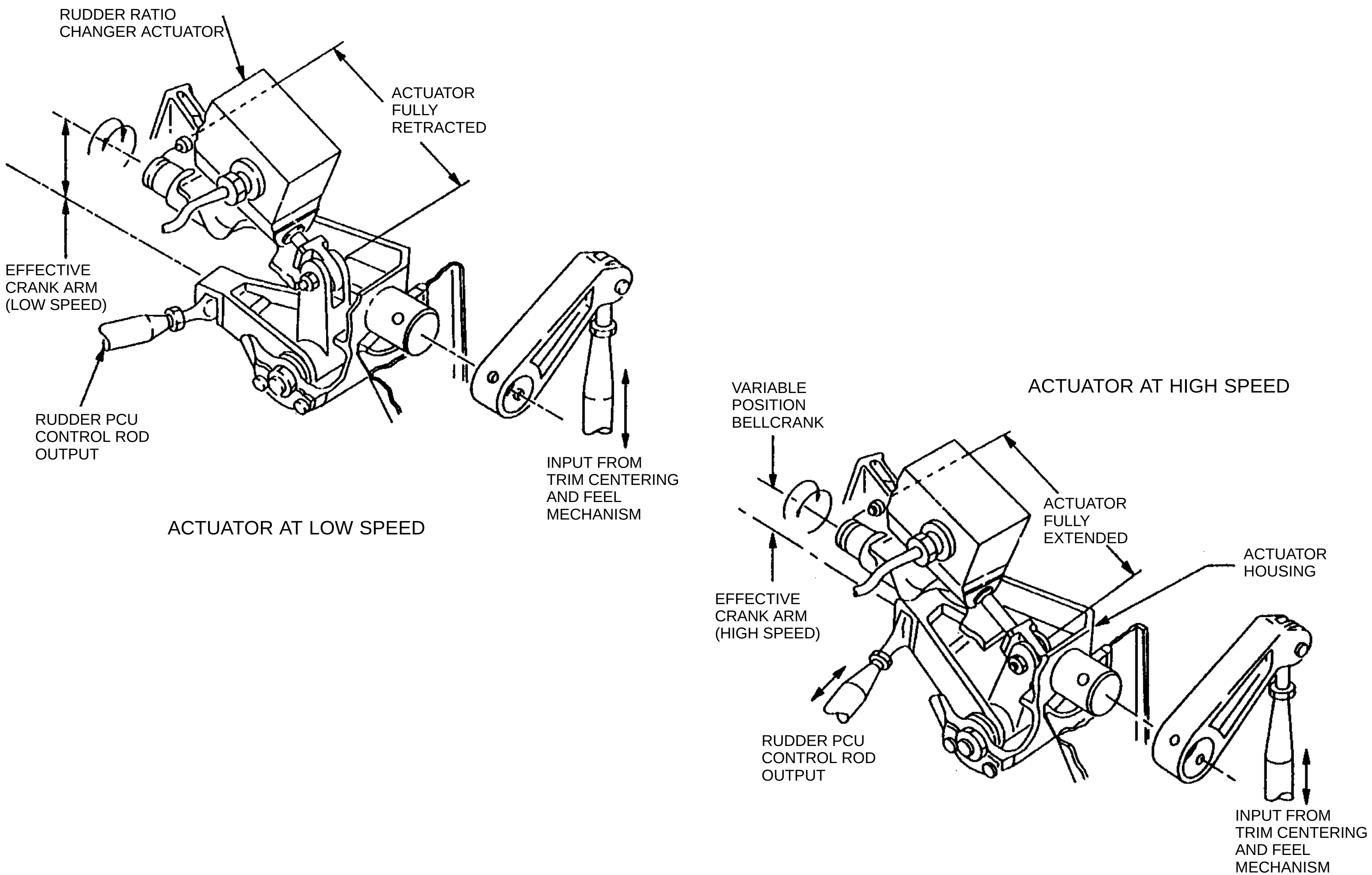


Figure 80 RUDDER RATIO CHANGER OPERATION

RUDDER RATIO CHANGER SYSTEM

FUNCTIONAL DESCRIPTION

Beide Stab. Trim/Rudder Ratio Modules (SRM's) sind so auf die Rudder Ratio Changer Actuators geschaltet, daß bei Ausfall von einem Module das andere die Ansteuerung beider Actuators weiterhin durchführen kann.

Das Rudder Ratio Changer System begrenzt den Rudderausschlag bei Betätigung durch die Pedals und durch den Trim Actuator.

Kleiner 150KTS erfolgt kein Eingriff durch das Rudder Ratio Changer System auf die das Rudder System.

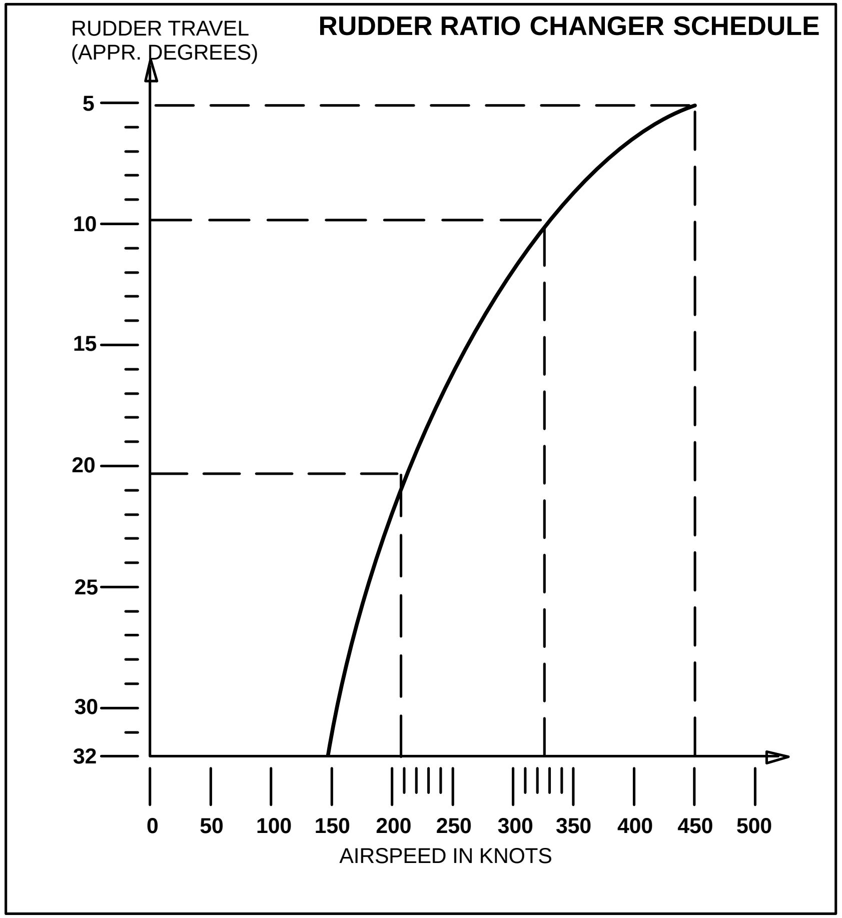
Zwischen 150 KTS und 450 KTS werden die Ratio Changer Actuators so von der aktiven SRM angesteuert, daß der Pedalausschlag durch die Rudder Ratio Changer proportional verändert wird, daß mit zunehmender Fluggeschwindigkeit, der Rudderausschlag verkleinert wird (siehe Tabelle).

Über 450KTS ist die maximale Begrenzung erreicht, d.h. bei maximalen Pedalausschlag werden die Rudder nur noch 5° ausgeschlagen, bei maximaler Trim Betätigung nur noch 80% von dem maximaler Pedalausschlag (ca. 25°).

Fällt während des Betriebes z.B. im Reiseflug der gesamte Air Speed Input (DADC) weg, so wird der Upper Ratio Changer Actuator in die 329 KTS Position und der Lower Ratio Changer Actuator in die 209 KTS Position angesteuert. Daraus ergeben sich unterschiedliche Rudder Ausschläge (siehe Tabelle).

Fällt während Autoland der gesamte Air Speed Input (DADC) weg, dann erfolgt für beide Ratio Changer Actuators die Low Speed (0 KTS) Ansteuerung (max. Rudder Travel).

Bei einer Actuator Rod Differenz von 0.01 " bzw. bei einem System Fehler in dem Rudder Ratio Changer System erfolgen EICAS Messages und im CMC werden die Fehler gespeichert.



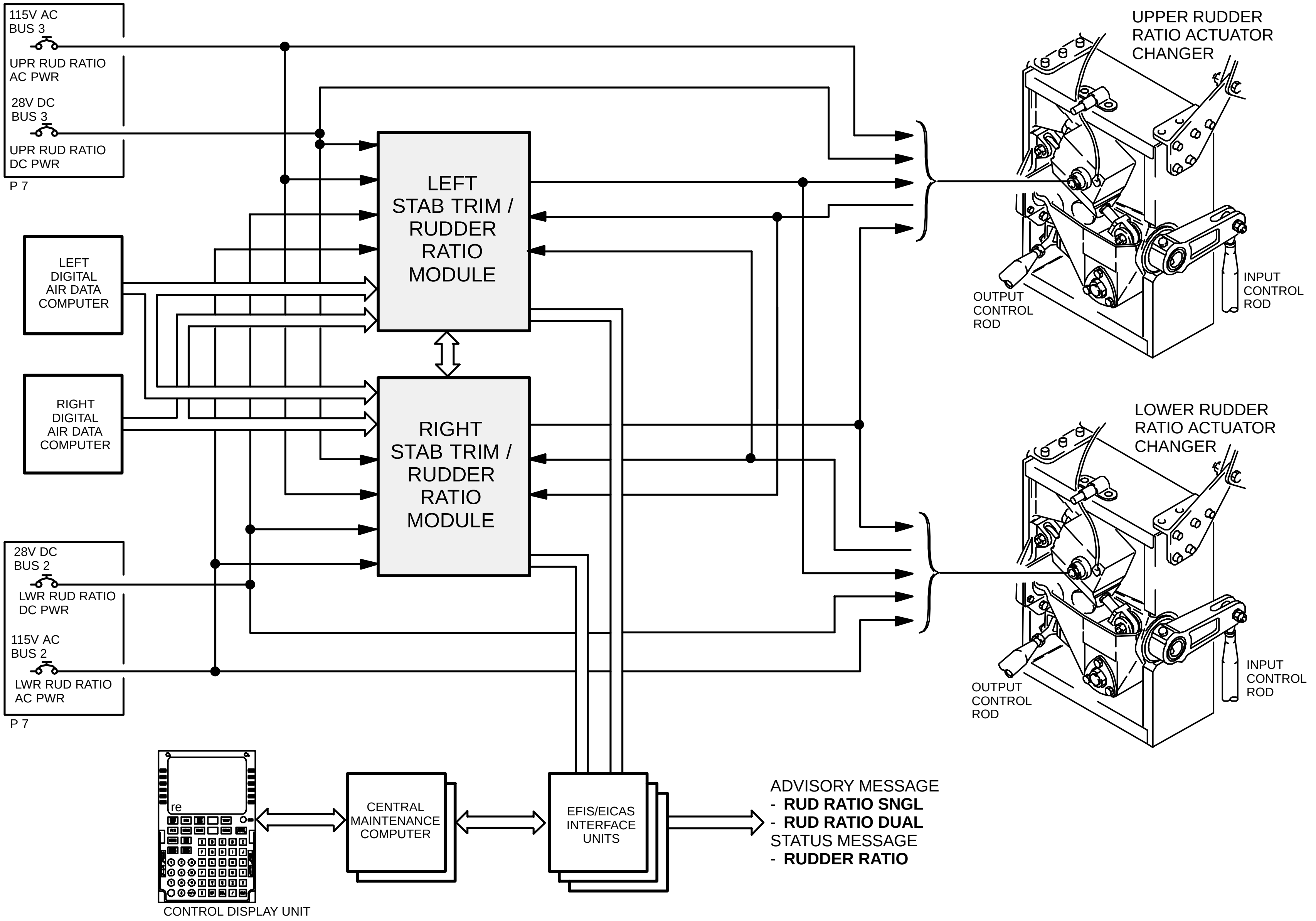


Figure 81 RUDDER RATIO CHANGER SYSTEM SCHEMATIC

GROUND TEST - RUDDER RATIO CHANGER ACTUATORS

GENERAL

(1) These are a test of the BITE functions of the rudder ratio changer. Use one of the two subsequent procedures to do a check for existing faults in the rudder ratio changer system.

REFERENCES

(1) 24-22-00/201, Manual Control

ACCESS

(1) Location Zone

221Control Cabin, LH

222Control Cabin, RH

NOTE: Use one of the subsequent procedures to do a check for the existing faults in the rudder ratio changer system.

PROCEDURE 1: (Airplanes with two SRM's P/N 285U0015-108 or later)
Prepare for the Test

(1) Supply electrical power (Ref 24-22-00/201).

(2) Set the GND TEST switch on the overhead maintenance panel, P461, to the ENABLE position.

(3) Open and close these circuit breakers on the P7 panel:

NOTE: This is to make sure that the left SRM controls the actuators.

(a) FLT CONT ELEC 2RAC (C10265)

(b) FLT CONT ELEC 2RDC (C10266)

(4) Prepare the CDU for the test:

(a) Push the MENU key on the CDU to show the MENU.

(b) Push the line select key (LSK) that is adjacent to **<CMC** to show the CMC MENU.

(c) If <RETURN shows after you push the LSK, push the LSK that is adjacent to <RETURN until you see the CMC MENU.

(d) Push the LSK that is adjacent to **<GROUND TESTS** to show the GROUND TESTS menu.

(e) Push the NEXT PAGE key until you find <27 RUDDER RATIO.

(f) Push the LSK that is adjacent to **<27 RUDDER RATIO** to show the GROUND TESTS menu for the rudder ratio changer.

(g) Find the **<RUD RATIO ACTR** prompt.

NOTE: If INHIBITED shows above <RUD RATIO ACTR, the test will not operate.

(h) If INHIBITED shows above <RUD RATIO ACTR:

1) Push the LSK that is adjacent to the test prompt.

2) Do the steps shown on the CDU.

3) Push the LSK that is adjacent to <RETURN to show the ground test menu again.

RUDDER RATIO CHANGER GROUND TEST

(1) Push the LSK that is adjacent to the <RUD RATIO ACTR prompt.

(a) When the TEST PRECONDITIONS page shows, make sure each instruction on the page is completed. (Push the NEXT PAGE key to see the subsequent pages.)

WARNING: MAKE SURE THAT PERSONS AND EQUIPMENT ARE CLEAR OF THE RUDDER, AILERONS AND THE TRAILING EDGE FLAPS. THE RUDDER AND AILERONS CAN MOVE DURING THIS TEST IF HYDRAULIC POWER IS SUPPLIED. THE TRAILING EDGE FLAPS CAN ALSO MOVE AUTOMATICALLY DURING THE TEST. THIS CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

(b) Push the LSK that is adjacent to **START TEST>**.

NOTE: IN PROGRESS shows during the test.

(2) When IN PROGRESS goes out of view, look for **PASS or FAIL**> adjacent to <RUD RATIO ACTR.

NOTE: If a PASS indication shows, no failures occurred during the test.

(a) If FAIL> shows:

1) Push the LSK that is adjacent to FAIL> to see the GROUND TEST MSG pages for the failure.

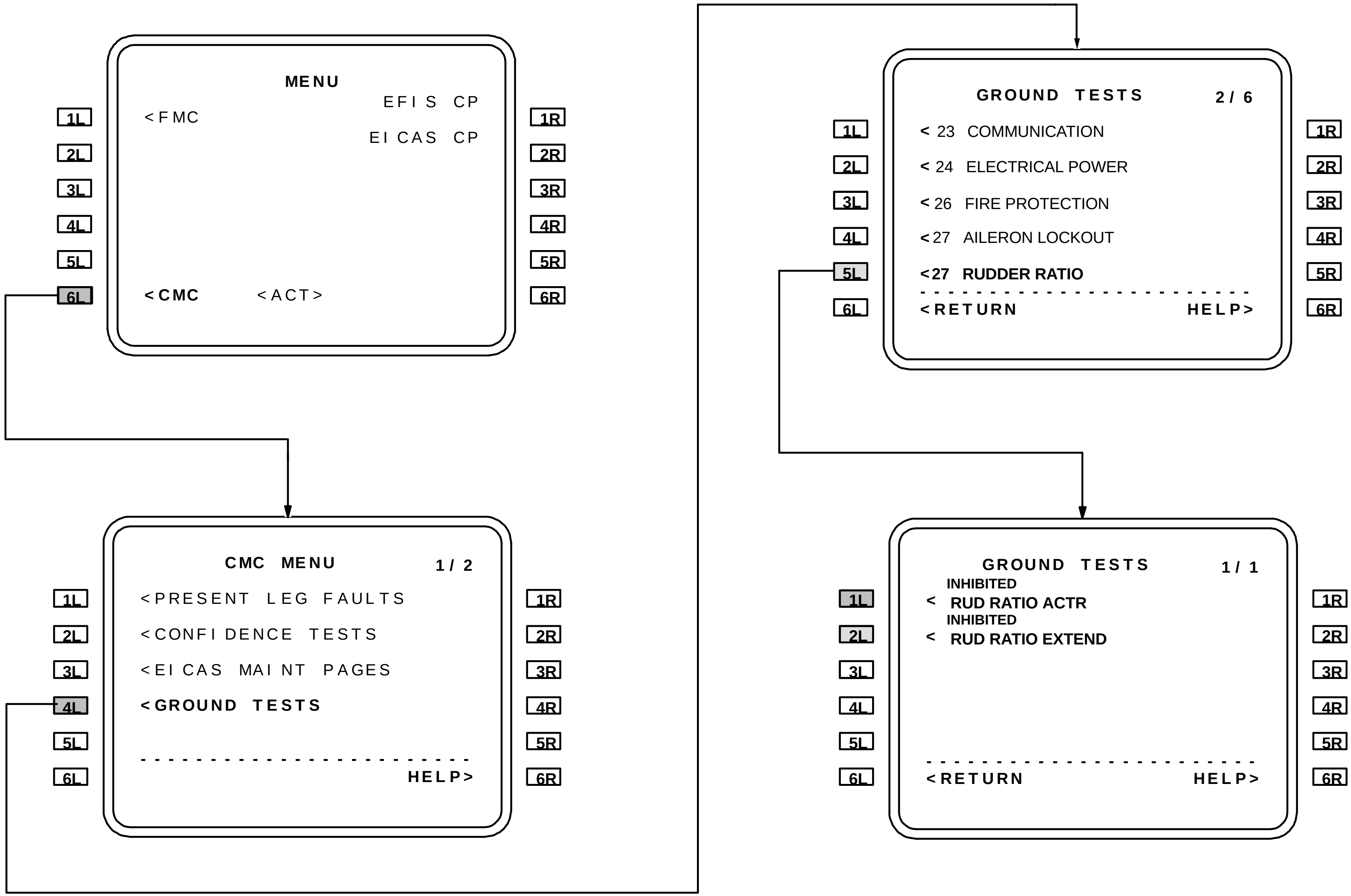


Figure 82 RUDDER RATIO ACTUATORS GROUND TEST

2) Push the NEXT PAGE key until you find all the GROUND TEST MSG pages.

3) Make a list of all CMCS messages, CMCS message numbers, and ATA numbers that show on the GROUND TEST MSG pages.

4) Open and close these circuit breakers on the P7 panel:

NOTE: This is to make sure the right SRM controls the actuators.

a) FLT CONT ELEC 2L AC (C10263)

b) FLT CONT ELEC 2LDC (C10264)

c) FLT CONT ELEC 1LAC (C8782)

d) FLT CONT ELEC 1LDC (C8783)

5) Do the rudder ratio ground test a second time.

NOTE: Do not open and close the FLT CONT ELEC 2RAC and the FLT CONT ELEC 2RDC circuit breakers when you do the rudder ratio ground test a second time.

6) Go to the CMCS message index of the Fault Isolation Manual (FIM) to find the corrective action for each CMCS message.

NOTE: For CMC messages 27110, 27111, 27210 and 27211, the information that follows applies: If both SRM's show a failed actuator, use the FIM corrective action. However, if only one SRM shows a failed actuator, repair the rudder ratio command wiring from that SRM to the actuator.

Procedure 2:
(Airplanes with any combination of SRM part numbers installed)

(1) Supply electrical power (Ref 24-22-00/201).

(2) Look for existing faults in the rudder ratio changer system (Ref 45-27-00/201).

(a) Select <EXISTING FAULTS from the CMC main menu.

(b) Select <27 RUDDER RATIO from the existing faults menu.

(c) Make sure that there are no existing faults on the CDU.

(d) Select <27 STABILIZER TRIM from the existing faults menu.

NOTE: If 27 RUDDER RATIO AND 27 STABILIZER TRIM do not come into view, there are no existing faults with the rudder ratio changer system.

(e) Make surethat these messages do not show on the CDU:

1) SRM-L FAIL (SRM-L)
2) SRM-R FAIL (SRM-L)
3) SRM-R > SRM-L DATA FAIL
4) SRM-R > SRM-L BUS FAIL
5) ADC-C > SRM-L DATA FAIL
6) SRM-L FAIL or ADC-C > SRM-L BUS FAIL
7) ADC-L > SRM-L DATA FAIL
8) SRM-L FAIL or ADC-L > SRM-L BUS FAIL
9) ADC-R > SRM-L DATA FAIL
10) SRM-L FAIL or ADC-R > SRM-L BUS FAIL
11) ADC DATA DISAGREE (SRM-L)
12) SRM-L CHANNEL CODE FAULT (SRM-L)
13) SRM-R FAIL (SRM-R)
14) SRM-L FAIL (SRM-R)
15) SRM-L > SRM-R DATA FAIL
16) SRM-L > SRM-R BUS FAIL
17) ADC-C > SRM-R DATA FAIL
18) SRM-R FAIL or ADC-C > SRM-R BUS FAIL
19) ADC-L > SRM-R DATA FAIL
20) SRM-R FAIL or ADC-L > SRM-R BUS FAIL
21) ADC-R > SRM-R DATA FAIL
22) SRM-R FAIL or ADC-R > SRM-R BUS FAIL
23) ADC DATA DISAGREE (SRM-R)
24) SRM-R CHANNEL CODE FAULT (SRM-R)

Put the Airplane Back to Its Usual Condition

(1) Set the GND TEST switch to the NORM position.

(2) Remove electrical power (Ref 24-22-00/201).

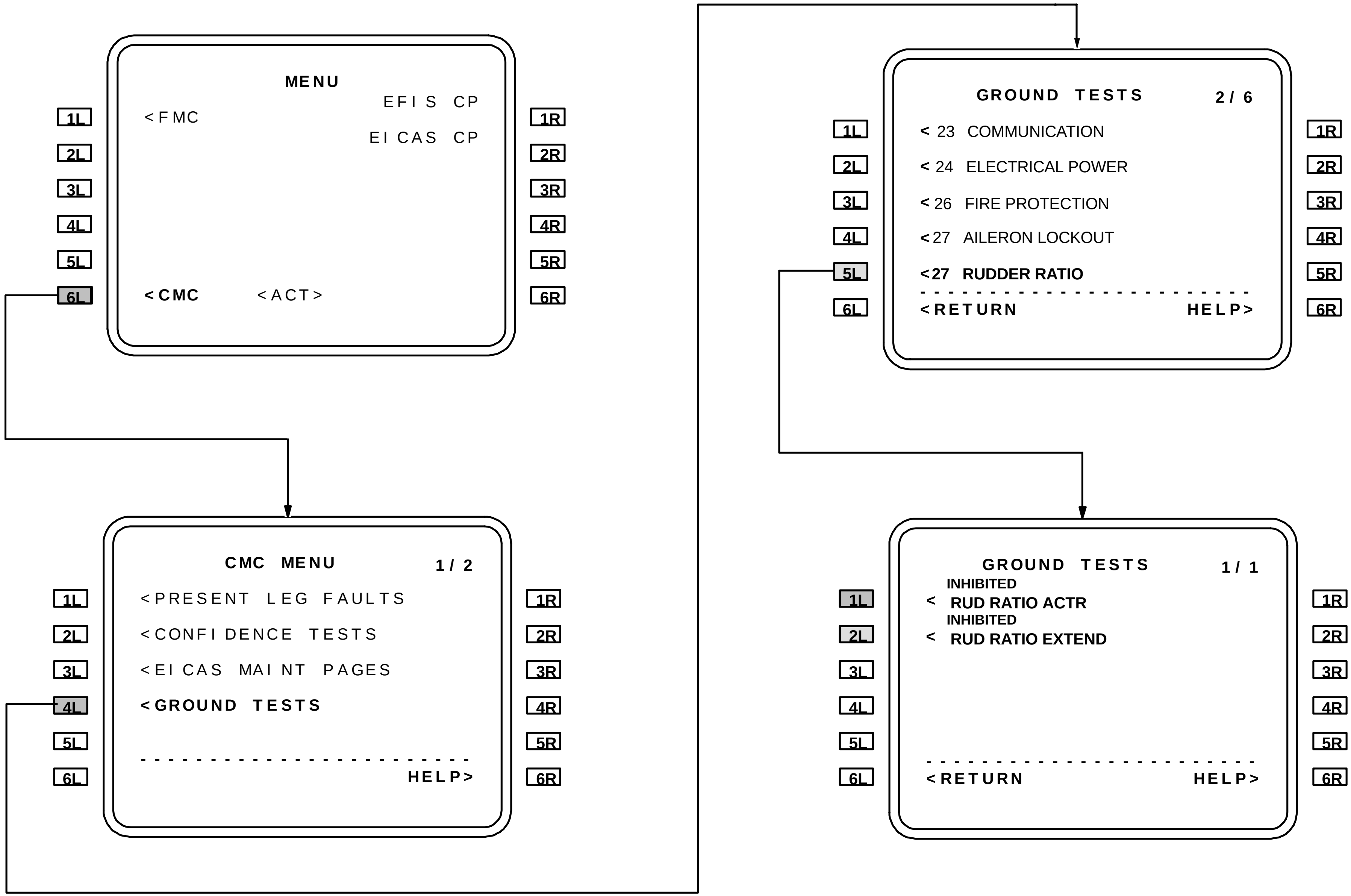


Figure 83 RUDDER RATIO ACTUATORS GROUND TEST

LOWER RUDDER POWER CONTROL ACTUATOR

DESCRIPTION

The lower rudder PCP consists of a PCM, two hydraulically driven PCAs, mounting trunnion, and associated hydraulic connections. The PCM consists of duel spool control valve, yaw damper actuator, solenoid valve, and position transducer. Airplane hydraulic systems No. 2 and 4 supply the lower rudder PCM. The PCM then regulates flow to the two hydraulic PCAs attached to the lower rudder front spar. Replaceable filters in the PCM protect the unit from contamination.

SUMMARY :

- Push Rod Bewegungen gelangen über den Rudder Ratio Changer, die Control Rod, dem Summing Lever und die Control Valve Rod zu dem Control Module.
- Durch die Auslenkung von dem Control Valve gelangt der Hydraulic Pressure zu den zwei Actuators
- Der Follow Up wird durch den an der Lower Actuator Rod angelenkten Summing Lever über die Control Valve Rod erreicht
- Bei einer Control Valve Blockierung ist durch einen Internal Override Mechanism die weitere Betätigung des anderen Control Modules ermöglicht
- Das Control Module, der Upper- und Lower Actuator sind an einen gemeinsamen Trunnion gelagert
- für Yaw Damping Control befinden sich noch ein Solenoid Valve, Transfer Valve und Linear Transducer angebaut (in der Abbildung nicht sichtbar).

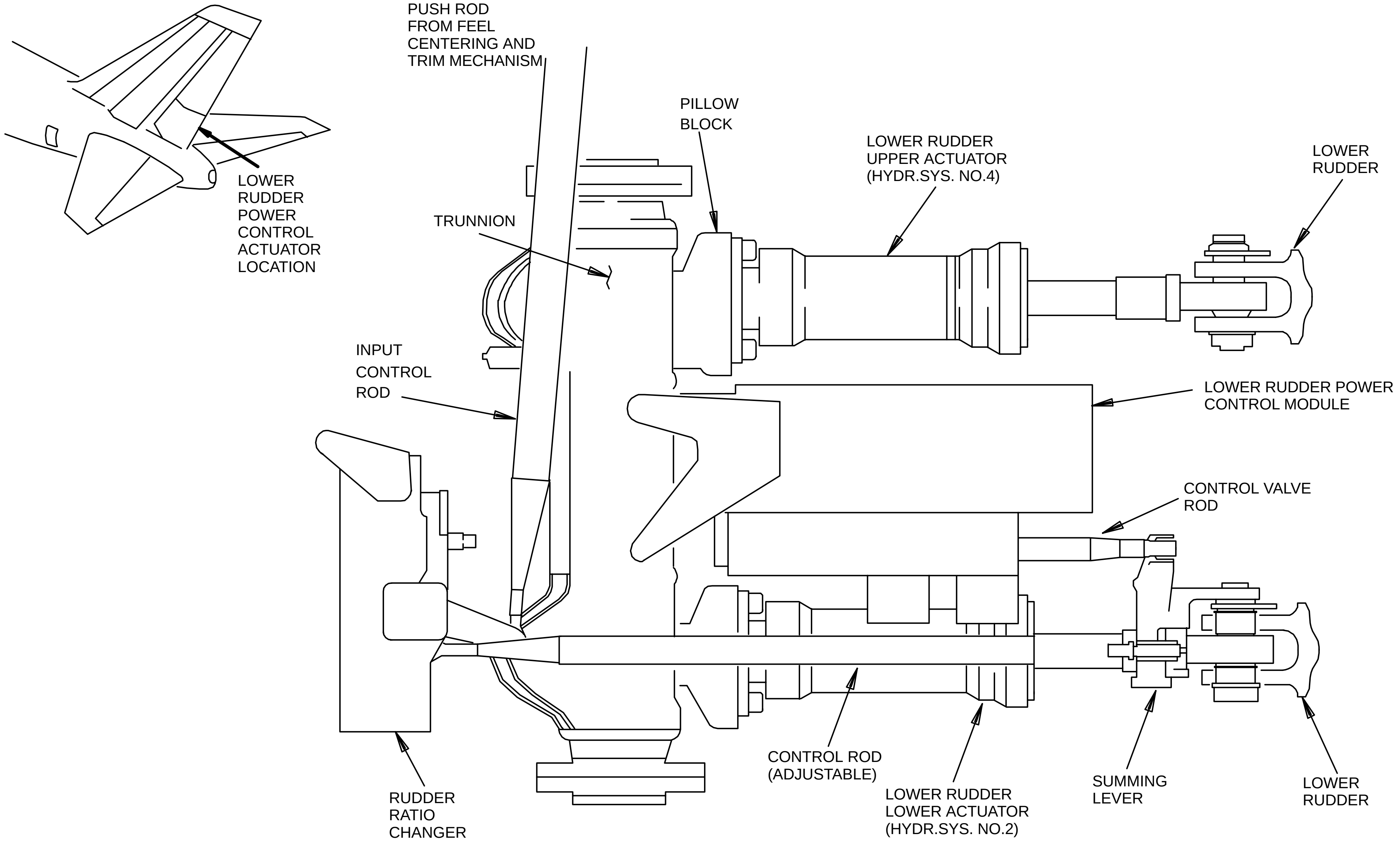


Figure 84 LOWER RUDDER POWER CONTROL ACTUATOR

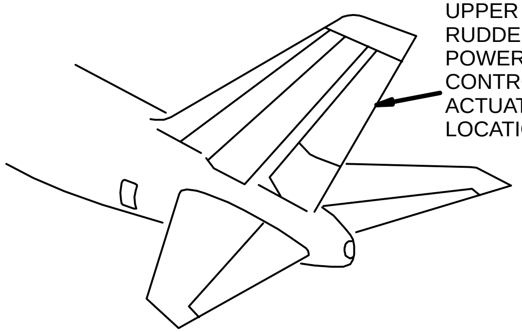
UPPER POWER CONTROL ACTUATOR

DESCRIPTION

The upper rudder power control package (PCP) consists of a PCM, three hydraulically driven PCAs, mounting trunnions, and associated hydraulic connections. The PCM consists of a triple spool valve, yaw damper actuator, solenoid valve, and position transducer. Airplane hydraulic systems No. 1 and 3 supply the upper rudder PCM. The PCM then regulates flow to the three PCAs attached to the rudder front spar. Replaceable filters in the PCM protect the unit from contamination.

SUMMARY :

- Push Rod Bewegungen gelangen über den Rudder Ratio Changer, die Control Rod, dem Summing Lever und die Control Valve Rod zu dem Control Module.
- Durch die Auslenkung von dem Control Valve gelangt der Hydraulic Pressure zu den drei Actuators
- Der Follow Up wird durch den an der Center Actuator Rod angelenkten Summing Lever über die Control Valve Rod erreicht
- Bei einer Control Valve Blockierung ist durch einen Internal Override Mechanism die weitere Betätigung des anderen Control Modules ermöglicht
- Das Control Module, der Upper- und Center Actuator sind an einen gemeinsamen Trunnion gelagert; der Lower Actuator ist an einem Hinge Arm befestigt
- für Yaw Damping Control befinden sich noch ein Solenoid Valve, Transfer Valve und Linear Transducer angebaut (in der Abbildung nicht sichtbar).



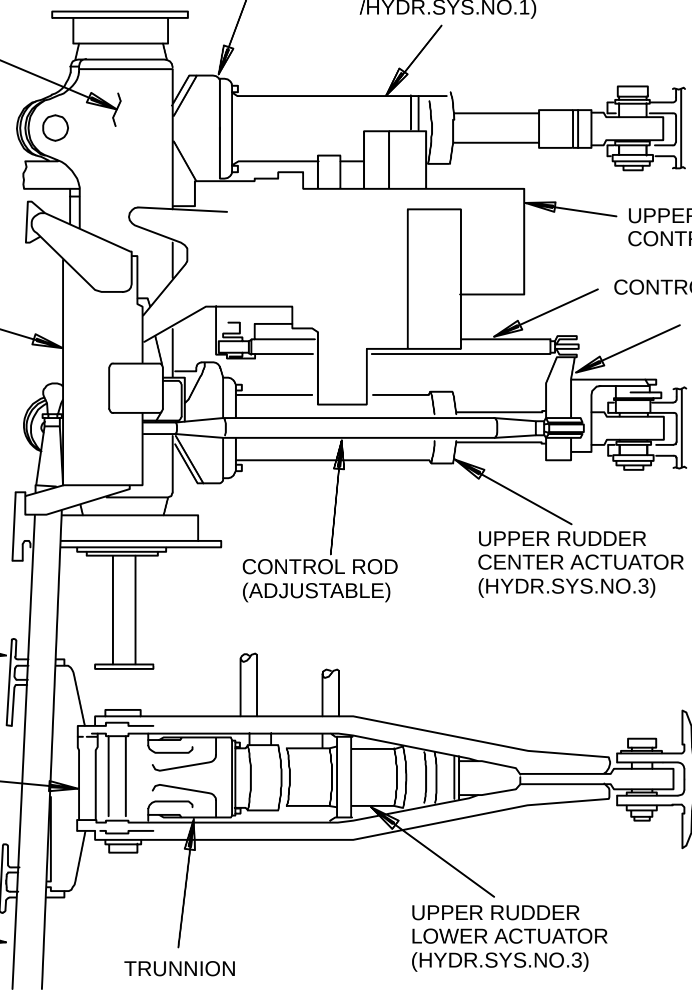


Figure 85 UPPER RUDDER POWER CONTROL ACTUATOR

RUDDER PEDAL POSITION TRANSMITTER

GENERAL

The position of the aileron control wheel, elevator control column, and rudder pedals is sensed by position transmitters for display on the EICAS flight controls maintenance page and for use by the flight data recorder system. The electrical signal from the position transmitters is processed by the column/rudder pedal position digitizer card for transmission to the EIU's.

RUDDER PEDAL POSITION TRANSMITTER

The rudder pedal position transmitter is located in front of the rudder right forward quadrant near the first officer's rudder pedals. The transmitter contains a synchro transducer. Movement of the rudder pedals is transferred to the position transmitter shaft through a crank and a control rod attached to the rudder forward quadrant. The transmitter is adjusted to zero the **PEDAL** readout on the EICAS flight controls maintenance page when the rudder pedals are in the neutral position.

SUMMARY :

Der Rudder Pedal Position Transmitter überträgt den gemessenen Wert zur Surface Position Digitizer (YLMA 10) Card und über die EFIS/EICAS Interface Units (EIU's) als

- **PEDAL** - Indication

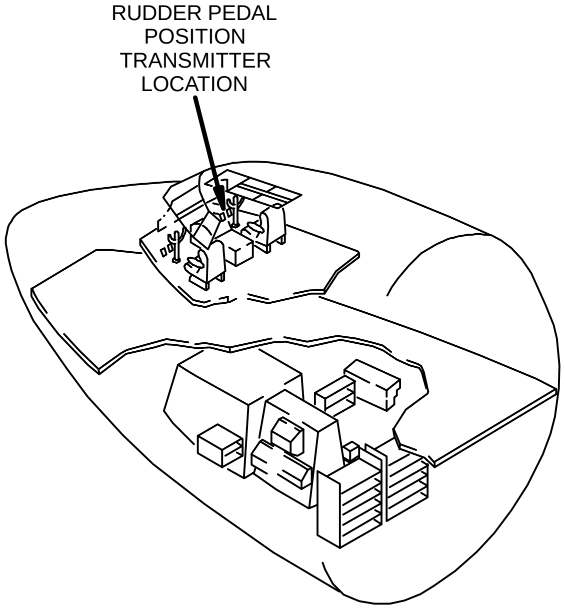
auf die Maintenance Page Flight Control.

Surface Position Digitizer (SPD) Card Beschreibung siehe Aileron Position Indication Components.

FAILURE INDICATION OF THE RUDDER PEDAL POSITION TRANSMITTER:

For example :
Whenever a fault is detected at the rudder pedal positon transmitter
on the MCDU is shown the
CMC message :

RUDDER PEDAL SYNCHRO FAIL (SPD-COLUMN) 27 990
omly.



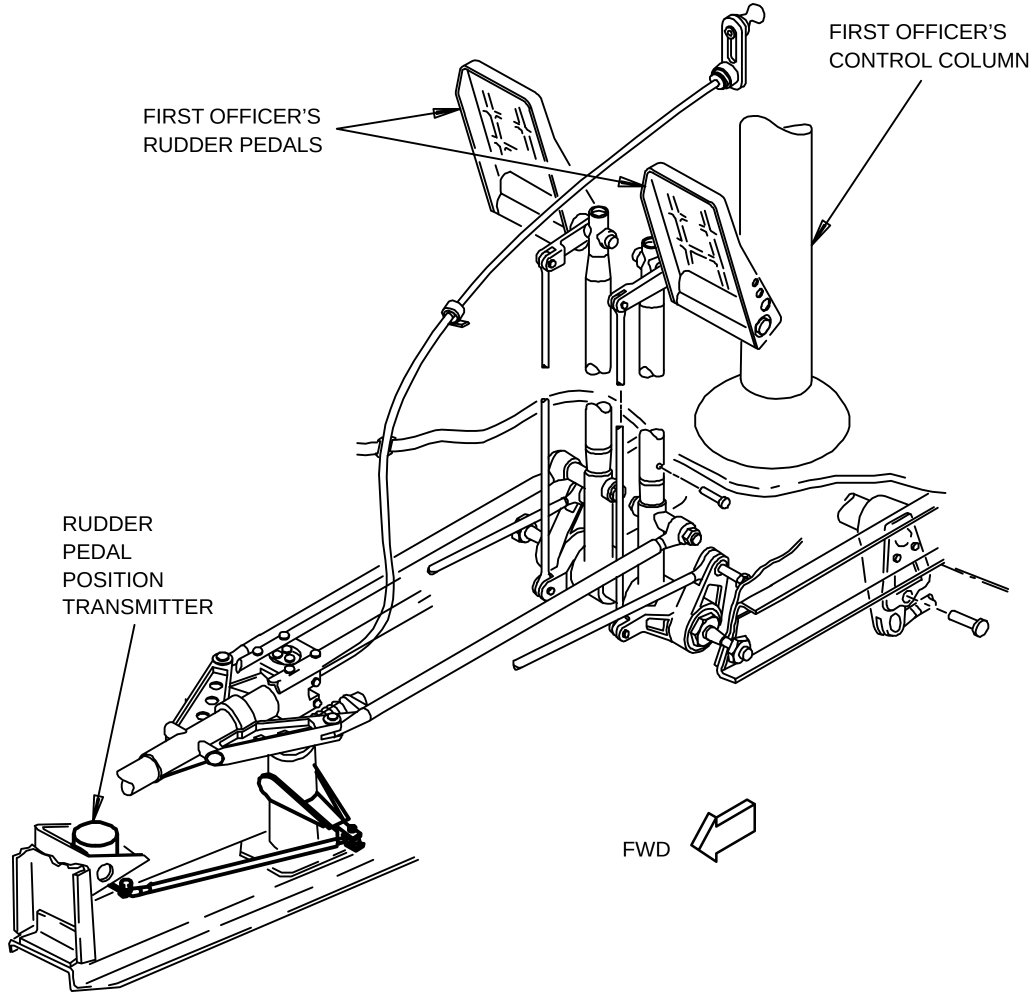


Figure 86 RUDDER PEDAL POSITION TRANSMITTER

RUDDER POSITION TRANSMITTER

GENERAL

The rudder position indicating system provides visual indication on the flight deck of upper and lower rudder angular displacement. The rudder position indicators appear on the EICAS status page as part of the surface position display.

Components used by the rudder position indicating system are the upper and the lower rudder position transmitters, the rudder/elevator surface position digitizer circuit card, and the EIU's and EICAS display. The system is powered by 28 volts dc from the 28 vdc bus 3 and by 28 volts ac from the 28 vac bus 3 through circuit breakers on the P6 panel.

A separate electrical indication system drives the rudder trim position pointer on the aileron/rudder trim control module in the flight compartment.

RUDDER POSITION TRANSMITTER

The rudder position transmitters are located between each rudder and the vertical stabilizer rear bulkhead. An adjustable control rod attaches the transmitter to the rudder. With the rudder in the neutral position, the control rod can be adjusted to set the rudder position readout on the EICAS flight controls maintenance page to zero.

FAILURE INDICATION OF THE RUDDER POSITION TRANSMITTER :

For example :

Whenever a fault is detected for the rudder position transmitter on the MCDU is shown the

CMC message :

UPPER RUDDER SYNCHRO FAIL (AFT-SPD) 27 977

or

LOWER RUDDER SYNCHRO FAIL (AFT-SPD) 27 978.

only.

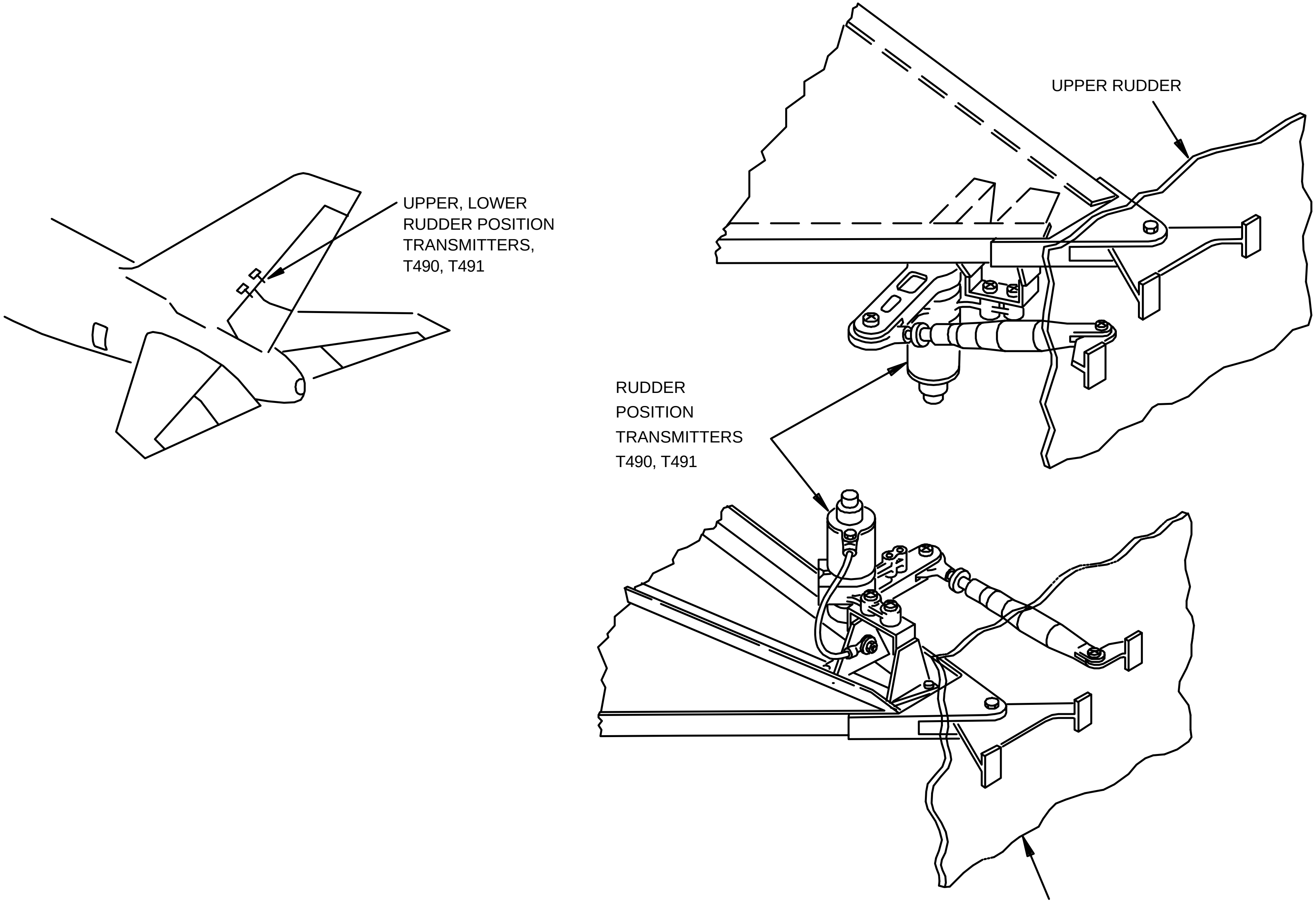


Figure 87 RUDDER POSITION TRANSMITTER

AFT SURFACE POSITION DIGITIZER CARD

DESCRIPTION

RUDDER TRIM CONTROL (RTC) CIRCUIT CARD

The RTC card is located in the surface position digitizer (SPD) card file located on the E8 aft electrical equipment shelf. The RTC card receives electrical information from the aileron-rudder trim control module and provides electrical signals to the rudder trim actuator to provide requested trim.

AFT SURFACE POSITION DIGITIZER CARD

The aft surface position digitizer circuit card YM5A001 receives the signals from the rudder position transmitters and converts the signals to a serial digital format for transmission to the EIU's on an ARINC 429 bus. The card is located in the SPD card file M8011 in the E8 aft electrical equipment rack.

FAILURE INDICATION OF THE AFT SURFACE POSITION DIGITIZER CARD

For example :

Whenever a fault is detected for the aft surface position digitizer card on the MCDU is shown the

CMC message :

AFT SURFACE SPD CARD FAIL (SPD-AFT) 27 972

only.

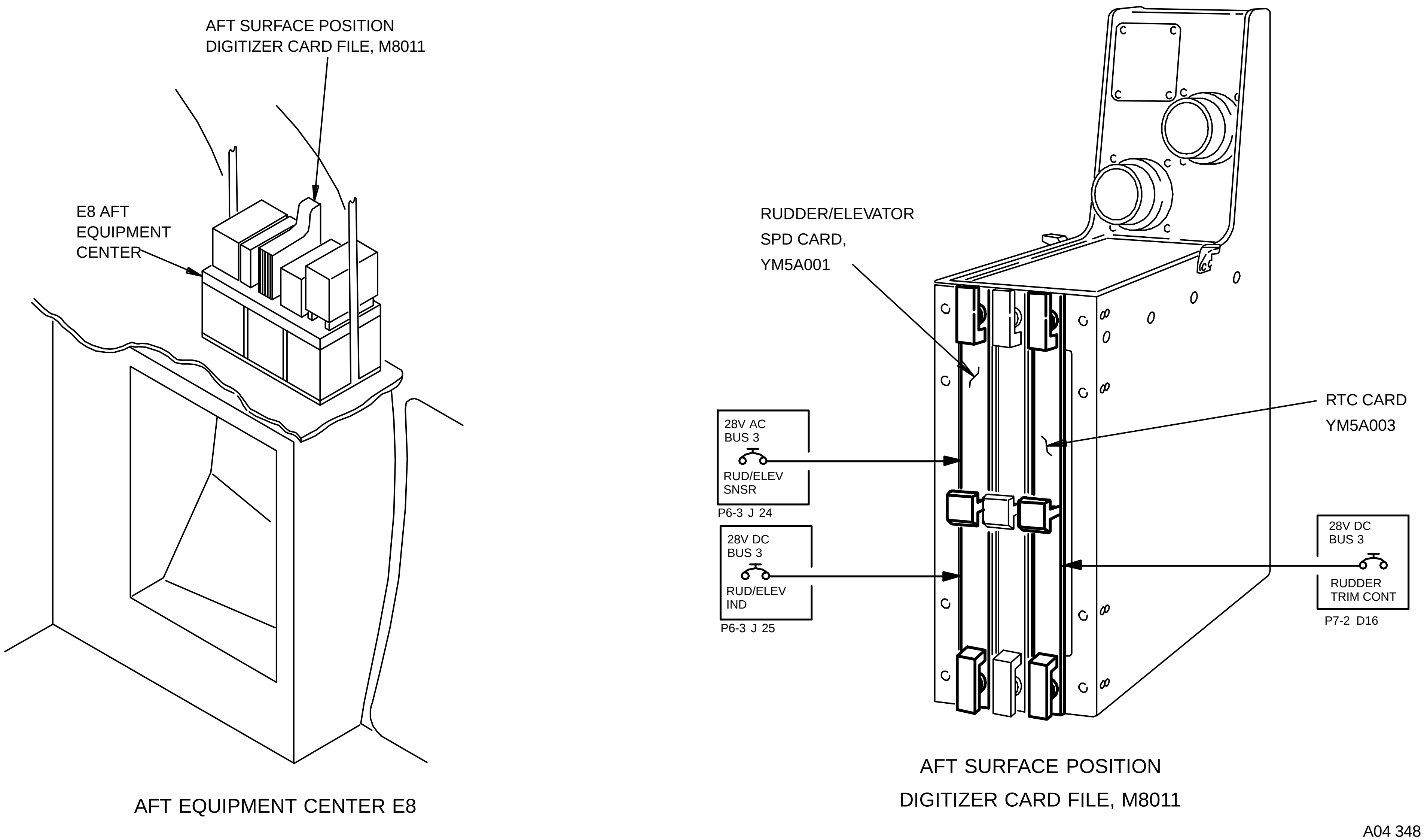


Figure 88 AFT SURFACE POSITION DIGITIZER CARD

RUDDER INDICATION ELECTRICAL SCHEMATIC

FUNCTIONAL DESCRIPTION

When the rudder is deflected from the neutral position, the attached control rod drives the transmitter crank which pivots the transmitter shaft. The transmitter electrical output varies as the shaft pivots. The output signal passes to the surface position digitizer which processes the signal and routes it to the EIU's for display on EICAS.

CONTROL

Operation of the rudder position indicating system is automatic. The EICAS surface position display appears when the EICAS status page is invoked.

The flight controls maintenance page may be called up on the auxiliary EICAS display. This page displays the values of rudder angular displacement as numeric readouts for system adjustment and trouble shooting.

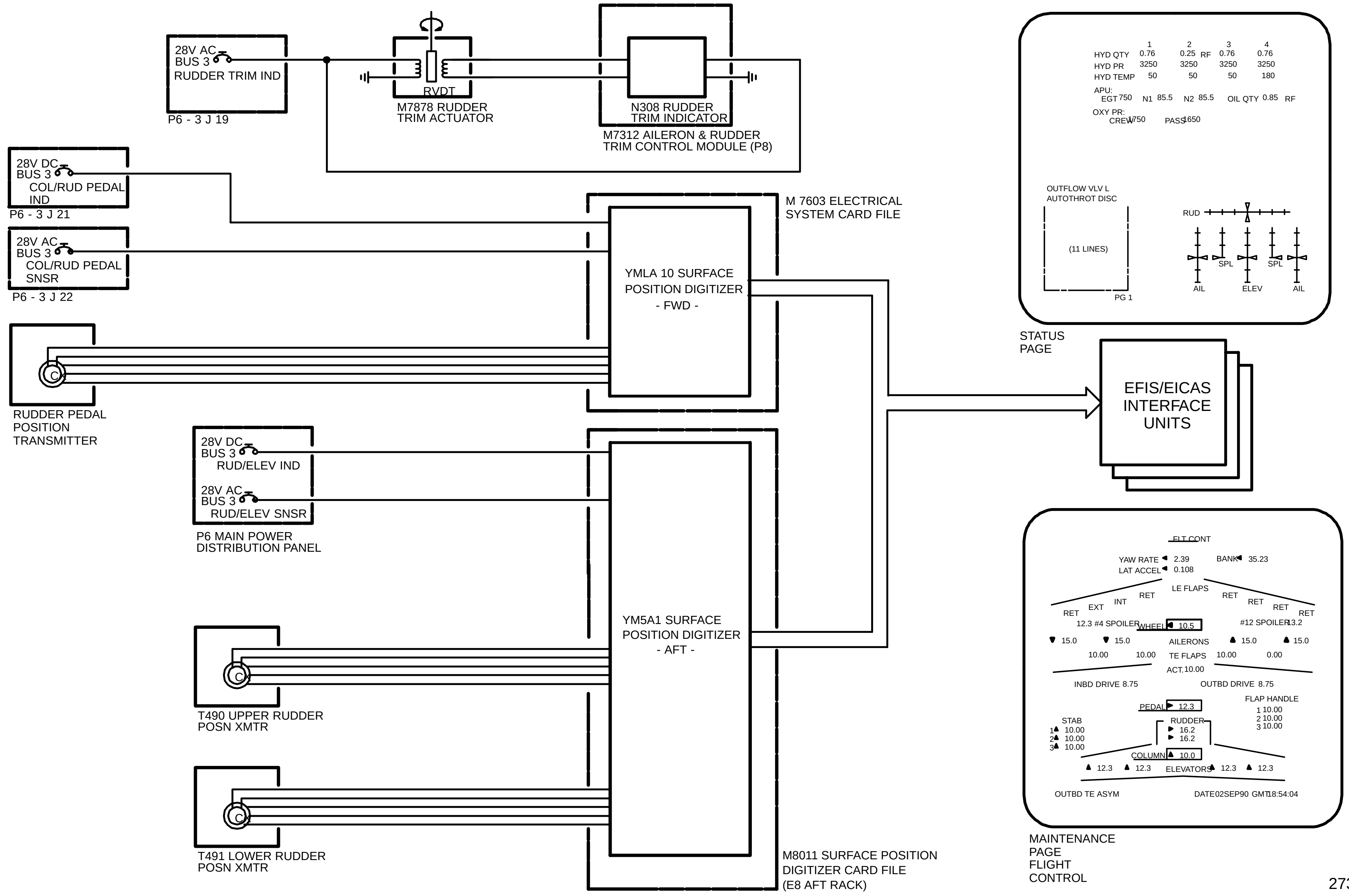


Figure 89 RUDDER POSITION INDICATING SYSTEM SCHEMATIC

27-30 ELEVATOR

FLIGHT CONTROL MAINTENANCE- AND STATUS PAGE

DESCRIPTION MAINTENANCE PAGE

Die Maintenance Page für das Flight Control System ist über das Central Maintenance Computer System (CMCS) folgendermaßen aufrufbar :

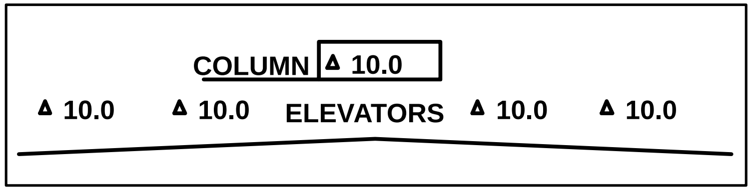
- CMC
- MENü
- MAINTENANCE PAGE
- ATA 27
- DISPLAY.

Die Anzeigen:

- der Control Columns
- des Left Outboard Elevators
- des Left Inboard Elevators
- des Right Inboard Elevators
- des Right Outboard Elevators

erfolgt in ° .

Die Anzeige erfolgt in Steps von $^{1}/_{10}$ ° .



- Control Column Auschlag von 10° Airplane NOSE UP
- Left Elevators 10° Airplane NOSE UP
- Right Elevators 10° Airplane NOSE UP

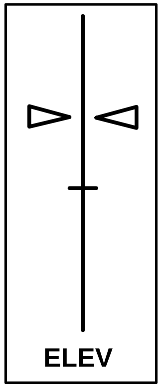
DESCRIPTION STATUS PAGE

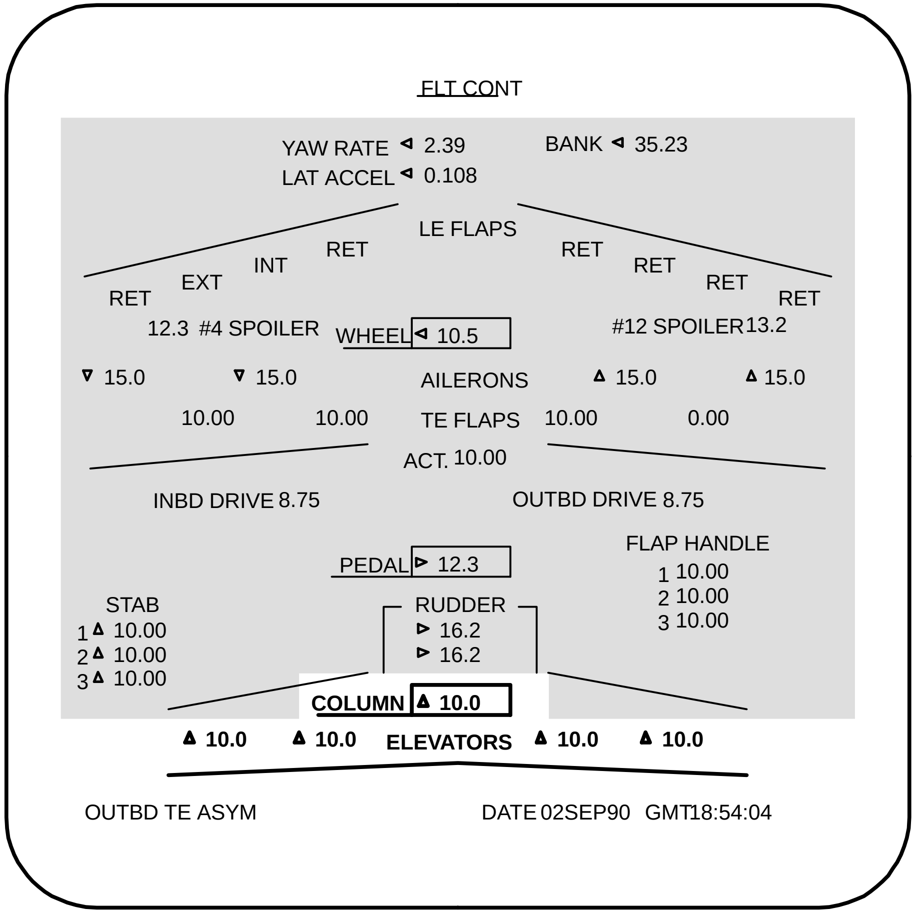
Die Status Page ist über das EICAS Data Select Panel (EDSP) auf dem Glearshild über den Select Button STATUS aufrufbar.

Auf der Status Page befindet sich in der rechten unteren Ecke die Informationen des Flight Control Systemes.

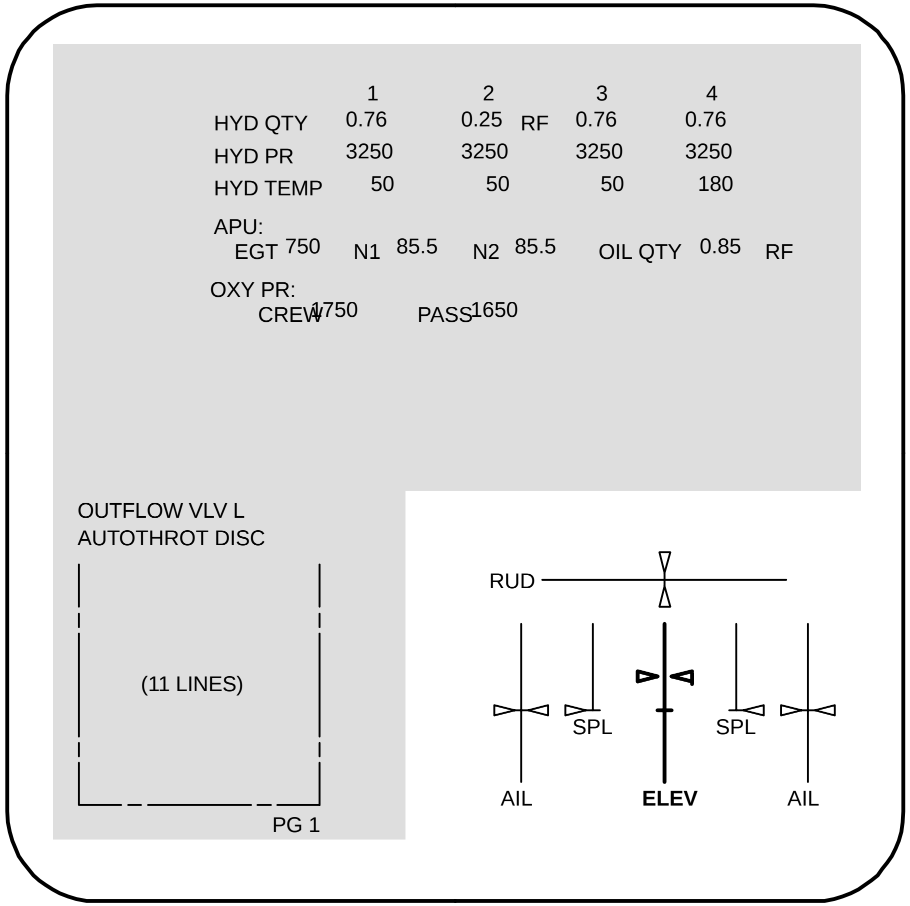
Die Anzeigen der Elevators erfolgt unter der Bezeichnung **ELEV** für :

- des Left Outboard Elevators
- des Right Outboard Elevators





MAINTENANCE PAGE
FLIGHT CONTROLS



STATUS PAGE

Figure 90 MAINTENANCE PAGE FLIGHT CONTROL AND STATUS PAGE

ELEVATOR BASIC SCHEMATIC DESCRIPTION

CAPTAINS- AND F/O's CONTROL COLUMN

- sind mit Torque Tube verbunden.

COLUMNS

- betätigen Forward Quadrant und Cable Arm. Über Control Cables gelangen die Inputs zu den Aft Quadrants und damit auf die Aft Torque Tube.

AFT TORQUE TUBE

- steuert über Push Rods die Control Valves der Inboard Elevator Power Control Packages
- ist mit Feel- and Centering Unit verbunden
- bekommt Inputs von den Autopilot Servos.

INBOARD ELEVATOR POWER CONTROL PACKAGE

- betätigen die Inboard Elevators

INBOARD ELEVATOR

- steuern über Push Rods die Control Valves der Outboard Elevator Power Control Packages

FEEL- AND CENTERING UNIT

- zentriert die Columns nach Auslenkung
- erhält Feel Pressure vom Feel Computer

FEEL COMPUTER

- erzeugt Feel Pressure in Abhängigkeit der Speed (Pitot and Static) und der Stabilizer Position
- Speed
  - Low - Low Feel Pressure
  - High - High Feel Pressure
- Stabilizer Position für Flugzeuggewicht bzw. Schwerpunktslage
  - großer Anstellwinkel (Stabilizer nach Airplane Nose Up getrimmt); Low Feel Pressure
  - kleiner Anstellwinkel (Stabilizer nach Airplane Neutral getrimmt); High Feel Pressure
- Feel Pressures werden durch 2 Differential Switches überwacht
- Pressure Differential Switches überwachen die Feel Pressures; bei >25% Differenz erscheint EICAS Mess. mit CMC Speicherung

AUTOPILOT

- Signals gelangen über Solenoid- und Transfer Valves auf die Autopilot Avtuators (Servos). Dadurch wird über die Aft Torque Tube das Column Control System betätigt, d.h. es werden alle Power Packages angesteuert.

REFER TO DIN A3 PAGE

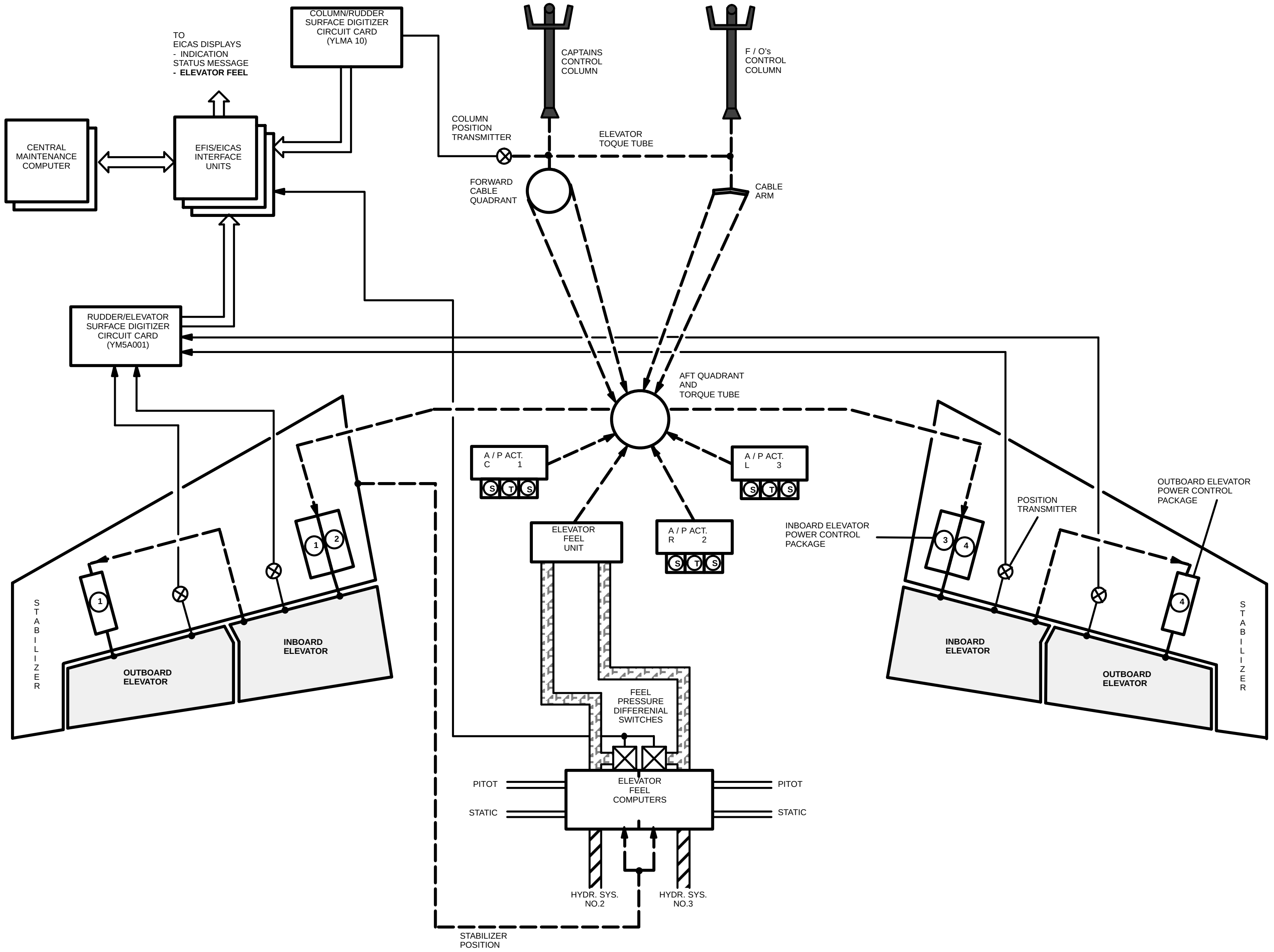


Figure 91 ELEVATOR BASIC SCHEMATIC

ELEVATOR CONTROL SYSTEM SCHEMATIC

FUNCTIONAL DESCRIPTION

Airplane hydraulic systems No. 1, 2, 3 and 4 operate the elevators in response to manual or electrical control inputs. The operator applies manual inputs to either control column; the autopilot systemapplies inputs to the three autopilot servo modules connected to the aft torque tube.

In the manual mode, fore and aft displacement of the control columns transmits motion from the forward control quadrant and crank to the common aft quadrant through two pairs of cables. As the control column is displaced progressively from neutral, the elevator feel unit imparts a progressively increasing centering force to the control system .

The feel force is controlled by the feel computer, and is exerted by the feel actuator acting through the feel unit. In each of the two groups of components in the computer, a Qc-sensing bellows acts through a leaf spring upon a pivot linkage to displace a force balanced slide valve. A cam, connected by linkage to the horizontal stabilizer, acts through another leaf spring in opposition to the Qc-sensing bellows. The sum of these two forces, together with hydraulic return pressure, loads the force balance valve to pressurize the associated chamber of the feel actuator. The force balance valve closes when the force exerted by feel pressure on the opposite end of the valve balances the input forces. The feel pressure acts on the feel actuator rams to apply a force which resists rotation of the feel unit cam. As the cam is connected to the aft quadrant, this resistance plus feel unit centering spring tension resists control column displacement from neutral.

When the control columns are moved, the aft quadrant translates the fore and aft cable movement into lateral control rod movement to transmit the motion to the main control valve linkage on each inboard elevator power control pakkage. The resulting movement of each inboard elevator activates the attached slave control linkage. This results in the movement of the main control valve linkage on the corresponding outboard elevator PCP, causing simultaneous movement of that surface in the same direction.

Stops limit the travel of the crank at the end of the control column torque tube. These stops, and stops in the PCPs, constrain elevator travel. The inboard elevator rig neutral position is at 1.0+/-0.2 degrees up and the outboard elevator rig neutral position is at 1.0+/-0.5 degree down. Surface position transmitters connected to the inboard and the outboard elevators provide electrical signals to the aft surface digitizer circuit card. This is then displayed on EICAS to show relative displacement and positions of the elevators.

In manual operation, the inboard and outboard elevator PCPs function similarly. On the inboard elevator PCP, pressure from both associated hydraulic systems is applied to two separate pressure ports. The functions performed by both systems on the inboard elevator PCP are identical, but complete hydraulic isolation is maintained between the two systems. On the outboard elevator PCP, only one hydraulic system is active.

The fluid from each system enters the pressure port and passes through a filter and a pressure check valve to the main control servo valve. On inboard elevator PCPs, pressure is applied simultaneously to a time delay valve. This valve consists of a self-cleaning orifice which delays pressurization of the linkage overtravel mechanism by 0.75 second to prevent stick kick at the control column when hydraulic power is turned on. No time delay is required on the outboard elevator PCPs, because they are not directly connected to the control column and because the outboard elevators are balanced.

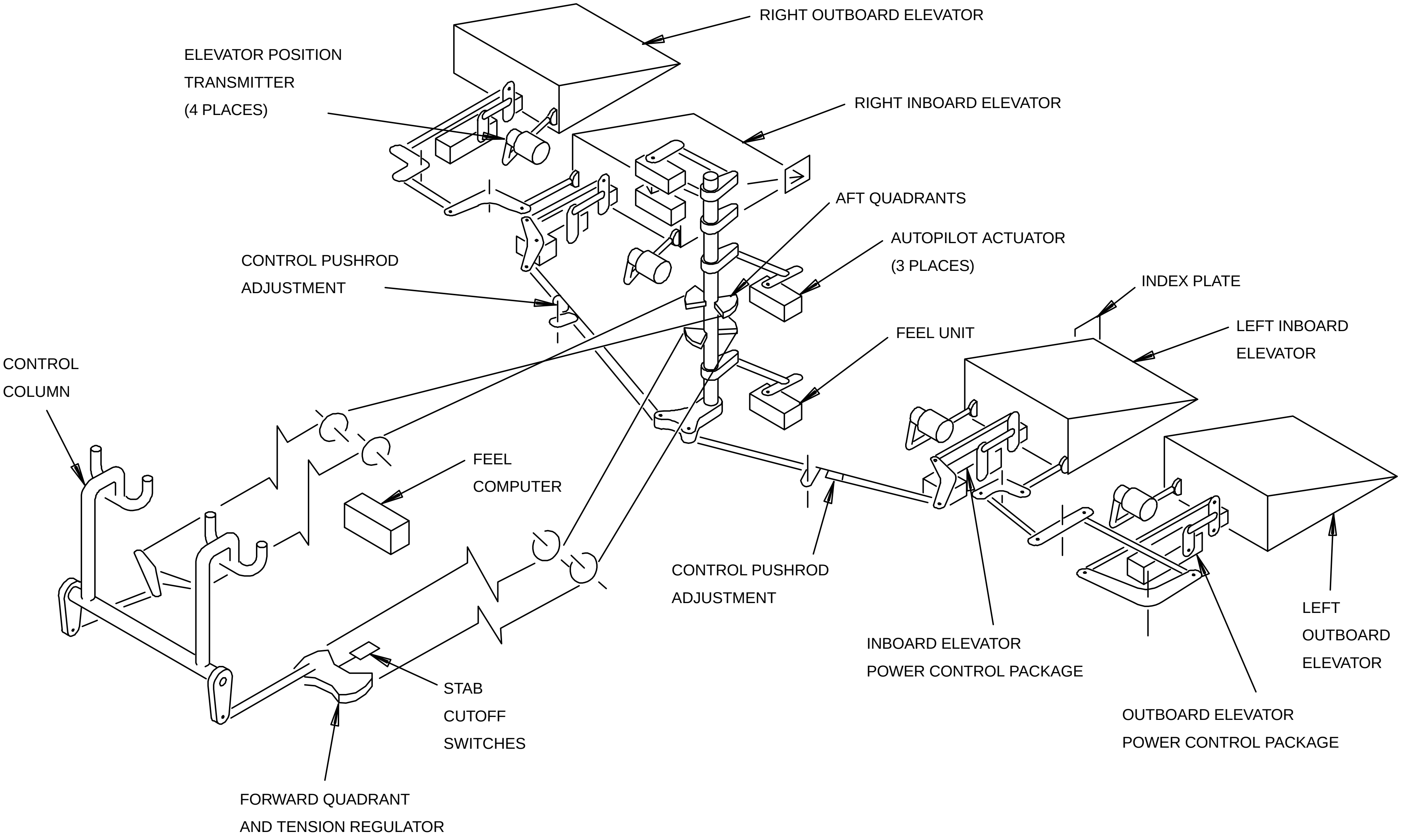


Figure 92 ELEVATOR CONTROL SYSTEM SCHEMATIC

On both inboard and outboard elevator PCPs, pressurization of the over- travel mechanism provides a hydraulically supported pivot for the control linkage, arming the linkage. With the linkage armed, control inputs are applied to the main control servo valve. When the control system demands elevator movement, the main control valve directs fluid to and from the appropriate chambers of the actuator. Feedback linkage from the actuator returns the control valve to neutral when the commanded amount of elevator movement is achieved.
When no hydraulic system associated with a particular unit is pressurized, the input lever has unrestricted travel for any position of the actuator. A bias spring holds the pivot in place firmly enough to transmit small operating forces to the control valve in this condition. Outboard units contain a centering mechanism to ensure that an outboard elevator returns to neutral if connection with the associated inboard elevator is lost.

Return fluid from the actuator chambers passes via the main control valve to a compensator, which it charges to capacity if required. Pressure buildup then opens a check valve in the compensator piston, allowing the fluid to exit through the return port. The compensator retains a reserve of pressurized return fluid to ensure proper operation of check valves within the package.
Two anticavitation valves are provided in each system. These valves permit fluid flow from the return system to the actuator service ducts of the unpressurized actuator chambers if the packages are operated with one hydraulic system unpressurized.

In the auto flight mode, electrical signals generated by the autopilot pitch channels operate the elevator autopilot servo modules. Inputs are then conveyed to the elevator aft torque tube thru control rods, and to the inboard elevator PCP control valve linkages via the inboard elevator PCP control valve linkages. See 22-12-00/001 for operation of the elevator autopilot servo modules.

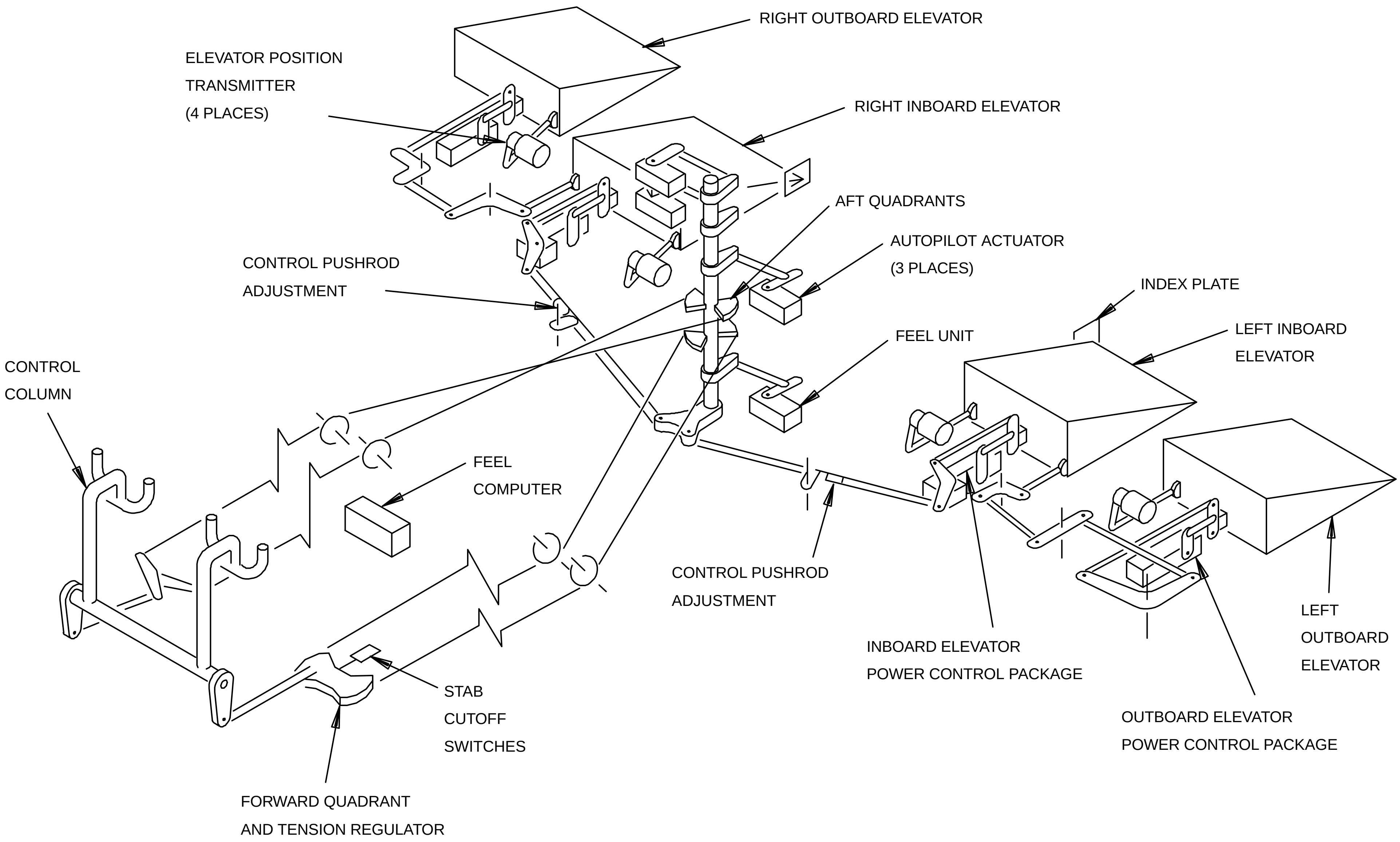


Figure 93 ELEVATOR CONTROL SYSTEM SCHEMATIC

AUTOFLIGHT CONTROL SCHEMATIC

DESCRIPTION

ELEVATOR CONTROL

Zwei Seilsysteme verbinden Steuersäule und Aft Torque Tube, an der 3 A/P Elevator Servos (EAS) installiert sind. Die Aft Torque Tube ist über ein Gestänge mit den beiden Inboard Elevator Power Control Packages (PCP's) gekoppelt. Control Rods verbinden jeden Inboard Elevator mit dem danebenliegenden Outboard Elevator Power Control Package.

Somit kann ein FCC alle Elevators verstellen.

Ist z.B. der Left FCC eingeschaltet, erhält der Left Elevator Servo (untere Einbauposition) ein Signal und verstellt über die Torque Tube und deren Control Rods die Inboard PCP's.

Gleichzeitig bewegen sich über das Seilsystem die Steuersäule und über Control Rods die äußeren Elevators.

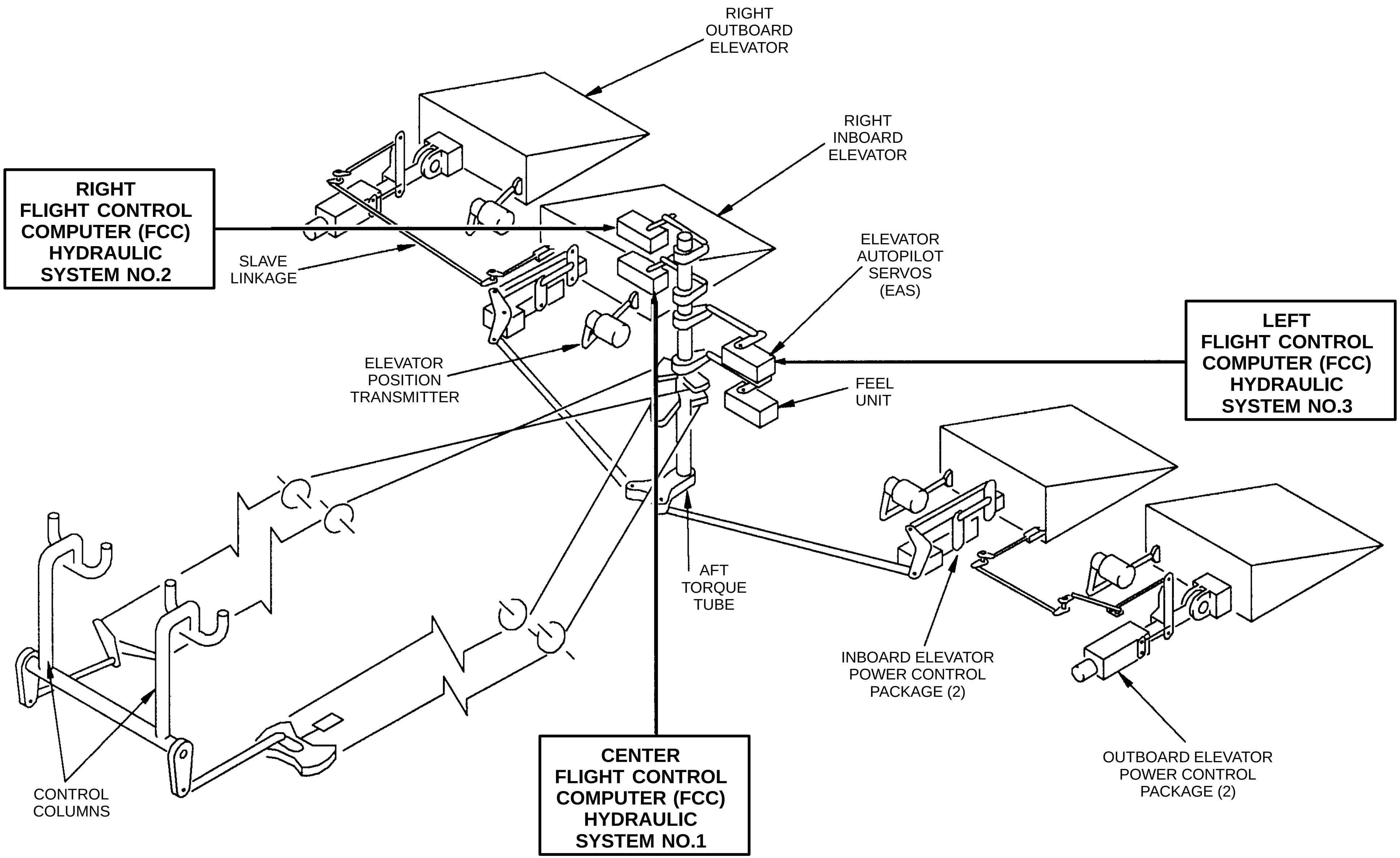


Figure 94 AUTOFLIGHT CONTROL SCHEMATIC

CONTROL COLUMNS

DESCRIPTION

The two control columns transmit commands to control the airplane about the pitch and roll axes. Forward and aft motion of the control columns actuates the elevators to control the airplane about its pitch axis. Rotating a control wheel on either column operates the ailerons and spoilers to control the airplane about its roll axis.

The control columns are rigidly mounted on a torque tube located just below the control cabin floor. Crank assemblies on each end of the torque tube transmit motion aft by pushrods to the forward quadrant and crank. Stops on the left torque tube crank and its bearing housing limit control column fore and aft movement and, hence, elevator control input travel. Access to the torque tube and to the forward quadrant and crank is gained from the bottom through the passenger cabin ceiling.

SUMMARY :

- dienen zur Steuerung der Elevators
- sind mittels einer Torque Tube miteinander verbunden
- betätigen den Forward Quadrant und den Cable Arm über Push Rods
- ein Tension Regulator für Captain’s Control Cable Tension

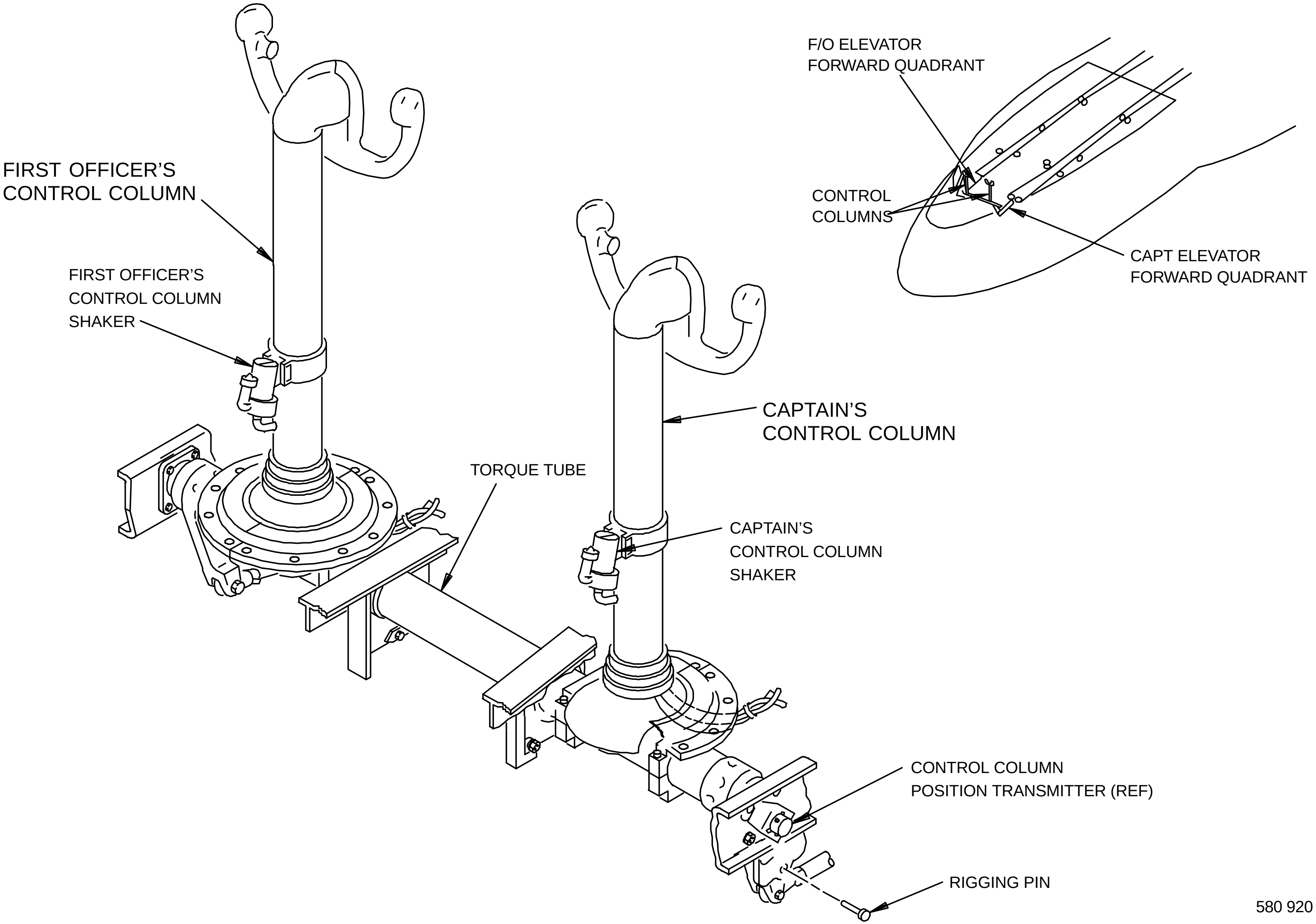


Figure 95 CONTROL COLUMNS

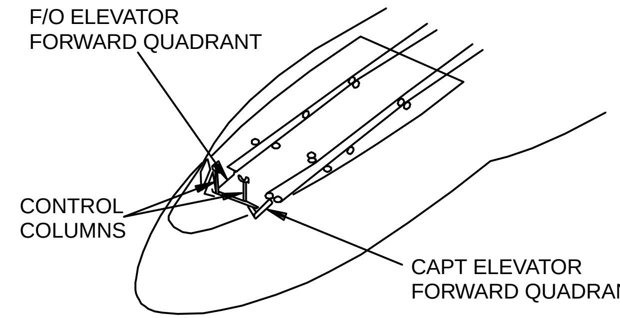
ELEVATOR FORWARD QUADRANTS

DESCRIPTION

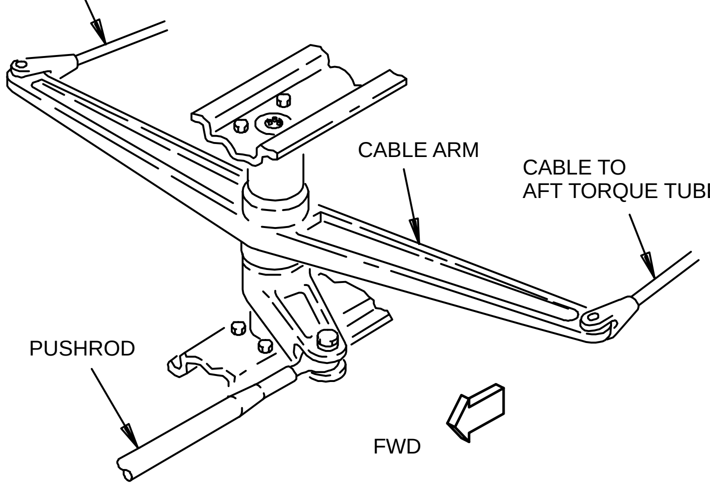
The forward elevator control quadrant and crank are located beneath the control cabin just aft of the control column torque tube. A pushrod connects each component to a lever arm on each end of the control column torque tube, and separate pairs of cables connect them to the common rear quadrant.

The forward quadrant incorporates a tension regulator to regulate the control cable tension. The tension regulator mechanically compensates for the effects of temperature variation and structural deflections on the elevator system left-hand body control cables. A position indicator with a graduated scale provides information convertible to cable tension for the existing temperature, with appropriate markings to show the acceptable operating limits. The range of regulator tension compensation is limited by positive stops.

FORWARD QUADRANT LOCATION



F/O ELEVATOR FORWARD QUADRANT



SUMMARY :

TORQUE TUBE
- Stops
  - an Structure und Crank
  - nicht justierbar
- betätigt Push Rods

FORWARD QUADRANT
- besteht aus zwei Sectoren
- wird durch Links vom Tension Regulator betätigt

TENSION REGULATOR
- Springs spannen über Crosshead, Links und Sectors das Captain’s Control Cable
- Scale dient zum Überprüfen der Seilspannung

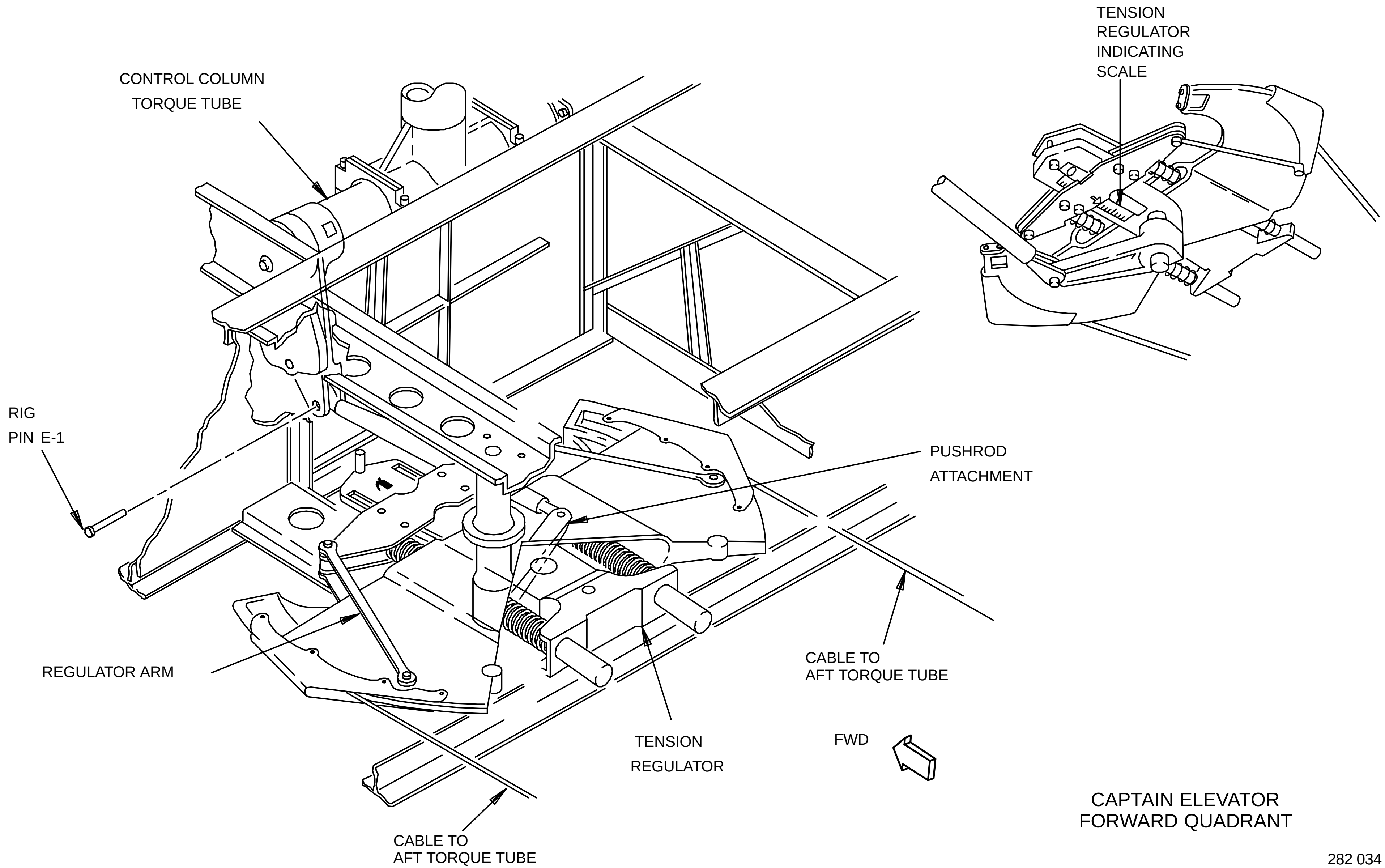


Figure 96 ELEVATOR FORWARD QUADRANTS

ELEVATOR CONTROL COMPONENTS OVERVIEW

The elevator control system provides primary control of the airplane about its pitch axis. Hydraulic power drives the elevators in response to control column inputs. Two elevators are provided on each side of the airplane. The elevators are attached by hinges to the stabilizer aft torque boxes.

Fore and aft movement of the captain's and first officer's control columns activates the elevator control system. A torque tube rigidly interconnects the control columns. Crank arms on the torque tube transmit movement to pushrods. The left pushrod connects to a forward quadrant; the right pushrod connects to a crank. The forward quadrant and the crank are connected by cables to quadrants on a torque tube (referred to as common aft quadrant), which delivers control input to the inboard elevator power control packages (PCPs) through crank arms and pushrods. The PCPs are attached between the stabilizer rear spar and the elevator front spars. Activation of the inboard elevator PCPs, which can be accomplished manually or by the autopilot, causes deflection of the associated inboard elevators. Input to each outboard PCP is conducted through a slave linkage system from an input control rod mounted on the front spar of the adjacent inboard elevator.

Elevator feel is provided by an elevator feel unit. A feel computer directs modulated hydraulic pressure to the feel unit, which then applies a resistance force in the feel unit actuator and through the common rear quadrant to simulate elevator aerodynamic centering forces. The metered feel pressure is controlled by stabilizer position and airplane pitot system pressure.

AFT TORQUE TUBE

- wird betätigt durch Control Cables und Aft Quadrant
- betätigt Control Rods zur Ansteuerung der Inboard Power Control Packages
- ist durch Linkage mit der Feel- and Centering Unit verbunden

FEEL- AND CENTERING UNIT

- erzeugt in Verbindung mit Feel Actuator Gegenkräfte für die Control Columns
- stellt Control Columns nach Auslenkung auf Neutral (Centering)

FEEL ACTUATOR

- erzeugt variable Gegenkräfte
- erhält Feel Pressures vom Feel Computer

INBOARD ELEVATOR POWER CONTROL PACKAGE

- betätigt Inboard Elevator
- Control Rod
  - betätigt Summing Lever
  - wird von Aft Torque Tube betätigt
  - Adjustment für Inboard Elevator Neutral
- Summing Lever dient zur Betätigung vom Control Valve bei Ansteuerung und Follow Up
- Control Valve kann bei Blockierung übersteuert werden, so daß die Ansteuerung der anderen Control Packages weiterhin gewährleistet ist.

INBOARD ELEVATOR

- ist statisch nicht ausgewogen
- Control Rods (Slave Linkage)
  - betätigt Outboard Elevator Control Package Control Valve
  - Shear Rivet schert ab bei einer Blockierung
- Neutral Justierung bei Stabilizer Neutral

OUTBOARD ELEVATOR POWER CONTROL PACKAGE

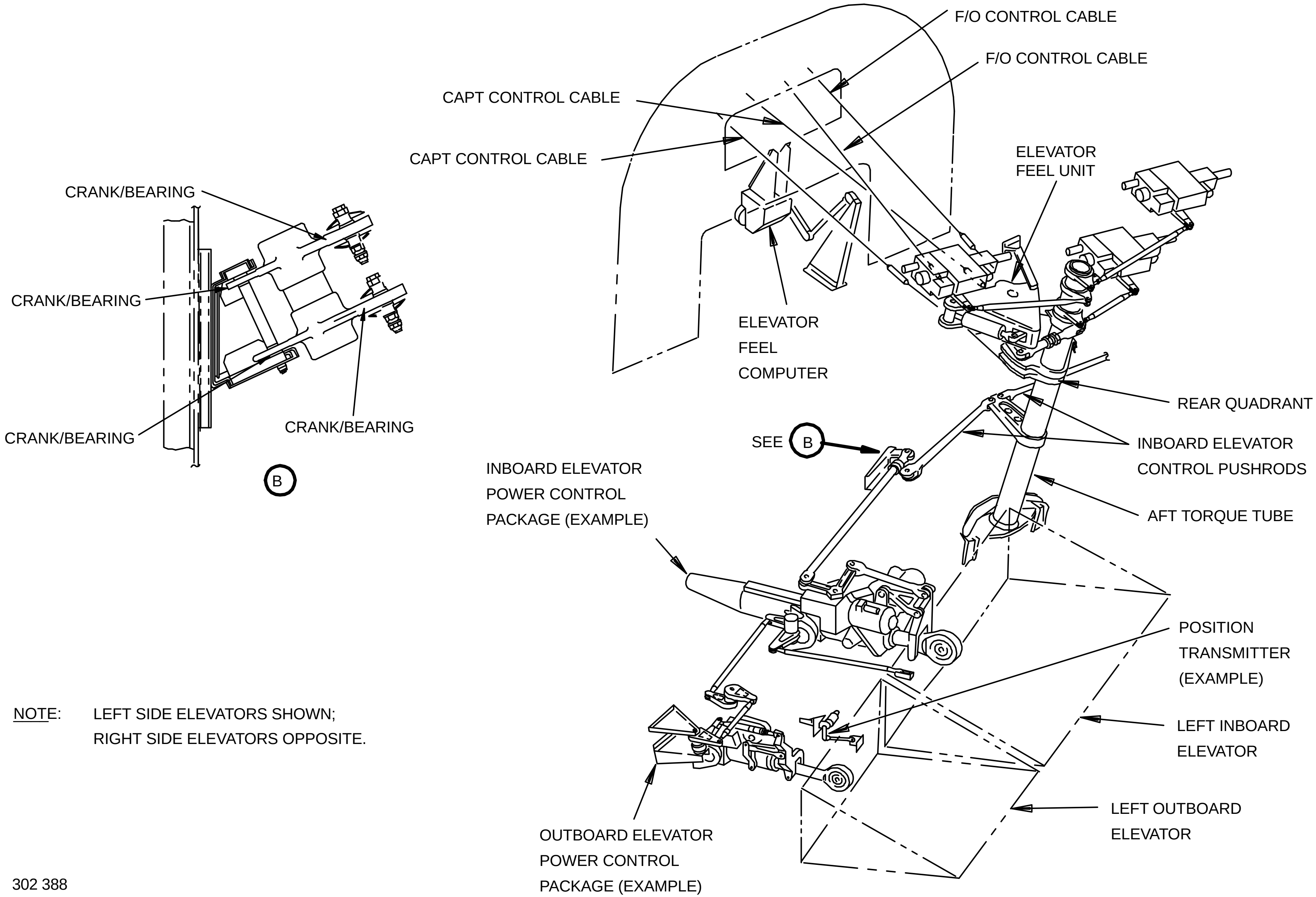
- betätigt Outboard Elevator
- Control Valve wird durch Control Rods vom Inboard Elevator betätigt. Adjustable Control Rod steuert über Summing Lever Power Control Package Control Valve.

OUTBOARD ELEVATOR

- ist statisch ausgewogen

ELEVATOR RIG POSITION

- Inboard Elevator Rig Neutral Position : 1.0 +/- 0.2° UP
- Outboard Elevator Rig Neutral Position : 1.0 +/- 0.5° DOWN



NOTE: LEFT SIDE ELEVATORS SHOWN;
RIGHT SIDE ELEVATORS OPPOSITE.

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Figure 97 ELEVATOR CONTROL COMPONENTS OVERVIEW

AFT TORQUE TUBE COMPONENTS

DESCRIPTION

A common aft quadrant receives the cable-transmitted input from the forward quadrant and crank. The aft quadrant is mounted on a torque tube located on the stabilizer hinge bulkhead. A lever arm and linkage on the torque tube transmit centering forces and artificial feel from the feel unit to the cable system. Another lever arm conveys input through linkages to the input controls on each inboard power control package. Three cranks mounted on the top of the torque tube convey input from the three autopilot servo modules mounted on the stabilizer hinge bulkhead.

SUMMARY :

AFT TORQUE TUBE

- wird betätigt durch Control Cables und Aft Quadrant
- betätigt Control Rods zur Ansteuerung der Inboard Power Control Packages
- Rig Pin für Neutral
- ist durch Linkage mit der Feel- and Centering Unit verbunden

FEEL- AND CENTERING UNIT

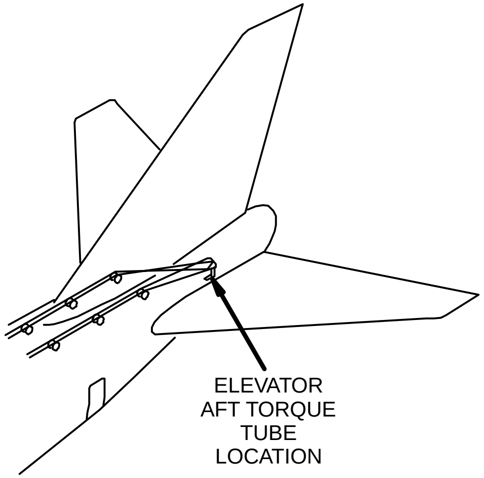
- erzeugt in Verbindung mit Feel Actuator Gegenkräfte für die Control Columns
- stellt Control Columns nach Auslenkung auf Neutral (Centering)

FEEL ACTUATOR

- erzeugt variable Gegenkräfte
- erhält Feel Pressures vom Feel Computer

AUTOPILOT ACTUATORS

- 3 Autopilot Actuators, je einer auf den jeweiligen Flight Control Computer (FCC) aufgeschaltet ist mit der Aft Torque Tube verbunden und steuert die Elevators



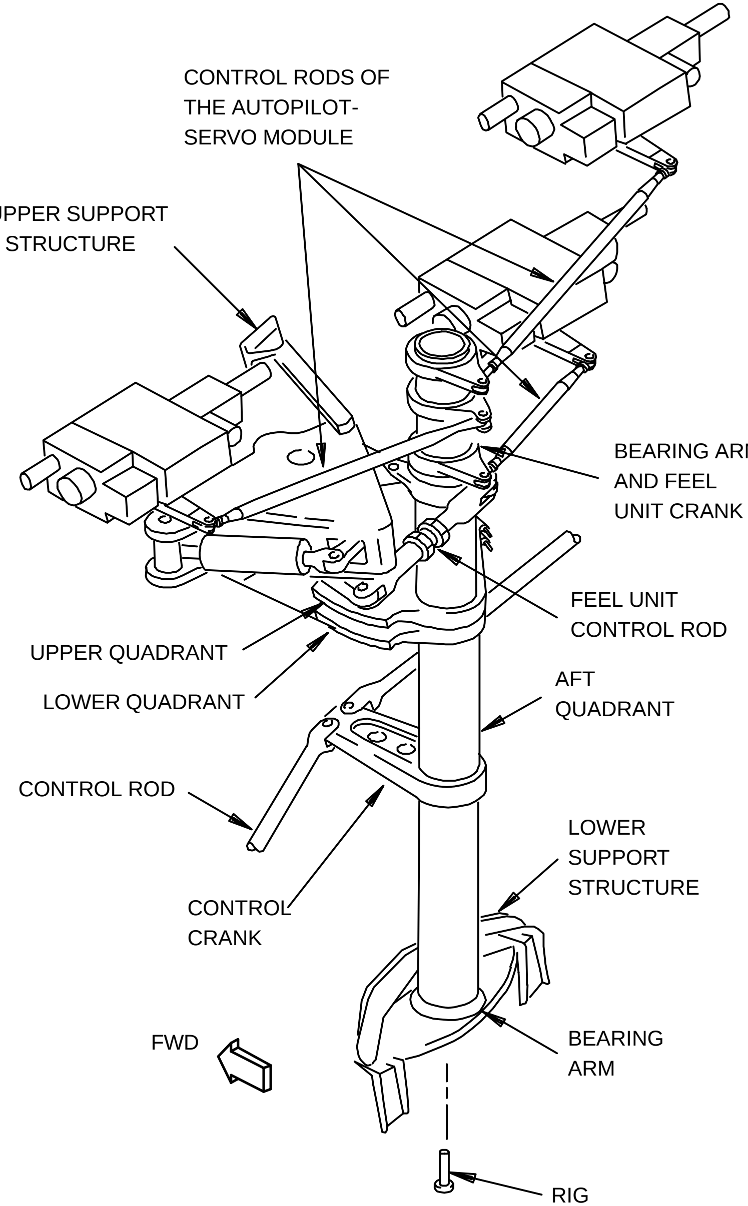


Figure 98 AFT TORQUE TUBE COMPONENTS

ELEVATOR AUTOPILOT SERVO (EAS)

DESCRIPTION

The three elevator autopilot servos (EASs) are mounted on the aft side of the stabilizer hinge bulkhead and are held in place with four mounting bolts. Looking down on the aft quadrant torque tube. The Center EAS is on the left, the Right EAS is the center servo (left side of torque tube) and the Left EAS is on the far right. Each EAS is linked by an adjustable control rod from its output crank arm to the aft quadrant torque tube.

The Left EAS is fed by hydraulic system No. 3, the Center EAS is fed by hydraulic system No. 1, and the Right EAS is fed by hydraulic system No. 2.

The basic function of the servo is to position the airplane control linkage in response to electrical command signals provided by AFDS.

The EAS is an electrohydraulic actuator driven by an electrohydraulic servovalve. The actuator output force is controlled by a regulated pressure that is supplied to two concentric detent pistons. Two solenoid valves allow the servovalve to be pressurized separately from the detent piston, for arming and engaging respectively. The output displacement of the detent pistons is transmitted to the control linkage through an internal crank arm. The positions of the actuator and output arm are monitored by identical LVDT type position sensors.

SOLENOID VALVES

Two solenoid valves (ARM and ENGAGE) are mounted on each EAS. The valves are installed with four mounting bolts and sealed with a gasket plate and O-ring. Electrical connectors mate when the valve is bolted into position. Both valves are opened by a 28 volt discrete signal which is supplied by the FCC when the appropriate logic is satisfied.

When opened, the ARM solenoid ports hydraulic fluid to both the servovalve and the ENGAGE solenoid. When opened, the ENGAGE solenoid ports hydraulic fluid to the detent pistons. The detent pistons, when pressurized, clamp the actuator piston to the output crank, The autopilot commands can then be translated to the elevator control surface.

ELECTROHYDRAULIC SERVOVALVE (EHSV)

One EHSV is mounted on each EAS. The EHSV is mounted with four mounting bolts and sealed with a gasket plate and O-ring. Electrical connectors mate when the valve is bolted into position. The EHSV contains a sealed torque motor, feedback spring, projector jet and an internal piston.

The EHSV distributes hydraulic fluid to the autopilot actuator piston at a rate, and in a direction, proportional to the electrical current flow in either of the two motor windings. Thus, the polarity on the motor windings determines the direction of flow of hydraulic fluid (toward C1 or C2) and the magnitude of the current determines the flow rate of hydraulic fluid.

LINEAR VARIABLE DIFFERENTIAL TRANSDUCER

Each EAS has 2 LVDTs: one is the autopilot LVDT, the other is the output (surface position) LVDT. The autopilot LVDT senses position of the actuator piston. This electrical position signal is fed back to the FCC to complete the control loop for EHSV command signals and to detect servo failure. The output LVDT is operated by an internal crank which is connected to the external crank, thus providing the FCC with elevator surface position. This electrical position signal is compared with the autopilot LVDT for synchronization and failure detection.

Both LVDTs are variable reluctance transformers with an output that varies directly with linear mechanical motion. Each LVDT is excited by 26 volts ac that is supplied by its associated FCC. LVDTs are not line replaceable units (LRUs).

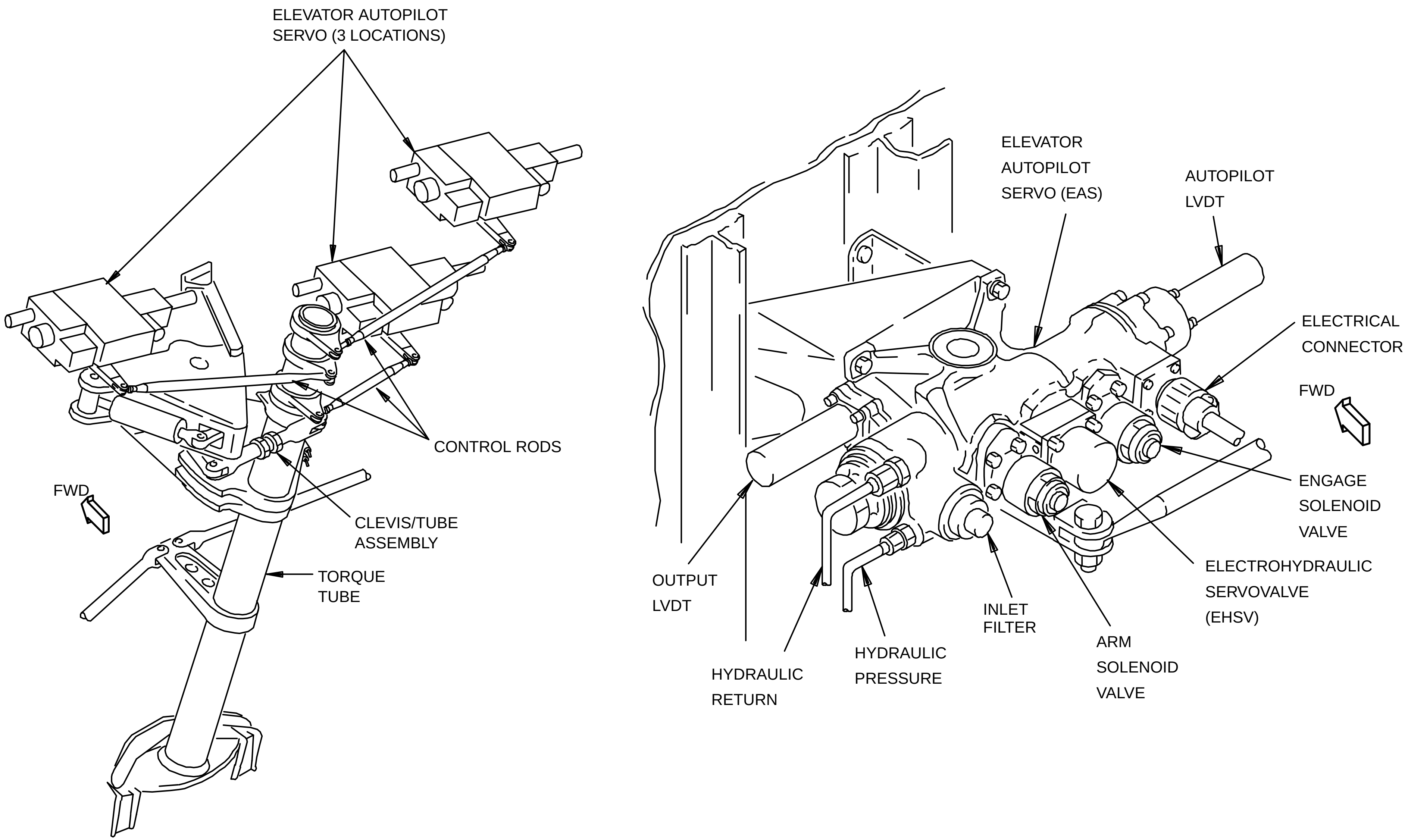


Figure 99 ELEVATOR AUTOPILOT SERVO (EAS)

ELEVATOR FEEL COMPUTER

DESCRIPTION

The feel computer is the controlling element in a hydraulically powered subsystem comprising the computer, a feel actuator and a feel unit. The computer modulates hydraulic pressure inputs to the feel actuator in response to changes in dynamic air pressure (Qc) and horizontal stabilizer position. Airplane hydraulic systems No. 2 and 3 provide the hydraulic pressure inputs from which feel pressure is derived.

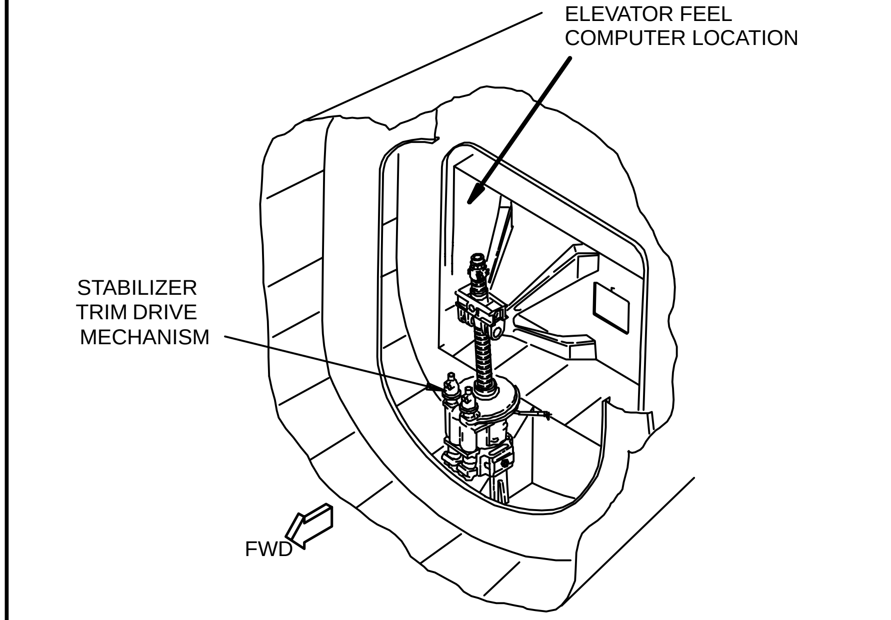
The computer contains two identical groups of components, each of which provides a separate feel pressure input to the feel actuator. A pressure differential sensing actuator in the computer senses the feel pressure output of both groups of components. The actuator closes one of two switches if the output pressure from one group falls to approximately 75 percent of the output from the other group.

SUMMARY :

FEEL COMPUTER

- Pressure Regulators
  - erzeugt Feel Pressures
  - werden versorgt vom Hydraulic System No. 2 und No.3
  - Pitot Pressure von Aux.System No.1 und No.2
  - Static Pressure über Static Ports
  - Stabilizer Trim Input über Input Arm und Input Rod vom Stabilizer
  - Rig Pin für Input Arm (Stabilizer Neutral)
- Feel Pressure Differential Switches
  - vergleichen Feel Pressures
  - schalten bei 25% Differenz EICAS Message

ELEVATOR FEEL COMPUTER



For example :

FAILURE INDICATION OF A COMPONENT OF THE ELEVATOR FEEL COMPUTER

Whenever a fault is detected for the elevator feel computer the status message :

ELEVATOR FEEL 27 30 01 00

appears

and on the MCDU is shown the reason for the EICAS message

CMC message :

ELEVATOR FEEL COMPUTER FAIL 27 401.

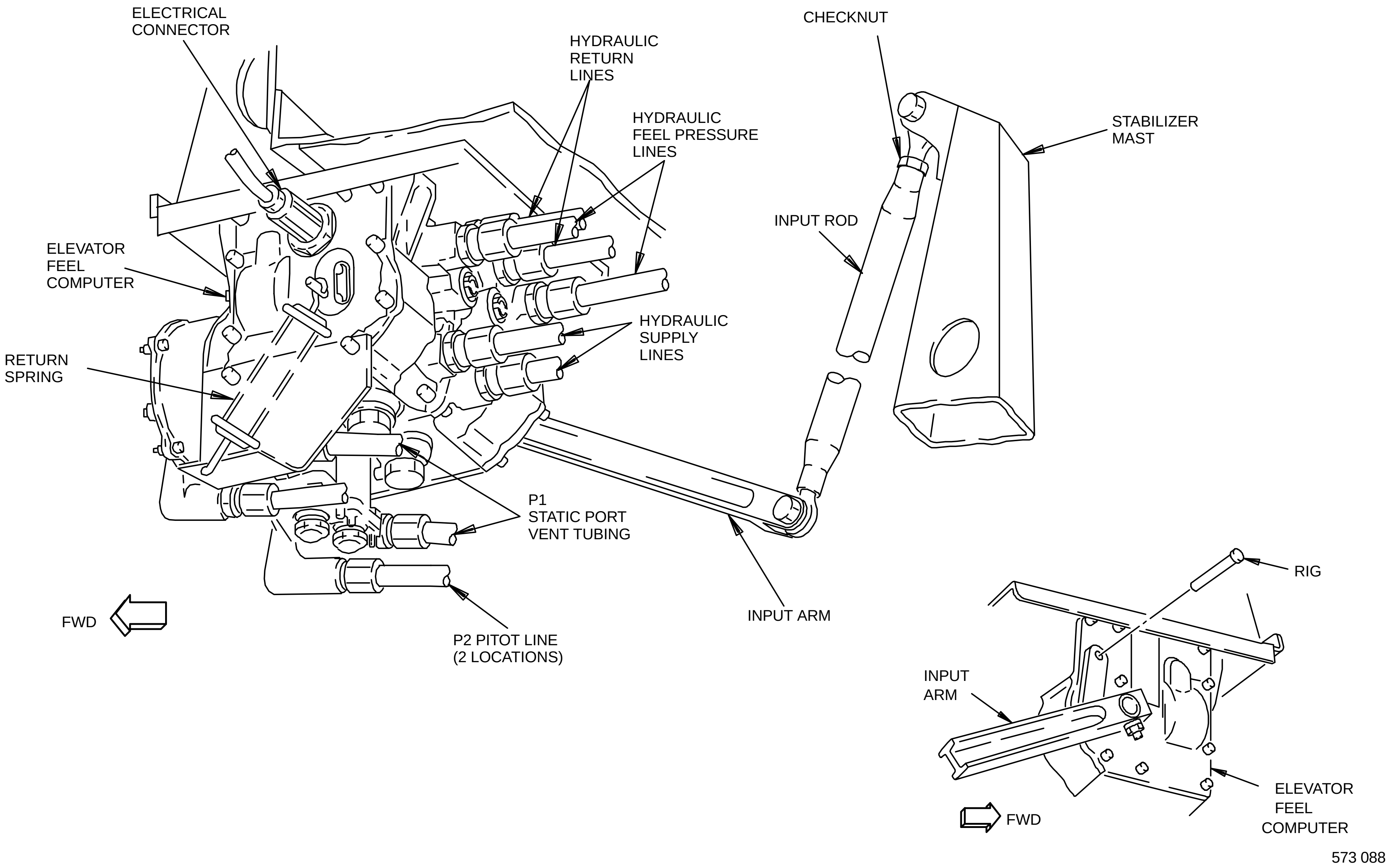


Figure 100 ELEVATOR FEEL COMPUTER

ELEVATOR CONTROL SYSTEM STANDPIPE

DESCRIPTION

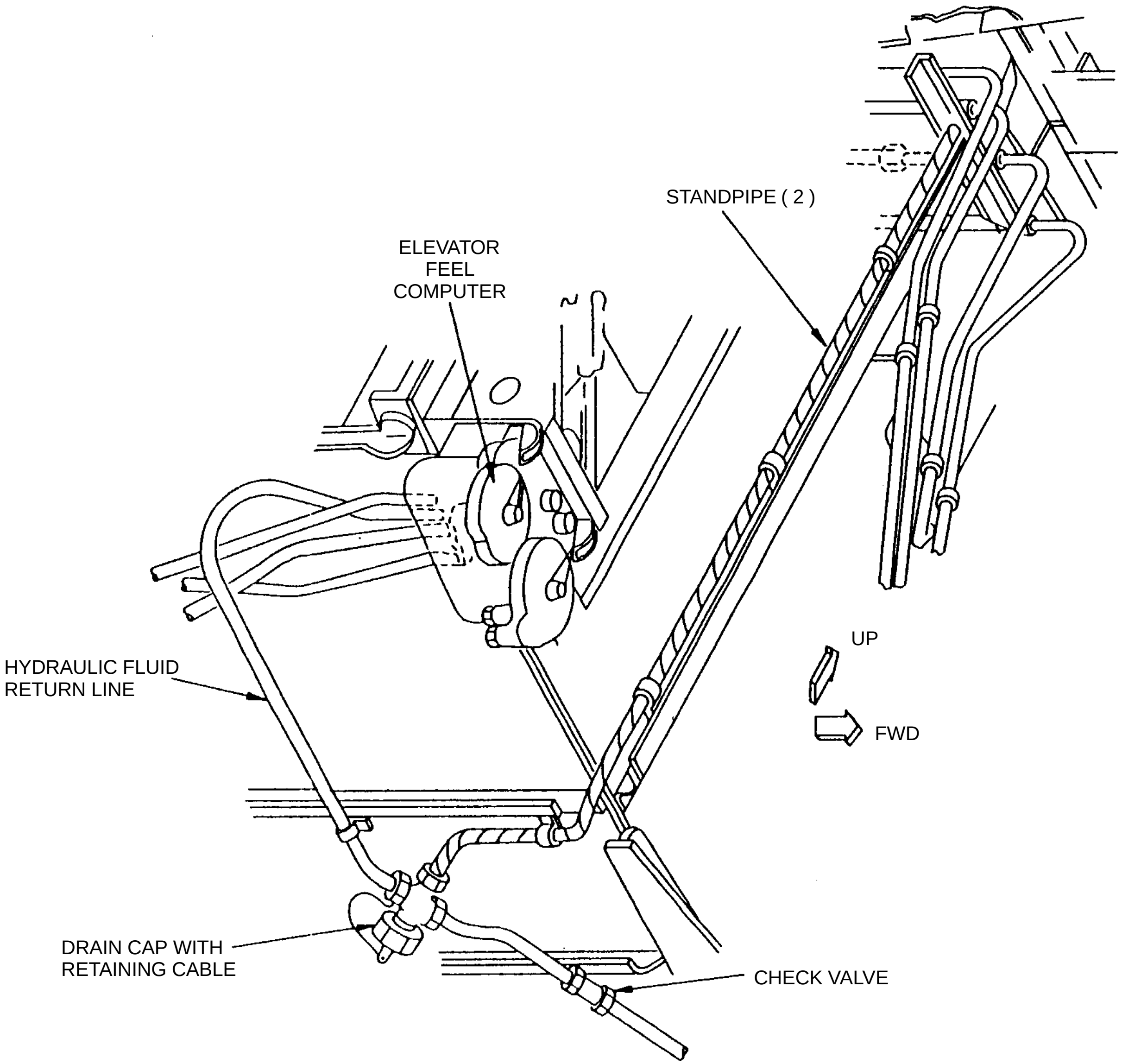
STANDPIPE (2)

- dämpfen die Druckstöße in den Return Lines von dem Feel Actuator und Feel Computer, damit wird ein besseres Regelverhalten für die Pressure Regulators erreicht

- Cap für Drain

- Check Valve zwischen dem Feel Actuator / Feel Computer und dem Hydraulic Return System in der Return Line, damit beim Drainen, der Return Pressure nicht wirksam werden kann.

- sind im Stabilizer Compartment im Bereich links und rechts der Feel Computers eingebaut



LEFT SIDE SHOWN,
RIGHT SIDE SIMILAR.

Figure 101 ELEVATOR CONTROL SYSTEM STANDPIPE

ELEVATOR FEEL UNIT

DESCRIPTION

ELEVATOR FEEL ACTUATOR

The feel actuator, which is mounted on the elevator feel unit, receives hydraulic pressure inputs from the feel computer. The actuator comprises two rams acting in opposite directions within a free floating cylinder. One ram is connected to the feel unit body, which is attached to the airplane structure, and the other to the feel linkage. The force exerted by the actuator is proportional to the parallel outputs of the feel computer, therefore failure of one output does not effect elevator feel. The feel force is transmitted to the elevator controls through the feel unit.

ELEVATOR FEEL UNIT

The feel unit transmits the force exerted by the feel actuator to the elevator controls. Feel pressure acts on the feel actuator rams to apply force through a Y linkage attached to a cam mounted on a pivot shaft. A lever mounted on the same shaft connects the feel unit to the elevator aft quadrant. When moving the control column in either direction, the operator must overcome the feel force transmitted through the linkage to rotate the cam. As the cam rotates, a roller in contact with the cam surface moves out of detent, displacing a lever arm against the force exerted by two centering springs. When the pilot releases the control column, the roller exerts pressure to center the cam, acting with feel pressure to return the control column to neutral.

SUMMARY :

ELEVATOR FEEL UNIT

- Feel Actuator
  - erhält Feel Pressure von dem Elevator Feel Computer
  - hat 2 Kolben
  - Kolbenstangen sind mit Feel- and Centering Mechanism verbunden
- Feel- and Centering Mechanism
  - erzeugt Gegenkräfte
  - zentriert Aft Torque Tube nach Auslenkung

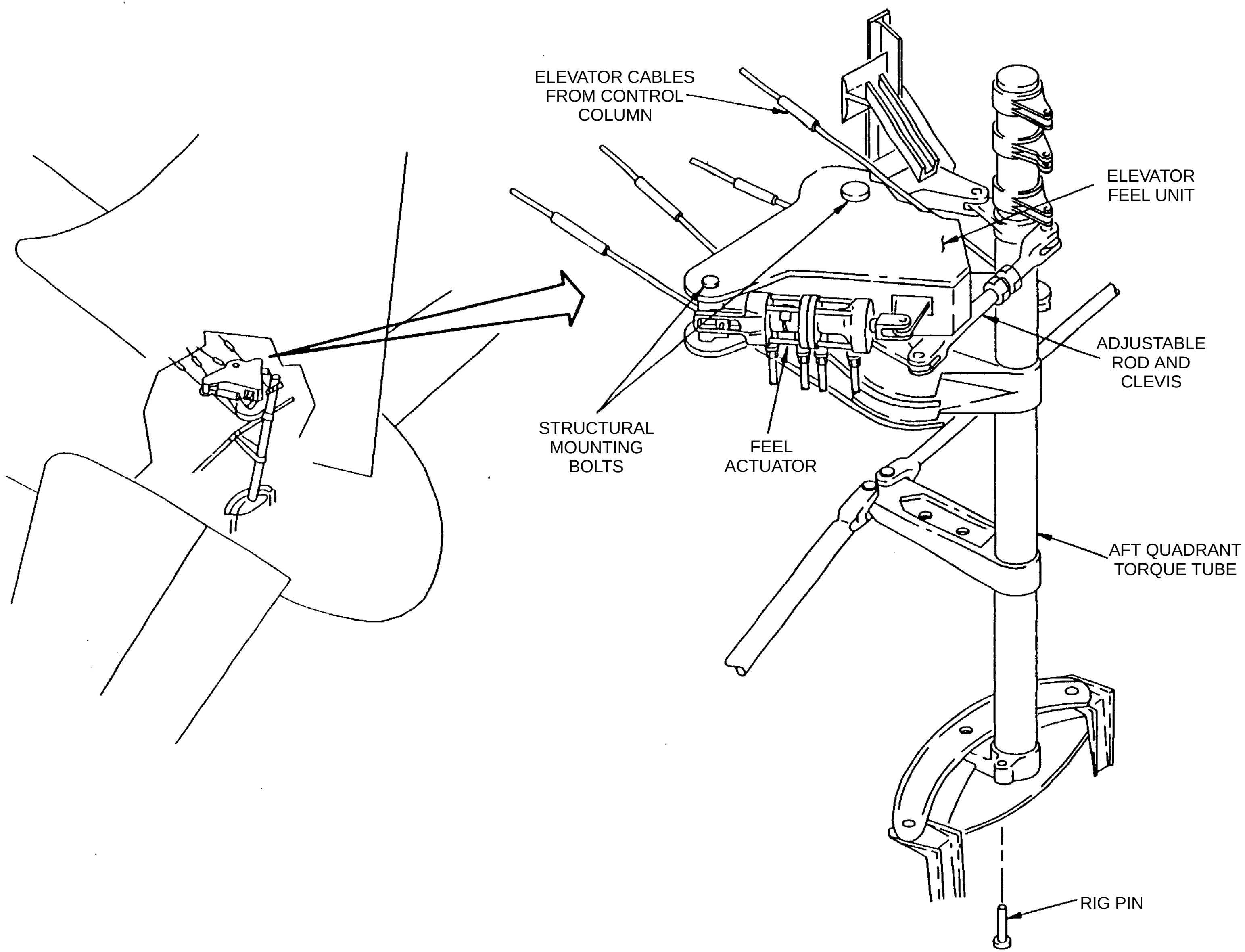


Figure 102 ELEVATOR FEEL UNIT

ELEVATOR FEEL UNIT FUNCTIONAL SCHEMATIC

DESCRIPTION

FEEL MECHANISM

- der Centering Cam, die Roller und die Spring sind immer wirksam, wobei die Spring ständig den Roller in die tiefste Position der Centering Cam zieht
- das Gehäuse des Feel Mechanism selbst ist an der Structure angelenkt und damit feststehend

FEEL ACTUATOR

- beaufschlagt den Centering Cam
- das Gehäuse ist nicht mit dem Feel Mechanism verbunden
- das Gehäuse wandert, wenn eine Feel Pressure Differenz vorhanden ist, z.B. Ausfall des Hydraulic Systemes No.2 oder No.3; Auf- und Abschalten der Hydraulic Pressure Versorgung (see FEEL PRESSURE Message)

KRäFTE

- werden an den Control Columns gemessen
- die Kräfte sind von verschiedenen Faktoren abhängig

NOTE :

Je schwerer das Flugzeug und geringer die Geschwindigkeit, desto mehr Airplane Nose Up und desto leichter die Betätigungskräfte und umgekehrt.

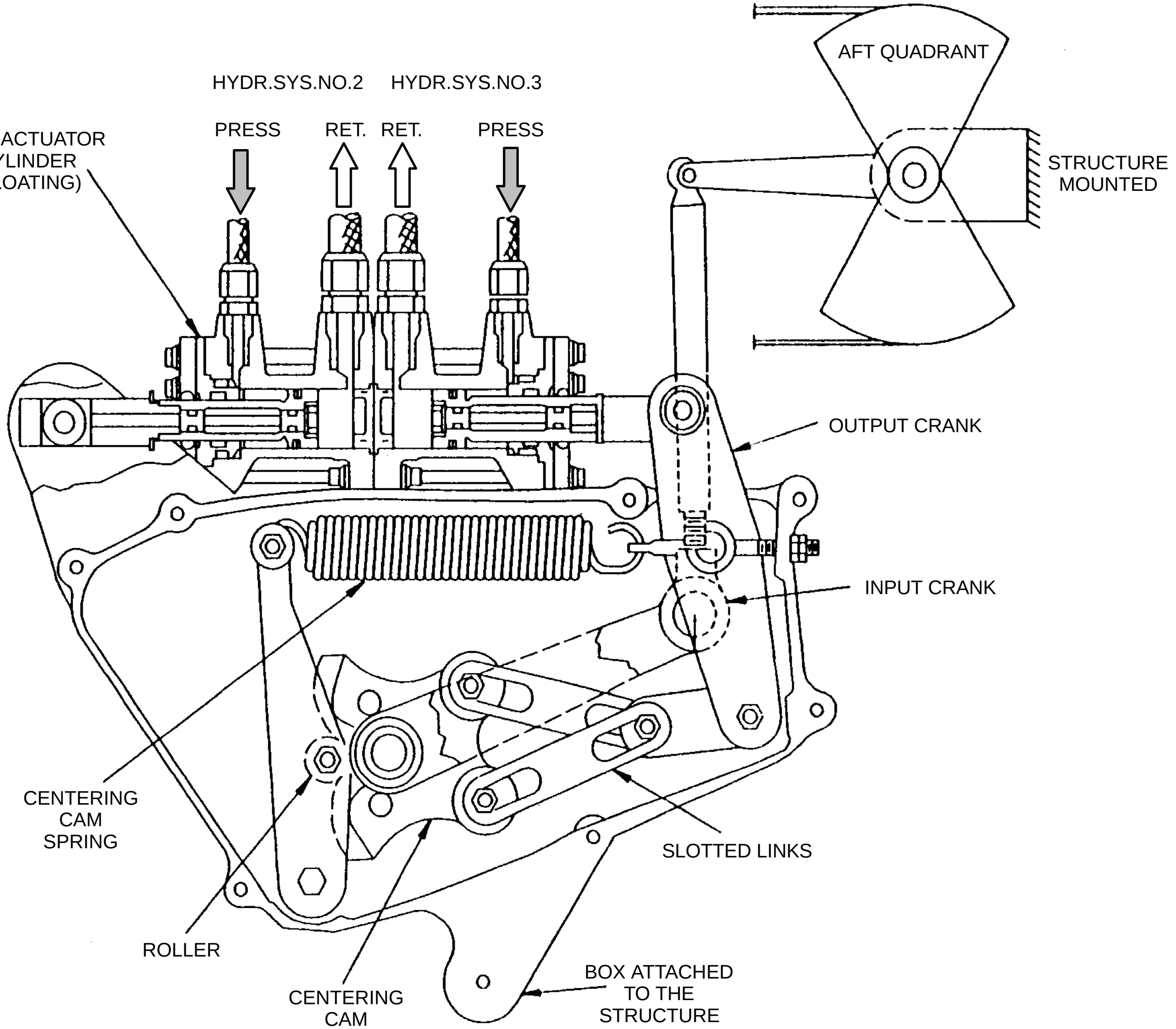


Figure 103 ELEVATOR FEEL UNIT FUNCTIONAL SCHEMATIC

ELEVATOR FEEL SYSTEM FUNCTIONAL SCHEMATIC

DESCRIPTION

Der Elevator Feel Computer verarbeitet folgende Eingangssignale zur Steuerung des Elevator Feel Pressures :

- Static Pressure über Vent Fittings
- Pitot Pressure vom Aux. System No.1 und No.2
- Stabilizer Position Input
- Hydraulic System No.2
- Hydraulic System No.3.

In dem Pressure Regulator des Feel Computers wird der Hydraulic Pressure (System Pressure) durch die Inputs von Pitot- und Static Pressure, sowie der Stabilizer Position (Schwerpunktlage / Gewicht) verändert.

Der Ausgangspressure des Pressure Regulators ist der Feel Pressure, dieser wird durch die Feel Pressure Differential Pressure Switches überwacht und schaltet bei einer **FEEL PRESSURE DIFFERENZ von > 25%** die

Status Message :

ELEVATOR FEEL

und die CMCS Message

ELEVATOR FEEL COMPUTER FAIL.

NOTE: Durch das zeitlich versetzte Ausschalten der Hydraulic Systeme No.2 und No.3, z.B. Engine Shutdown erscheint die Message z.Zt. auch, welches dann aber nicht auf einen Fehler hinweist.
Siehe FIM und NOTES im CMCS (Line Select Key 4R)!

Der Feel Pressure gelangt zu dem Feel Actuator, dessen Kolben fest mit Feel Mechanism verbunden sind und dadurch ein schwimmender Kolben vorhanden ist, d.h. fällt einer der beiden Feel Pressure aus, so wandert der Kolben bis auf Anschlag zur entgegengesetzten Seite.

Der Elevator Feel Actuator- und der Pressure Regulator Return Pressure sind mit einer Leitung verbunden. Diese Leitung hat eine Standpipe, die im Kopfende mit Luft gefüllt ist, dadurch werden die Druckstöße gedämpft und ein besseres Regelverhalten der Pressure Regulators in dem Feel Computer erreicht. Über ein Drain Valve, verschlossen mit einer Drain Cap, kann die Standpipe entlüftet werden.

Damit beim Drainen nicht der System Return Pressure wirksam ist, wurde ein Check Valve in der jeweiligen Return Leitung eingebaut.

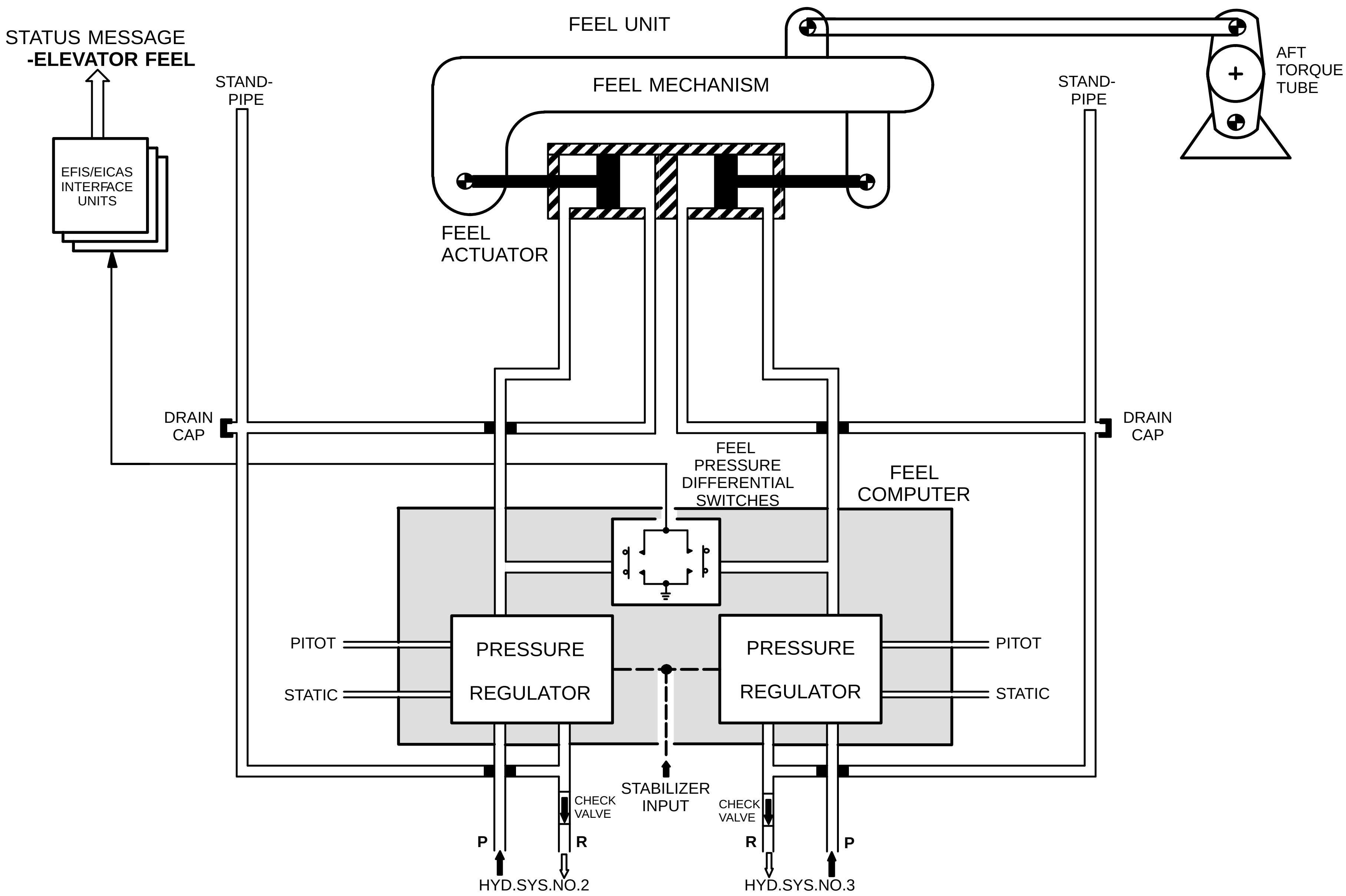


Figure 104 ELEVATOR FEEL SYSTEM FUNCTIONAL SCHEMATIC

INBOARD ELEVATOR SYSTEM

DESCRIPTION

INBOARD ELEVATORS

The inboard elevators are similar in construction to the outboard elevators. Each elevator attaches to the horizontal stabilizer trailing edge at four points. The attachments are similar to those provided for the outboard elevators. The inboard elevators are not mass balanced. Seven panels in the lower skin provide access to the interior.

INBOARD ELEVATOR POWER CONTROL PACKAGE

The inboard elevator PCPs are hydraulic power units used to actuate the inboard elevators. Each PCP drives its associated inboard elevator independently. The two inboard PCPs are identical to each other, but different from the two outboard PCPs. The differences stem chiefly from the load output requirements. The inboard elevator PCPs contain many components which are functionally similar to outboard elevator PCP components, as well as unique components reflecting their function as master units with dual hydraulic inputs.

The inboard elevator PCPs receive mechanical inputs through linkage from the rear elevator control quadrants. The left PCP is powered by hydraulic systems No. 1 and 2; and the right PCP by hydraulic systems No. 3 and 4.

SUMMARY :

INBOARD ELEVATOR POWER CONTROL PACKAGE

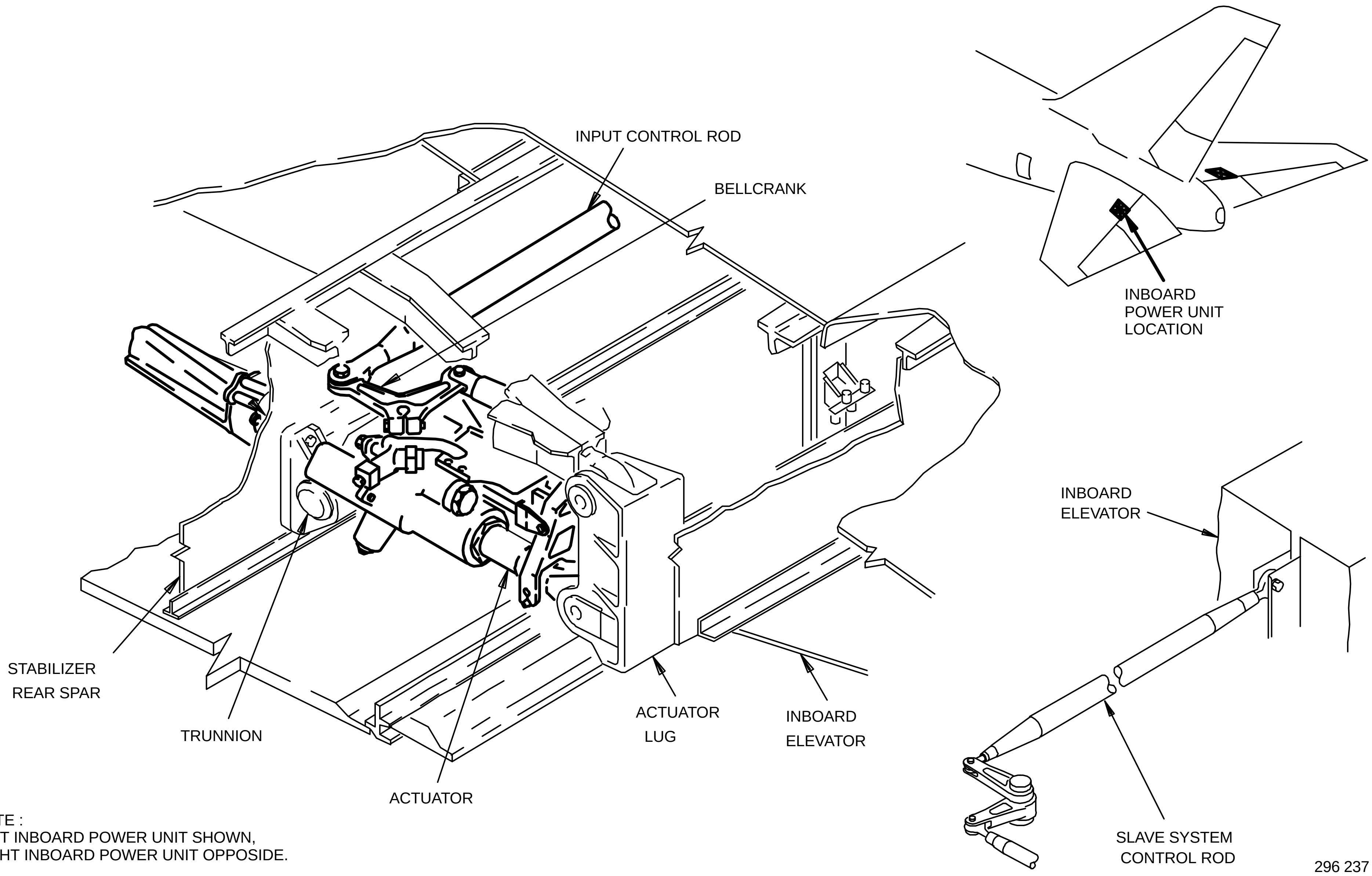
- betätigt Inboard Elevator
- Control Rod
  - betätigt Summing Lever
  - wird von Aft Torque Tube betätigt
  - Adjustment für Inboard Elevator Neutral
- Summing Lever dient zur Betätigung vom Control Valve bei Ansteuerung und Follow Up
- Control Valve kann bei Blockierung übersteuert werden, so daß die Ansteuerung der anderen Control Packages weiterhin gewährleistet ist.

INBOARD ELEVATOR

- ist statisch nicht ausgewogen
- Control Rods (Slave Linkage)
  - betätigt Outboard Elevator Control Package Control Valve
  - Shear Rivet schert ab bei einer Blockierung
- Neutral Justierung bei Stabilizer Neutral

INBOARD ELEVATOR RIG POSITION

- Inboard Elevator Rig Neutral Position : 1.0 +/- 0.2° UP



NOTE :
LEFT INBOARD POWER UNIT SHOWN,
RIGHT INBOARD POWER UNIT OPPOSIDE.

Figure 105 INBOARD ELEVATOR POWER CONTROL PACKAGE

OUTBOARD ELEVATOR SYSTEM

DESCRIPTION

OUTBOARD ELEVATORS

Each outboard elevator consists of a conventional spar and rib frame supporting honeycomb sandwich skins. The frame members are of aluminum alloy. The front spar and ribs are built up from extruded upper and lower flange members with alclad sheet webs supported by stiffeners. The skin panels consist of fiberglass honeycomb core material contained between two 5-ply bonded surfaces of fiberglass fabric reinforced epoxy plastic. A trailing edge, also of fiberglass honeycomb bonded construction with reinforced plastic surfaces, is riveted to the rear spar. A leading edge, consisting of aluminum alloy skins supported by ribs, projects forward of the front spar. The leading edge structure supports mass balance weights.

Each outboard elevator attaches to the horizontal stabilizer trailing edge at six points. The major attachment is at the actuator reaction structure, where the hinge bearing is carried by support structure in the horizontal stabilizer trailing edge. At each of the remaining attachment points, which are of lighter construction, the hinge bearing is contained in a machined hinge fitting bolted to the elevator front spar. Balance weight installations project forward of the hinge line. Each supports a tungsten balance weight. The three inboard installations also provide fittings for additional adjustment weights. Eleven panels in the lower skin provide access to the interior of the elevator.

OUTBOARD ELEVATOR CONTROL

The mechanical control to each outboard elevator PCP is transmitted mechanically through a slave system from the corresponding inboard elevator. A control rod connected to the inboard elevator front spar operates a control linkage, which is connected by control rods to the corresponding outboard elevator PCP.

OUTBOARD ELEVATOR POWER CONTROL PACKAGE

The outboard elevator PCPs receive mechanical inputs via the inboard elevators. Each unit actuates in response to movement of the adjacent inboard elevator. The left PCP is powered by hydraulic system No. 1 and the right PCP by hydraulic system No. 4.

SUMMARY :

OUTBOARD ELEVATOR POWER CONTROL PACKAGE

- betätigt Outboard Elevator
- Control Valve wird durch Control Rods vom Inboard Elevator betätigt. Adjustable Control Rod steuert über Summing Lever Power Control Package Control Valve.

OUTBOARD ELEVATOR

- ist statisch ausgewogen

OUTBOARD ELEVATOR RIG POSITION

- Outboard Elevator Rig Neutral Position : 1.0 +/- 0.5° DOWN
  daraus folgt :
- Outboard Elevator nach Inboard Elevator 2.55” - 2.75” DOWN

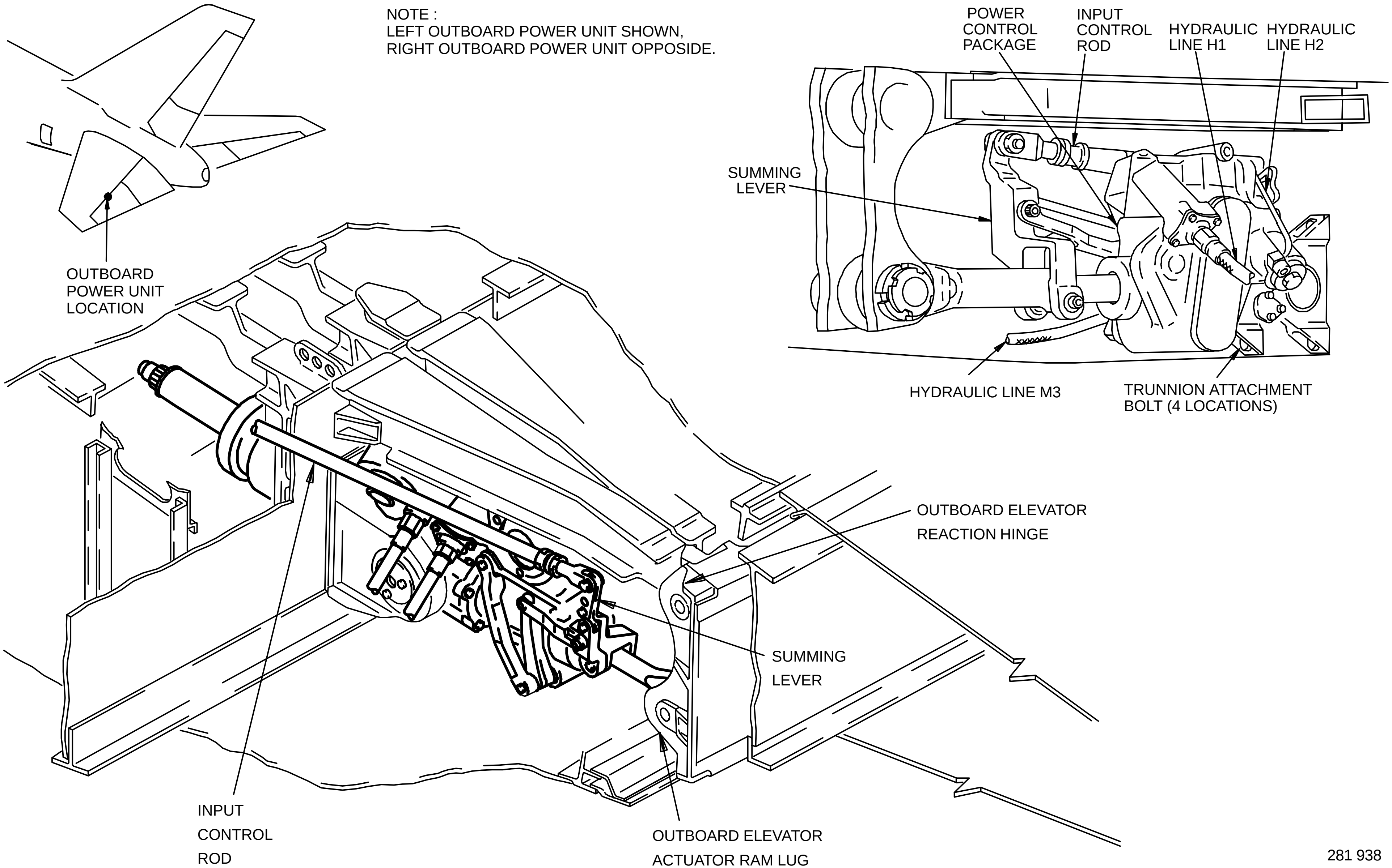


Figure 106 OUTBOARD ELEVATOR POWER CONTROL PACKAGE

ELEVATOR ADJUSTMENT

DESCRIPTION

Bevor die Elevator Position eingestellt werden kann, muß der Stabilizer in die Neutral Position gefahren werden.

Siehe Beschreibung der Stabilizer Neutral Positons Einstellung in ATA 27-41-00.

This task is used to set the horizontal stabilizer to the neutral rig position. It can also be used to set the stabilizer to other positions.

The horizontal stabilizer is at the neutral rig position when the "B" dimension is at 7.42+/-0.05 inches and the stabilizer position indicator is at the 3 units of trim.

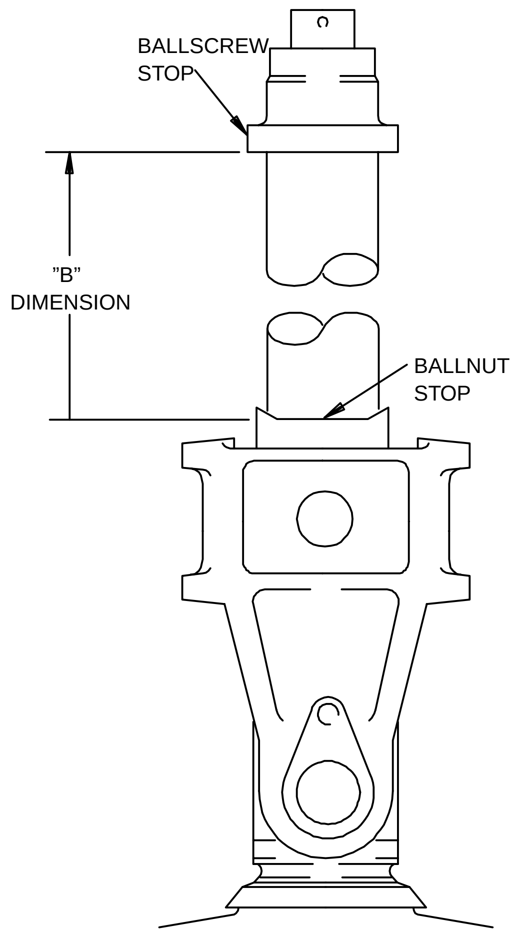
The "B" dimension is the distance along the ballscrew between the surfaces of the ballnut stop and the ballscrew stop.

Anschließend werden die Inboard Elevators über die beidseitig am Rumpfheck angebrachten Rigplates eingestellt und die Outboard Elevator nach den Inboard Elevators eingestellt.

Die Inboard Elevator werden grundsätzlich **1° UP von der Neutral Position** eingestellt.

Die Outboard Elevator werden grundsätzlich **1° DOWN von der Neutral Position oder 2° DOWN von dem Inboard Elevator** eingestellt.

STABILIZER TRIM JACK SCREW



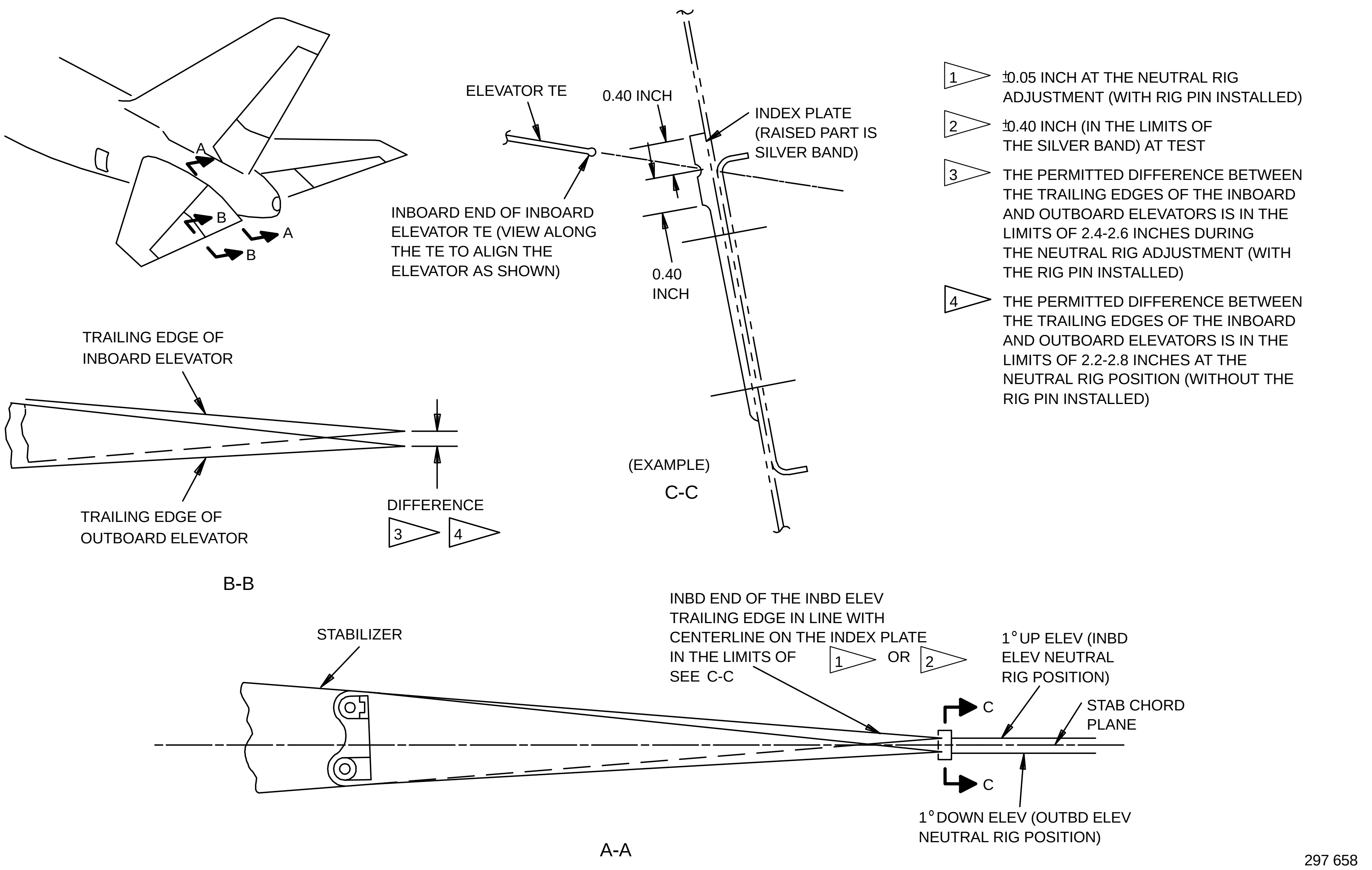


Figure 107 IN- AND OUTBOARD ELEVATOR ADJUSTMENT

COLUMN POSITION TRANSMITTER

GENERAL

The position of the aileron control wheel, elevator control column, and rudder pedals is sensed by position transmitters for display on the EICAS flight controls maintenance page and for use by the flight data recorder system (Ref 31-31-00). The electrical signal from the position transmitters is processed by the column/rudder pedal position digitizer card for transmission to the EIU's.

CONTROL COLUMN POSITION TRANSMITTER

The control column position transmitter is located at the left end of the elevator torque tube below the captain's control column. The transmitter contains a synchro transducer. Movement of the torque tube is transferred to the position transmitter shaft through a short actuator shaft. The transmitter is adjusted to zero the **COLUMN** readout on the EICAS flight controls maintenance page when the control column is in the neutral position.

FAILURE INDICATION OF THE COLUMN POSITION TRANSMITTER

For example :

Whenever a fault is detected for the column position synchro on the MCDU is shown the

CMC message :

COLUMN POSITION SYNCHRO FAIL (SPD-COLUMN) 27 989

only.

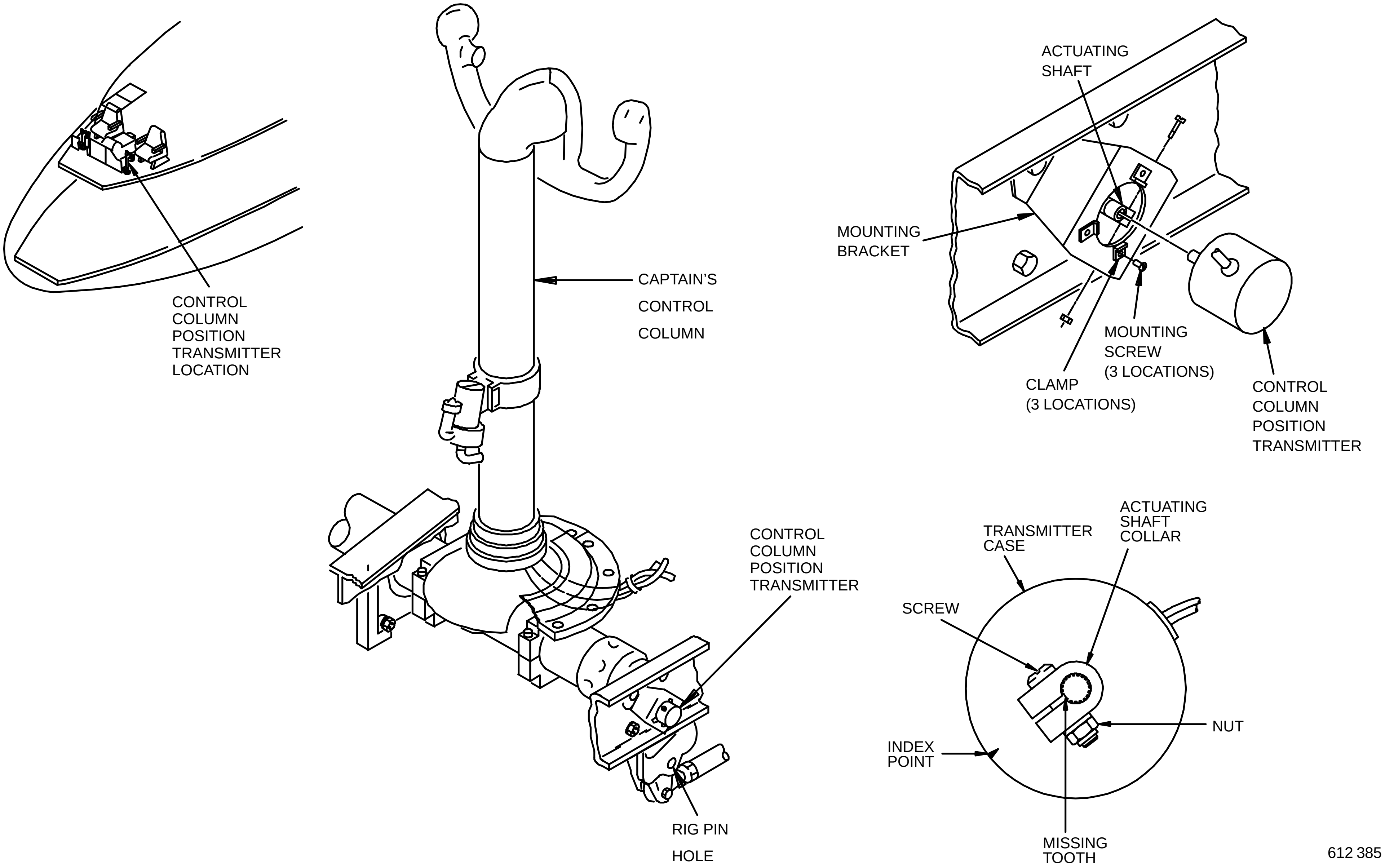


Figure 108 CONTROL COLUMN POSITION TRANSMITTER

ELEVATOR POSITION TRANSMITTER

GENERAL

The elevator position indicating system provides visual indication on the flight deck of outboard elevator angular displacement. The elevator position indicators appear on the EICAS status page as part of the EICAS surface position display.

Components used by the elevator position indicating system are the four elevator position transmitters, the rudder/elevator aft surface position digitizer circuit card, and the EIU's and EICAS display. The system is powered by 28 volts dc from the 28 vdc bus 3 and by 28 volts ac from the 28 vac bus 3 through circuit breakers on the P6 panel.

ELEVATOR POSITION TRANSMITTER

The elevator position transmitters are located between each elevator and the horizontal stabilizer rear spar. An adjustable control rod attaches the transmitter to the elevator. With the elevator in the neutral position, the transmitter can be adjusted to set the elevator position readout on the EICAS flight controls maintenance page to zero.

FAILURE INDICATION OF THE LEFT OUTBOARD ELEVATOR SYNCHRO :

Whenever a fault is detected for the left outboard elevator synchro on the MCDU is shown the

CMC message

LEFT OUTBOARD ELEVATOR SYNCHRO FAIL (SPD-AFT) 27 973.

only.

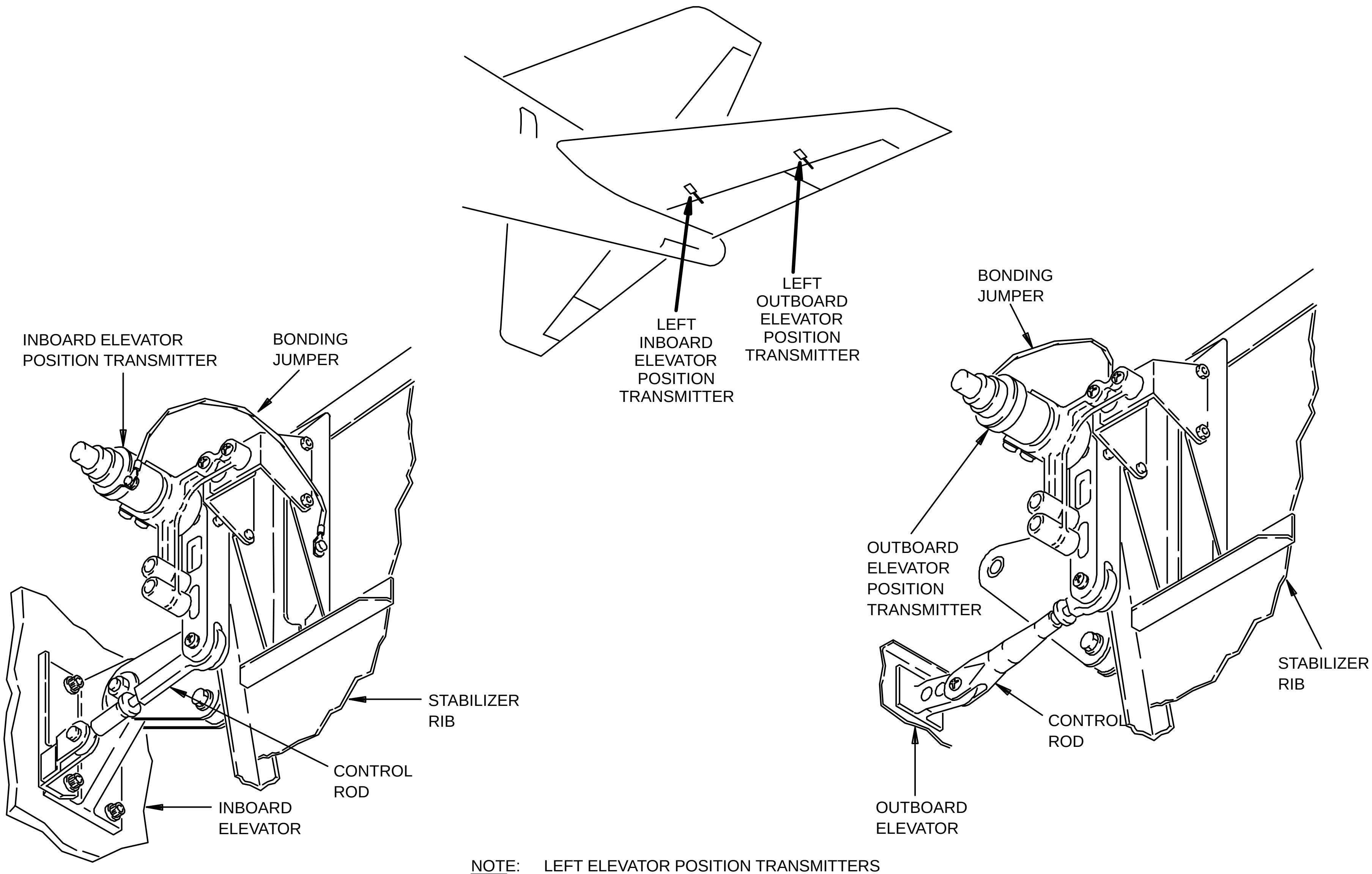


Figure 109 ELEVATOR POSITION TRANSMITTER

AFT SURFACE POSITION DIGITIZER CARD

DESCRIPTION

SURFACE POSITION DIGITIZER CARD

The aft surface position digitizer circuit card YM50001 receives the signals from the elevator position transmitters and converts the signals to a serial digital format for transmission to the EIU's on an ARINC 429 bus. The card is located in the aft SPD card file M8011 in the E8 aft electrical equipment rack.

SUMMARY :

Die Aft Surface Position Digitizer (SPD) Card YM5A001 in dem Aft Equipment Center ist für die Indication über die EFIS/EICAS Interface Units (EIU's) für

- die **ELEVATORS (4)**
  - Elevator Position Transmitter
- die **RUDDER (2)**
  - Rudder Position Transmitter

zuständig,

d.h. sie setzt die von den Transmittern erhaltenen, analogen Signale in digitale um und leitet diese über die EIU's auf

- die FLIGHT CONTROL Maintenance Page

  und
- die Status Page.

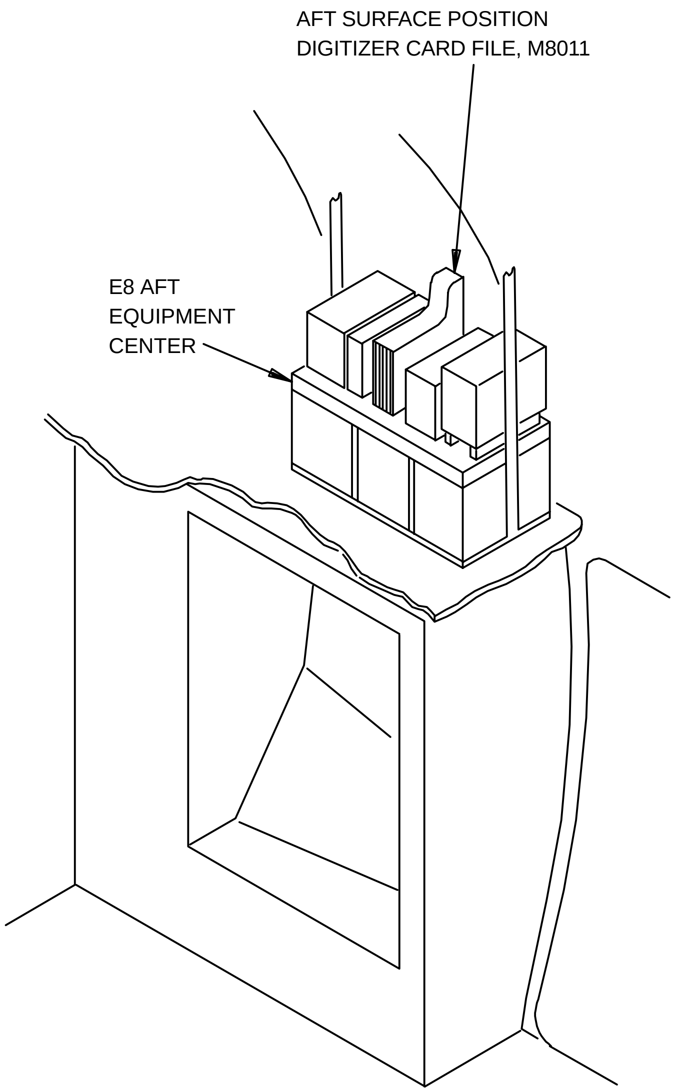
FAILURE INDICATION OF THE AFT SPD CARD :

Whenever a fault is detected for the aft surface position digitizer card on the MCDU is shown the

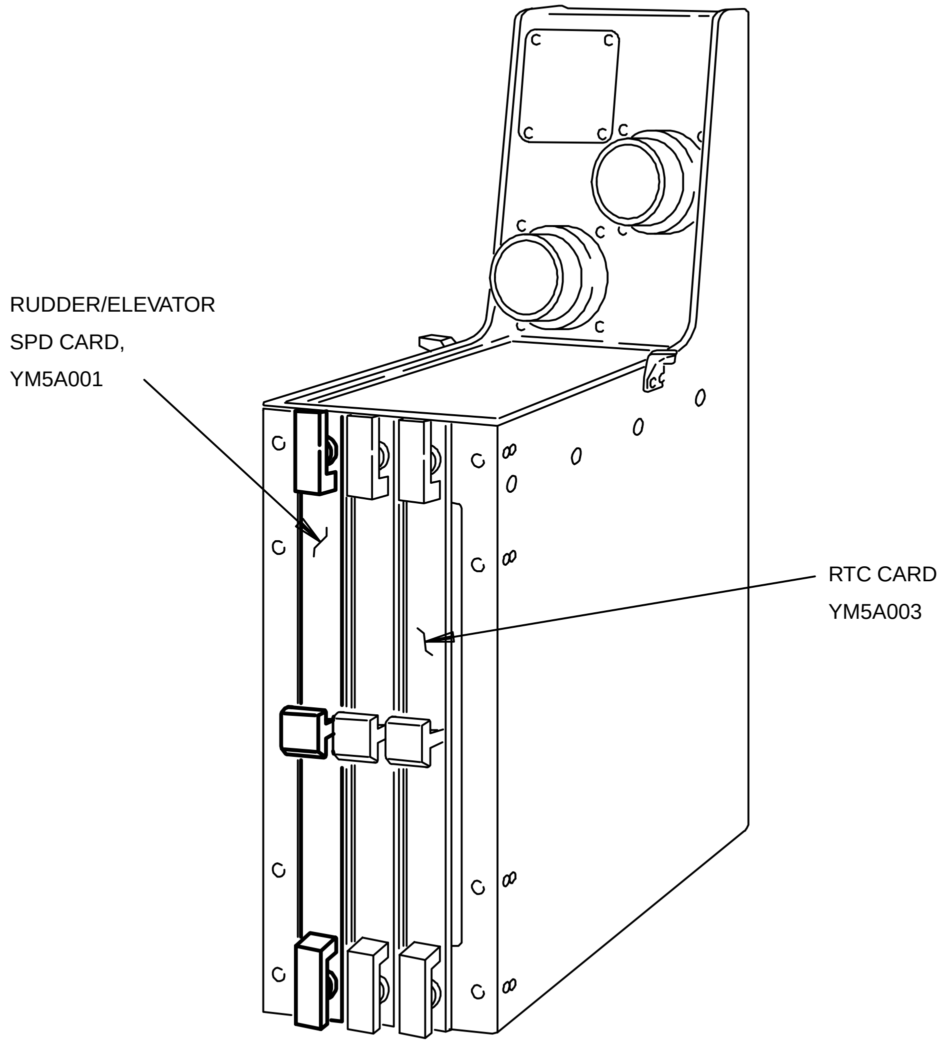
CMC message

AFT SURFACES SPD CARD FAIL (SPD AFT) 27 972

only.



AFT EQUIPMENT CENTER E8



AFT SURFACE POSITION
DIGITIZER CARD FILE, M8011

A04 348

Figure 110 AFT SURFACE POSITION DIGITIZER CARD

ELEVATOR POSITION INDICATING SYSTEM

DESCRIPTION

OPERATION

FUNCTIONAL DESCRIPTION

When the elevator is deflected from the neutral position, the attached control rod drives the transmitter crank which pivots the transmitter shaft. The transmitter electrical output varies as the shaft pivots. The output signal passes to the surface position digitizer which processes the signal and routes it to the EIU's for display on EICAS.

CONTROL

Operation of the elevator position indicating system is automatic. The EICAS surface position display appears when the EICAS status page is invoked.

The flight controls maintenance page may be called up on the auxiliary EICAS display. This page displays the values of elevator angular displacement as numeric readouts for system adjustment and trouble shooting.

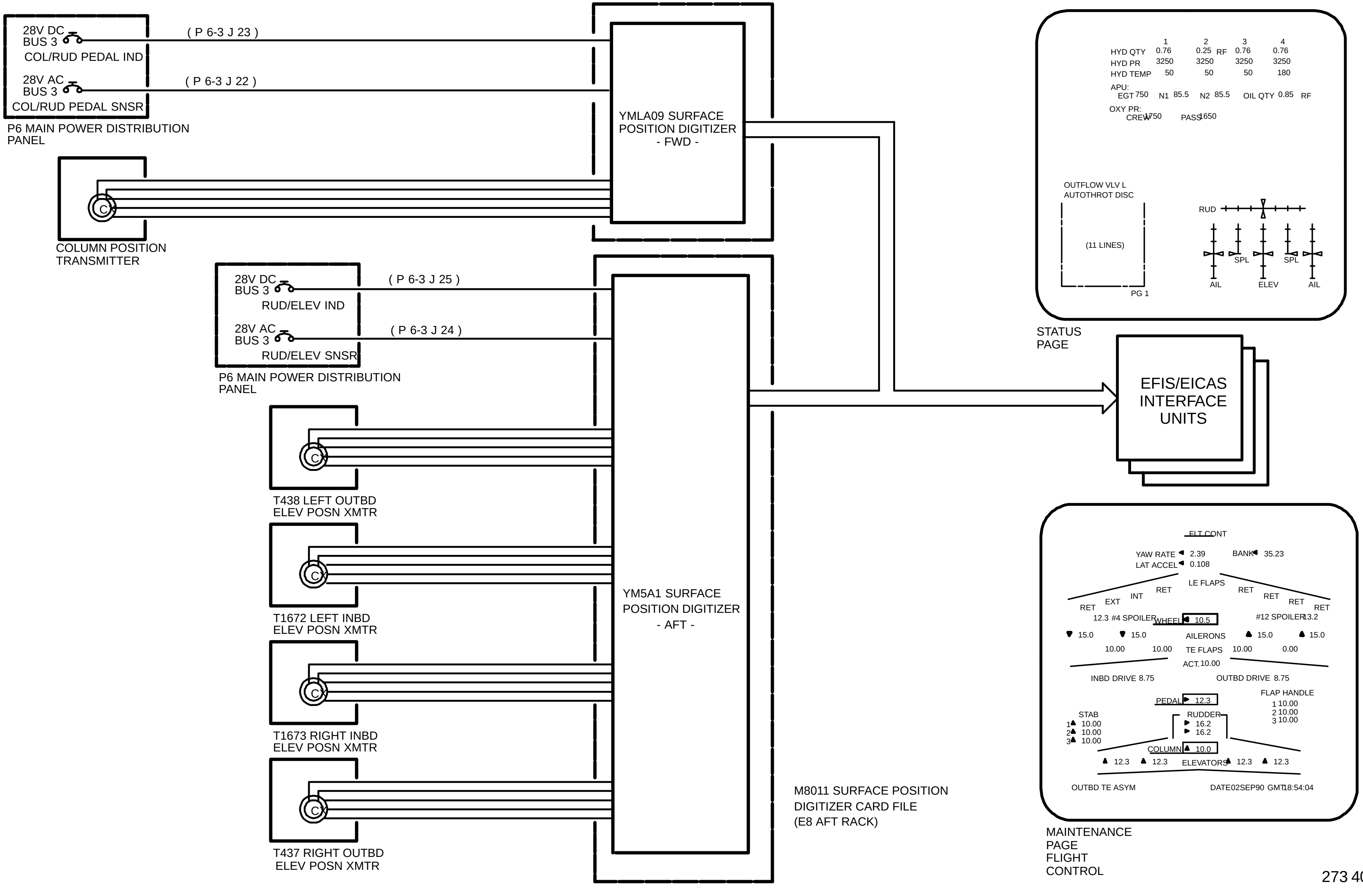


Figure 111 ELEVATOR POSITION INDICATING SYSTEM

27-40 HORIZONTAL STABILIZER

FLIGHT CONTROL MAINTENANCE PAGE

DESCRIPTION

Die Maintenance Page für das Flight Control System ist über das Central Maintenance Computer System (CMCS) folgendermaßen aufrufbar :

- CMC
- MENü
- MAINTENANCE PAGE
- ATA 27
- DISPLAY.

Die Anzeigen:

- des Left Stabilizer Position Transmitters (RVDT's) No.1
- des Center Stabilizer Position Transmitters (RVDT's) No.2
- des Right Stabilizer Position Transmitters (RVDT's) No.3

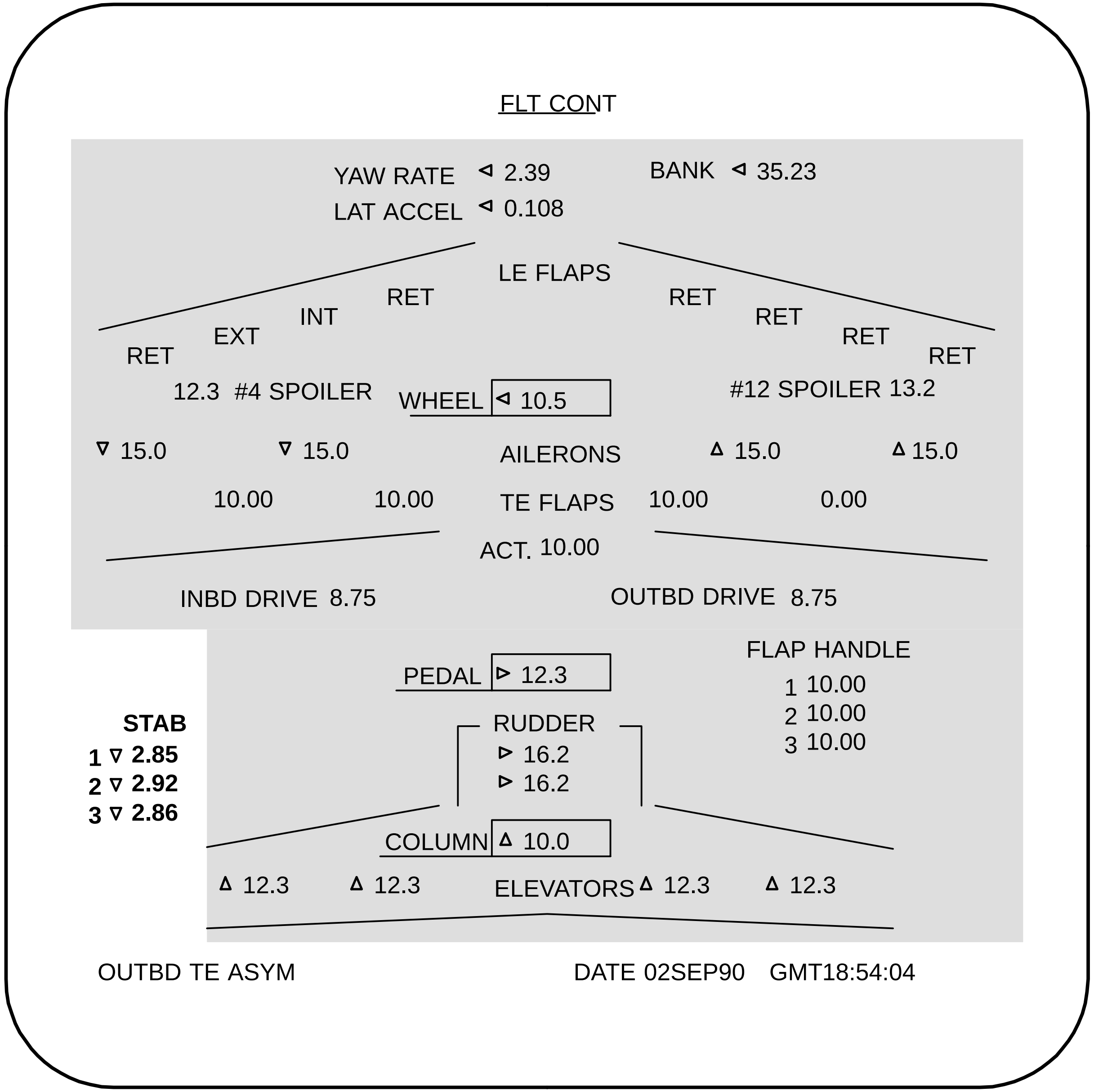
erfolgt in ° .

Die Anzeige erfolgt in Steps von $^{1}/_{10}$ ° .

STABILIZER POSITION :

STAB		
1	▽	2,85
2	▽	2.92
3	▽	2.86

- zeigt den Stabilizer Leading Edge Ausschlag von 1) 2.85°, 2) 2.92° und 3) 2.86° nach DOWN an, d.h. Airplane NOSE UP.



MAINTENANCE
PAGE
FLIGHT
CONTROLS

Figure 112 MAINTENANCE PAGE FLIGHT CONTROL

STABILIZER TRIM POSITION INDICATOR

DESCRIPTION

The stabilizer trim position indicators are located on either side of the P8 pilots' control stand. The indicators give stabilizer position in units of trim, from 0 units (stabilizer at maximum AIRPLANE NOSE DOWN position) to 15 units (stabilizer at maximum AIRPLANE NOSE UP position), with 3 units being stabilizer neutral position. Each stabilizer position indicator contains a synchro receiver which positions the indicator strip.

A lighted bar next to the indicator strip specifies the stabilizer green band during takeoff.

Die Stabilizer Trim Position Indicator zeigen die Stabilizer Position in **UNITS** an,

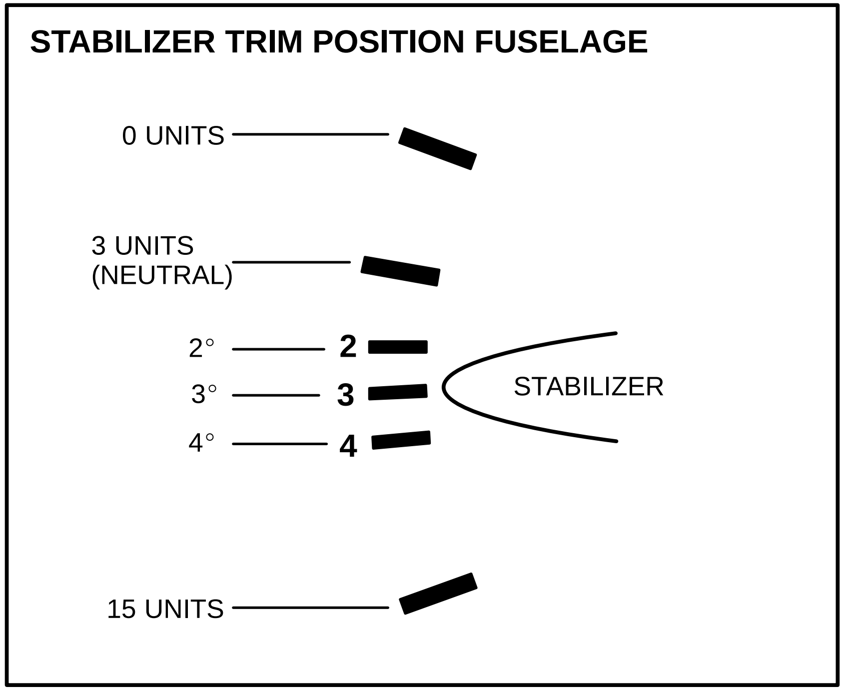
- 0 Units = Airplane NOSE DOWN
- 15 Units = Airplane NOSE UP,

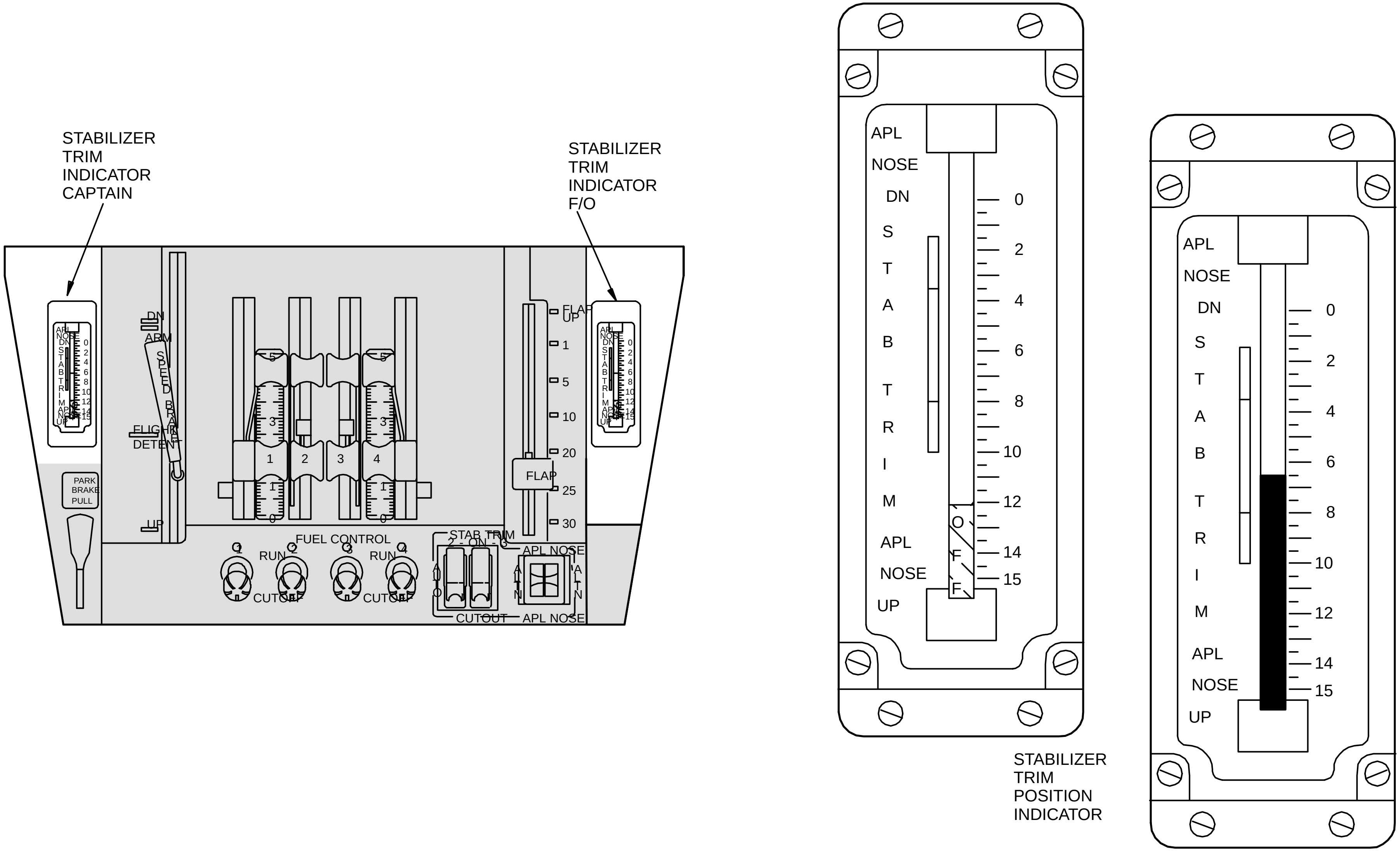
z.B.

EICAS DISPLAY (DEGREES)	STAB TRIM INDICATOR (UNITS OF TRIM)
△ 3.00	0
0.00	3 (NEUTRAL)
▽ 3.00	6
▽ 6.00	9
▽ 9.00	12
▽ 12.00	15

- die Indicator befinden sich auf dem Pedestal P 8
- Captain's Indication wird von dem linken Position Transmitter (RVDT) ausgeführt
- F/O's Indication wird von dem rechten Position Transmitter (RVDT) ausgeführt.

Besteht keine Stromversorgung der Stabilizer Trim Position Indicator, z.B. Circuit Breaker (Captain : P 6-3 K 23 ; F/O's : P 6-3 K 24) gezogen, so erscheint in dem unteren Teil des Anzeigebandes ein schraffiertes Feld mit dem Schriftzug OFF.





720 303
580 037

Figure 113 STABILIZER TRIM POSITION INDICATOR

BASIC SCHEMATIC

GENERAL DESCRIPTION

The stabilizer trim control system trims the airplane longitudinally by varying the horizontal stabilizer angle of attack. The system pivots the stabilizer about its rear attachments to the empennage structure by driving a hydraulically powered trim drive mechanism. This mechanism consists of a linear ball screw actuator driven by two hydraulic motors. A gimbal mounting attaches the lower end of the mechanism to the empennage structure. A ball nut driven by the ball screw connects to the stabilizer through another gimbal attachment. Thus the actuator constitutes the stabilizer forward attachment. Two independent stabilizer trim control modules (STCMs) direct hydraulic power to the trim drive mechanism.

The system provides electrical modes of stabilizer control. The electrical modes permit manual-electric actuation by either the captain or the first officer, speed trim actuation due to airspeed changes, or alternate electric actuation through the alternate control switches on the aisle stand. In all modes, hydraulic pressure drives the trim drive mechanism to position the stabilizer.

The autopilot provides two independent channels of stabilizer trim operation: one channel connected to the left STCM and the other to the right STCM.

Hydraulic power for the stabilizer trim system is obtained from No. 2 and 3 airplane hydraulic systems. Each system supplies power to an independently functioning group of components. Each group of components consists of a STCM, a hydraulic motor and a hydraulic brake. No. 2 hydraulic system supplies the right component group (A system); No. 3 hydraulic system supplies the left component group (B system). Two normally ON, guarded switches on the control stand control hydraulic power to the stabilizer system. These switches, designated STAB TRIM 2 and 3, control motor-driven valves on the STCMs.

Stabilizer trim cutout switches are located on the right hand side of the center aisle stand. The switches are a three position toggle switch. The CUTOUT position closes the motor-operated-shutoff valves in the STCMs, removing hydraulic power from the stabilizer trim drive mechanism. The ON position open the motor-operated-shutoff valves in the STCMs, enabling trim control through the STCM. The AUTO position renders control of the motor-operated-shutoff valves to the SRM. Override capability is provided to the ON and CUTOUT positions over the automatic control.

Travel limiting devices control the range of stabilizer movement in all operating modes. In the electrical control modes, limit switches prevent stabilizer travel beyond that required by the normal flight envelope for the prevailing operating condition (manual-electric, autopilot). Mechanical stops on the actuator constrain absolute travel, but the trim system does not normally drive the stabilizer to these stops.

Two horizontal stabilizer trim indicators, mounted one on each side of the control stand in the control cabin, provide visual indication of stabilizer position.

Three stabilizer position transmitters are located at the aft end of the stabilizer center section. Each contains a synchro transmitter and an RVDT transmitter. The left and right position transmitters provide synchro inputs to the stabilizer position indicators on the control stand. Input from the RVDT mechanical position transmittier is sent to the flap control unit (FCU) where it is processed and routed to the EIU's for display on the EICAS flight control maintenance page. The synchro in the center position transmitter is not used.

REFER TO DIN A3 PAGE

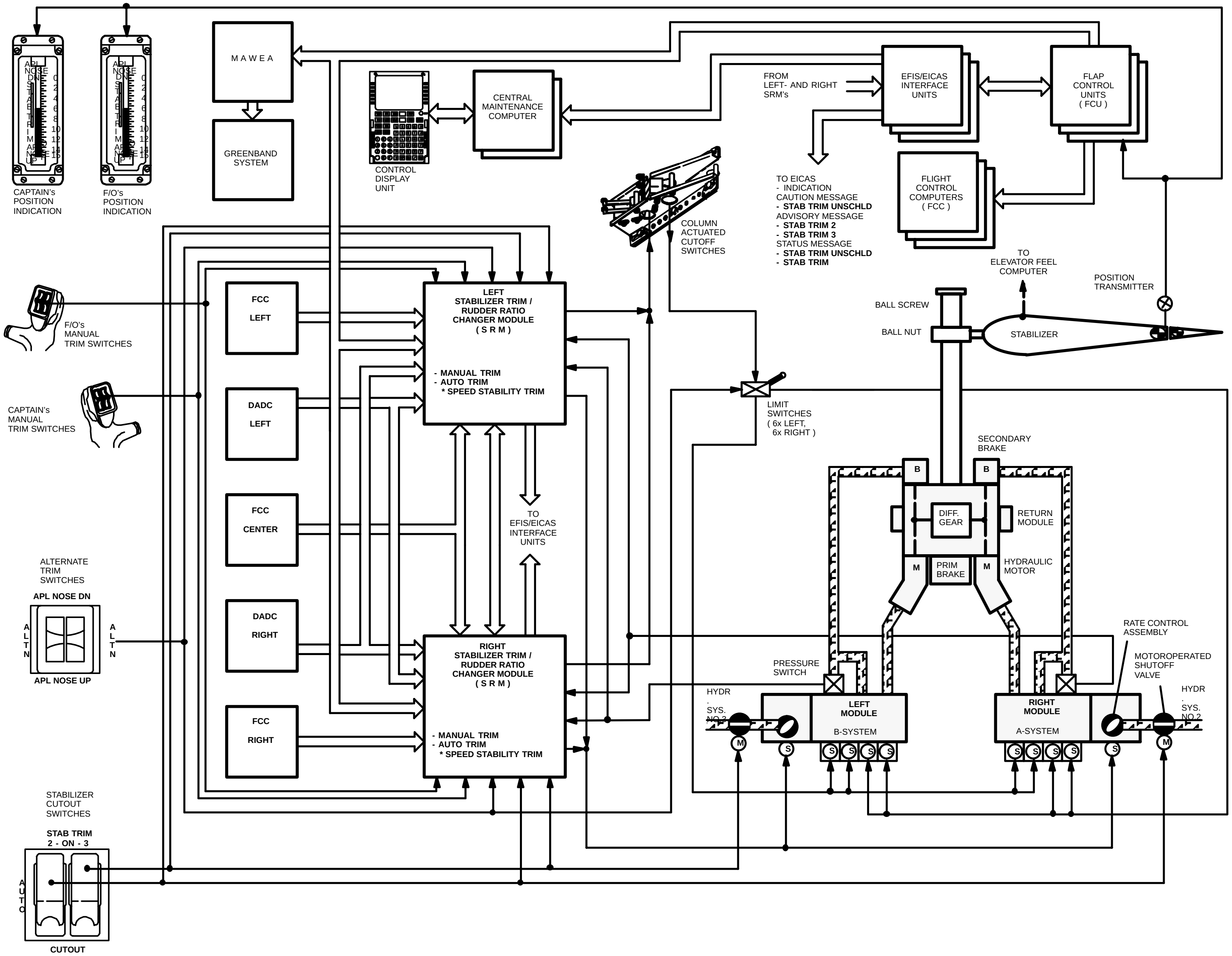


Figure 114 HORIZONTAL STABILIZER BASIC SCHEMATIC

FUNCTIONAL DESCRIPTIOIN

Stabilizer operation can be commanded in any of the three electrical modes. The electrical modes provide for manual-electric, mach/speed trim, and autopilot operation. The autopilot modes are auto flight system functions. In all modes, the stabilizer is hydraulically driven. No. 2 and No. 3 hydraulic systems normally supply the right and left STCM respectively.

The stabilizer trim system requires simultaneous application of hydraulic power from No. 2 and No. 3 hydraulic systems to achieve the normal trim rate. Stabilizer trim rate has two positions which are calculated by the SRMs, using calculated airspeed from the digital air data computer (DADC). The SRMs then position a rate control solenoid valve located on the STCM to provide the required trim rate. With both systems operative, the trim rates are 0.5 degree per second and 0.2 degree per second; with only one system operative, the trim rates are 0.25 degree per second and 0.1 degree per second. The rate control system is controlled by the SRMs, and it is not a linear change, but a step change between the rates mentioned above. The SRM uses the DADC inputs (Vc). Each SRM is capable of controlling both left and right STCM rates. Defaults to slow speed, thus eliminating trim oversensitivity at high speeds.

In the manual-electric mode, the STAB TRIM dual thumb switches on the captain's and first officer's control columns command operation of the STCMs. Each switch controls both STCMs simultaneously. Selection of either switch to the nose up or nose down position energizes a pair of solenoids in each STCM; an arming solenoid and a control solenoid. Both solenoids must be energized to initiate stabilizer operation. All solenoids are dual wound, with one winding for manual-electric, mach/speed trim and auto flight system operation. The other is for alternate electric trim operation. The STCMs function identically in all electrical modes.

With trim selected in either direction, hydraulic fluid enters each package through integral check valves and passes through a filter and a normally open shutoff valve to the trim rate controller. The controller regulates the fluid flow rate in proportion to aircraft speed and flow continues through the arming and control service ducts as directed by the arming and control up or down solenoid.

The solenoids direct flow according to the commanded trim direction to position corresponding directional selector valves; the arming valve and the control valve. When energized, each solenoid releases pressure from a balance cylinder at one end of its corresponding valve. Pressure exerted via the opposite solenoid upon the other end of the valve drives the valve to the end of its travel in the selected direction. With both the up and down solenoids de- energized, the valve is pressure balanced and spring-loaded to the center neutral position. With both the arming and control valves positioned to command trim in the same direction, fluid is directed through outlet ports to the trim drive mechanism. No flow can take place if the valves are commanded in opposite directions or if only one valve is directionally positioned.

With trim selected, pressure is applied sequentially to the hydraulic brake and to the nose up or nose down port on the hydraulic motor, which drives the trim drive mechanism. Pressure is also applied simultaneously to close a pressure switch. Hydraulic power is sustained until the STAB TRIM switch returns to neutral, terminating the command signal. The arming and control valve ports are designed so that pressure is always applied to release the trim drive mechanism hydraulic brake before driving the motor. Conversely, pressure to the motor is always cut off before brake pressure so that the brake is not applied while the motor is powered.

A pushbutton on the front of each STCM operates a manual brake bypass valve for maintenance checks. When the button is pressed, the valve releases the pressure in the hydraulic brake and motor, applying the brake.

When the hydraulic output from each STCM is delivered to the hydraulic brake and motor, the hydraulic brake releases and the hydraulic motor rotates in the selected direction. Each motor drives the trim drive mechanism through the differential. When the STCM cut off the hydraulic pressure, the motors stop rotating and the hydraulic brakes are applied by spring pressure.

When stationary, the stabilizer is prevented from creeping by the primary and secondary brakes. The primary brake is applied by the thrust exerted on the ballscrew by stabilizer air loads. Downward thrust compresses the lower brake disk of the primary brake between the flange and the lower ratchet. As the ballscrew is right-hand threaded, downward thrust attempts to turn it clockwise (viewed from the drive end). Two diametrically opposed pawls prevent the lowe ratchet from turning clockwise, constraining the screw. Upward thrust exerted on the screw compresses the upper disk and applies anticlockwise torque which is similarly resisted by the upper ratchet. Actuator drive to trim the stabilizer in a direction opposed to airload thrust is unresisted, because the ratchet and compressed brake disk rotate freely with the flanged screw shaft. Drive in a direction with the thrust is opposed by primary brake. The hydraulic motors, assisted by the thrust exerted by the airload, overcome brake friction to trim the stabilizer in this direction. Secondary braking is provided through the hydraulic brakes and by the control valves which hydraulically lock each motor when no trim signal exists.

REFER TO DIN A3 PAGE

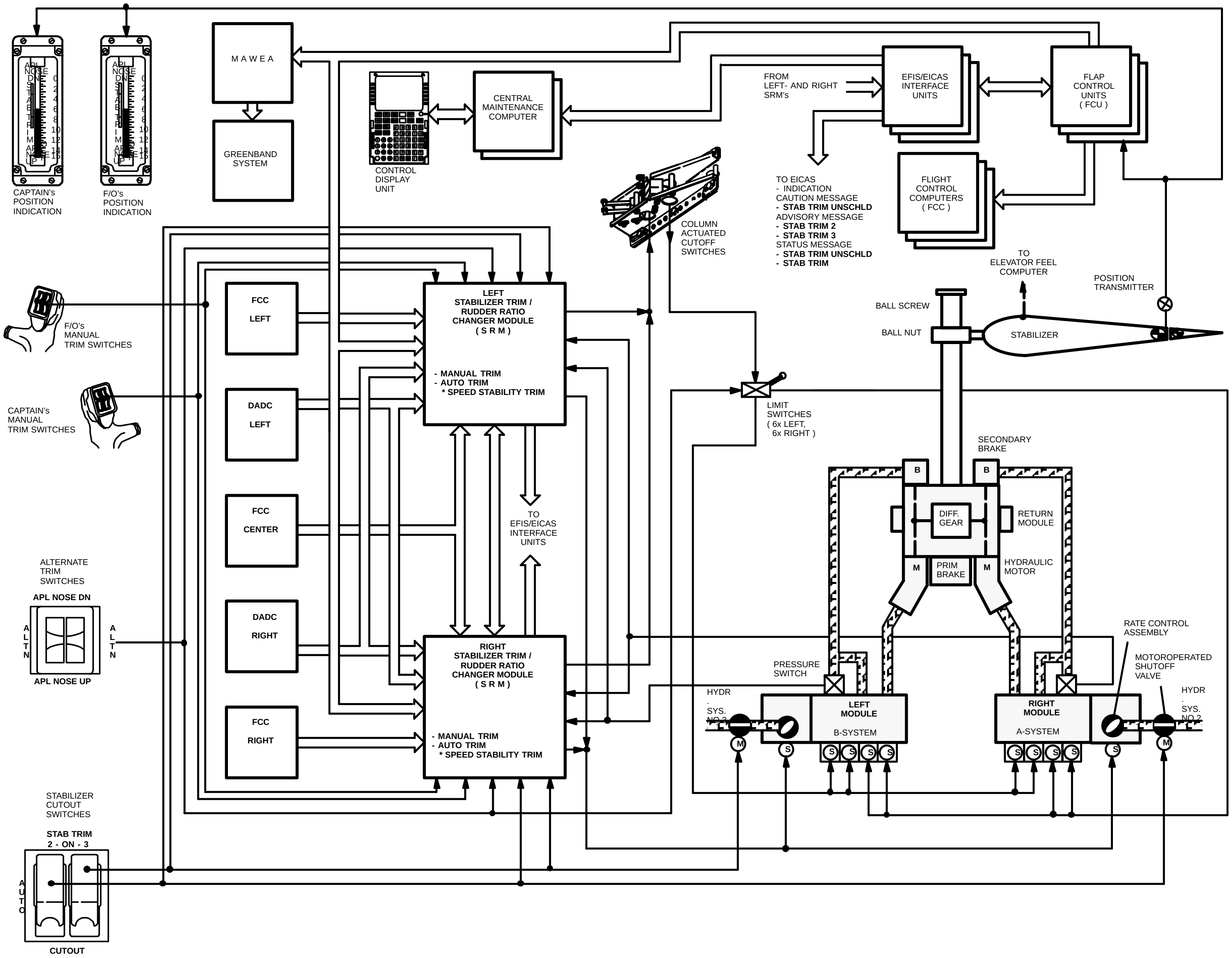


Figure 115 HORIZONTAL STABILIZER BASIC SCHEMATIC

MANUAL ELECTRIC TRIM SWITCHES

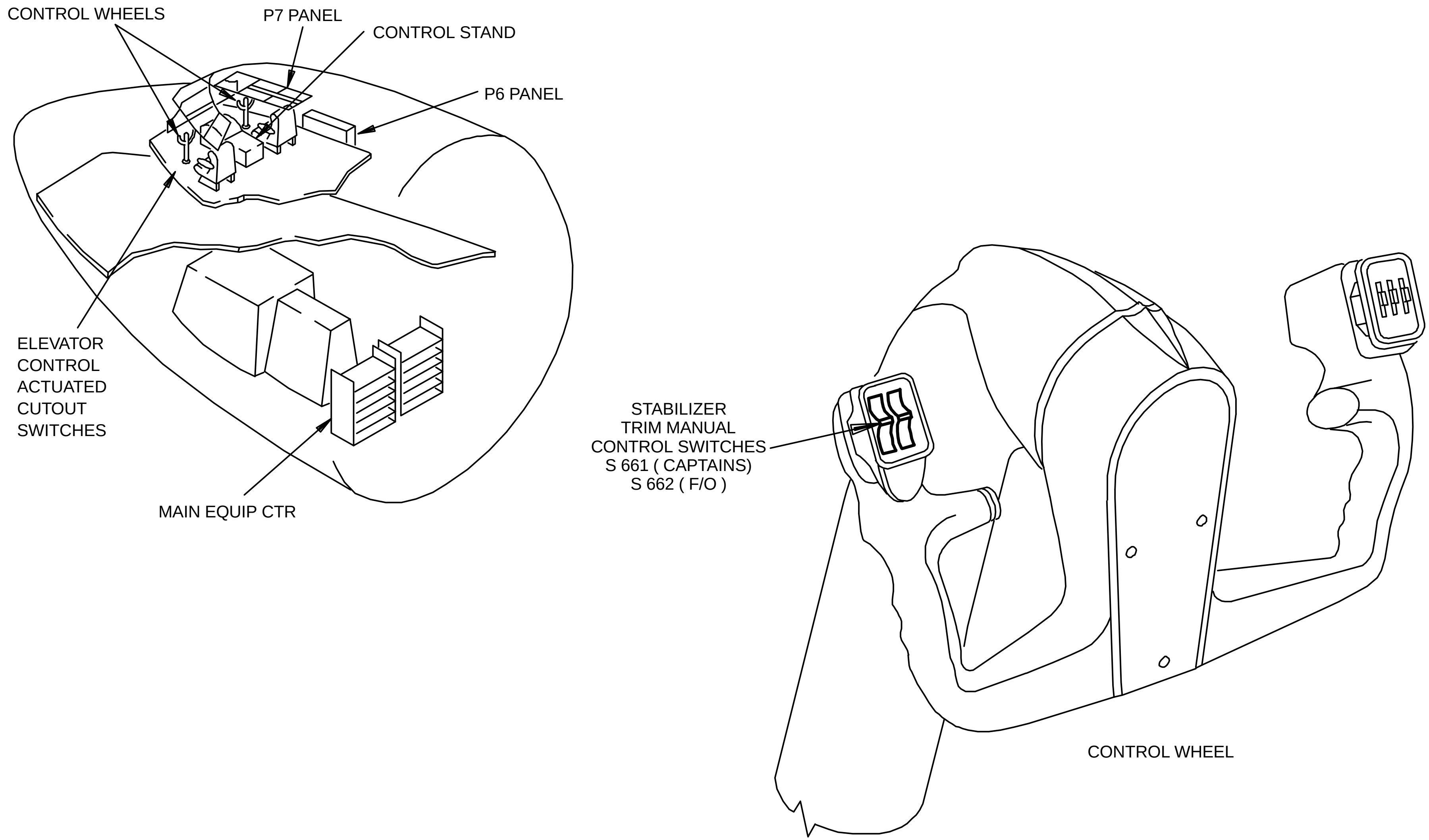
DESCRIPTION

MANUAL ELECTRIC TRIM SWITCHES

Two sets of dual switches, located in the captain's and first officer's control wheels actuate the stabilizer trim system in the manual-electric control mode. The two segments in each switch are mechanically and electrically isolated from each other. Each segment operates a pair of solenoids on each STCM. One segment controls a pair of arming solenoids and the other, a pair of directional control solenoids. As an arming solenoid and its associated directional control solenoid must both be energized to trim the stabilizer, both segments must be held in the same direction to obtain movement. Hence, a malfunction in a single segment of circuit cannot cause runaway stabilizer.

SUMMARY :

- Captain's Control Wheel Left Side
- F/O's Control Wheel Right Side
- besteht aus jeweils zwei Switches :
  - Arming Switch
  - Control Switch
- beide müssen gleichzeitig und gleichsinning betätigt werden
- steuern die Stabilizer Trim / Rudder Ratio Changer Module (SRM's) und diese die Stabilizer Trim Control Module (STCM's) an



NOTE :
CAPTAINS STABILIZER TRIM MANUAL SWITCHES SIDE SHOWN,
F/OSTABILIZER TRIM MANUAL SWITCHES OPPOSIDE.

580 037

Figure 116 CONTROL WHEELS

CONTROL STAND

ALTERNATE ELECTRIC TRIM SWITCHES

Alternate electric stabilizer trim control switches are located on the control stand. These switches bypass the stabilizer trim/rudder ratio changer control module (SRM) and provide inputs directly to the STCMs. The alternate electric stabilizer trim switches are also used to position the stabilizer when maintenance is required.

The alternate electric trim switches function is similar to the manual trim switches and are provided as an emergency override in case the manual trim system is malfunctioning. The alternate electric trim switches are powered by the 28 volts dc battery bus and the signals are sent directly to the STCMs to a separate set of coils on the trim control solenoids. Alternate electric trim will function even if both SRMs are disabled or removed.

SUMMARY :

- befinden sich auf dem Pedestal (P 8)
- bestehen aus 2 Switches :
  - Arming Switch
  - Control Switch
- beide Switches müssen gleichzeitig und gleichsinning betätigt werden
- steuert die Stabilizer Trim Control Module (STCM's) direkt an.

STABILIZER TRIM CUTOUT SWITCHES

The two stab trim cutout switches on the pilots' control stand are three-position guarded switches; switch positions are ON, AUTO, and CUTOUT. One switch is for the No. 2 hydraulic system (right channel) and the other is for the No. 3 hydraulic system (left channel). When the switch is in the ON position, the motor operated value (MOV) on the STCM for the specific channel is open and allows hydraulic fluid to flow into the STCM. In the CUTOUT position, the MOV is closed, the STCM is inoperable, and the specific channel is disabled. In the AUTO position, the SRM will automatically open the MOV and then close the MOV automatically when unscheduled trim is sensed.

SUMMARY :

- befinden sich auf dem Pedestal (P 8)
- ein Switch für das Hydraulic System No.2
- ein Switch für das Hydraulic System No.3

ON :

- das Motoroperated Shutoff Valve ist direkt nach OPEN angesteuert

AUTO :

- das Motoroperated Shutoff Valve wird von den SRM's gesteuert
- Normal OPEN
- bei einem Fehler, z.B. Unscheduled Trim durch die active SRM nach CLOSED gesteuert

CUT OFF :

- das Motoroperated Shutoff Valve ist direkt nach CLOSED angesteuert.

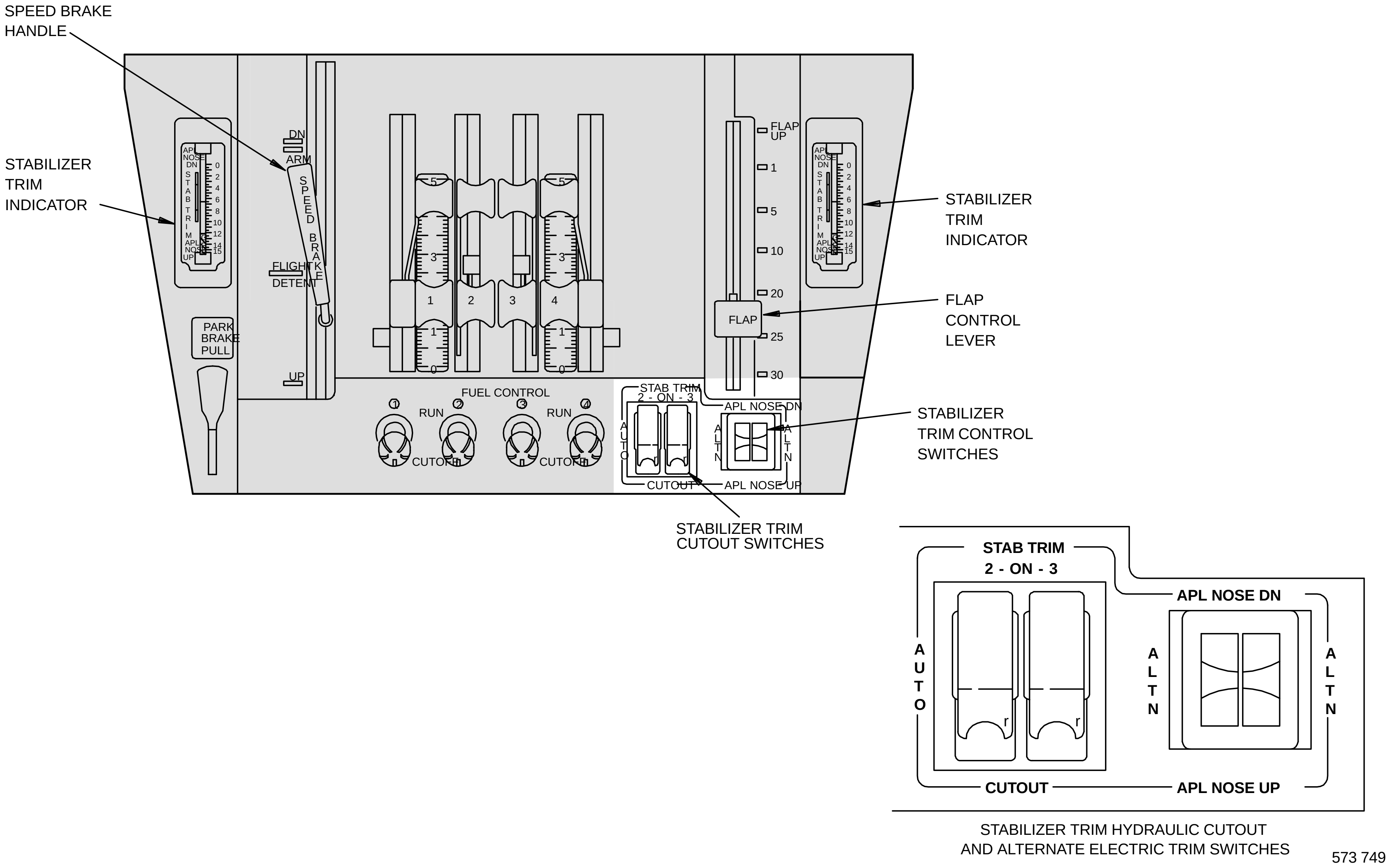


Figure 117 CONTROL STAND

LEFT AND RIGHT STABILIZER TRIM COMPONENTS

DESCRIPTION

STABILIZER TRIM CONTROL MODULE (STCM)

Two identical STCMs are mounted in the empennage at the bottom of the stabilizer actuator bulkhead. Each STCM is an integrated assembly of hydraulic, electrical and mechanical components. Hydraulic pressure is applied to each STCM from its associated hydraulic system. An electrical command for stabilizer trim positions two directional selector valves called arming and control valves. Both of these valves must be positioned to command trim in the same direction before fluid can flow from the STCM. With the valves correctly positioned, separate outlet ports supply fluid to the trim drive mechanism. Pressure is applied sequentially to the hydraulic brake and to the nose up or nose down port on the actuator hydraulic motor.

FAILURE INDICATION OF THE PRESSURE SWITCH :

For example :

Whenever a fault is detected at the pressure switch, on the EICAS display following is indicated :

the advisory message :

> STAB TRIM 2

the advisory message :

or

> STAB TRIM 3

and

the status message :

STAB TRIM

and on the MCDU is shown the reason for the EICAS message :

CMC message :

HYD - (#) STAB TRIM ACT BRAKE RELEASE SW FAIL (SRM).

SUMMARY :

MOTOROPERATED SHUTOFF VALVE

- schaltet Hydraulic für Module
- wird durch Cutout Switch oder durch SRM’s gesteuert

RATE CONTROL SOLENOID VALVE

- reduziert ab 230 KTS den Internal Hydraulic Flow für langsamere Verstellgeschwindigkeit
- wird durch SRM’s gesteuert

ARMING- AND CONTROL SOLENOID VALVE

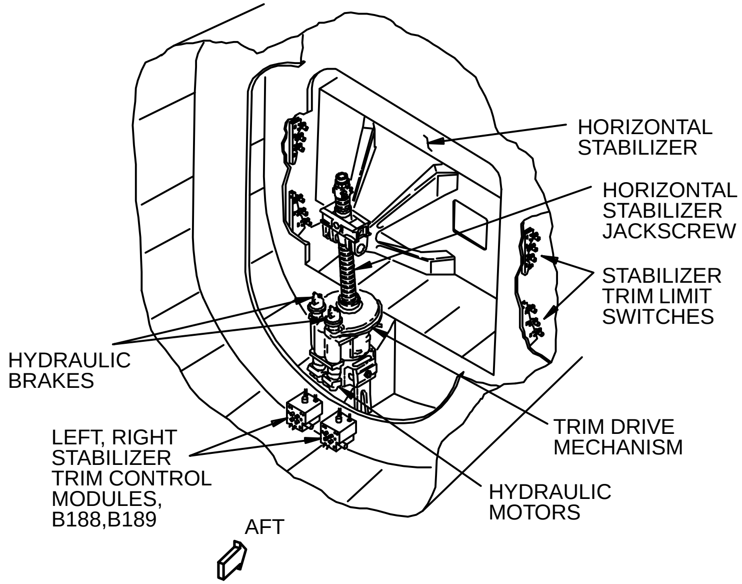
- je 2 für Airplane Nose Down- bzw. Nose Up Trim
- werden durch SRM’s oder durch Alternate Trim Switches gesteuert

PRESSURE SWITCH

- meldet Secondary Brake Release Pressure zu den SRM’s

MANUAL BRAKE BYPASS VALVE

- Button Push: Brake Release Pressure zur Secondary Brake wird weggeschaltet; Secondary Brake hält Hydraulic Motor fest
- Button Release: Secondary Brake muß lösen, d.h. Hydraulic Motor ist in Betrieb.



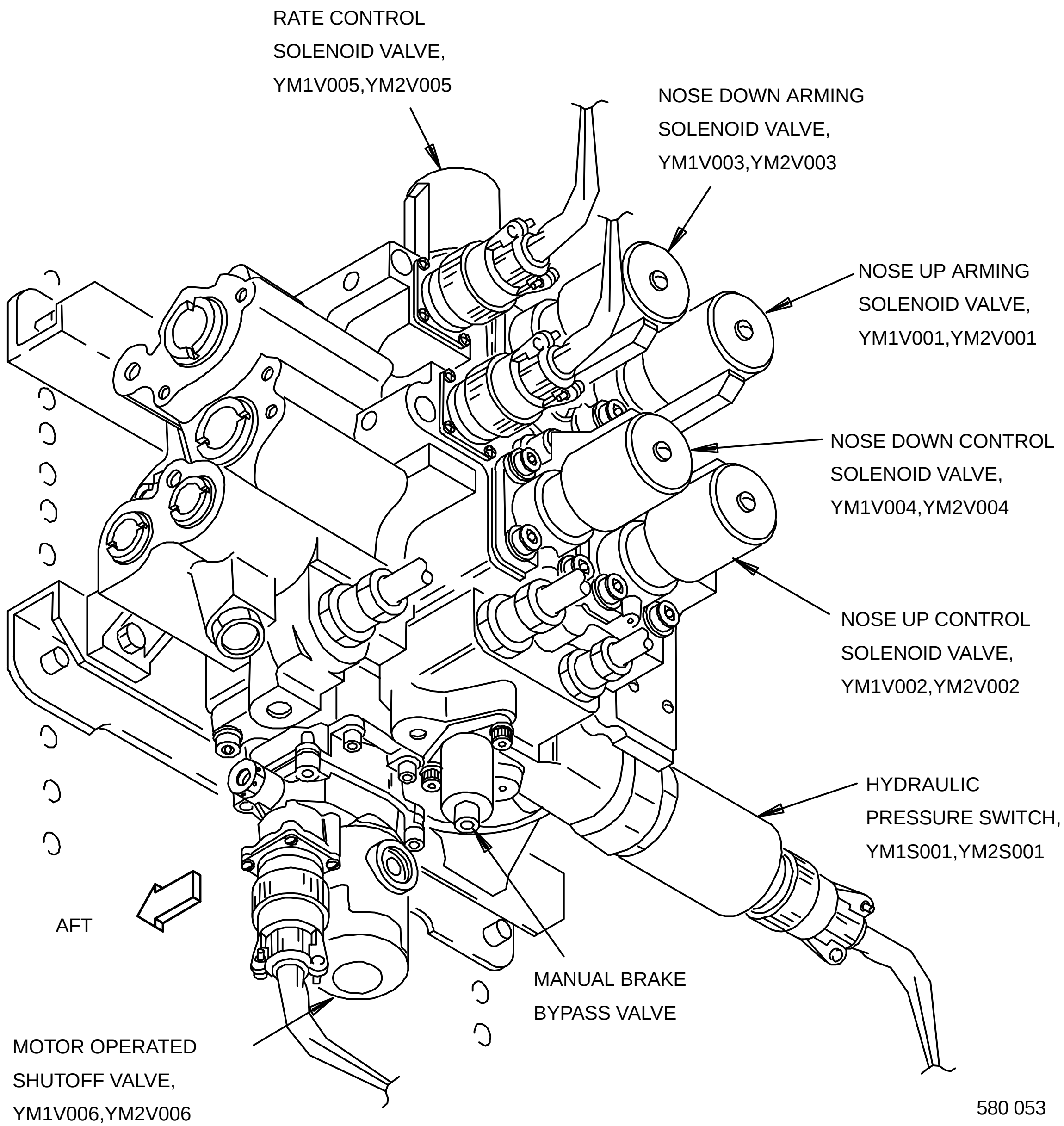


Figure 118 LEFT, RIGHT STABILIZER TRIM CONTROL MODULE

STABILIZER TRIM DRIVE MECHANISM - LOWER

DESCRIPTION

STABILIZER TRIM DRIVE MECHANISM

The stabilizer trim drive mechanism comprises two hydraulic motors driving a linear ball screw actuator through a gear train, with two hydraulic brakes for secondary anti-creep control. The motors drive a ball nut and screw through differential and bull gear trains. The hydraulic brakes act upon shafts driven directly by the motors. An upper gimbal mounted on the actuator ball nut connects the mechanism to the stabilizer forward attachment fitting. A lower gimbal anchors the trim drive mechanism to the bottom of the actuator bulkhead. Two lubrication fittings in the lower gimbal retaining pins and four in the upper gimbal provide servicing points for the moving parts.

The two hydraulic motors convert hydraulic pressure to rotary motion to drive the ball screw. The two hydraulic brakes lock the motor shafts to provide redundant braking when the motors are not driving. Each combination of motor and brake is activated by its associated STCM, and can control stabilizer movement independently through the differential. In normal operation, however, the two combinations act in unison.

The differential, on which the hydraulic motors are mounted, is bolted to the bull gear housing, which contains a spur gear splined to the ballscrew. A safety rod inserted lengthwise through the screw, retained by a safety nut at the top and a safety sleeve and shaft at the bottom, prevents failure of the stabilizer front attachment if the ballscrew fails. A housing bolted to the lower face of the bull gear housing contains the primary brake and incorporates the lower gimbal attachment.

The trim drive mechanism is equipped with a primary brake contained in an oil-filled primary brake housing. A replaceable lip seal at the bottom of the housing prevents oil leakage. The primary brake consists of two brake disks, located one on each side of a flange on the ball screw. Each disk acts in conjunction with an irreversible pawl- controlled ratchet to prevent the stabilizer from creeping under the influence of aerodynamic loads.

The ball screw drives a ball nut consisting of a primary and a secondary nut splined together and joined by a bolted mating flange. Ball bearings circulating within the primary nut and through two external ball return tubes, transmit the drive from the ballscrew to the upper primary nut. The lower, secondary nut, carries loads only in event of primary nut or gimbal yoke failure. The nut is internally threaded for drive transmission. An internal scraper at the upper end of the primary nut removes ice and coarse particles from the screw and prevents their entry into the nut during upward travel. A wiper adjacent to the scraper excludes fine particles and retains lubricant. A scraper at the lower end of the secondary nut and a wiper at the lower end of the primary nut perform identical functions during downward travel. Integral stops at each end of the ball nut assembly contact the stops on the actuator shaft and bull gear at the travel extremities.

Two diametrically opposed trunnions on the primary nut engage the upper gimbal, which connects to the stabilizer. Two trunnions on the secondary nut, oriented perpendicular to the primary trunnions, also engage the upper gimbal. A lubrication fitting and a lubrication vent on the primary nut are provided for packing the nut with grease. Each of the trunnions on the primary nut also provides a lubrication fitting.

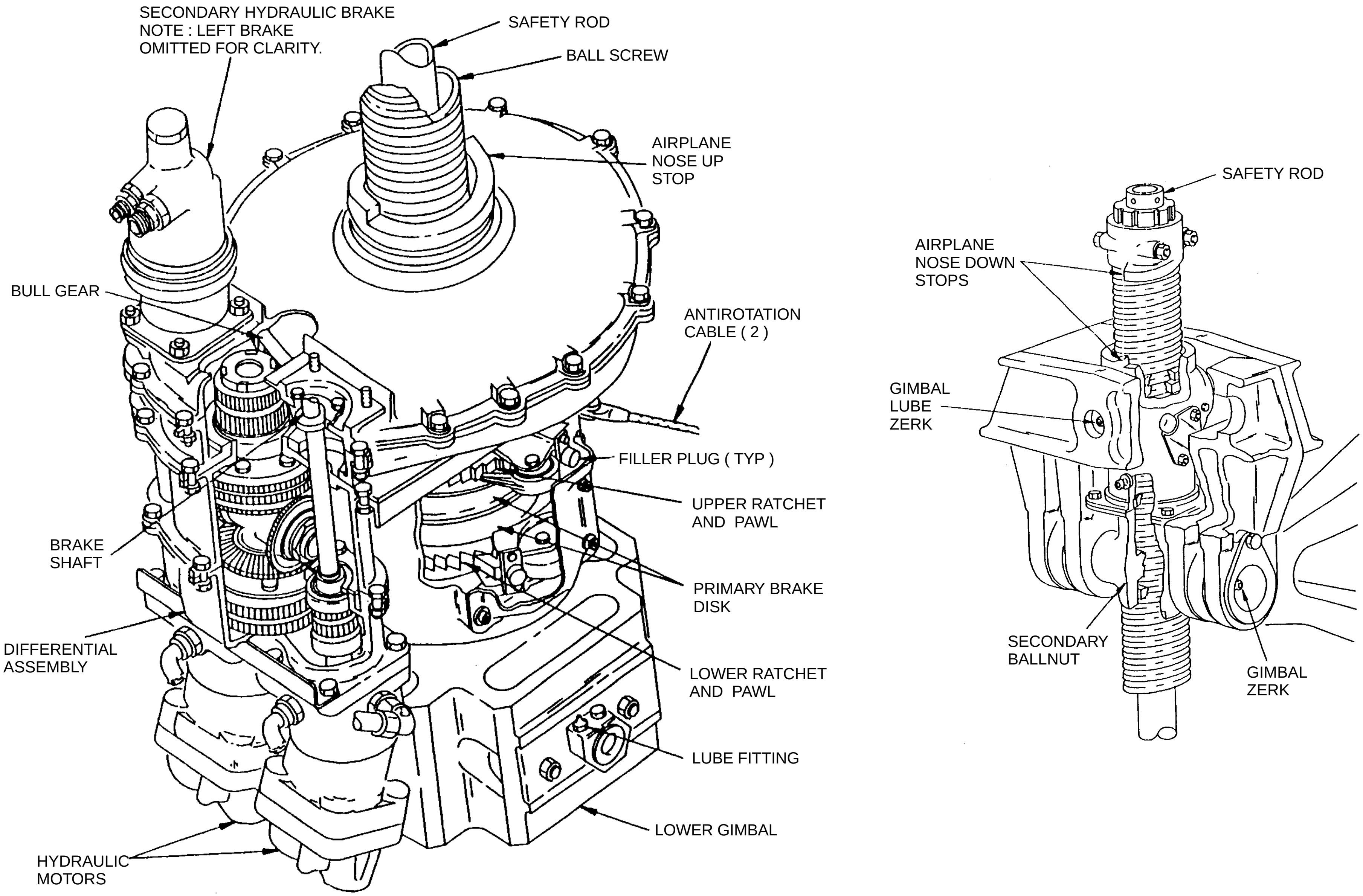


Figure 119 STABILIZER TRIM DRIVE MECHANISM - LOWER

STABILIZER TRIM HYDRAULIC MOTOR AND -BRAKE

DESCRIPTION

STABILIZER TRIM DRIVE MECHANISM HYDRAULIC MOTORS

The two hydraulic motors are identical units, configured for left or right mounting by the arrangement of hydraulic port adapters during installation. The motors can easily be changed with the trim drive mechanism installed in the airplane. Each motor is a nine-cylinder, piston-type, reversible unit. The motors are mounted side by side on the differential gear assembly casing, which is bolted to the bull gear housing. Besides driving the ball screw, the motors act as back-up anti-creep brakes by hydraulically locking the trim drive mechanism gear train when idle. The motors drive the gear train through separate shafts to permit single-motor operation if one should fail.

STABILIZER TRIM MECHANISM HYDRAULIC BRAKES

The hydraulic brakes are also identical units and are configured identically for installation. Like the motors, they are easily accessible for changing with the trim drive mechanism installed. Each brake is of the pressure disk type, spring loaded to on. The brakes are mounted side by side on top of the bull gear housing. Friction lined stator disks are keyed to a rotating shaft which the associated hydraulic motor drives through a quill shaft. With the brake unit unpressurized, coil springs compress the stator and rotor disks firmly together, locking the shaft connected to the hydraulic motor. To release the brake, hydraulic pressure acts on a piston and compresses the coil springs. Separator springs then force the rotor disks away from the stator disks, freeing the shaft to rotate.

SUMMARY :

HYDRAULIC MOTORS

- treiben über Gear die Ball Screw

SECONDARY BRAKES

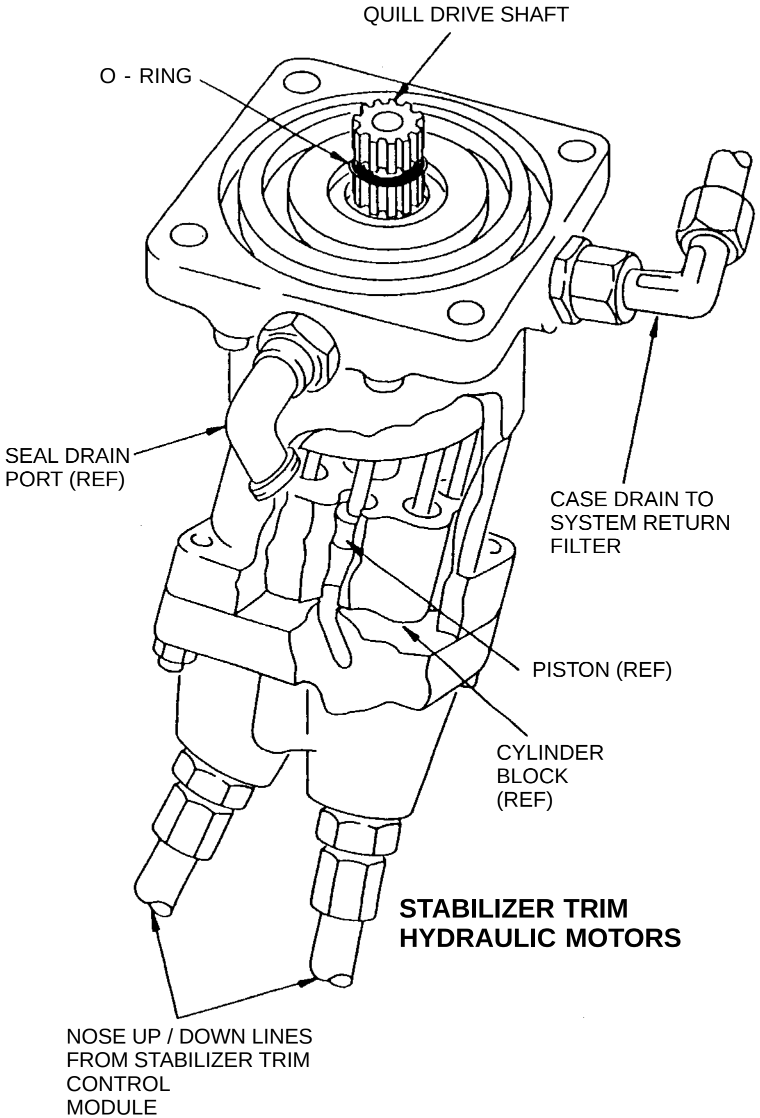
- sitzen auf Hydraulic Motor Antriebswellen
- Load Springs erzeugen Bremswirkung über Stator und Rotor Discs
- Piston
  - erhält während Trim Release Pressure
  - löst die Discs

PRIMARY BRAKES

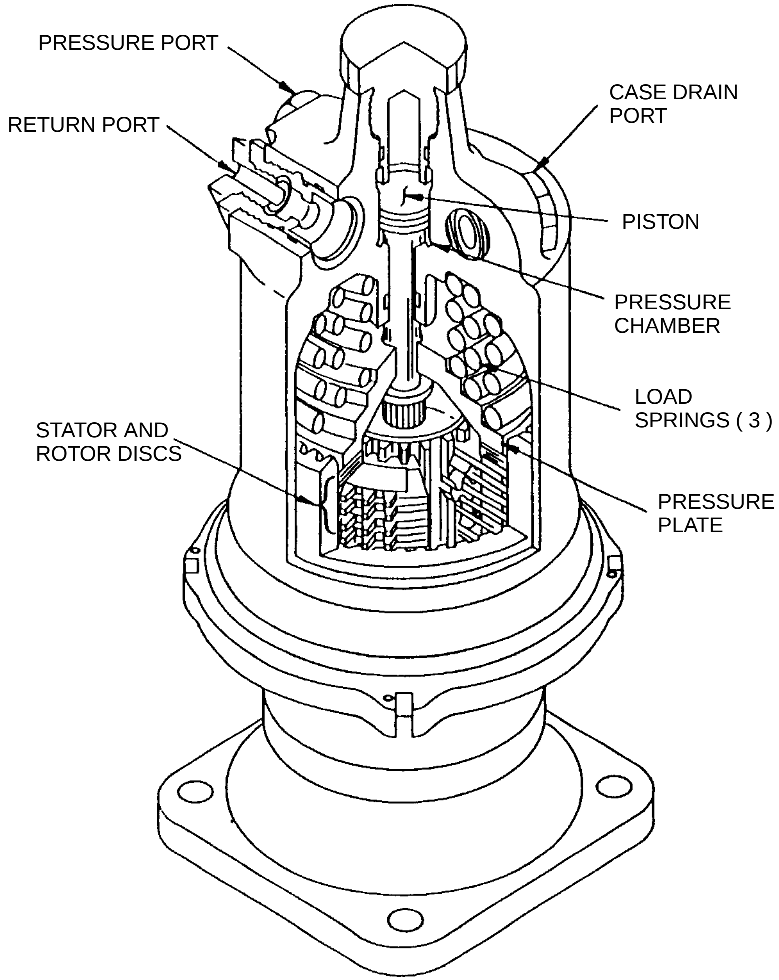
- verhindert, daß Luftkräfte den Stabilizer verstellen
- wirkt über Kupplungsscheiben und Sperrklinken
- Fill Plug für Schmierstoff Service

BALL SCREW

- betätigt über Ball Nut den Stabilizer
- Stops für mechanischen Anschlag
- Safety Rod hält Stabilizer falls Ball Screw bricht



STABILIZER TRIM HYDRAULIC MOTORS



STABILIZER TRIM HYDRAULIC BRAKE

Figure 120 STABILIZER TRIM HYDRAULIC MOTOR AND -BRAKE

STABILIZER TRIM RETURN FILTER ELEMENTS

DESCRIPTION

There are two stabilizer trim hydraulic return filter modules. The filter modules are mounted on the left and right side of the stabilizer trim drive mechanism aft of the pressure bulkhead in section 48.

System return fluid from the secondary hydraulic brake and hydraulic trim motor case pass thru the respective return filter module prior to returning to system no.2 and no.3 hydraulic reservoirs.

MAINTENANCE PRACTICE :

Prior to changing the return filter elements ensure the hydraulic power is removed and the hydraulic reservoirs are depressurized.

WARNING: ENSURE PERSONNEL AND EQUIPMENT ARE CLEAR OF HORIZONTAL STABILER AND ELEVATOR SURFACES BEFORE MOVING STABILIZER. INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT COULD OCCUR.

After replacing the filter element lockwire filter element housing. Perform a leak check of the system prior returning airplane to service.

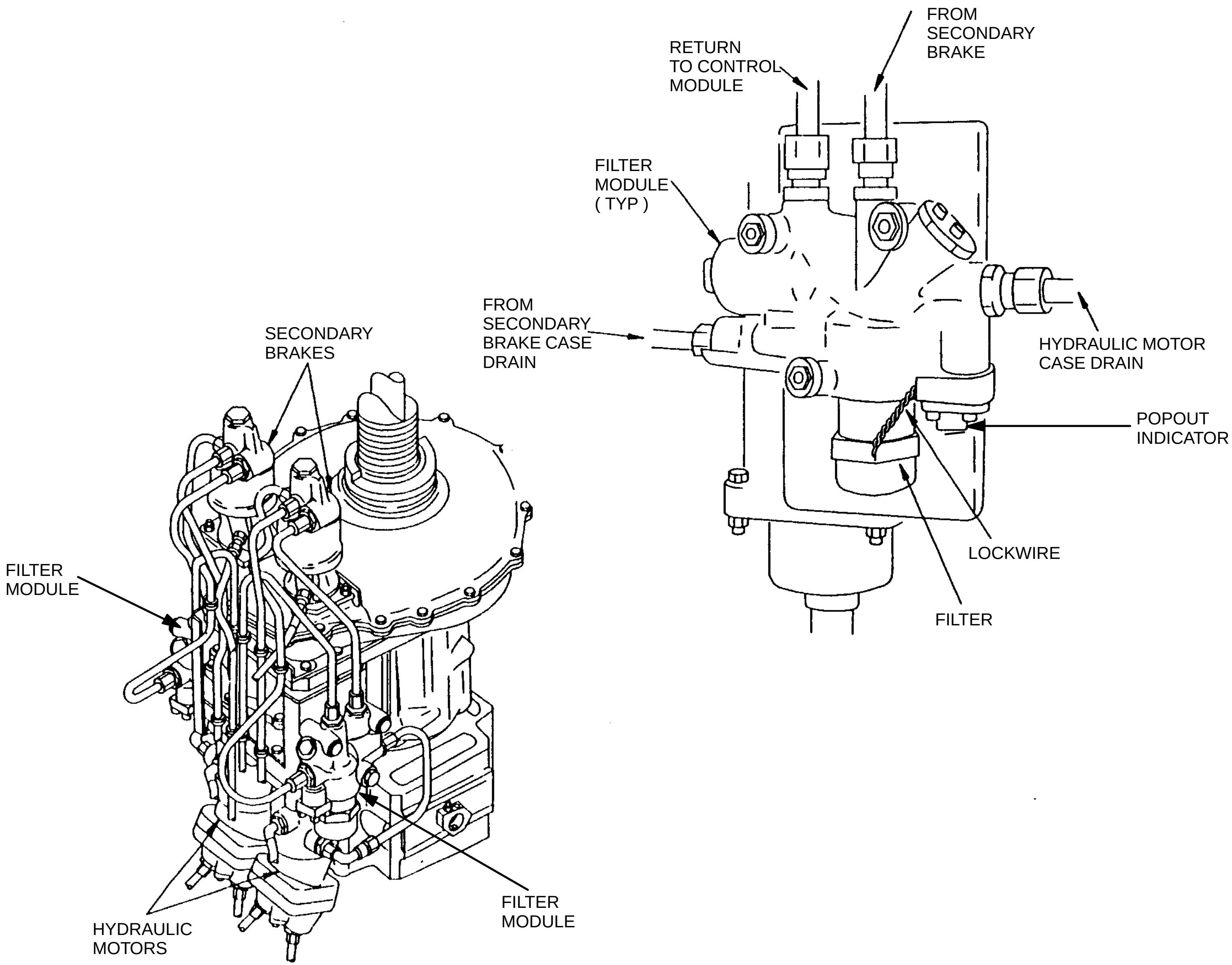


Figure 121 STABILIZER TRIM RETURN FILTER ELEMENTS

ELEVATOR CONTROL ACTUATED LIMIT (CUTOFF) SWITCHES

DESCRIPTION

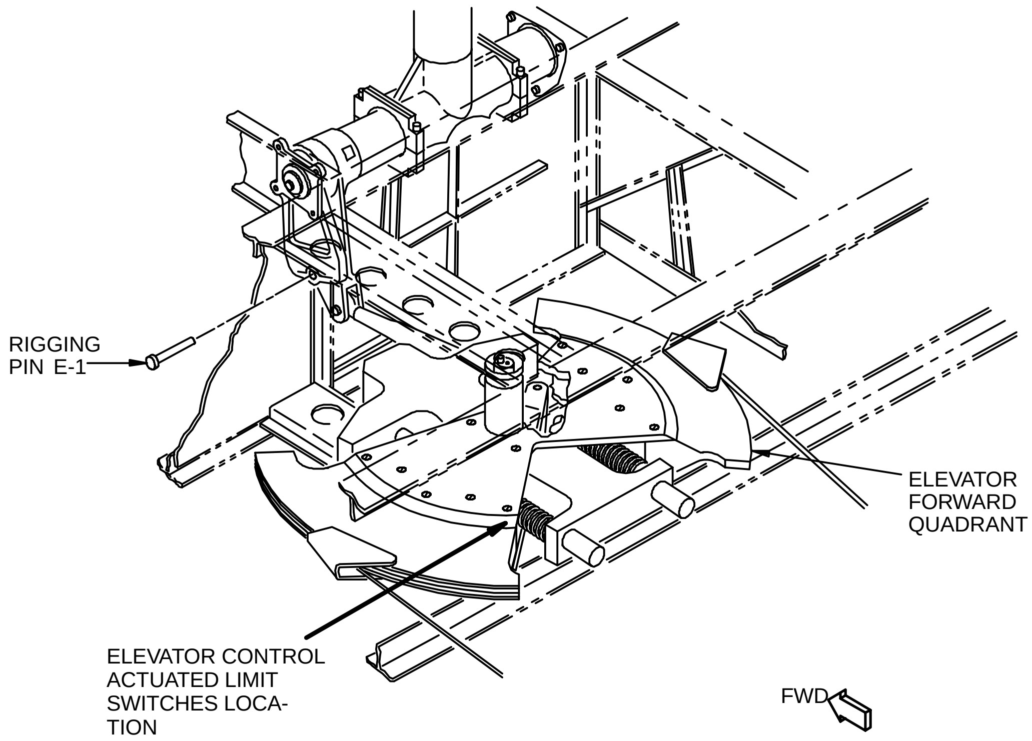
Four microswitches actuated by movement of the elevator forward quadrant are mounted aft of the quadrant on the structure beneath the control cabin. Two switches are operated by control column movement in the up- elevator direction; and two, by movement in the down-elevator direction. These switches interrupt electrical commands to the STCMs if the control column is displaced 3.7 to 5.5 degrees from neutral in a direction opposed to the trim. A cam on the elevator forward quadrant operates the switches.

SUMMARY :

ELEVATOR CONTROL ACTUATED LIMIT (CUTOFF) SWITCHES

- unterbrechen während Manual Trim, Auto Trim, Speed Stability Trim und entgegengesetzter Auslenkung der Elevator Control Columns die Ansteuerung zu den Module Solenoids und die Hydraulic im Module ist abgeschaltet, d.h. der Trimmvorgang ist unterbrochen.

LOCATION OF THE ELEVATOR ACTUATED LIMIT SWITCHES



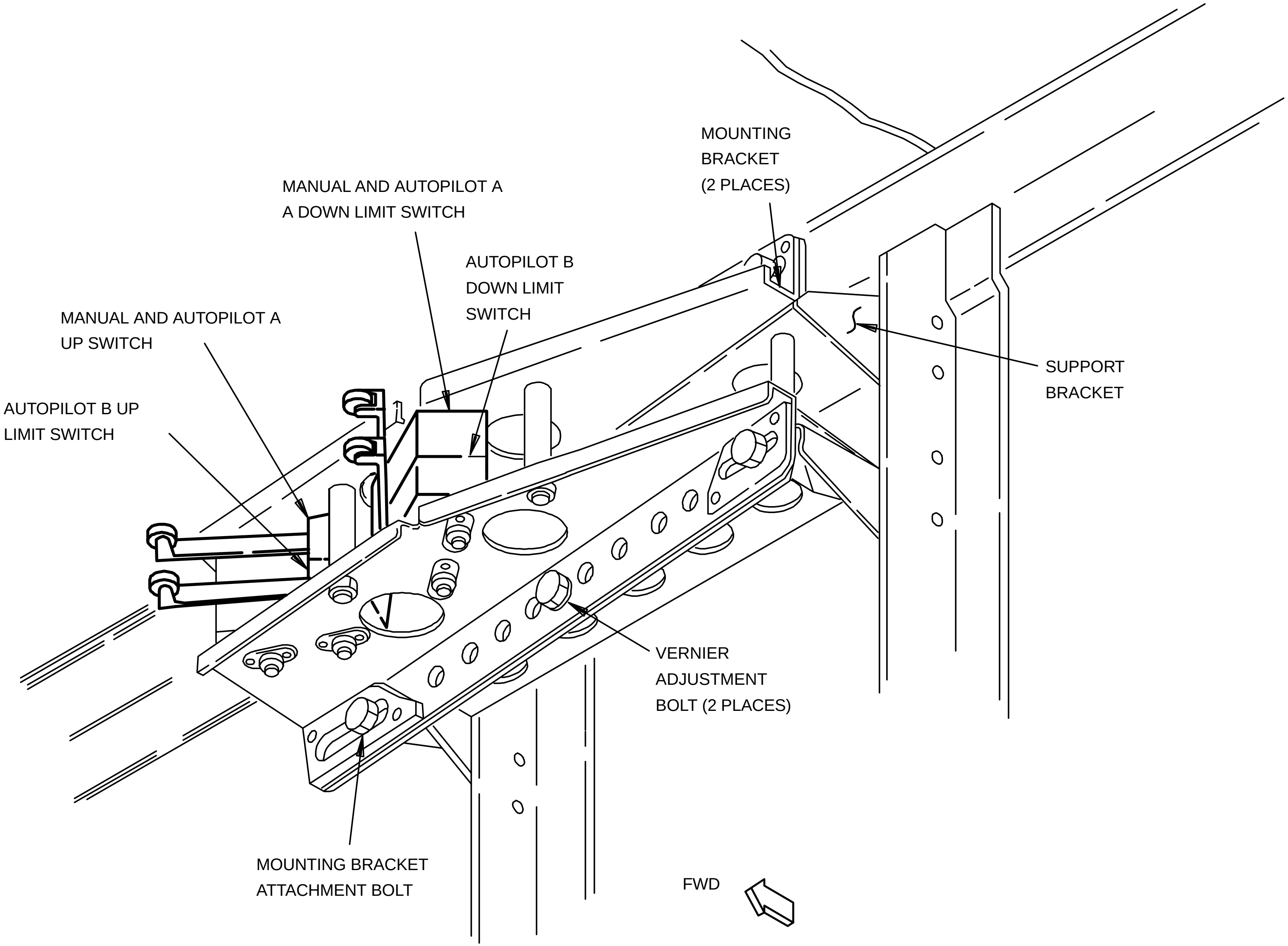


Figure 122 ELEVATOR CONTROL ACTUATED LIMIT SWITCHES

STABILIZER TRIM CONTROL LIMIT SWITCHES

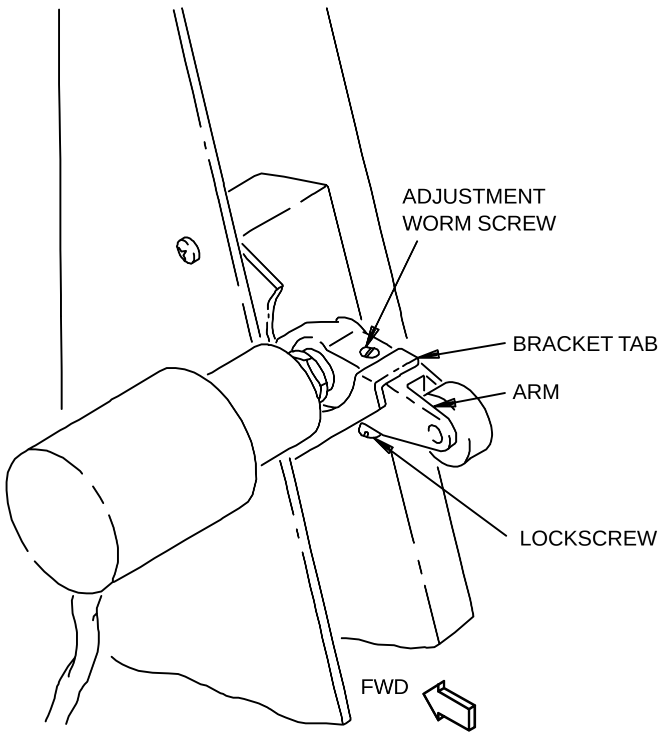
DESCRIPTION

Twelve rotary limit switches are mounted outboard on the aft face of the actuator bulkhead; six on the left side and six on the right. Cams attached to the stabilizer front spar actuate the switches. One pair of switches limits travel in the manual-electric control mode; two pairs limit travel in the autopilot control modes (one pair for each autopilot channel) and the remaining pair operates a warning horn if the throttles are advanced for takeoff with the aircraft on the ground and the stabilizer trimmed beyond the green band limits. All other switches interrupt the circuits to the solenoid valves on the stabilizer trim modular control package.

SUMMARY :

- die Stabilizer Trim Control Switches unterbrechen die Stabilizer Trim Ansteuerung in der entsprechenden Mode bei erreichen der Limits
- rechte Seite (von oben nach unten) :
  - Main Trim (Gear Down) 0.8 Units
  - Alternate Electric Trim 0.25 Units
  - Main Trim (Gear Up) 1.8 Units
  - Main Trim (Gear Down) 11.6 Units
  - Alternate Electric Trim 14.75 Units
  - Main Trim (Autoland) 13.5 Units
- linke Seite (von oben nach unten) :
  - Main Trim (Gear Down) 0.8 Units
  - Alternate Electric Trim 0.25 Units
  - Main Trim (Gear Up) 1.8 Units
  - Stabilizer Fueling 5-7 Units
  - Main Trim (Gear Down) 11.6 Units
  - Alternate Electric Trim 14.75 Units
  - Main Trim (Autoland) 13.5 Units

STABILIZER TRIM CONTROL SWITCH



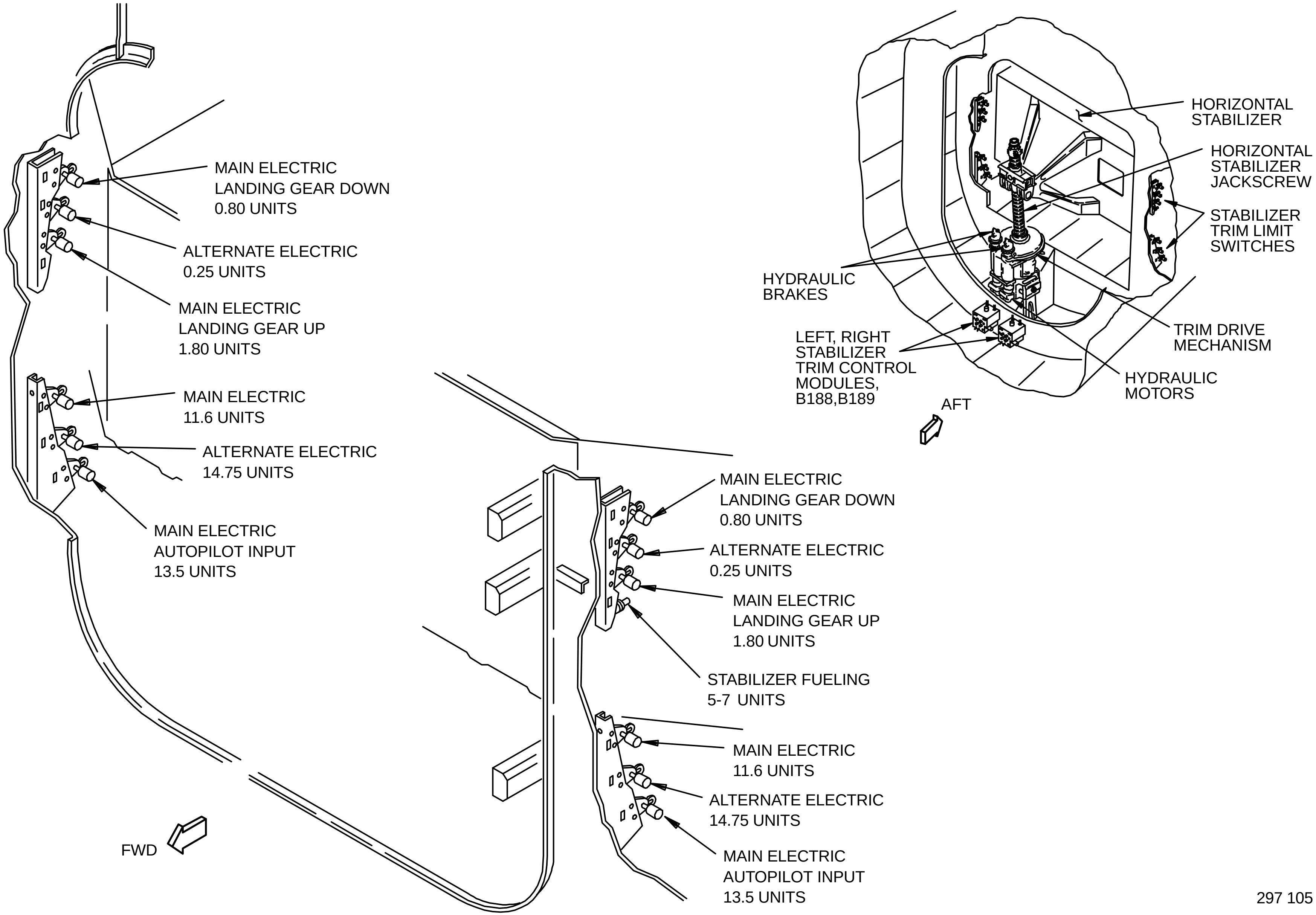


Figure 123 STABILIZER TRIM CONTROL LIMIT SWITCHES

STABILIZER TRIM CONTROL LIMIT SWITCHES, D-ABVO AND ON

DESCRIPTION

DLH 012-099, 108-999;
Travel limiting devices control the range of stabilizer movement in all operating modes. In the electrical control modes, limit switches internal to the SRM prevent stabilizer travel beyond that required by the normal flight envelope for the prevailing operating condition (manual-electric, autopilot). Mechanical stops on the actuator constrain absolute travel, but the trim system does not normally drive the stabilizer to these stops.

DLH 012-099, 108-999;
ALL Four rotary limit switches are mounted outboard on the aft face of the actuator bulkhead; two on the left side and two on the right. Cams attached to the stabilizer front spar actuate the switches. One pair of switches on each side limit the stabilizer travel in the nose up and nose down directions for alternate electric trim operation (all other trim limiting is incorporated in the SRM for manual-electric, autopilot and speed trim operation).

SUMMARY :

- die Stabilizer Trim Control Switches unterbrechen die Stabilizer Trim Ansteuerung in der Alternate Mode bei erreichen der Limits
- rechte Seite (von oben nach unten) :
  - Alternate Electric Trim 0.25 Units
  - Alternate Electric Trim 14.75 Units
- linke Seite (von oben nach unten) :
  - Alternate Electric Trim 0.25 Units
  - Alternate Electric Trim 14.75 Units

NOTE: Die Stabilizer Trim Control Switches für die Abschaltung in der Manual Electric- und in der Autopilot Trim Mode befinden sich an der D-ABVO and ON <u>innnerhalb der SRM</u> und erhalten die Stabilizerposition von den Stabilizer Position RVDT Transmitter über die Flap Control Units (FCU’s).

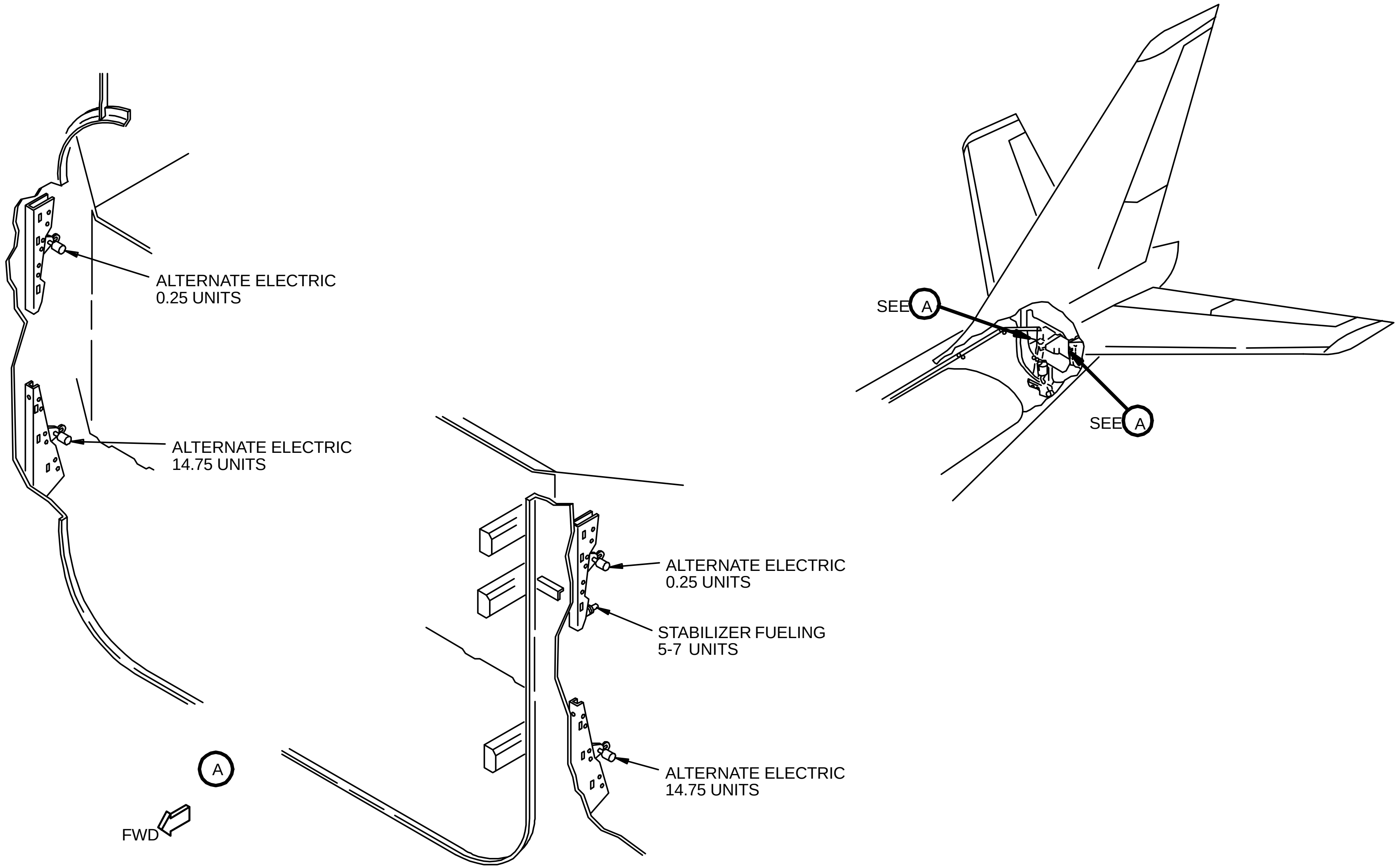


Figure 124 STABILIZER TRIM CONTROL LIMIT SWITCHES

NOSE GEAR PRESSURE SWITCH

PURPOSE :

The greenband nose gear pressure switch senses the forward and aft airplane Center of Gravity (CG) as a function of shock strut oleo pressure.

LOCATION AND ACCESS :

The pressure switch is threaded into a shock strut air charging manifold attached to a bracket on top of the nose gear shock strut trunnion.

CHARACTERISTICS :

The pressure switch senses increasing and decreasing oleo pressure as the strut compresses extends.

- < 750 psi = Aft CG
- > 900 psi = Fwd CG

PRESSURE SWITCH REPLACEMENT :

Prior to pressure switch replacement, the air charging manifold must be depressurized. This may be accomplished by closing the shutoff valve, and loosening the air charging valve nut two turns maximum.

With shock strut air charging manifold depressurized, the pressure switch may be removed by unthreading from manifold. Install new switch in accordance with the Maintenance Manual.

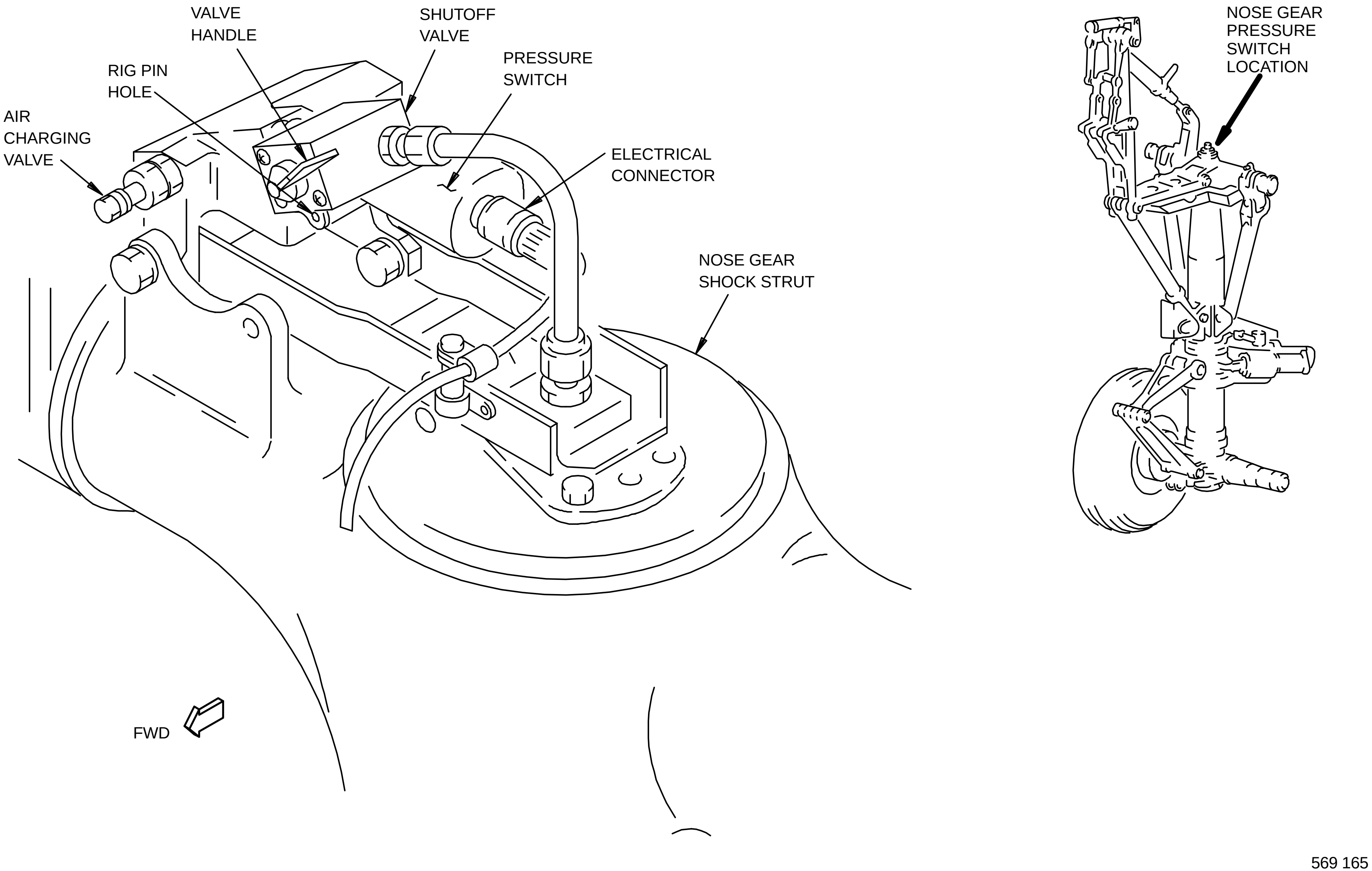


Figure 125 NOSE GEAR PRESSURE SWITCH

HYDRAULIC SHUTOFF VALVE- AND RATE CONTROL SCHEMATIC

STABILIZER SHUTDOWN DESCRIPTION

With the stabilizer trim cutout switches in the AUTO-position, both Stabilizer trim/rudder ratio modules (SRM's) control the motor-operated shut-off valves in both stabilizer trim control modules (STCM's) simultaneously.

The stabilizer trim control modules motor-operated shut-off valves will be commanded CLOSED by both SRM's when the associated STCM brake release pressure switch is open and an unscheduled trim monitor detects stabilizer movement.

SRM's crossfeed unscheduled trim signal.

When the associated cutout switch is placed to the AUTO-position for five seconds, both SRM's provide an OPEN-command to the motoroperated shutoff valves. SRM open and close command are of ten-second duration. The auto shutdown function can be overriden by placing the STAB trim cutout switches in ON or cutout. After automatic motoroperated shutoff valve operation, the auto open command requires the cutout switch to be repositioning to AUTO from ON or CUTOUT.

STABILIZER RATE CONTROL FUNCTION

A rate control solenoid valve in each stabilizer trim control module (STCM) is controlled by one of the stabilizer trim/rudder ratio modules (SRM). The SRM in control is selected randomly, at power up. The SRM not selected is placed in a standby mode by an inhibit input from the selected SRM. Failure of the rate control function in the controlling SRM causes loss of valid in engage logic and transfer of function to the stanby SRM.

The STCM rate control solenoids are unpowered when the Digital Air Data Computer (DADC) computed airspeed input increases to 230 kts to provide low trim rate (0.10 deg/sec - one motor, 0.20 deg/sec - both motors). Decreasing airspeed to 220 kts (or loss of rate control function in both SRM's) powers the solenoids to provide high rate trim (0.25 deg/sec - one motor, 0.50 deg/sec - both motors).

SUMMARY :

STABILIZER TRIM AND RUDDER RATIO MODULES (SRM's)

- sind so auf die Shutoff Valves geschaltet, daß bei Ausfall von einem SRM das andere weiterhin Auto Shutdown bzw. Rate Control für beide Trim Module durchführen kann.

SHUTOFF VALVE CONTROL

STAB TRIM Switch

- **ON:** Shutoff Valve Open, keine EICAS Mess.
- **AUTO:** Shutoff Valve wird bei Unscheduled Trim und Pressure Switch >1200 psi automatisch nach Closed angesteuert, mit
  Advisory Message **">STAB TRIM 2** und/oder **3"** und
  Status Message **">STAB TRIM"**.
  Auto Shutdown kann durch STAB TRIM Switch ON übersteuert werden, d.h. das Shutoff Valve wird nach Open angesteuert.
- **CUTOUT:** Shutoff Valve Closed mit Message
- Ein Shutoff Valve Fehler wird im CMC gespeichert.

RATE CONTROL

- Bis 220 KTS ist das Rate Control Solenoid erregt, d.h. kein Hydraulic Flow Drosselung.
  Über 230 KTS oder Verlust der Rate Control Funktion von beiden SRM's ist das Rate Control Solenoid stromlos, d.h. Hydraulic Flow Drosselung und damit Reduzierung der Hydraulic Motor Drehzahl. Ein Solenoid Fehler wird im CMC gespeichert.

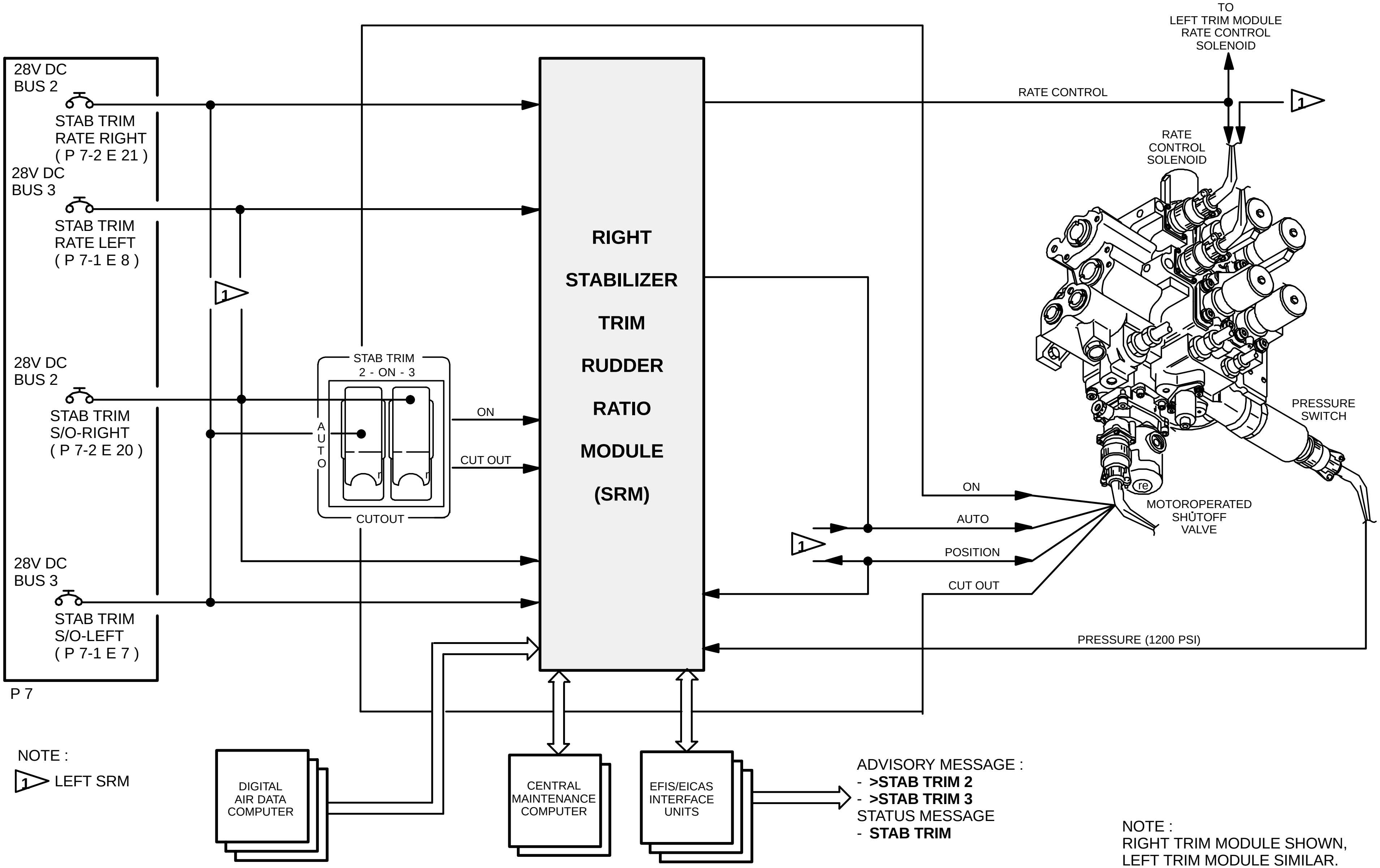


Figure 126 HYDRAULIC SHUTOFF VALVE- AND RATE CONTROL SCHEMATIC

HORIZONTAL STABILIZER MANUAL TRIM MODE
(D-ABVA UP TO -VN, -TA UP TO -TH)

OPERATION DESCRIPTION

Actuation of either control wheel arm and control manual trim switches in the airplane nose up or nose down direction provides power (L STAB CONT, CB) to the associated solenoids in both Stabilizer Trim Control Modules (STCM).

The manual trim path in the stabilizer Trim/Rudder Rario Module (SRM) is through the auto/manual transfer relays which are powered in the autotrim mode. The SRM functions as a switch for the manual trim mode, thus an SRM fault causing module shutdown normally does not inhibit manual trim. Manual trim arm and control switch inputs are monitored by the SRM for fault annunciation and ground test.

When an SRM is engaged in the autotrim mode, the auto/manual transfer relay is powered. A manual trim input unpowers the transfer relay (except during autotrim autoland mode) and disengages autotrim. Manual trim input also cause the SRM to disengage the mach trim mode if engaged.

TRIM LIMIT CONTROL

Each SRM provides control of stabilizer trim limits in the manual, autotrim and mach trim mode.
When the landing gear is not down, the SRM relay operation limits airplane nose down trim to1.8 units.

When the gear is down, nose down trim to 0.8 units is possible.

When Full-Rate Autotrim (FRAT) is engaged by the FCC, the airplane nose up trim limit is 13.5 units.

When FRAT is not engaged the trim limit is 11.6 units.

COLUMN CUTOUT

Moving the control column 4.5° in the opposide direction to the electric trim command interrupts power to the control solenoids stopping stabilizer movement.

SUMMARY :

MANUAL TRIM

- Durch Betätigen der Manual Trim Switches werden durch die SRM's über die Stabilizer Actuated Limit Switches die Arming Solenoids und über die Column Actuated Switches die Control Solenoids angesteuert.
- Für die Trimmung muß das jeweilige Arming- und Control Solenoid öffnen.
- Wird während Trim ein Limit Switch betätigt oder wird die Steuersäule entgegengesetzt zur Trimmrichtung ausgelenkt, dann wird das entsprechende Solenoid stromlos und die Hydraulic im Module ist abgeschaltet.
- Trimmbereiche:
  - Gears Up und Leading Edge Devices Retract 1.8 - 11.6 Units
  - Gears Down oder Leading Edge Devices Extend 0.8 - 11.6 Units, bei Autoland in Full Rate Trim Mode 0.8 - 13.5 Units
- Meldet ein Pressure Switch nach Ansteuerung <1200 psi, dann erscheinen die EICAS
  Advisory Message **" >STAB TRIM 2** und/oder **3"** und
  Status Message **">STAB TRIM"**.

  Bei unkontrollierter Ansteuerung erscheint die
  Caution/Status Message **"STAB TRIM UNSCHD"**
  und es erfolgt Auto Shut Down. Alle Fehler werden im CMC gespeichert.

- Die Trimmbereiche gelten auch bei Auto Trim und Speed Stability Trim.

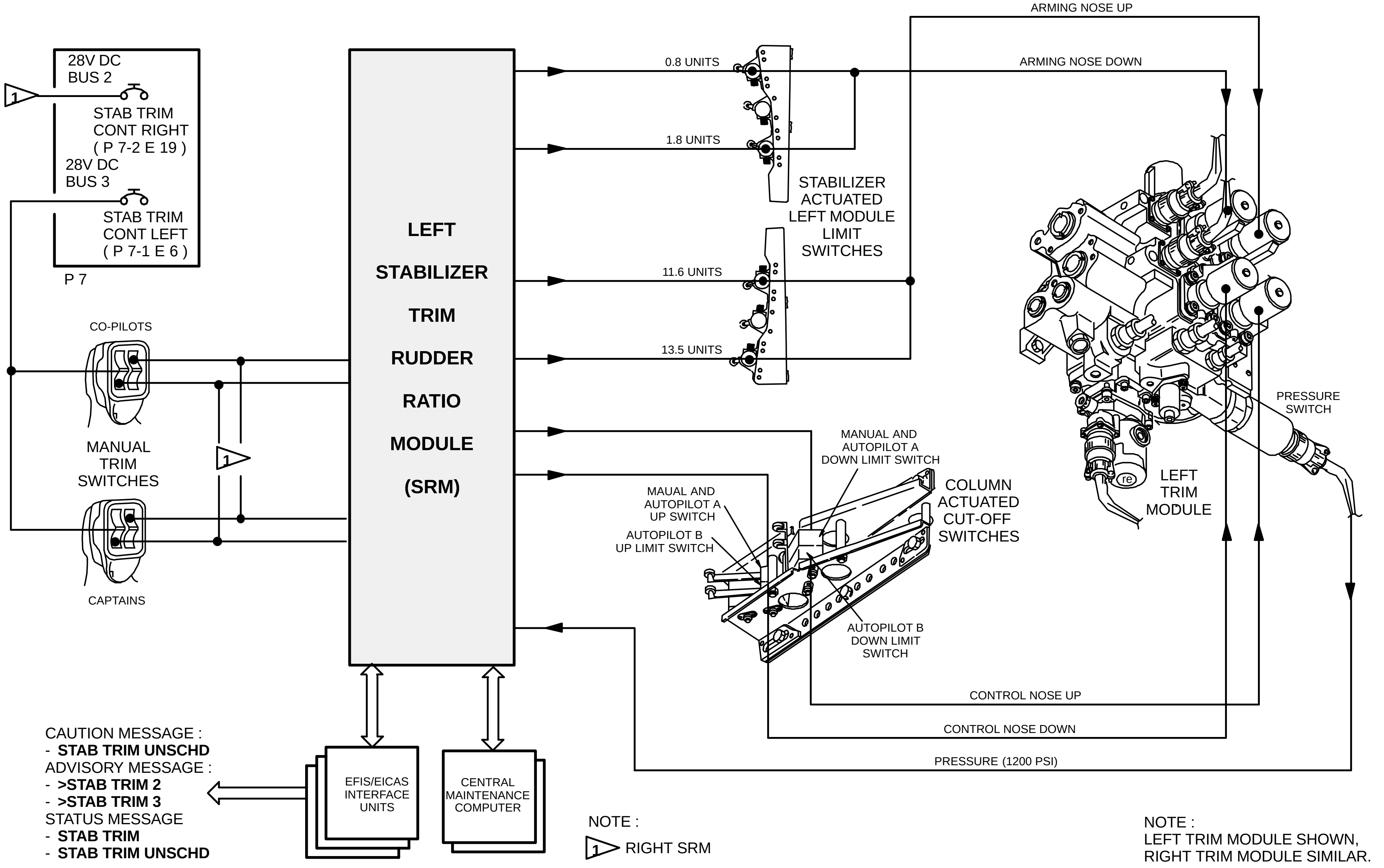


Figure 127 HORIZONTAL STABILIZER MANUAL TRIM MODE

HORIZONTAL STABILIZER ALTERNATE TRIM MODE

OPERATION DESCRIPTION

Alternate trim control and arming switches on the control stand provide direct operating power to the dual coil control and arm solenoids in both Stabilizer Control Modules (STCM).

Nose up and down trim limits are controlled by stabilizer operated alternate electric limit switches at 0.25 units stabilizer leading edge up (airplane nose down) and 14.75 units stabilizer leading edge down (airplane nose up).

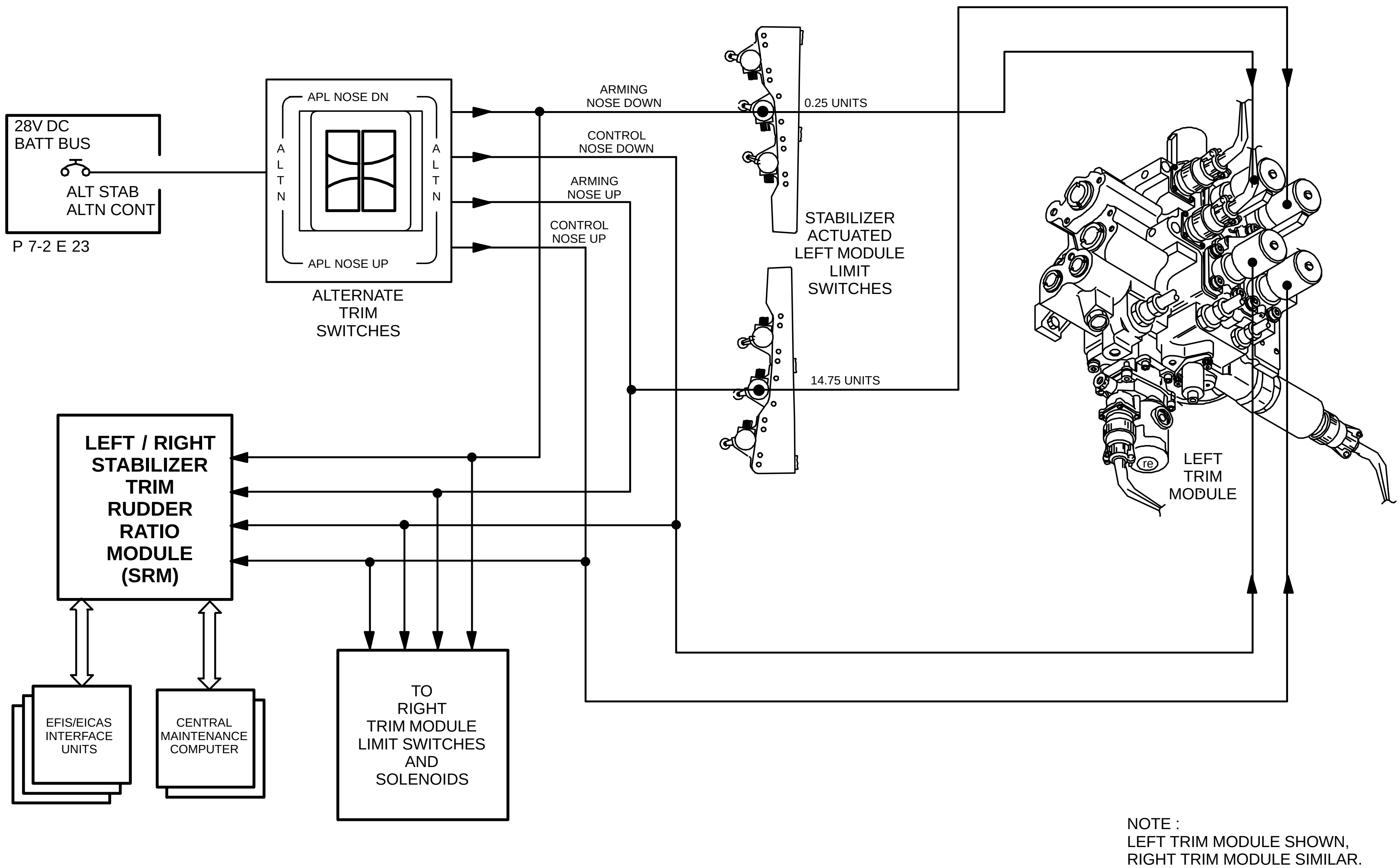


Figure 128 HORIZONTAL STABILIZER ALTERNATE TRIM MODE

HORIZONTAL STABILIZER MANUAL TRIM MODE (D-ABVO AND ON)

OPERATION DESCRIPTION

Actuation of either control wheel arm and control manual trim switches in the airplane nose up or nose down direction provides power (L STAB CONT, CB) to the associated solenoids in both Stabilizer Trim Control Modules (STCM).

The manual trim path in the stabilizer Trim/Rudder Rario Module (SRM) is through the auto/manual transfer relays which are powered in the autotrim mode. The SRM functions as a switch for the manual trim mode, thus an SRM fault causing module shutdown normally does not inhibit manual trim. Manual trim arm and control switch inputs are monitored by the SRM for fault annunciation and ground test.

When an SRM is engaged in the autotrim mode, the auto/manual transfer relay is powered. A manual trim input unpowers the transfer relay (except during autotrim autoland mode) and disengages autotrim. Manual trim input also cause the SRM to disengage the mach trim mode if engaged.

TRIM LIMIT CONTROL

Each SRM provides control of stabilizer trim limits in the manual, autotrim and mach trim mode.
When the landing gear is not down, the SRM relay operation limits airplane nose down trim to1.8 units.

When the landing gear is down, nose down trim to 0.8 units is possible.

When Full-Rate Autotrim (FRAT) is engaged by the FCC, the airplane nose up trim limit is 13.5 units.

When FRAT is not engaged the trim limit is 11.6 units.

NOTE: Die Stabilizer Actuated Limit Switches (0.8, 1.8, 11.6, 13.5) befinden sich bei der D-ABVO and On innerhalb der SRM.
Die Stabilizer Position wird von den Stabilizer RVDT's über die FCU's an die SRM übertragen und damit Switch Relays geschaltet.

COLUMN CUTOUT

Moving the control column 4.5° in the opposide direction to the electric trim command interrupts power to the control solenoids stopping stabilizer movement.

SUMMARY :

MANUAL TRIM

- Durch Betätigen der Manual Trim Switches werden durch die SRM's über die Stabilizer Actuated Limit Switches die Arming Solenoids und über die Column Actuated Switches die Control Solenoids angesteuert.
- Für die Trimmung muß das jeweilige Arming- und Control Solenoid öffnen.
- Wird während Trim ein Limit Switch betätigt oder wird die Steuersäule entgegengesetzt zur Trimmrichtung ausgelenkt, dann wird das entsprechende Solenoid stromlos und die Hydraulic im Module ist abgeschaltet.
- Trimmbereiche:
  - Gears Up und Leading Edge Devices Retract 1.8 - 11.6 Units
  - Gears Down oder Leading Edge Devices Extend 0.8 - 11.6 Units, bei Autoland in Full Rate Trim Mode 0.8 - 13.5 Units
- Meldet ein Pressure Switch nach Ansteuerung <1200 psi, dann erscheinen die EICAS
  Advisory Message **" >STAB TRIM 2** und/oder **3"** und
  Status Message **">STAB TRIM"**.

  Bei unkontrollierter Ansteuerung erscheint die
  Caution/Status Message **"STAB TRIM UNSCHD"**
  und es erfolgt Auto Shut Down. Alle Fehler werden im CMC gespeichert.

- Die Trimmbereiche gelten auch bei Auto Trim und Speed Stability Trim.

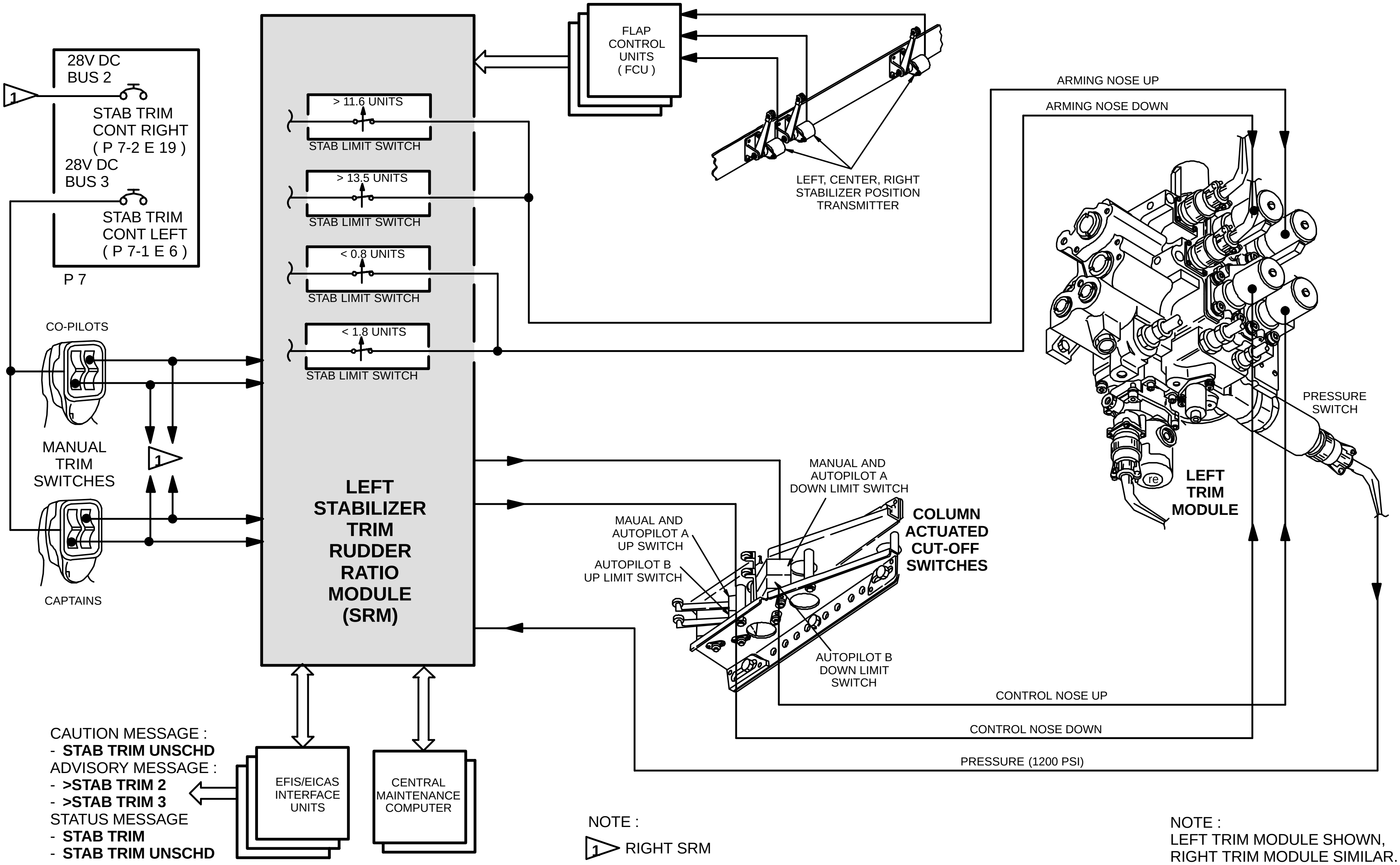


Figure 129 HORIZONTAL STABILIZER MANUAL TRIM MODE (D-ABVO AND ON)

HORIZONTAL STABILIZER TRIM BEREICHE

DESCRIPTION

Aus der unten dargestellten Tabelle können Sie für die Trimarten :

- Alternate Trim
- Manual Trim
- Auto Trim

die entsprechenden Funktionen, wie :

- Stabilizer Steuerung
- Trim Bereiche
- Abschaltung
- Stablizer Trim Control Module
- Rate Control

entnehmen.

TRIMMUNGSART	STABILIZER STEUERUNG	TRIM BEREICHE	ABSCHALTUNG	STABILIZER CONT. MOD.	RATE CONTROL < 220 KTS	RATE CONTROL > 230 KTS
ALTERNATE TRIM	DIRECT	0.25 - 14.75	LIMIT SWITCHES : *ARMING SIGNAL	BOTH	0.5° /SEC.	0.25° /SEC.
MANUAL TRIM 1.) GEAR NOT DOWN AND LE FLAPS RET.	SRM (FCU) (PSEU)	1.8 - 11.6	CUT OFF SWITCHES : *CONTROL SIGNAL LIMIT SWITCHES : *ARMING SIGNAL	BOTH	0.5° /SEC.	0.25° /SEC.
2.) GEAR DOWN OR LE FLAPS EXT. (FRT-MODE)		0.8 - 11.6				
3.) AUTOLAND		0.8 - 13.5				
AUTO TRIM	SRM (FCU) (DADC)	GEAR UP AND LE FLAPS RET. (CRUISE FLIGHT) 1.8 - 11.6	CUT OFF SWITCHES : *CONTROL SIGNAL	ONE	0.2° /SEC	0.1° /SEC.
SPEED STABILITY TRIM (ONE STABILIZER TRIM CONTROL MODULE ONLY) > 20 SEC. AFTER TAKEOFF ACTIVE		GEAR DOWN AND LE FLAPS EXT. (AUTOLAND) 0.8 - 11.6	LIMIT SWITCHES : *ARMING SIGNAL	BOTH	0.5° /SEC.	0.25° /SEC.

Figure 130 HORIZONTAL STABILIZER TRIM BEREICHE

SPEED STABILITY- AND AUTOTRIM SYSTEM (STS)

STABILIZER TRIM MODE SELECTION

When the left, center or right autopilot is engaged, the appropriate SRM enters autotrim mode and accepts trim commands from the FCC.
When all autopilots are disengaged and the airspeed is below 220 knots, the SRM enters the Speed Trim mode (and the Mach Trim mode is entered above 0.86).
The SRM uses Computed Airspeed from the DADC and stabilizer position from the FCU to adjust the stabilizer to increase static speed stability for speed trim (and cruise longitudinal static stability for Mach trim.
If the manual trim switches are used, the SRM will enter manual trim mode; manual trim has priority over Mach/Speed Trim and single channel autotrim.
With multi-channel engaged in autoland, autotrim mode has priority over all modes except alternate electric trim.

SINGLE - CHANNEL ENGAGED

During single channel engaged operation, the engaged FCC will generate stabilizer trim commands to reduce the elevator load. The ELEV SERVO CMD is the signal that commands the elevator to move. This signal is sent through the nose up and nose down threshold detectors. If the ELEV SERVO CMD exceeds, for example, the nose down threshold (THS), the nose down autotrim commands (TDA, TDC) are set high. These autotrim commands are sent to the SRM, which then delays the response for 3.5 seconds and sends the trim command to the STCM. As the stabilizer moves in the commanded direction, the elevator load is reduced. The ELEV SERVO CMD then drops below the threshold (THR) and the discretes (TDA, TDC) are reset low again. The SRM then immediately stops the stabilizer time command to the STCM. The sequence of events are identical for nose up trim except that the nose up threshold detector limits are negative.

The AUTOTRIM ARM analog discrete and ENGAGE SRM L, R digital descretes will remain low until the FCC is engaged This forces AUTOTRIM MODE Logic low in the SRM. After a FCC is engaged, the SRM will enter AUTOTRIM MODE if the FCC input monitor sets ENABLE high. Also, after AUTOTRIM ARM is received by the SRM, the AUTOTRIM VALID output becomes sensitive to manual trim and FRAT command requests. In other words manual trim input or FRAT input will cause the AUTOTRIM VALID to go low. Stabilizer trim faults will also cause AUTOTRIM VALID to go low and with single channel engaged, loss of AUTOTRIM VALID will cause the autopilot to disengage.

MULTI - CHANNEL ENGAGED

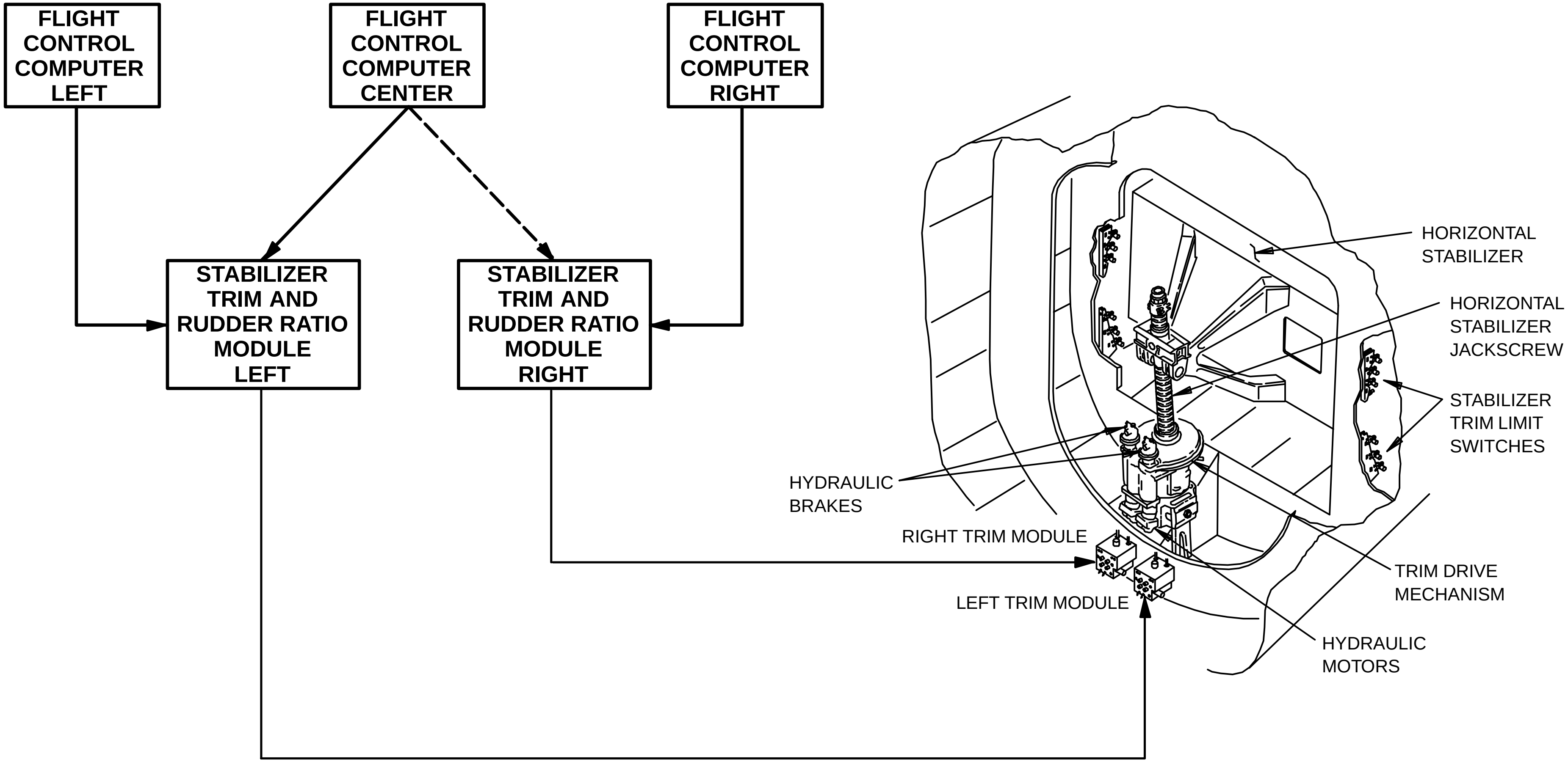
The major differences with multi-channel engaged are the stabilizer trim bias, the FRAT capability, the failure annunciations, and the AUTOTRIM VALID logic function.

The purpose of the stabilizer trim bias is to intentionally introduce a nose up trim command on a dual autoland approach; this causes the FCCs to command elevator in the opposite direction to compensate for the stabilizer trim. If the elevator fails to compensate, the FCCs will command the elevator neutral and the stabilizer flares the airplane to land.

With the multi-channel and radio altitude less than 500 feet, the engaged FCCs interrogate the SRMs for FRAT capability; this causes the AUTOTRIM VALID to go low, which signals the FCC that there is FRAT capability. During multi-channel engaged, AUTOTRIM VALID transition to low will not cause the autopilot to disengage. The self-test, which lasts 4 seconds is conducted and trim commands are inhibited during the test.

The stabilizer trim bias and FRAT will only be used during dual-channel engaged autoland - LAND 2 annunciated. The trim bias will occur at 120 feet. During FRAT, both channels are driven separately by the two engaged FCCs and the SRMs do not delay the command to the STCM. However, if only one of the trim channels are found to be available during testing for FRAT capability such as when AUTOTRIM VALID goes low prior to initation of test or when no AUTOTRIM VALID transition to low 4 seconds after FRAT test is initiated occurs, then the stabilizer trim bias will be initiated at 190 feet.

Stabilizer trim commands are inhibited under the following conditions: Rollout or G/A is engaged. Multi-channel autotrim commands have priority over all other trim commands except alternate electric trim.



NOTE :
NORMAL ————
NOT NORMAL – – – – – –

Figure 131 SPEED - AND AUTOTRIM SCHEMATIC

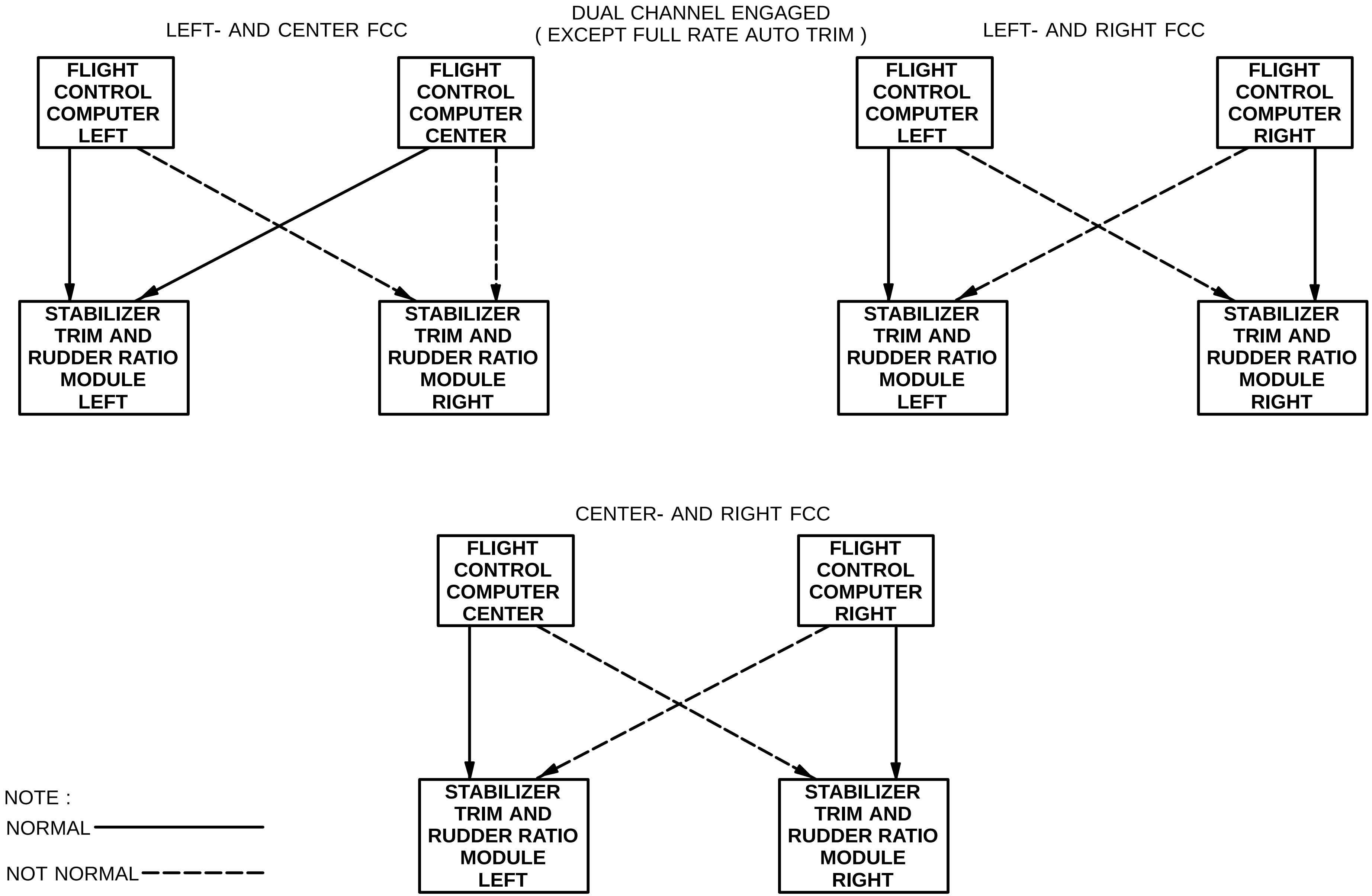


Figure 132 SPEED - AND AUTOTRIM SCHEMATIC

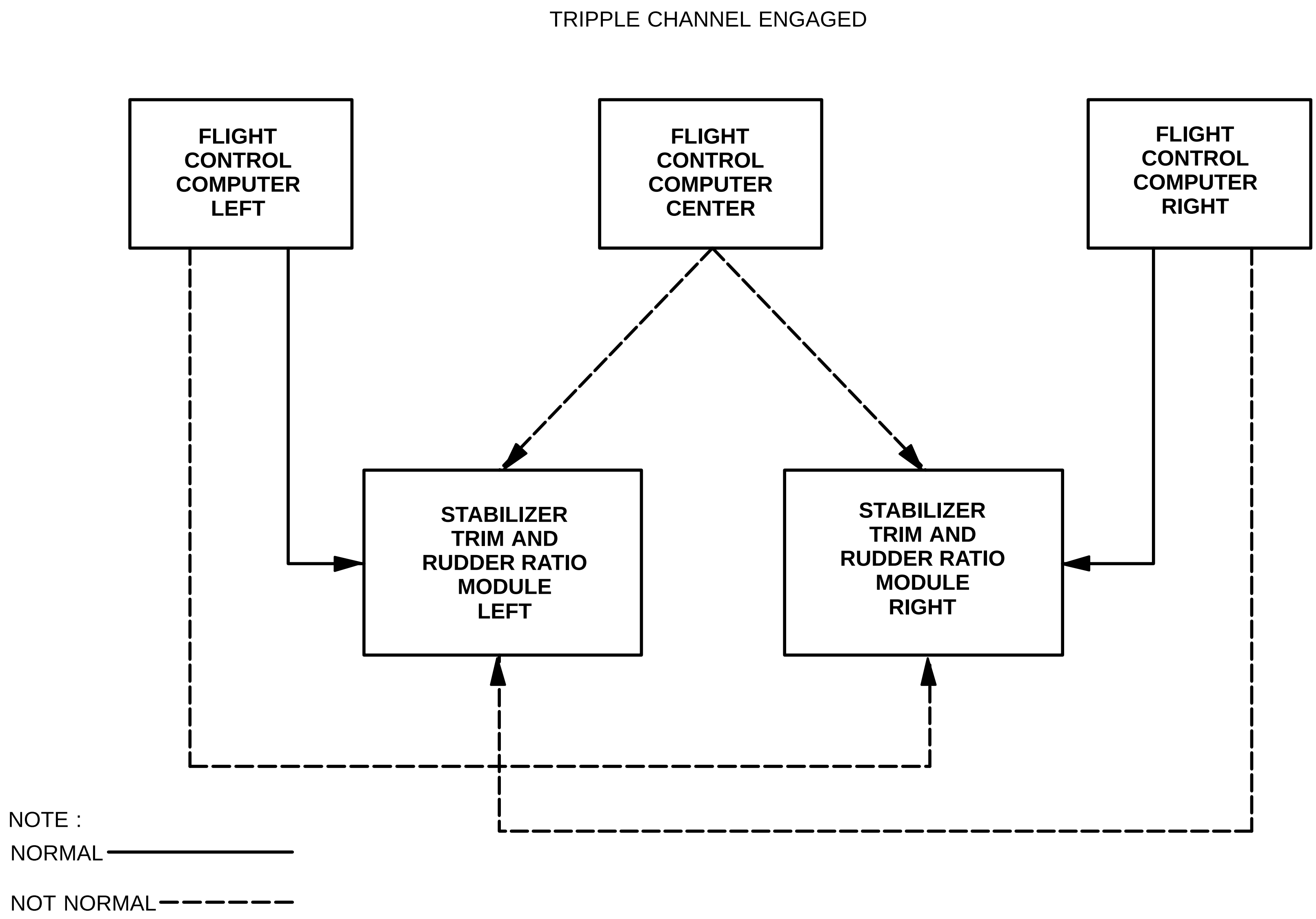


Figure 133 SPEED - AND AUTOTRIM SCHEMATIC

STABILIZER POSITION TRANSMITTER

GENERAL

The stabilizer trim indicating system provides visual indication on the flight deck of the position of the horizontal stabilizer. Units of stabilizer trim appear on the two stabilizer trim indicators located on either side of the P8 control stand.

Components used by the stabilizer trim indicating system are the 3 stabilizer position transmitters, the 2 stabilizer trim position indicators, the 3 flap control units, and the EIU's and EICAS display. The system is powered by 28 volts ac from the 28 vac bus 1 and the 28 vac ground service bus. Power is also supplied through the flap control units for the stabilizer trim maintenance displays on EICAS.

STABILIZER POSITION TRANSMITTER

The stabilizer position transmitters are mounted on the stabilizer hinge bulkhead. An adjustable control rod attaches each transmitter module to the stabilizer center box rear spar.
The left and right transmitters are adjusted to set the stabilizer trim indicators to 3 units when the stabilizer is in the neutral position.

Each stabilizer position transmitter module contains a synchro transmitter and an RVDT transmitter.
The synchro transmitters in the left and right modules drive the left and right stabilizer trim indicators on the pilots' control stand.
The synchro transmitter in the center module is not used.
The RVDT transmitters in all the modules supply position information to the flap control units (FCU's) for flight control computations and for display on the EICAS flight controls maintenance page.

SUMMARY :

- jeder der drei Stabilizer Position Transmitter enthält :
  - ein Synchro Transmitter

    für Stabilizer Position Indication auf dem Pedestal (P-8)
  - ein RVDT Transmitter

    für Stabilizer Position Indication über die FCU's auf die Flight Control Maintenance Page

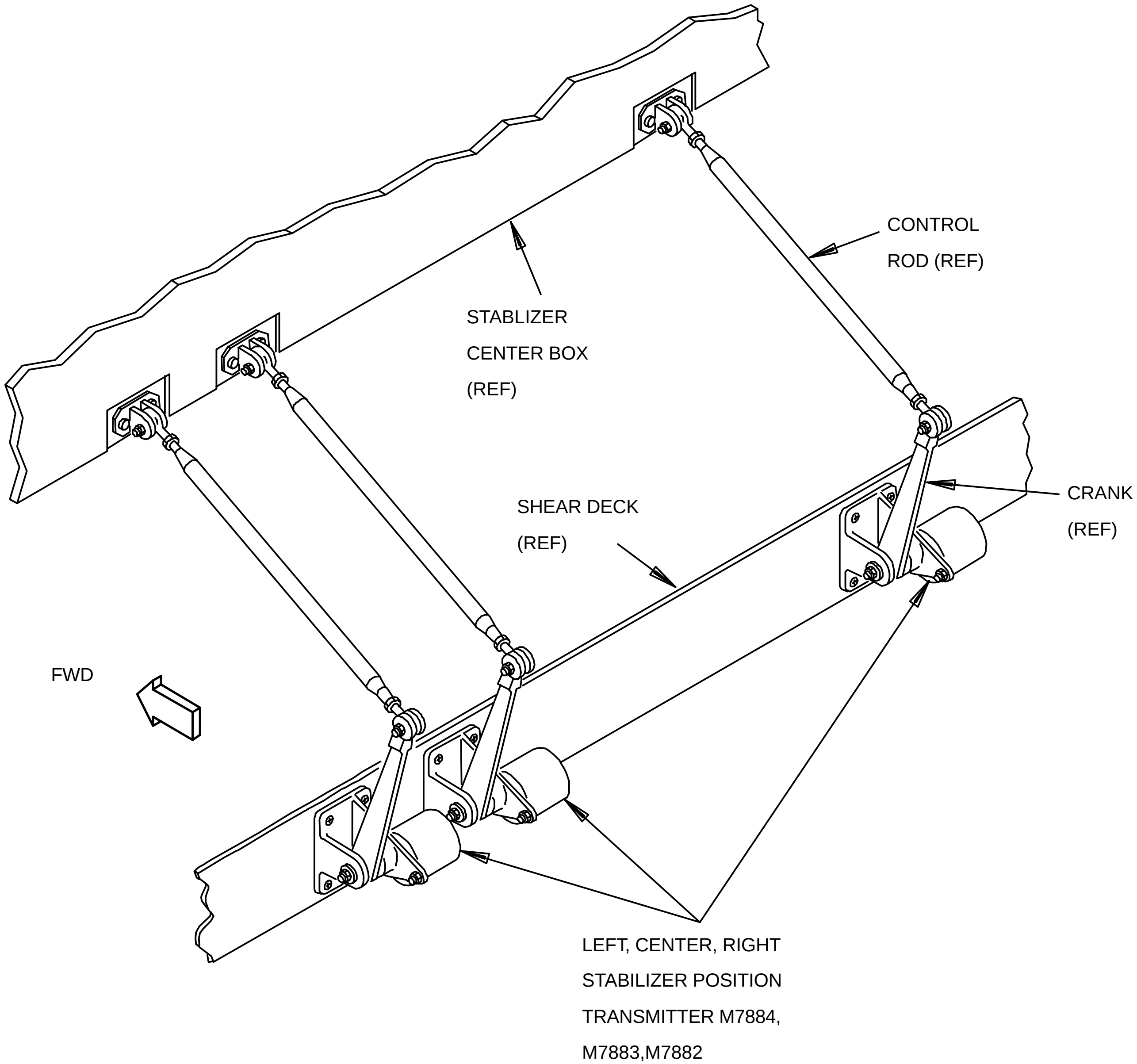


Figure 134 STABILIZER POSITION TRANSMITTER

STABILIZER POSITION INDICATION SYSTEM SCHEMATIC

OPERATION

FUNCTIONAL DESCRIPTION

As the stabilizer is deflected from the neutral position, the attached control rod drives the transmitter crank which pivots the transmitter module shaft. The transmitter electrical output varies as the shaft pivots. The synchro output signal drives the synchro receiver in the stabilizer trim position indicator which displays units of stabilizer trim. The RVDT output signal passes to the flap control units which process the signal and route it to the EIU's for display on EICAS and to other user systems.

CONTROL

Operation of the stabilizer trim indicating system is automatic. The stabilizer trim indicators give units of stabilizer trim continuously.

The flight controls maintenance page may be called up on the auxiliary EICAS display. This page displays the values of stabilizer angular displacement in degrees. The directional symbol points upward for leading edge up and downward for leading edge down.

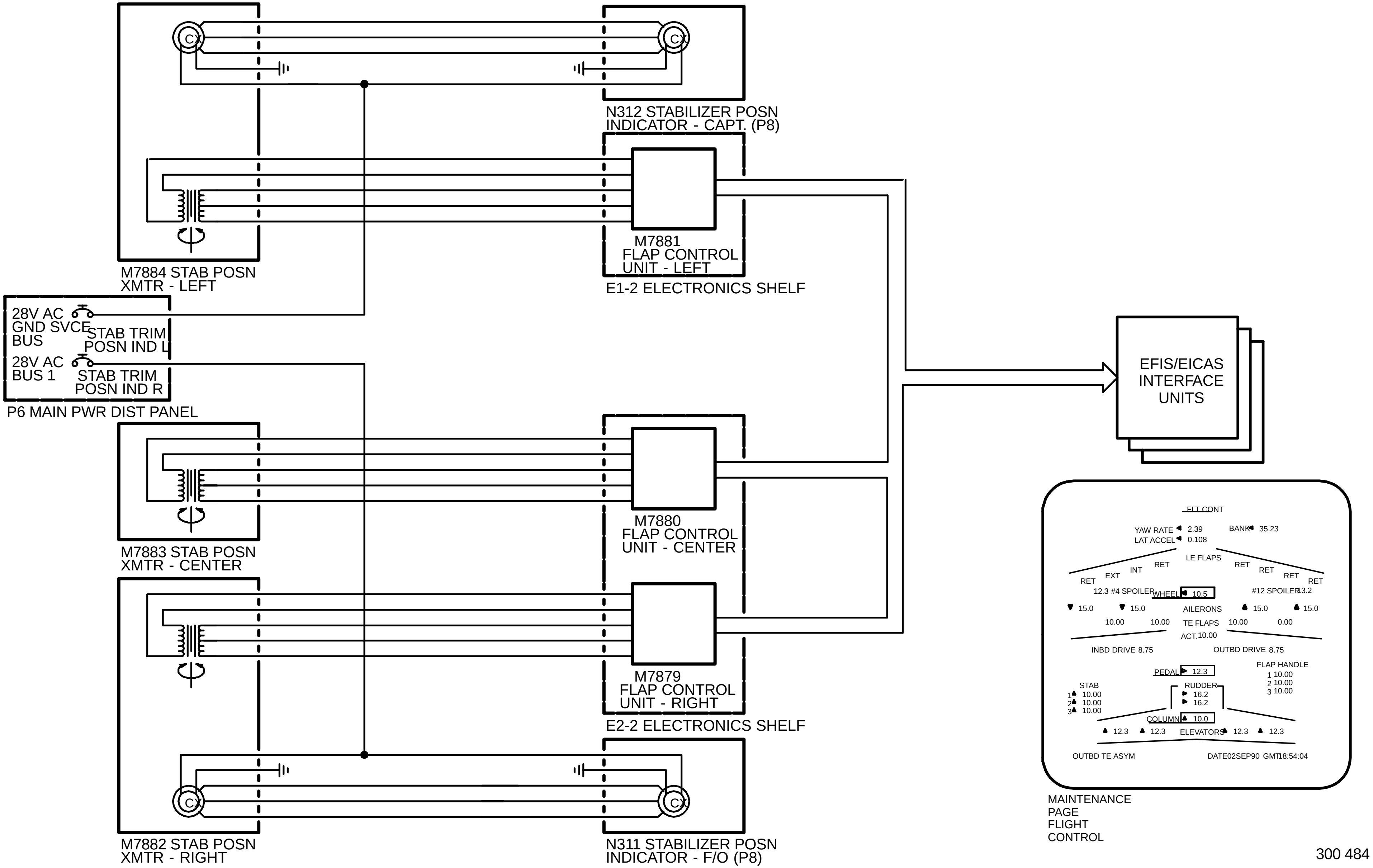


Figure 135 STABILIZER POSITION INDICATING SYSTEM SCHEMATIC

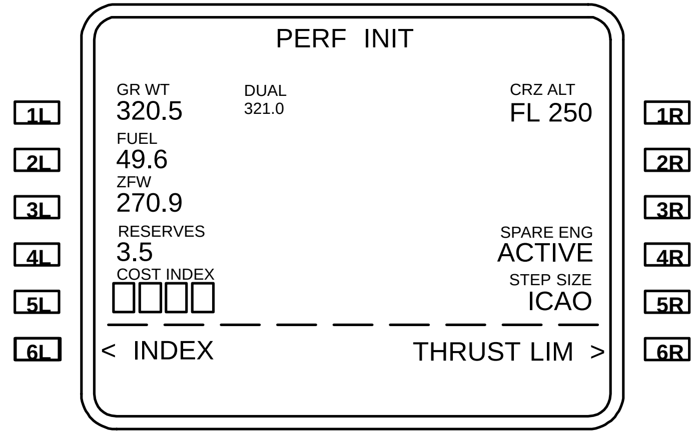
HORIZONTAL STABILIZER GREEN BAND BASIC SCHEMATIC

DESCRIPTION

Der Left-, Center- und Right Stabilizer Position Transmitter übertragen die Stabilizer Position in die Flap Control Units (FCU’s) Left, Center und Right zur Weiterleitung in die Flight Control Computer (FCC’s) Left und Right und in die Stabilizer Trim / Rudder Ratio Modules (SRM’s) Left und Right.

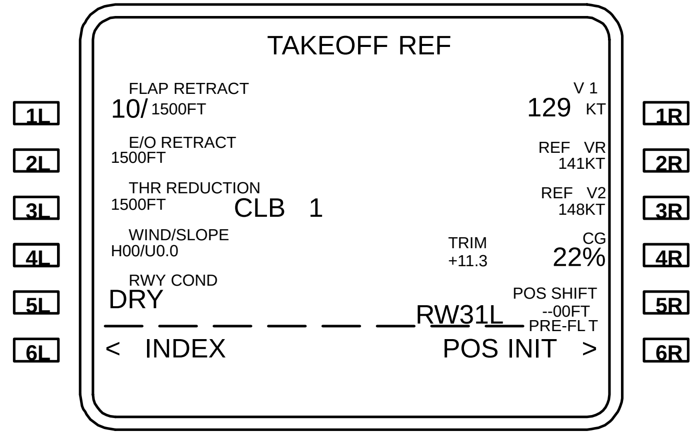
Die MAWEA erhält die Left-und Right Stabilizer Transmitter Position und über den Nose Gear Pressure Switch die Schwerpunktlage (Center of Gravity) des Flugzeuges.

Nach Eingabe von Gross Weight und Center of Gravity über den Flight Management Computer (FMC) steuert die MAWEA die Green Band Lights an und wählt damit den Take Off Bereich.



GROSSWEIGHT VOM WEIGHT AND BALANCE SYSTEM MIT "<" WIRD IN KLEINEN ZIFFERN ANGEZEIGT.
MIT DRUCK AUF 1L WIRD DER WERT AKZEPTIERT UND ERSCHEINT IN GROßEN BUCHSTABEN.
DIESER WERT KANN AUCH üBER DIE TASTATUR MANUELL EINGEGEBEN WERDEN.

CENTER OF GRAVITY VON WEIGHT AND BALANCE SYSTEM ODER MANUELLE EINGABE.
ERRECHNETE STABILIZER TRIM POSITION WIRD ANGEZEIGT.



FAILURE INDICATION OF A COMPONENT OF THE GREENBAND SYSTEM

Whenever a fault is detected for the greenband band system the advisory massage

> STAB GREENBAND 27 40 02 00

and / or

status message :

STAB GREENBAND 27 40 03 00

appears

and on the MCDU is shown the reason for the EICAS message

CMC message :

GREENBAND DISAGREE WITH NOSE GEAR PRESSURE SWITCH 27 400.

REFER TO DIN A3 PAGE

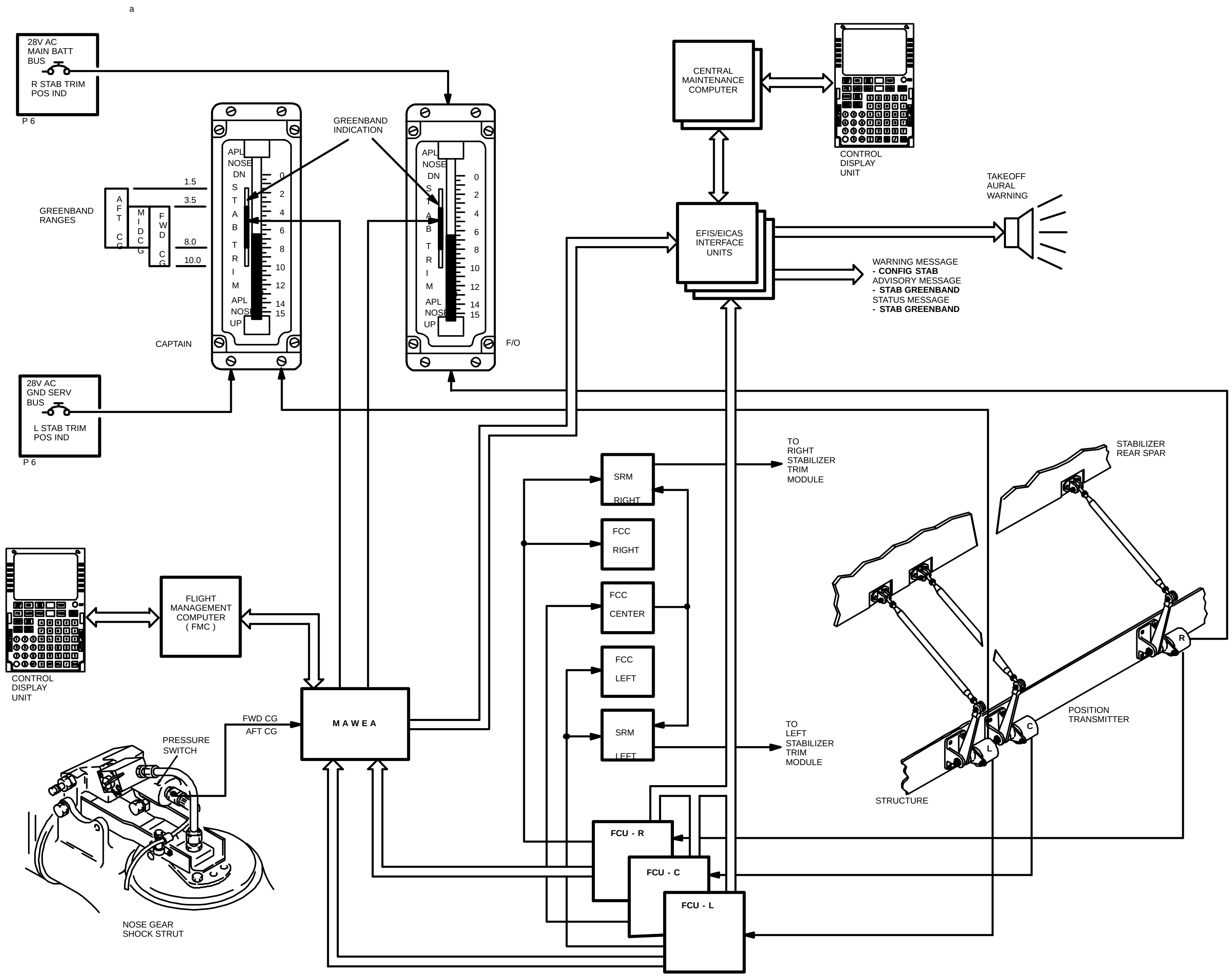


Figure 136 HORIZONTAL STABILIZER GREEN BAND BASIC SCHEMATIC

27-50 TRAILING EDGE FLAPS

TRALING EDGE FLAPS LOCATIONS

TRAILING EDGE FLAP SYSTEM

GENERAL

Two triple-slotted trailing edge flaps on each wing provide additional lift during takeoff, approach, and landing. As the trailing edge flaps are progressively extended, wing geometry is changed by first extending the chord and then increasing camber. Wing area and camber are further increased by 28 leading edge flaps (Ref 27-81-00), which operate in conjunction with the trailing edge flaps.

The inboard and outboard trailing edge (TE) flaps are positioned by independent drive systems. In normal operation, the TE flaps are hydraulically powered. As a backup to hydraulically powered operation, the flaps may be positioned by electric motors. The flaps are normally controlled from a flap control lever on the pilots' control stand. The lever is linked to a triple Rotary Variable Differential Transformer (RVDT) assembly. Each RVDT converts flap lever position to an electrical signal which is sent to the flap control units in the main electrical equipment center. The flap control units monitor flap lever position and other airplane systems to command the flap actuator to change flap position.

TRAILING EDGE FLAPS

Each flap assembly is a triple-slotted flap which consists of a foreflap, midflap, and aftflap. The three flap segments are mechanically separated to form three slots as the flaps are extended. Each midflap is attached to and is supported by two flap carriages which travel on the flap tracks. The midflap is attached to two ball screw and ball nut assemblies which are each driven by a transmission to extend or retract the flap.

FOREFLAPS

The foreflaps consist of front and rear spars connected by skin panels, a curved nose skin section, and a trailing edge. The foreflaps are supported by a track which extends into the midflap where it contacts rollers. The position of the foreflap is established by sequencing carriages attached to this surface. The foreflap extends with the midflap until the sequencing carriages contact detents in the flap tracks. At this point, the foreflaps and midflaps separate and the foreflaps do not extend further aft but are rotated relative to the midflap by cam action of the sequence carriages against the flap carriages.

MIDFLAPS

The midflaps consist of three spars and honeycomb skin panels. The midflaps are connected directly to flap carriages which ride on the flap tracks. The midflaps are also connected to the flap transmission ball screw. Additional rollers on the ends of the midflap contact tracks on wing structure to provide deflection control.

AFTFLAPS

The aftflaps are constructed in the same manner as the foreflaps. The aftflaps are supported by trunnion-mounted tubes which are

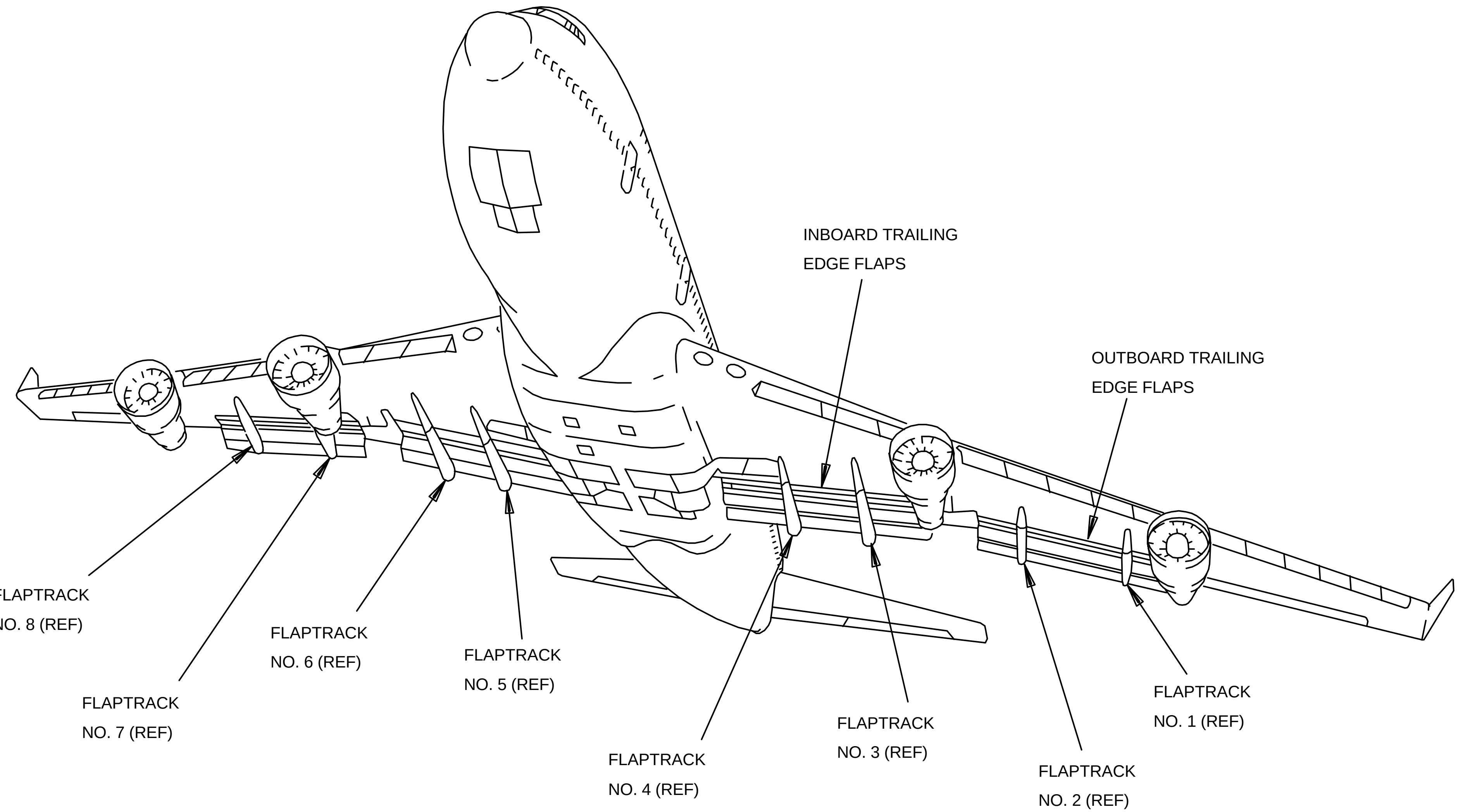


Figure 137 TRAILING EDGE FLAPS LOCATIONS

MAIN EICAS DISPLAY

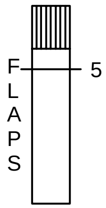
DESCRIPTION

Die Trailing Edge Flap Position Indication erfolgt in Abhängigkeit der Betriebsart auf dem Main EICAS Display wie folgt :

FLAP LEVER UP UND FLAPS UP :

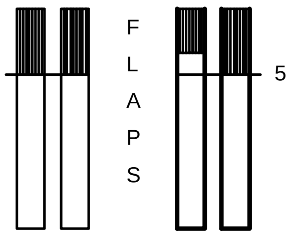
- die Flap Indication erlischt 15 sec. nachdem alle Flaps FULLY RETRACT melden

PRIMARY HYDRAULIC :



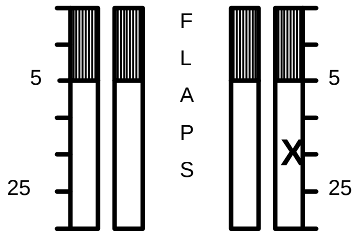
- Normal Flap Display
- es wird die Flap Lever Position mit einem Strich anzeigt
- die Trailing Edge Flaps werden mit einem gemeinsamen Band und der aktuellen Position angezeigt.

PRIMARY ELECTRIC :



- Expanded Flap Display erscheint nach dem Umschalten auf die Betriebsart Primary Electric
- Asymetrie
- Disagreement zwischen Flap Lever und Flaps
- Flap Inducation Data Invalid
- es wird die Flap Lever Position mit einem Strich angezeigt
- die Trailing Edge Flaps werden in je einem einzelnen Band und der aktuellen Position angezeigt.

ALTERNATE ELECTRIC :

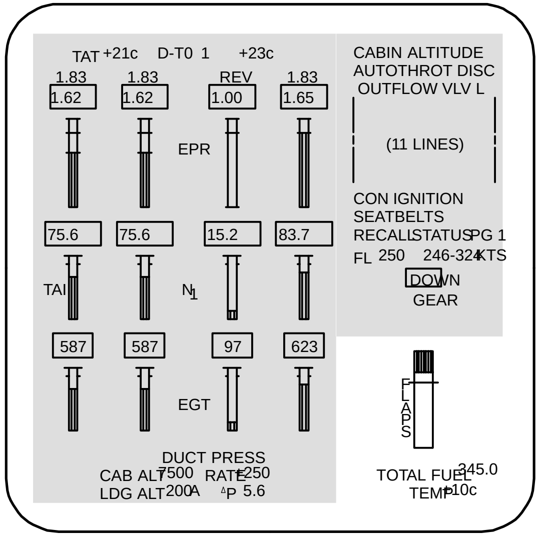


- Das Alternate Flap Display erscheint nach dem Betätigen des Alternate Flap Arming Switches nach ARM
- es erfolgt keine Anzeige des Flap Levers
- Anzeige einer Skala an der Flap Indication, mit einer 5er Unterteilung

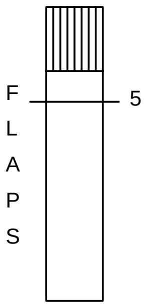
DISAGREEMENT :

- Besteht ein Disagreement zwischen dem Flap Control Lever und den Trailing Edge Flaps, so erscheint in der einzelnen Box (white) eine Kreuz (amber).

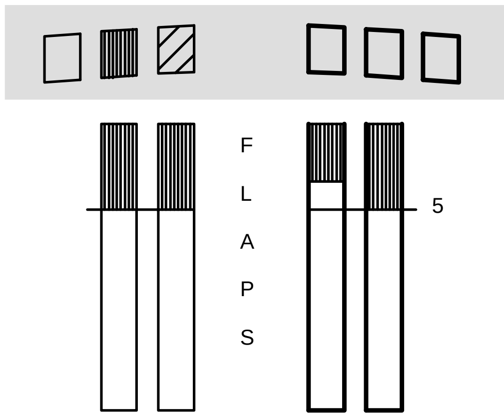
NOTE: (see MM 27-58-00 und MT 27-02R4)
Wenn das Flugzeug mit Standby Power stromversorgt ist, erscheint automatisch das Expanded Flap Display und in der Left Wing TE Flap Position Indication Bars erscheint ein AMBER " X " .
Die linke und rechte selected Position Bar, sowie die Flap Position Zahlen erscheinen in MAGENTA.
Das zeigt an, daß die entsprechenden Sensoren inoperativ oder nicht stromversorgt sind.



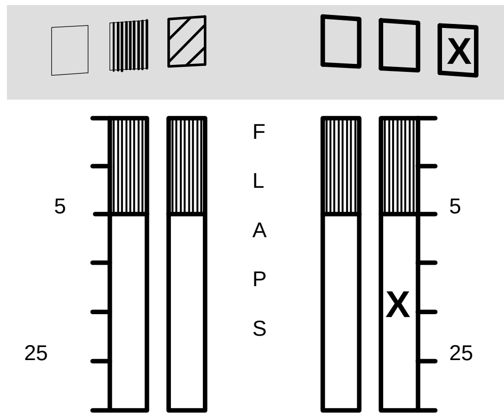
MAIN EICAS DISPLAY



NORMAL FLAPS DISPLAY



EXPANDED FLAPS DISPLAY



ALTERNATE FLAPS DISPLAY

298 501

Figure 138 MAIN EICAS DISPLAY

MAINTENANCE PAGE FLIGHT CONTROL

DESCRIPTION

Die Maintenance Page für das Flight Control System ist über das Central Maintenance Computer System (CMCS) folgendermaßen aufrufbar :

- CMC
- MENü
- MAINTENANCE PAGE
- ATA 27
- DISPLAY.

Die Anzeigen:

- des Flap Control Handles (3 RVDT's)
- des Flap Input Actuators
- der Left Inboard Drive Unit
- der Right Outboard Drive Unit
- der Right Outboard Trailing Edge Flaps
- des Right Inboard Trailing Edge Flaps
- des Left Inboard Trailing Edge Flaps
- des Left Outboard Trailing Edge Flaps

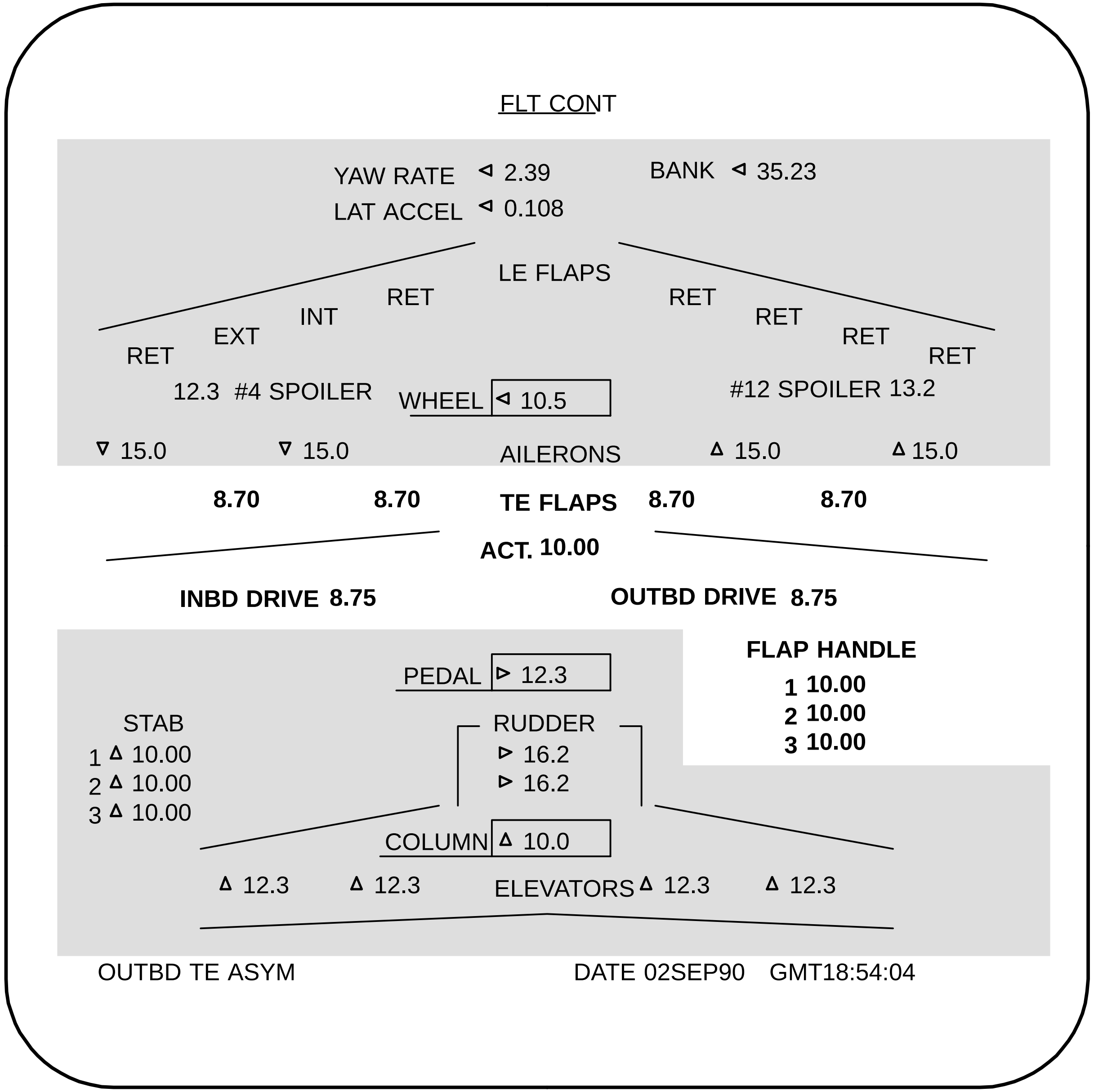
erfolgt in ° .
Die Anzeige erfolgt in Steps von $^{1}/_{10}$ ° .

FLAP HANDLE :
Es werden die drei Flap Handle Position RVDT's (SOLL) angezeigt, d.h. die vorgewählte Position des Flap Control Levers

ACT : (INPUT ACTUATOR)
Es wird die IST-Position des Internal Position RVDT's des Flap Input Lever Actuators angezeigt.

INBD- UND OUTBD DRIVE .
Es wird die IST-Position des Flap Power Package RVDT Transmitters angezeigt.

TE FLAPS :
Es wird die IST-Position der einzelnen Trailing Edge Flaps durch die TE Flap Position Transmitter (RVDT's) angezeigt.



MAINTENANCE
PAGE
FLIGHT
CONTROLS

Figure 139 MAINTENANCE PAGE FLIGHT CONTROL

FLAP CONTROL COMPONENTS

DESCRIPTION

FLAP CONTROL LEVER :

- dient zur Steuerung der Trailing Edge Flaps in :
  - der Primary Hydraulic Mode
  - der Primary Electric Mode

- **UP**
  - Flaps Retracted
- **1** (with Gate)
  - Trailing Edge Flaps UP
  - Leading Edge Group A fährt Extend
- **5**
  - Trailing Edge Flaps fahren auf Position 5
  - Leading Edge Group B fährt Extend
- **10**
  - Trailing Edge Flaps fahren auf Position 10
  - Take Off Position
- **20** (with Gate)
  - Trailing Edge Flaps fahren auf Position 20
  - maximale Take Off Position
- **25** und **30**
  - Trailing Edge Flaps fahren auf Position 25 bzw. 30
  - Landing Positionen

ALTERNATE FLAP ARMING SWITCH :

- armiert den Alternate Flap Control Switch
- steuert das Bypass Valve an der Flap Control Unit nach BYPASS
- schaltet die Primary Modes ab

- **PUSH - OFF :**
  - Primary Modes aktiv
  - Bypass Valve in der NORMAL-Position
- **PUSH - ON :**
  - Primary Modes abgeschaltet
  - Control Switch für Alternate Electric Mode aktiv
  - Bypass Valve in BYPASS - Position

ALTERNATE FLAP CONTROL SWITCH :

- steuert alle Trailing Edge Flaps (Inboard- und Outboard TE Flap)
- steuert die Electric Motore an den Flap Power Control Packages an
- **RET :**
  - Ansteuerung der Flaps nach UP
  - fixed Position
- **OFF :**
  - Normal Position
  - fixed Position
- **EXT :**
  - Ansteuerung der Flaps nach DOWN
  - fixed Position

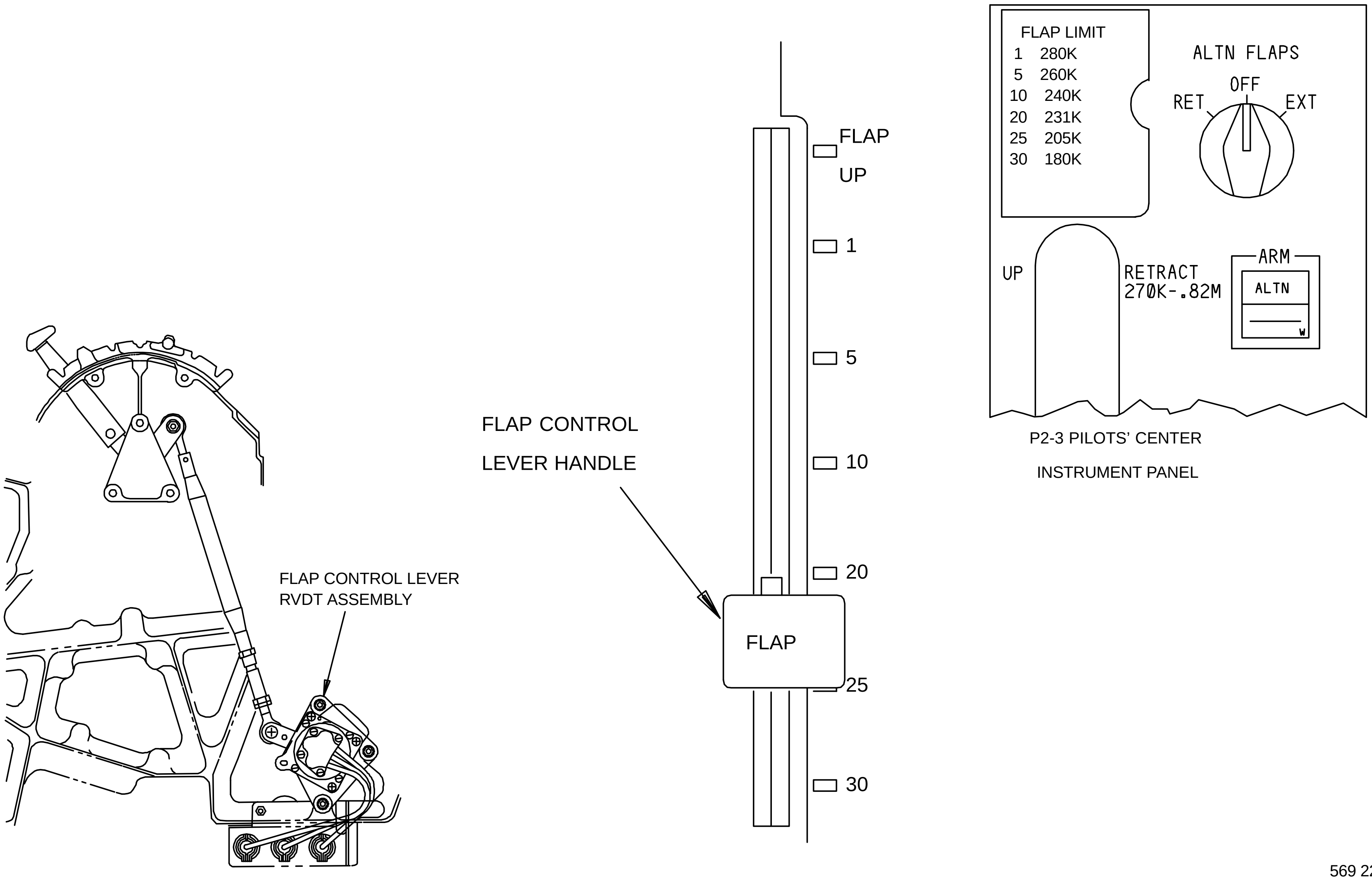


Figure 140 FLAP CONTROL LEVER

TRAILING EDGE FLAPS BASIC SCHEMATIC

DESCRIPTION

Two triple-slotted trailing edge flaps on each wing provide additional lift during takeoff, approach, and landing. As the trailing edge flaps are progressively extended, wing geometry is changed by first extending the chord and then increasing camber. Wing area and camber are further increased by 28 leading edge flaps (Ref 27-81-00), which operate in conjunction with the trailing edge flaps.

The inboard and outboard trailing edge (TE) flaps are positioned by independent drive systems. In normal operation, the TE flaps are hydraulically powered. As a backup to hydraulically powered operation, the flaps may be positioned by electric motors.

The flaps are normally controlled from a flap control lever on the pilots' control stand. The lever is linked to a triple Rotary Variable Differential Transformer (RVDT) assembly. Each RVDT converts flap lever position to an electrical signal which is sent to the flap control units in the main electrical equipment center. The flap control units monitor flap lever position and other airplane systems to command the flap actuator to change flap position.

The flap actuator in the left body gear wheel well moves the input cranks to the inboard and outboard flap power packages when commanded by the flap control units. The input cranks position a control valve in each power package to port hydraulic fluid to the hydraulic motors. Each hydraulic motor is joined to a reduction gearbox which drives a torque tube extending into each wing. Angle gearboxes are installed along the torque tubes to permit change of direction. The torque tubes connect to two transmissions at each flap. The transmissions position the midflap of each three-part TE flap set through ball screw drives. Foreflaps and aftflaps are positioned as the midflap is moved.

An electric motor in each power package drives the TE flaps as an alternate to hydraulically powered operation. If flaps fail to move under hydraulic power, the flap control units automatically activate the alternate electric motors to position the flaps. The motors can also be controlled independently of the flap control units with switches on the pilots' center instrument panel.

RVDT flap position transmitters (Ref 27-58-00) are installed in 7 places throughout the TE flap drive mechanisms. An RVDT transmitter is installed in each power package and in the outboard transmission of each flap. The flap actuator has an integral RVDT transmitter. Each RVDT transmitter is wired to all 3 flap control units, which process the position signal for use in flap control, position indication, and asymmetry and failure detection.

REFER TO DIN A3 PAGE

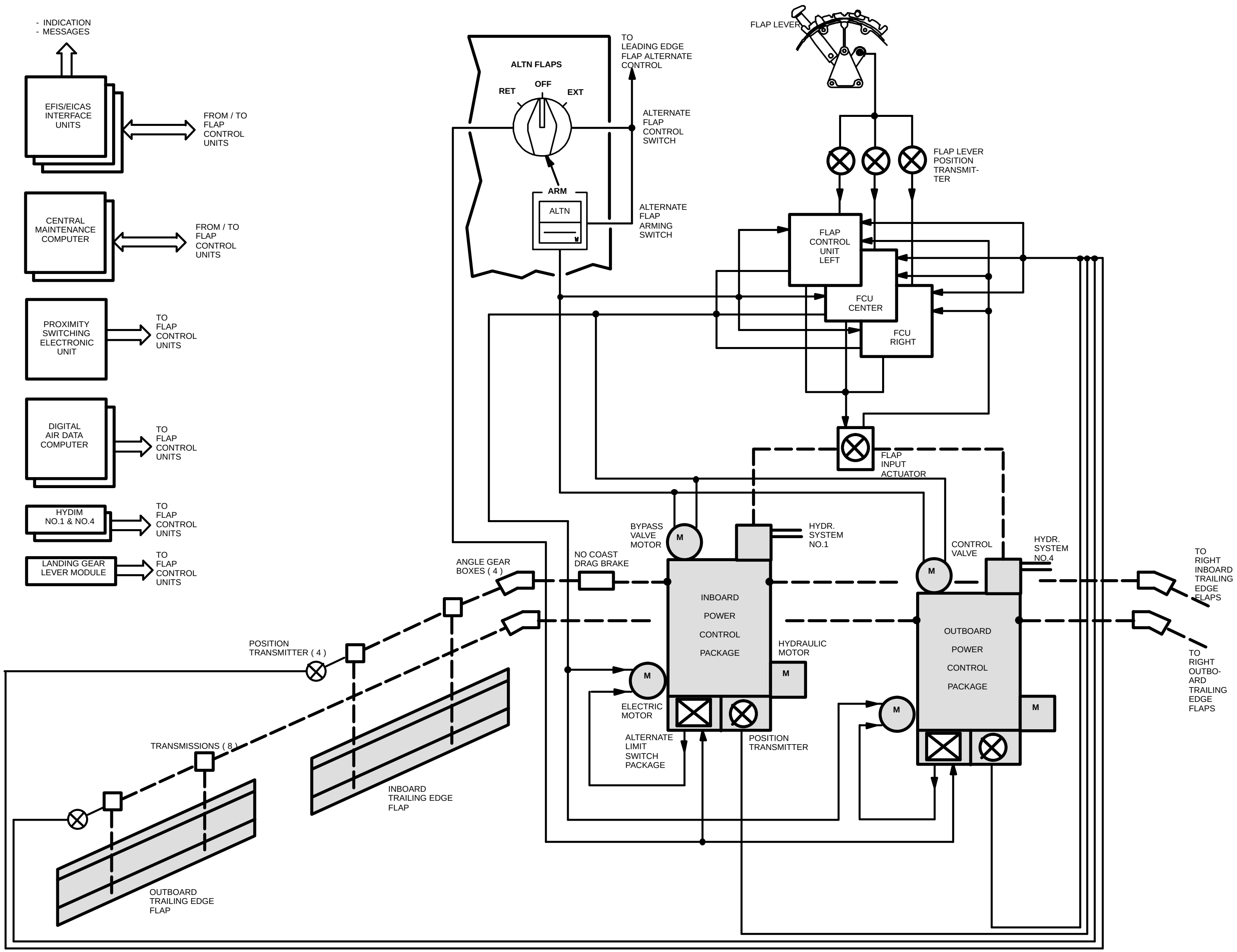


Figure 141 TRAILING EDGE FLAPS BASIC SCHEMATIC

FLAP CONTROL UNITS (FCU'S)

FLAP CONTROL UNITS

The three Flap Control Units (FCU's) provide control, protection, and indication for the trailing edge and leading edge flaps. The FCU's also process position indication signals for the horizontal stabilizer. The FCU's are located in the main electrical/electronic equipment center, with the left FCU on the E1-2 shelf and the center and right FCU's on the E2-2 shelf. The FCU's are powered by the Flight Controls Electronics Power Supply Modules.

Each FCU receives inputs from the following sources:

(1) Flap lever RVDT assembly

(2) Alternate flaps ARM switch and EXT/RET switch

(3) RVDT transmitters at TE flap actuator, power packages, and transmis sions

(4) Primary and alternate air/ground relay system

(5) Left and right Air Data Computers

(6) Engine 1 and 4 demand pressure and EDP pressure switches

(7) Engine 1 and 4 Hydraulic Discrete Interface circuit cards

(8) Central Maintenance Computer System

The inputs are processed independently by each FCU to generate output signals to the flap actuator, flap alternate electric motors, flap position and failure indication displays, leading edge flap power drive units and other airplane user systems. Only one FCU at a time is enabled to command a change in flap position for a given group of flaps (TE outboard, TE inboard, LE group A, LE group B). All automatic flap control functions will operate with one, two, or three FCU's operational.

The FCU in control operates in primary hydraulic mode or primary electric mode to command a change in flap position. Normally, flaps are moved in primary hydraulic mode. If no movement with a group of flaps under hydraulic power is detected, the FCU automatically switches to primary electric mode for that group of flaps. In primary electric mode, the flaps are commanded by the FCU to move under electric motor power. If alternate flaps are selected from the flight deck, the FCU control outputs are disabled and the electric drive motors for all flaps are under direct manual control.

In primary hydraulic mode, the priority of FCU in control of a group of flaps is the left FCU initially, then the center, and lastly the right following successive FCU failures. In primary electric mode, the priority of FCU in control for a group of flaps is the right FCU initially, then the center, and lastly the left following successive FCU failures.

Each FCU continuously provides flap system failure protection while operating in the primary hydraulic mode or the primary electric mode.

System failure protection includes asymmetry detection, uncommanded motion detection, flaps-moving-away detection, and primary hydraulic and primary electric disable functions. Protection is provided separately for inboard and outboard TE flaps.

Each FCU will disable its control outputs if it determines that a flap asymmetry condition exists. The FCU's will disable their control and failure protection functions when the alternate system is engaged, but will continue to provide position information for flight deck displays and user systems.

The flap control units automatically retract the TE flaps to relieve aerodynamic loads on the flaps if they are extended at an excessive airspeed. Load relief is activated based on flap position and on airspeed data supplied by the air data computers.

For example :

FAILURE INDICATION OF THE FLAP CONTROL UNIT

Whenever a fault is detected for the flap control unit the caution massage

FLAPS CONTROL 27 50 03 00

status message :

and

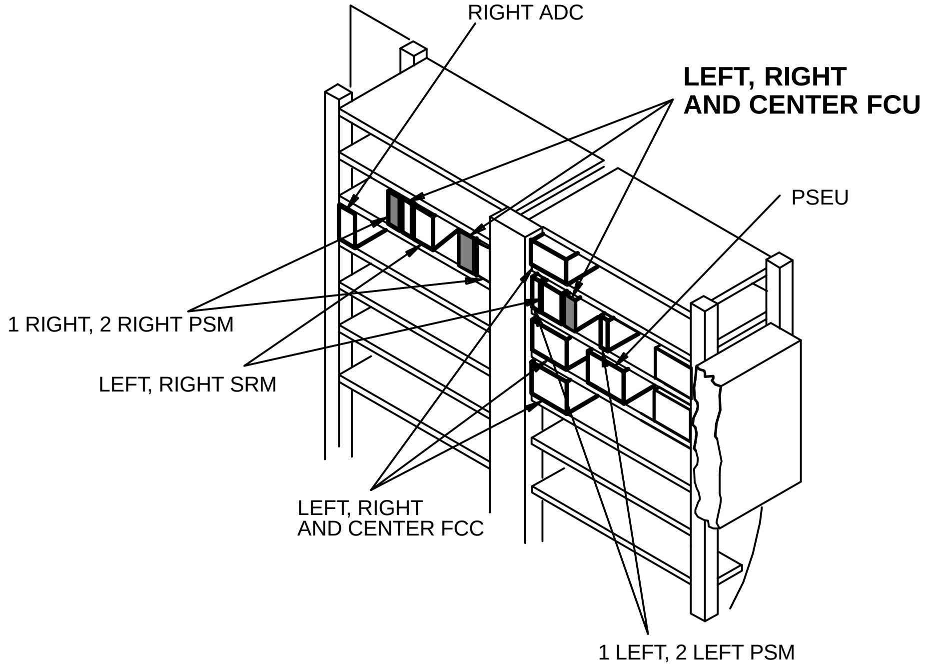
FLAP CONTROL R 27 50 09 00

appears

and on the MCDU is shown the reason for the EICAS message

CMC message :

FCU - R FAIL 27 602



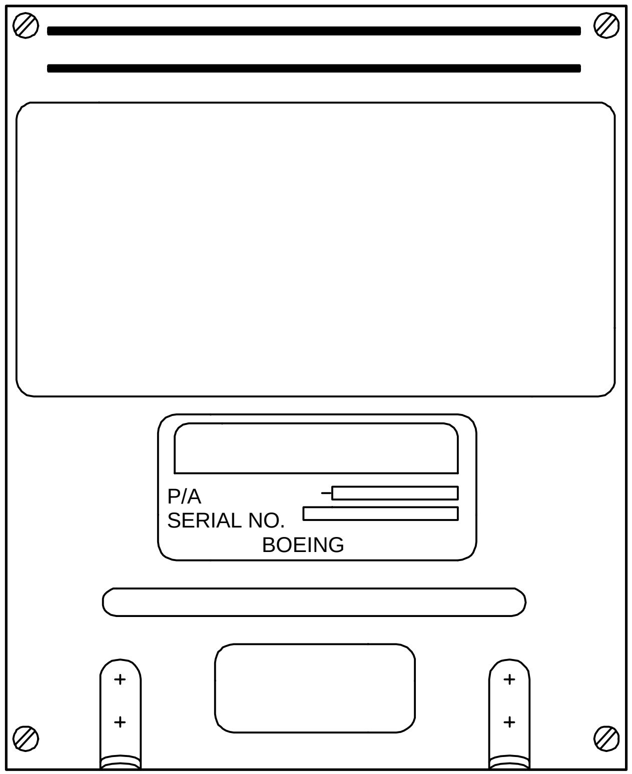


Figure 142 FLAP CONTROL UNITS (FCU's)

GROUND TEST - FLAP CONTROL UNITS (FCU'S)

GENERAL

(1) This is a test of the BITE functions of the flap control units (FCU's). This procedure is applicable to each of the three FCU's. During this test all internal functions of the applicable FCU are tested. Other high lift system LRU faults will also be reported to the FCU. You must not use this test to troubleshoot any high lift component other than the FCU's.

REFERENCES

(1) 24-22-00/201, Manual Control

ACCESS

(1) Location Zone

221Control Cabin, LH

222Control Cabin, RH

PREPARE FOR THE TEST

(1) Supply electrical power (Ref 24-22-00/201).

(2) Prepare the CDU for the test:

(a) Push the MENU key on the CDU to show the MENU.

(b) Push the line select key (LSK) that is adjacent to <CMC to show the CMC MENU.

(c) If <RETURN shows after you push the LSK, push the LSK that is adjacent to <RETURN until you see the CMC MENU.

(d) Push the LSK that is adjacent to **<GROUND TESTS** to show the GROUND TESTS menu.

(e) Push the NEXT PAGE key until you find <27 FLAP CONTROL.

(f) Push the LSK that is adjacent to **<27 FLAP CONTROL** to show the GROUND TESTS menu for the flap control units.

(g) Push the NEXT PAGE key until you find <FLAP CONTROL-L, -C, or -R.

NOTE: If INHIBITED shows above <27 FLAP CONTROL-L, -C, or -R, the test will not operate.

(h) If inhibited shows above <FLAP CONTROL-L, -C or -R:

1) Push the LSK that is adjacent to the test prompt.

2) Make sure the airplane is not in the air mode.

3) Make sure the airspeed is less than 70 knots.

4) Push the LSK that is adjacent to <RETURN to show the ground test menu again.

FLAP CONTROL UNIT GROUND TEST

(1) Push the LSK that is adjacent to the applicable prompt **<FLAP CONTROL-L, -C, or -R.**

NOTE: Do not use this test for troubleshooting any high lift system component except the flap control unit.

(a) When the TEST PRECONDITIONS page shows, make sure each instruction on the page is completed.

(b) Push the LSK that is adjacent to **START TEST>.**

NOTE: IN PROGRESS shows during the test.

(2) When IN PROGRESS goes out of view, look for **PASS or FAIL>** adjacent to <FLAP CONTROL -L, -C, or -R.

NOTE: If a PASS indication shows, no failures occured during the test.

(a) If FAIL> shows:

1) Push the LSK that is adjacent to FAIL> to see the GROUND TEST MSG pages for the failure.

2) Push the NEXT PAGE key until you find all the GROUND TEST MSG pages.

3) Make a list of all CMCS messages, CMCS message numbers, and ATA numbers that show on the GROUND TEST MSG pages.

4) Go to the CMCS Message Index of the Fault Isolation Manual (FIM) to find the corrective action for each CMCS message.

Put the Airplane Back to Its Usual Condition

(1) Remove the electrical power (Ref 24-22-00/201).

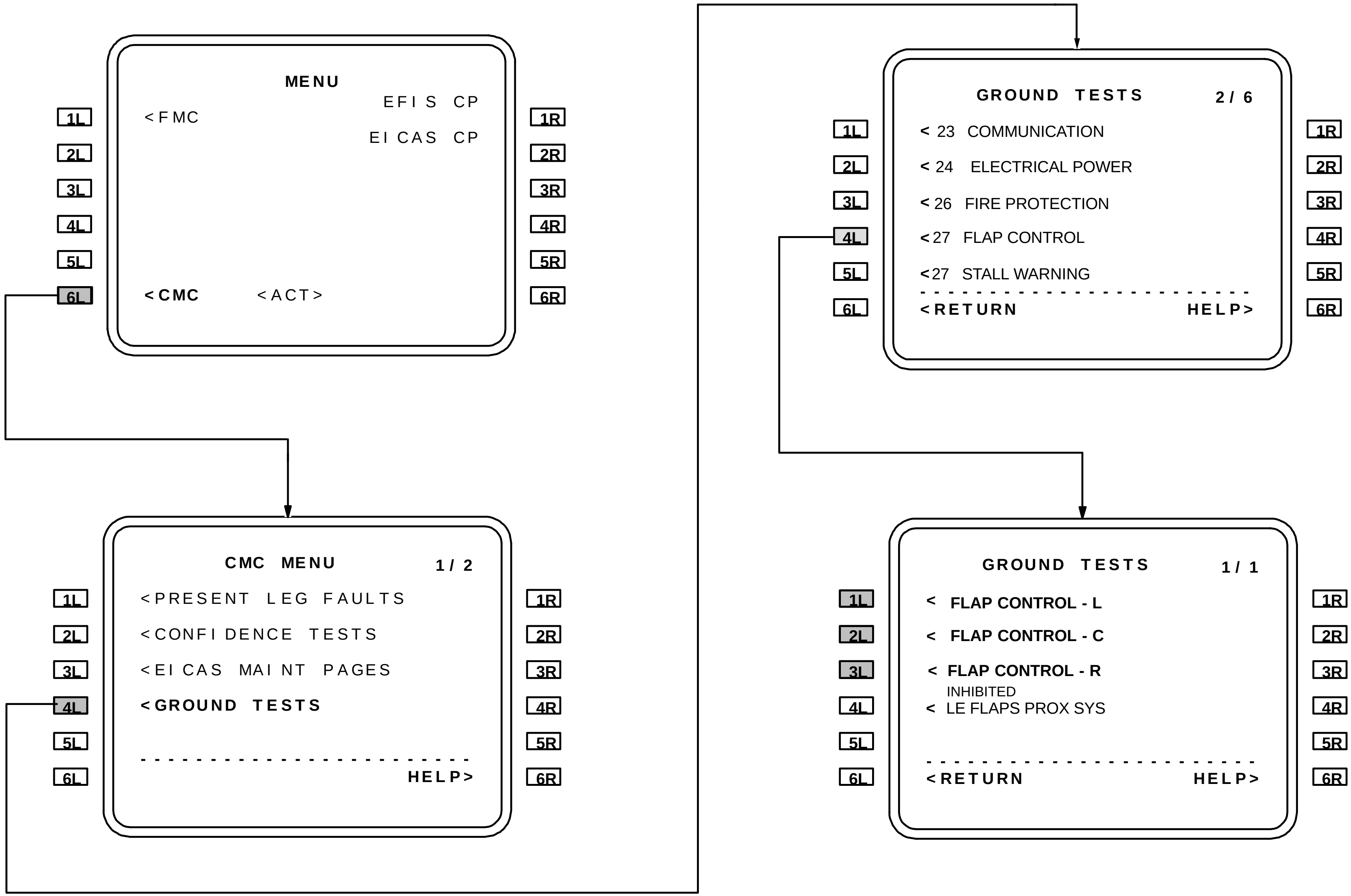


Figure 143 FLAP CONTROL UNIT (FCU) GROUND TEST

TRAILING EDGE FLAPS PRIMARY HYDRAULIC AND ELECTRIC CONTROL SCHEMATIC

DESCRIPTION

PRIMARY HYDRAULIC / PNEUMATIC MODE

The flaps are normally operated in primary hydraulic/pneumatic mode. In this mode, the flaps are controlled from the flap control lever. Movement of the flap control lever rotates the shaft of the flap control lever RVDT assembly. The electrical output of the RVDT assembly is monitored by the FCU, which moves the flaps until flap position agrees with flap control lever position.

To move the TE flaps by hydraulic power, the FCU activates the flap actuator in the TE flap input lever assembly. To move the LE flaps by pneumatic power, the FCU activates the shutoff valve and directional control motor in each LE flap power drive unit.

The flaps extend in a specific sequence as the flap control lever is moved aft from the UP detent:

- **At the 1-unit detent,** the group A LE flaps extend fully, and the TE flaps do not move. The group A LE flaps remain extended as the flap control lever is moved farther aft.
- **At the 5-unit detent,** the group B LE flaps extend fully, and the TE flaps extend to the 5-unit position. The group B LE flaps remain extended as the flap control lever is moved farther aft.
- **At the 10, 20, 25, and 30-unit detents,** the TE flaps extend to the corresponding position. The TE flaps extend fully when the flap control lever is at the 30-unit detent.

The flaps retract in a specific sequence as the flap control lever is moved forward:

- **At the 25, 20, 10, or 5-unit detent,** the TE flaps retract to the corresponding position.
- **At the 1-unit detent, the TE flaps retract fully.** The group B LE flaps retract as soon as the inboard TE flaps retract to less than 4.5 units.
- **At the UP detent,** the group A LE flaps retract as soon as **the outboard TE flaps are fully retracted.**

PRIMARY ELECTRIC MODE

If a group of flaps does not move within a certain amount of time after the flap control lever is moved, the FCU sets a disagree. The FCU then switches that flap group to primary electric mode and activates the flap drive electric motors.

In primary electric mode, the flaps respond to the flap control lever in the same sequence as they do for primary hydraulic/pneumatic mode. Flap movement is much slower under electric power than under hydraulic and pneumatic power. A LE flap group (group A or B) in primary electric mode will return to primary pneumatic mode as soon as the flap group reaches the commanded position.

If the FCU sets a disagree while a flap group is in primary electric mode, the FCU will continue to energize the electric motors, even though there may be no flap movement.

The times delays for the FCU to set a disagree are:

1) TE Hydraulic	- Extend:7 sec
	- Retract:7 sec
2) TE Electric	- Extend:25 sec
	- Retract: 25 sec
3) LE Pneumatic	- Extend:35 sec in air, 15 sec on ground

An additional time delay of 30 seconds for the TE flap hydraulic disagree is begun when the landing gear control lever is moved from UP to DN.

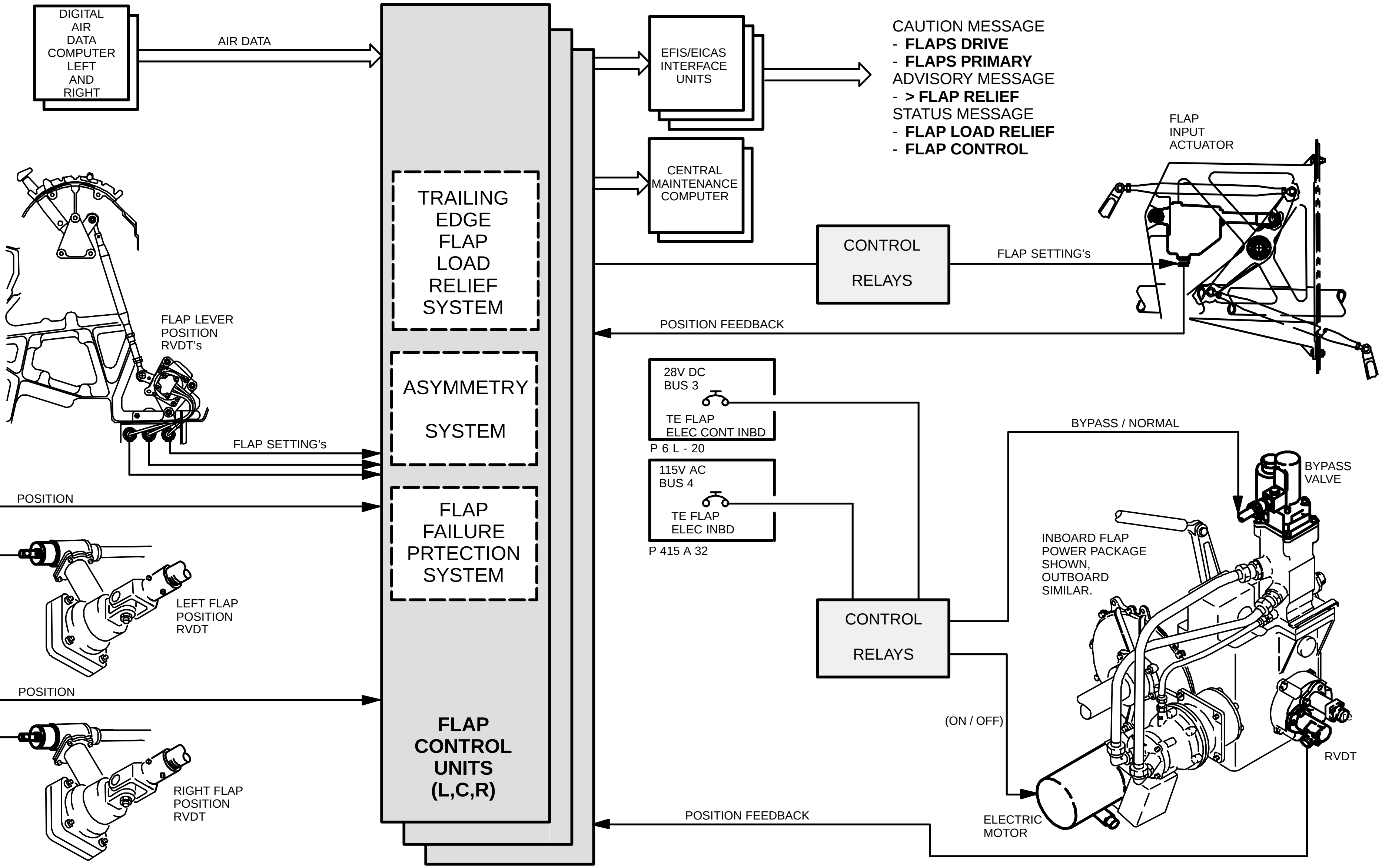


Figure 144 TRAILING EDGE FLAPS PRIMARY HYDRAULIC AND ELECTRIC CONTROL SCHEMATIC

TRAILING EDGE FLAPS PRIMARY HYDRAULIC AND ELECTRIC CONTROL SCHEMATIC

PRIMARY CONTROL

HYDRAULIC OPERATION

Durch die Betätigung vom Flap Lever wird durch die FCU's der Flap Input Actuator zur Auslenkung der Control Valves zum hydraulischen Fahren angesteuert.

Ist die für die gewählte Flap Position entsprechende Speed zu hoch, dann steuert der Flap Input Actuator die Flap Control Valves nur bis zu der zulässigen Position an, und es erscheint die Advisory Message: " **> FLAP RELIEF** " und/oder die Status Message: **FLAP LOAD RELIEF**.

ELECTRIC OPERATION

Bei einem Flap Input Actuator Failure oder wenn vom Flap Power Package RVDT kein Betätigungssignal gemeldet wird, dann schalten die FCU's Primary Hydraulic Control ab, und es erfolgt Primary Electric Control mit EICAS Message und Expanded Indication.

Die FCU's steuern über Control Relays die Bypass Valves und die Electric Motors an. Die Flap Power Package RVDT's übertragen dabei die Positions für Feedback (Follow Up) zu den FCU's.

PROTECTION CIRCUITS AVAILABLE AT :

- **PRIMARY HYDRAULIC :**
  - Flap Load Relief System
  - Flap Asymetrie System
  - Flap Failure Protection System
- **PRIMARY ELECTRIC :**
  - Flap Asymetrie System
  - Flap Failure Protection System
- **ALTERNATE ELECTRIC :**
  - Keine Protection Circuits available (FCU's bypassed)

FLAP LOAD RELIEF SYSTEM

Flap Lever Pos.	Airspeed (KTS)	Flap Pos.
30	>178	25 <- 30
30	>203	20 <- 25
30	<195	20 -> 25
30	<170	25 -> 30
25	>203	20 <- 25
25	<195	20 -> 25

ASYMMETRIE SYSTEM

Primary Hydraulic Control

Bei einer Inboard Flap Differenz von 6.2% bzw. bei einer Outboard Flap Differenz von 3.4%, überwacht durch die Flap Position RVDT's, erfolgt die Ansteuerung vom jeweiligen Bypass Valve nach Bypass und Hydraulic Control ist abgeschaltet. Gleichzeitig sorgt dieses Signal auch für Primary Electric Control Inhibit, sodaß auch kein Primary Electric Betrieb möglich ist.

Primary Electric Control

Bei genannter Flap Differenz erfolgt Primary Electric Inhibit, d.h. Primary Electric wird abgeschaltet.

FLAP FAILURE PROTECTION SYSTEM

Bei unkontrolliertem Fahren der Flaps, gesteuert vom Flap Lever Input und von den Flap Power Package RVDT's, erfolgen bei Primary Hydraulic- und Primary Electric Control ebenfalls die o. g. Abschaltungen.

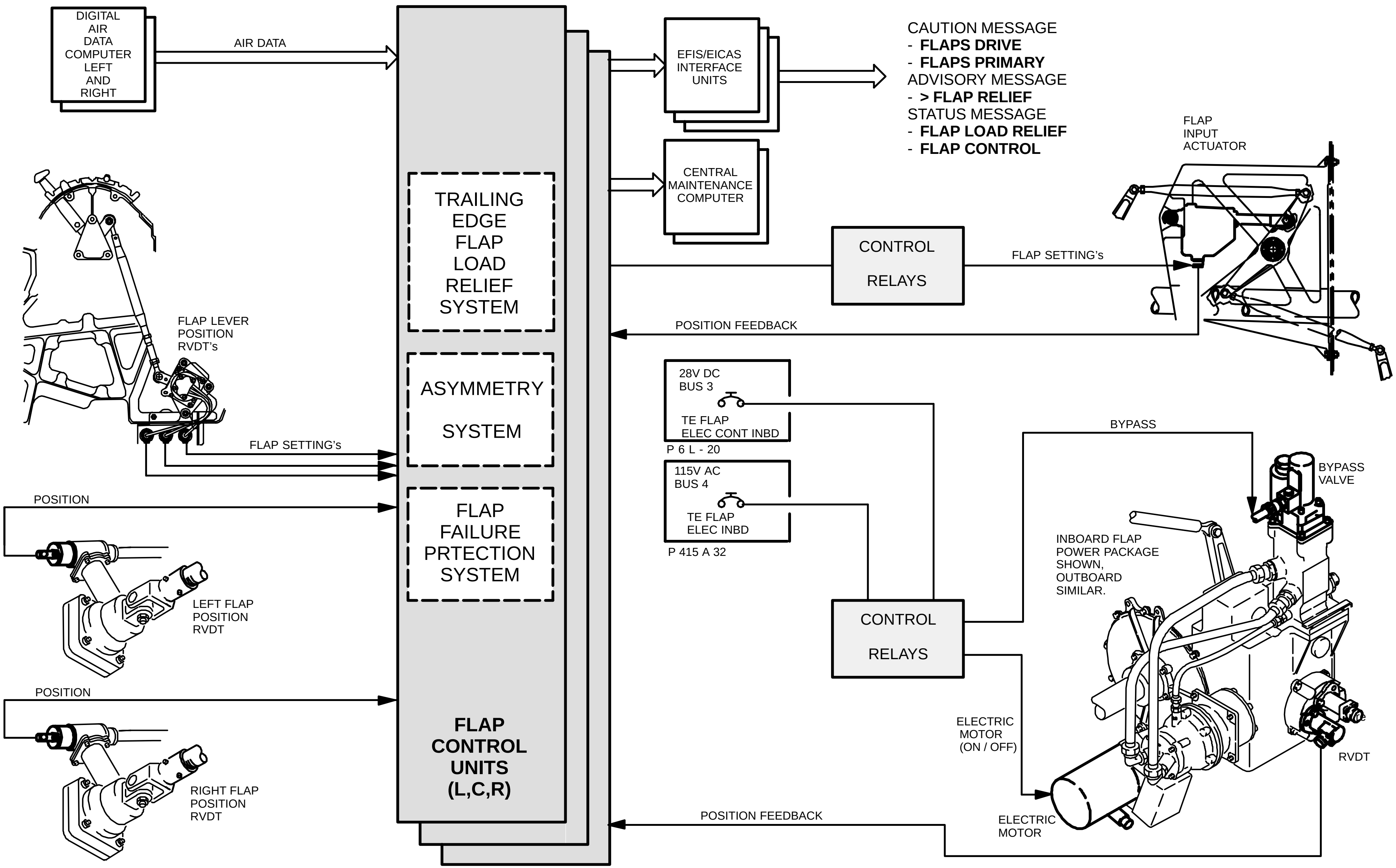


Figure 145 TRAILING EDGE FLAPS PRIMARY HYDRAULIC AND ELECTRIC CONTROL SCHEMATIC

TRAILING EDGE FLAPS ALTERNATE ELECTRIC CONTROL SCHEMATIC

DESCRIPTION

ALTERNATE ELECTRIC MODE

In alternate electric mode, the flap drive electric motors are under manual control independent of the FCU's. The flaps are controlled from two switches on the pilots' center instrument panel. The ALTN FLAPS ARM switch is pressed to enable the alternate system.

The ALTN FLAPS EXT/RET switch is placed in the EXT or RET position to activate the relays which power the electric motors. The relays are deactivated when the limit switches in the TE power packages and the LE power drive units open at flaps fully extended or retracted. The flaps may be stopped at any intermediate position by placing the ALTN FLAPS EXT/RET switch to OFF.

In alternate electric mode, the extend limit switches in the TE power packages do not allow the TE flaps to extend beyond the 25-unit position.

CAUTION: B 747-400 MT 27-030, 10 MAY 1996
SUBJECT : PREVENTION OF UNEXPECTED LE/TE FLAP MOVEMENT - TE FLAP SYSTEM LOCK EQUIPMENT P/N G27037-1.
DEPRESSING THE ALTERNATE ARM SWITCH WILL PLACE THE FLAPS IN THE ALTERNATE MODE OF OPERATION IF EITHER CIRCUIT BREAKER (P6L19) OR (P5L20) ARE CLOSED (SEE MT 27-026, 11 JANUARY 1995).
THE "FLAP CONTROL" EICAS CAUTION MESSAGE WILL BE DISPLAYED WHEN THE FLAP SYSTEM IS IN THE ALTERNATE MODE.
USING THE NEW P/N G 27037-1 TE FLAP BYPASS VALVE LOCK AND ALTERNATE MOTOR BLANKING PLUG TOOL WILL PREVENT TE FLAP MOTION IN ALL MODES (PRIMARY HYDRAULIC, PRIMARY ELECTRIC UND ALTERNATE ELECTRIC).

SUMMARY :

ALTERNATE ELECTRIC CONTROL

Durch Betätigen vom Arming Switch werden die Bypass Valves nach Bypass angesteuert und der Control Switch wird aktiviert.

Der Input in die FCU's bewirkt Primary Hydraulic- und Electric Control Inhibit (OFF) und es erfolgt EICAS Mess. mit Expanded Indication.

Durch Betätigen vom Control Switch wird der Electric Motor angesteuert. Bei Erreichen der gewünschten Position wird der Control Switch nach OFF geschaltet.

Die im Limit Switch Assy eingebauten Limt Switches schalten den Electric Motor bei Flaps Up, bzw. bei Pos. 25 ab.

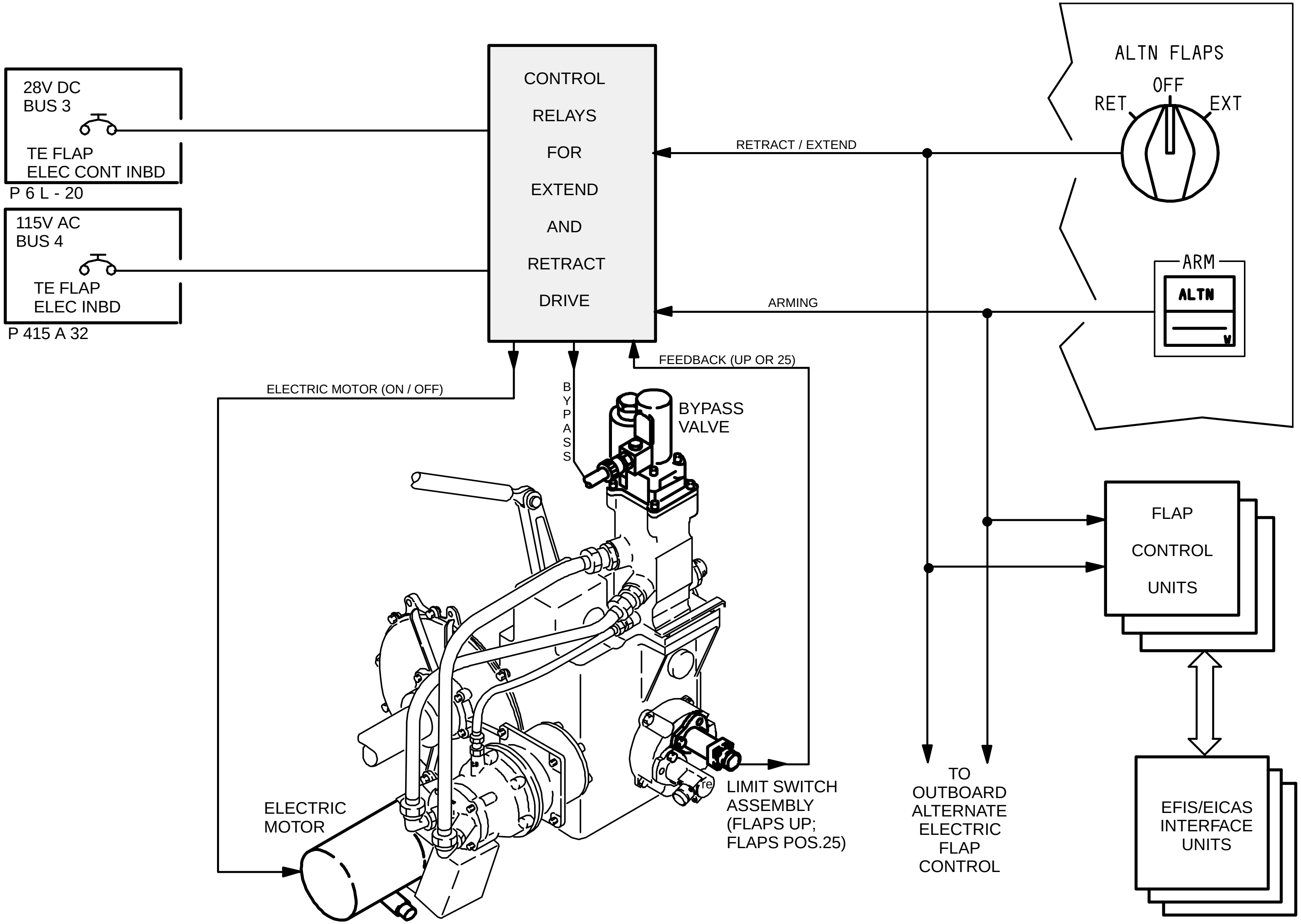


Figure 146 TRAILING EDGE FLAPS ALTERNATE ELECTRIC CONTROL SCHEMATIC

FLAP UNCOMMANDED MOTION / MOVING AWAY / ASYMMETRY

If a flap group moves when not commanded, or moves in the opposite direction of that commanded (flaps moving away), the FCU sets an uncommanded motion. If the uncommanded motion is set when the group is in primary hydraulic/ pneumatic mode, the FCU switches that group to primary electric mode.

If the uncommanded motion is set while the flap group is in primary electric mode, the FCU will shut down that group.
The group will remain shut down until power to the FCU's is cycled off and on following the flight.

The times delays for the FCU to set an uncommanded motion are:

1) TE Hydraulic:	0.5 sec
2) TE Electric:	4.0 sec
3) LE Pneumatic:	0.3 sec
4) LE Electric:	3.0 sec

If the FCU detects an asymmetry between left wing and right wing flaps of a TE flap group, the FCU will shut down both the hydraulic and electric drives for that group.

INDICATION :

Wenn der Alternate Flap Arming Switch in die ARMING - Position gedrückt wird, ist das Alternate Flap System armiert worden.
Es erscheint die
Caution Message :

FLAPS PRIMARY

und
die Status Messages :

FLAP CONTROL L

FLAP CONTROL C

FLAP CONTROL R

Sollte die CMC Software -009 installiert sein, erscheint die
CMCS Message :

ALTERNATE FLAP OPERATION ENGAGED " NO ACTION REQUIRED "
(27 717)

Wird der Alternate Flap Arming Switch wieder in die Normal - Position zurückgeschaltet, verlöschen die Caution- und die Status Messages automatisch und es erscheint die CMCS Message :

ALTERNATE FLAP OPERATION DISENGAGED " NO ACTION REQUIRED "
(27 718)

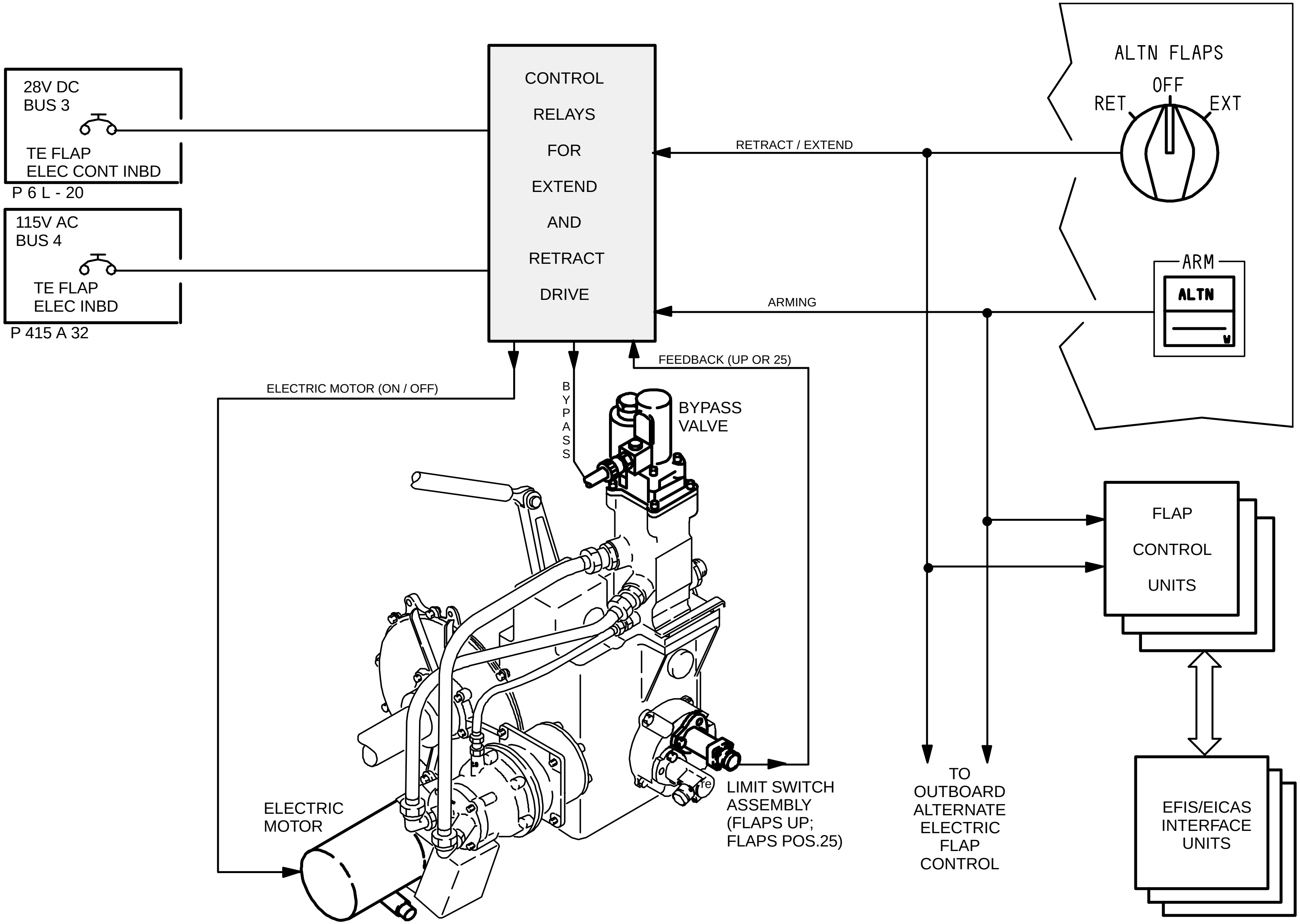


Figure 147 TRAILING EDGE FLAPS ALTERNATE ELECTRIC CONTROL SCHEMATIC

FLAP CONTROL LEVER RVDT'S

DESCRIPTION

The flap control lever and the flap lever RVDT assembly are located on the right side of the control stand. The RVDT assembly houses three RVDT's which are driven by the same input shaft. The lever controls the position of the trailing edge flaps by pivoting the shaft of the RVDT assembly through a mechanical linkage. The RVDT's convert flap lever position to an electrical signal which is routed to the three flap control units.

The flap control lever travels through a 90° arc with detents at 0, 1, 5, 10, 20, 25, and 30 units. The lever has a spring-loaded telescoping handle which locks in each detent as the lever is moved. Gates at 1 and 20 units prevent movement of the control lever past those detents without stopping. The control lever must be lowered into the detent at 1 or 20 units and passed under the gate before the lever can be moved further. The gate at 1 unit allows a slight pause in flap actuation while a group of leading edge flaps extend or retract. The gate at 20 units signals the maximum flap position for safe takeoff.

SUMMARY :

Die Flap Control Lever RVDT's setzen die mechanische Flap Lever Position in ein elektrisches Signal um, diese dienen als Input in die Flap Control Units (FCU's) Left, Center und Right.

NOTE: Die Electrical Connectors der RVDT's befinden sich unterhalb der Flight Compartment Floor und sind durch die Deckenpanels der Zone A zugänglich, dagegen die RVDT's durch das hintere Panel am Pedestal rechte Seite.

FAILURE INDICATION OF THE FLAP LEVER RVDT's :

For example :

Whenever a fault is detected at the flap lever RVDT's, on the EICAS display following is indicated :

the status message :

FLAP SYS MONITOR

and

FLAP CONTROL L

or

FLAP CONTROL C

or

FLAP CONTROL R

and on the MCDU is shown the reason for the EICAS message :

CMC message :

FLAP LEVER RVDT FAIL 27 664.

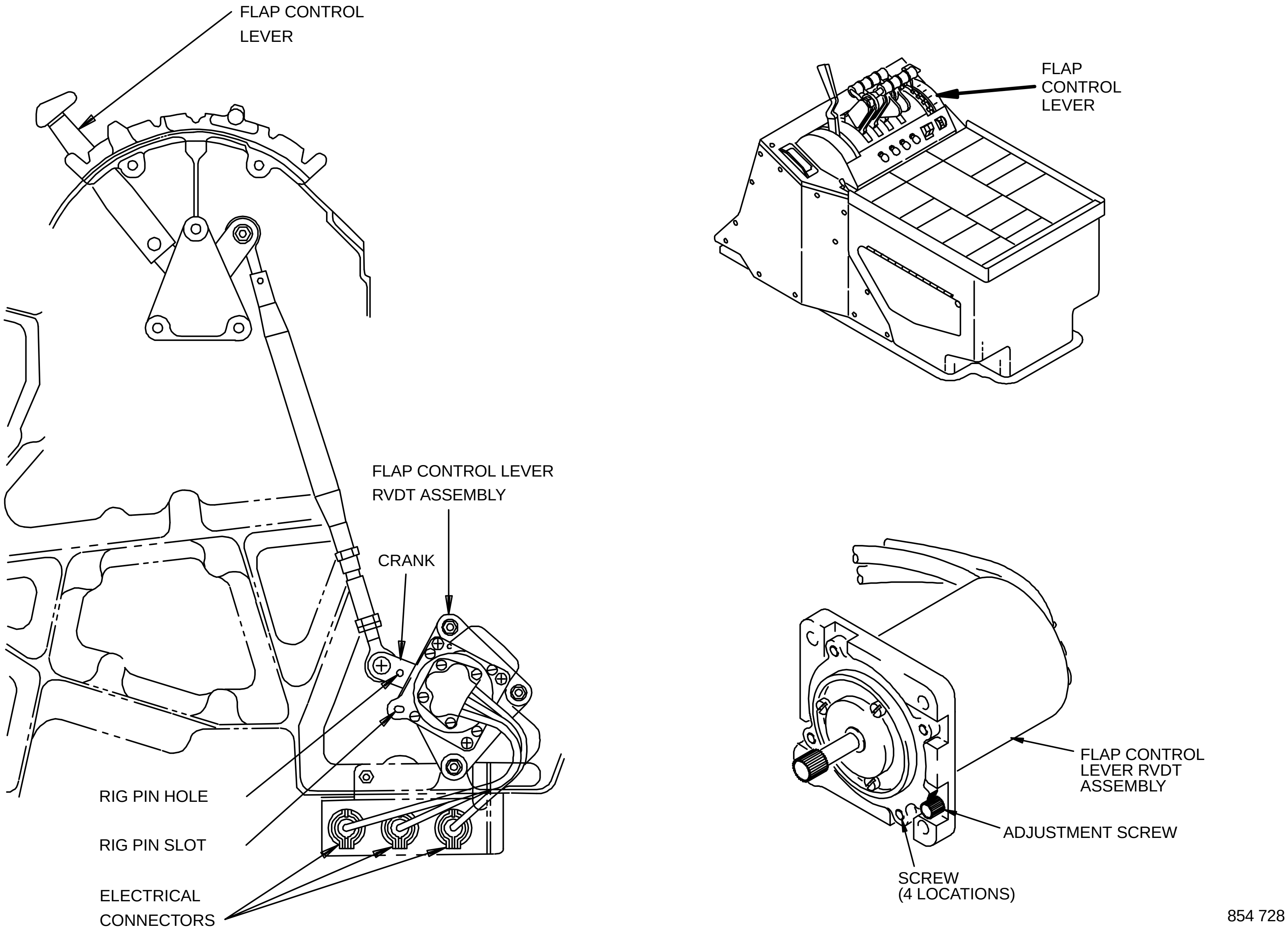


Figure 148 FLAP CONTROL LEVER RVDT'S

FLAP INPUT ACTUATOR

DESCRIPTION

The input lever assembly located on the left body gear wheel well forward bulkhead houses the flap actuator, the input lever, and the rods which link to the input crank on each power package.

The flap actuator is a linear actuator which drives its output shaft out or in to change flap position on command from the FCU's. The actuator contains a 115 volt ac reversible motor, a solenoid operated brake, gearing, and an RVDT position transmitter. The solenoid brake is released whenever an extend or retract command is received from the FCU's.

SUMMARY :

- Der Flap Input Actuator erhält das SOLL-Signal von der aktiven Flap Control Unit (FCU)
- steuert das Control Valve an dem Inboard- und Outboard Flap Power Pakkage an
- besteht aus :
  - 115V AC Motor
  - Solenoidoperated Brake
  - Gear
  - RVDT Position Transmitter (Feedback)

FAILURE INDICATION OF THE FLAP ACTUATOR RVDT :

For example :

Whenever a fault is detected at the flap lever RVDT, on the EICAS display following is indicated :

the status message :

FLAP SYS MONITOR

and on the MCDU is shown the reason for the EICAS message :

CMC message :

FLAP ACTUATOR RVDT FAIL 27 632.

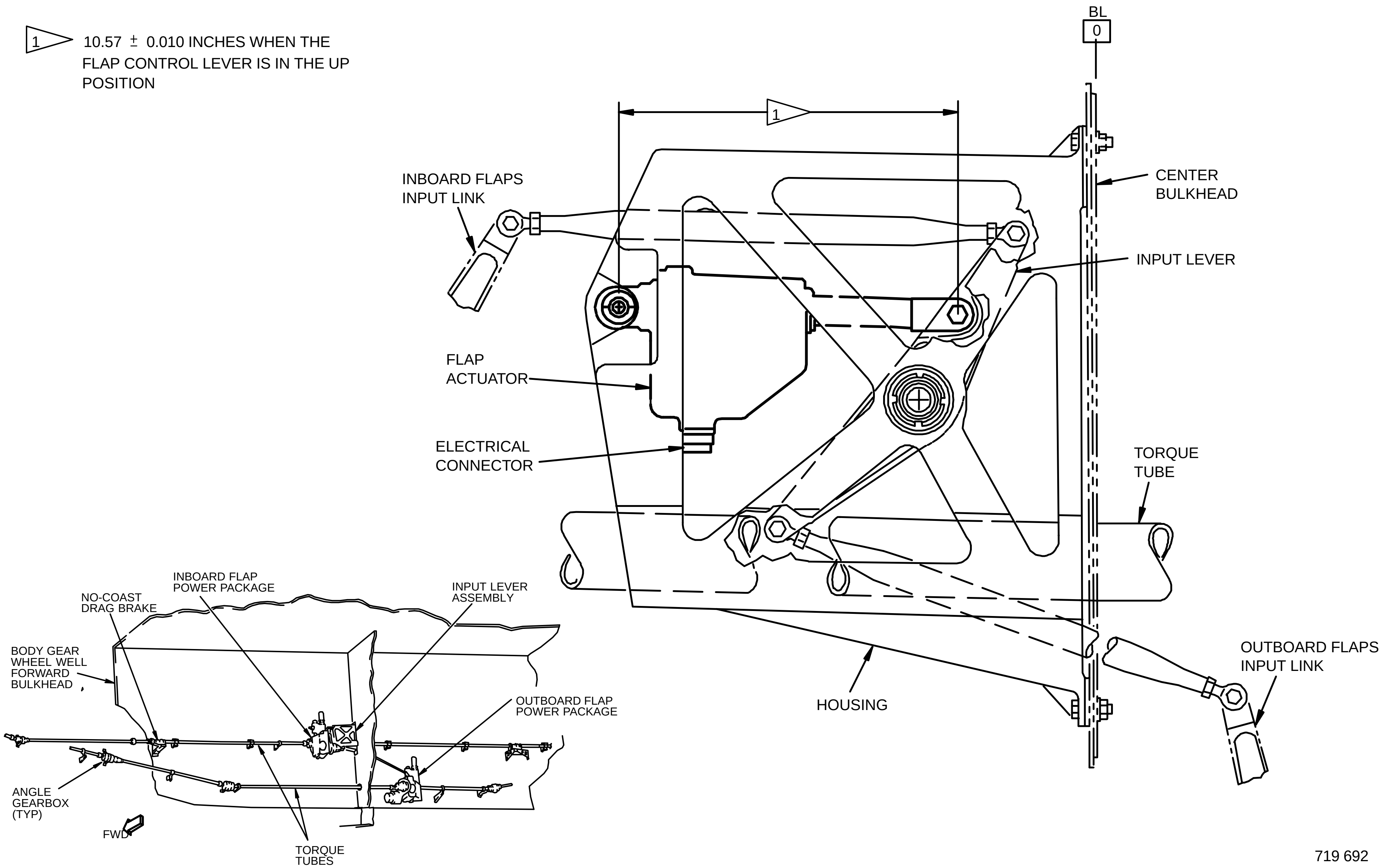


Figure 149 FLAP INPUT ACTUATOR

FLAP INPUT ACTUATOR ELECTRICAL SCHEMATIC

DESCRIPTION

FLAP INPUT ACTUATOR CONTROL

Die Flap Lever Signale gelangen über die Adjustable Rod und den drei Position Transmitter (RVDT's) zu den Flap Control Units (FCU's).

Die FCU's steuern über die Control Relays den Flap Input Actuator für Extend und Retract an.

Das Feedback Signal, d.h. die Actuator Position wird von einem Internal RVDT zu den FCU's übertragen.

Bei Flap Input Actuator Fail schalten die FCU's den hydraulischen Fahrvorgang ab und schalten auf Primary Electric Control Mode um.

Die Flap Input Actuator Bewegung gelangt über Input Lever, Control Rod und Input Cranks zu den Control Modules und damit zu den Control Valves.

Die Control Valves werden ausgelenkt, Hydraulic Pressure gelangt zu den Hydraulic Motors und die Flaps werden angetrieben. Der Follow Up für das jeweilige Control Valve wird durch einen Internal Follow Up Mechanism erreicht.

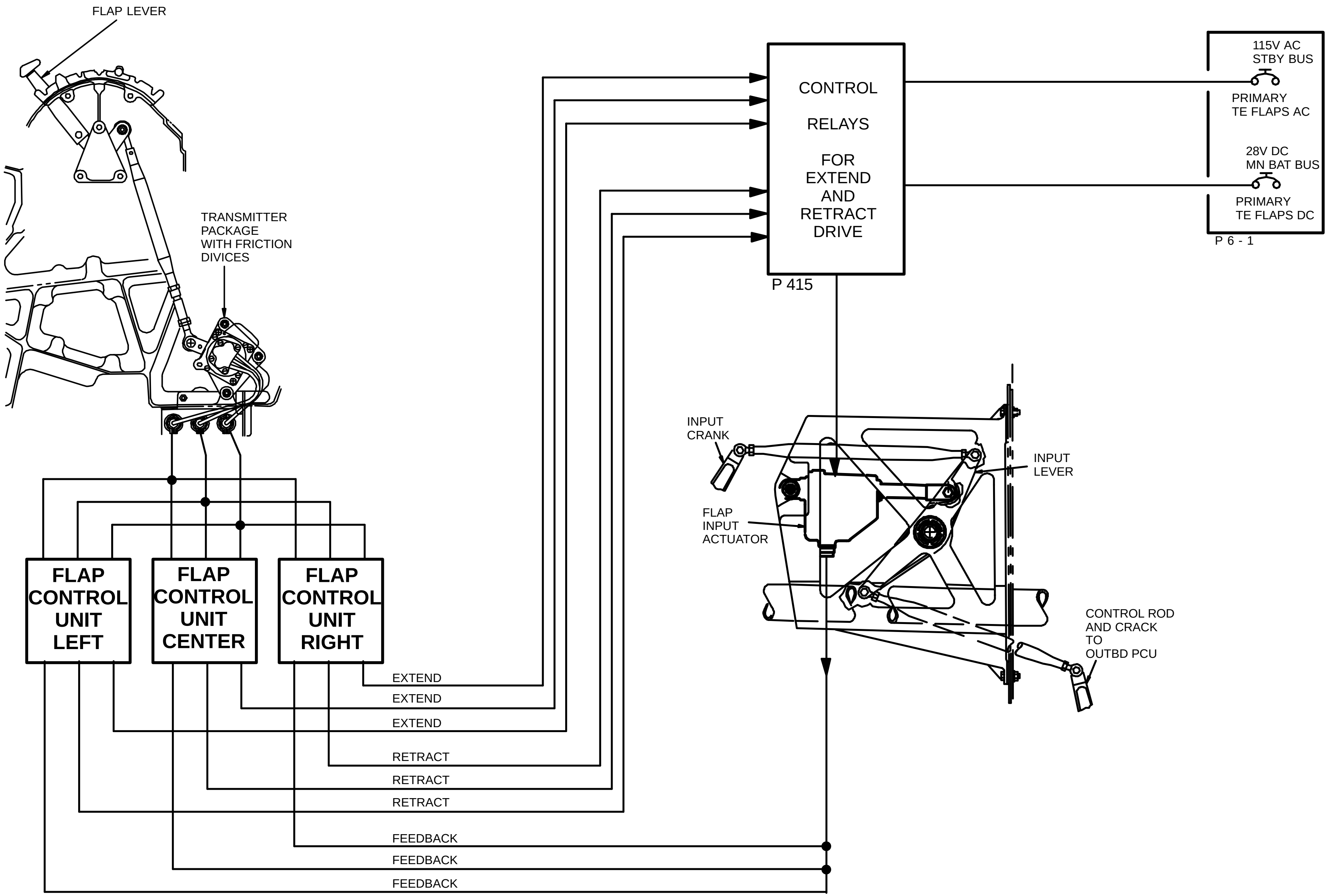


Figure 150 FLAP INPUT ACTUATOR ELECTRICAL SCHEMATIC

IN- AND OUTBOARD FLAP POWER CONTROL PACKAGE

DESCRIPTION (PART 1)

FLAP POWER PACKAGES

The TE flap power packages receive mechanical input from the input lever assembly or electrical input from the FCU's or the alternate flaps system relays. The inboard flaps power package is located on the forward bulkhead of the left body gear wheel well and the outboard flaps power package is located on the forward bulkhead of the right body gear wheel well. Each power package consists of a flap control assembly, a hydraulic motor, an electric motor, and a flap power unit (gearbox).

FLAP CONTROL ASSEMBLY

The flap control assembly houses the flap control module, the RVDT position transmitter, the power package limit switch pack, and the follow-up feedback mechanism.

FLAP CONTROL MODULE

The flap control module receives and regulates the hydraulic fluid flow to the hydraulic motor. The module consists of a control valve, a priority and flow control valve, a motor-operated bypass valve, and a check valve.

FLAP CONTROL VALVE

The flap control valve is a mechanically operated spool valve used to control directional flow of hydraulic fluid to the flap hydraulic motor. The valve is a cartridge type unit which mounts on the control module. The valve is mechanically driven by the flap control linkage. The valve may be removed as a unit only after the control module has been removed from the airplane.

The control valve consists of a ported housing and a spool. Ports on the housing connect to system pressure, return, and to both sides of the hydraulic motor. When the valve is in neutral position, fluid flow is blocked. When the flap control linkage is moved by the flap actuator, the valve spool is repositioned, permitting fluid to flow to the extend or retract side of the hydraulic motor. As the flaps approach the selected position the follow-up feedback mechanism positions the valve spool back to the neutral position, stopping the hydraulic motor.

PRIORITY AND FLOW CONTROL VALVE

The priority and flow control valve contains both a priority valve and a flow limiter. The priority valve permits fluid flow to the hydraulic motors only when hydraulic pressure exceeds 2000 +/-300 psi. This ensures that maximum fluid flow is available to the landing gear.

The flow limiter is an orifice which limits maximum speed of the hydraulic motor. The flow is adjusted differently on the two power packages so that inboard and outboard flaps extend at the same rate.

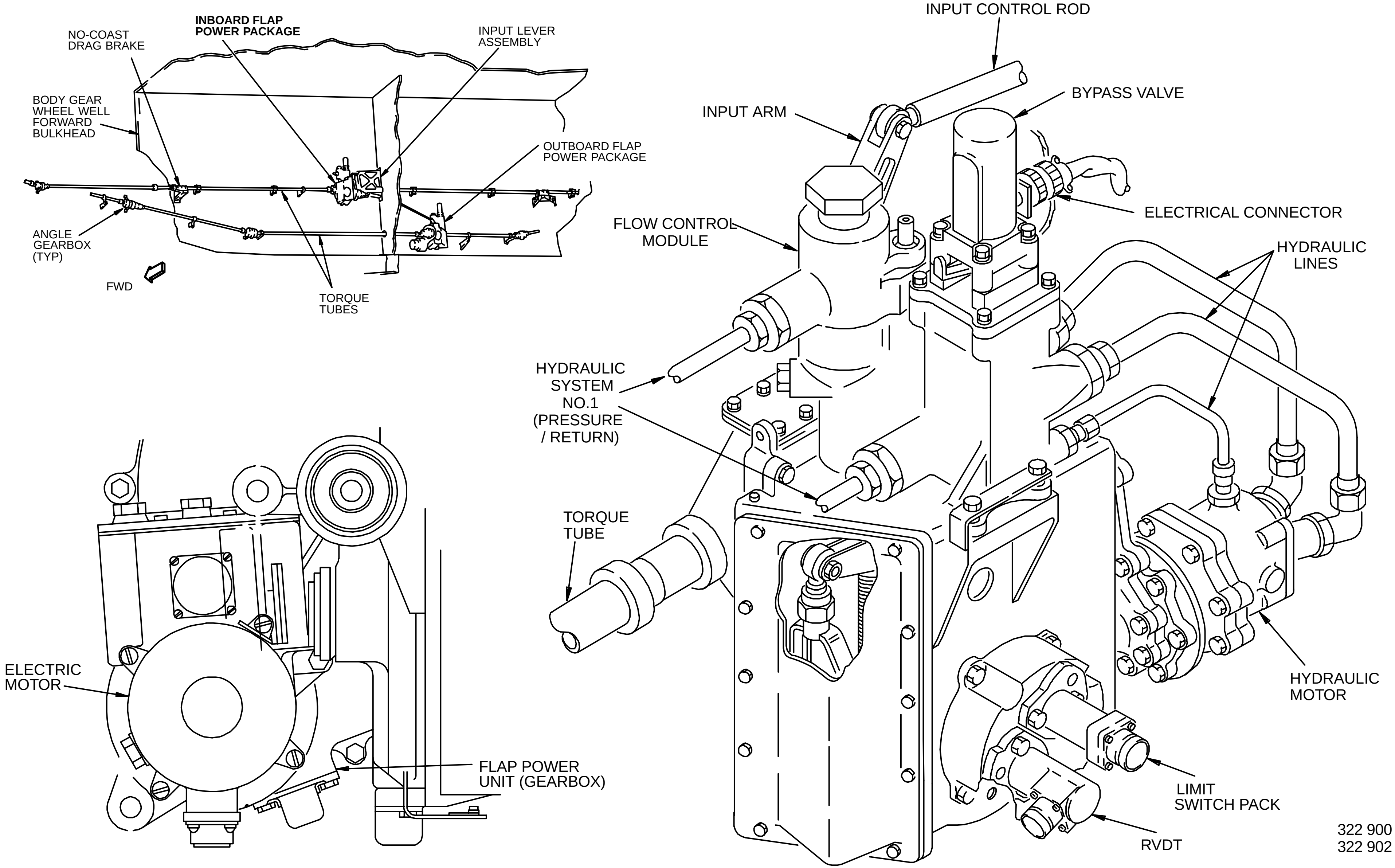


Figure 151 INBOARD FLAP POWER CONTROL PACKAGE

IN- AND OUTBOARD FLAP POWER CONTROL PACKAGE

DESCRIPTION (PART 2)

BYPASS VALVE

The bypass valve is a two-position valve operated by a 28 volt dc motor. The function of the valve is to disable the hydraulic motor, permitting alternate operation of the flaps or system shutoff due to flap asymmetry or other failure. The valve is actuated when the ALTN FLAPS ARM switch is pressed or when the FCU's are operating in primary electric mode. The valve or motor can be removed from the airplane without removing the control module or disconnecting fittings from it.

The bypass valve is normally open, porting hydraulic fluid to the flap drive motor. When the valve is closed, fluid flow to the drive motor is blocked and the drive motor ports are interconnected. The interconnect prevents a hydraulic lock while the flaps are being driven by the alternate motors. A manual override lever is provided on the valve for ground operations.

HYDRAULIC MOTOR

The hydraulic motor for each power package is a reversible axial piston motor which operates at a nominal supply system pressure of 3000 psi. The motors are mounted on the flap power unit (gearbox).

ELECTRIC MOTOR

The electric motor mounted on each power package provides an independent backup for the trailing edge flap system in the event of a failure in the primary hydraulic drive system. The motor assembly consists of an 115 vac motor, a clutch and torque limiter unit and reduction gearing. The motor is controlled by the ALTN FLAPS ARM and ALTN FLAPS EXT/RET switches on the pilots' center instrument panel or by a signal from the FCU's.

The electric motor is coupled through a double planetary gear train and the combination solenoid operated disconnect clutch/mechanical torque limiter to the main flap drive gear train. During hydraulic flap operation, the motor clutch allows the flap power unit gearing to back drive the second stage of the planetary reduction gearing without driving the electric motor. The internal torque limiter protects against a jammed flap system.

FLAP POWER UNIT

The flap power unit houses gears which connect the hydraulic and electric motors to the torque tubes. The follow-up feedback mechanism is driven by the torque tube follow-up worm gear drive.

SUMMARY :

CONTROL MODULE

- Priority Valve öffnet bei 2000 +/-300 psi
- Flow Limiter für konstanten Hydraulic Flow zum Hydraulic Motor
- Control Valve wird über Input Crank vom Flap Input Actuator ausgelenkt; Internal Mechanism für Follow Up

BYPASS VALVE

- schaltet Hydraulic Supply für Hydraulic Motor
- kann manuell betätigt werden
  - Pos. 2 Normal
  - Pos. 1 Bypass

CONTROL UNIT

- Hydraulic Motor
  - treibt Torque Tube bei Primary Hydraulic Control
- Electric Motor
  - treibt Torque Tube bei Primary- und Alternate Electric Control
  - ist bei Primary Hydraulic Betrieb abgekuppelt
- Cover
  - Zugang für Internal Follow Up Mechanism Adjustment
- RVDT
  - überträgt Control Unit Positions zu den FCU's
- Alternate Limit Switch Pack
  - für Up- und 25 Units Limit bei Alternate Electric Control

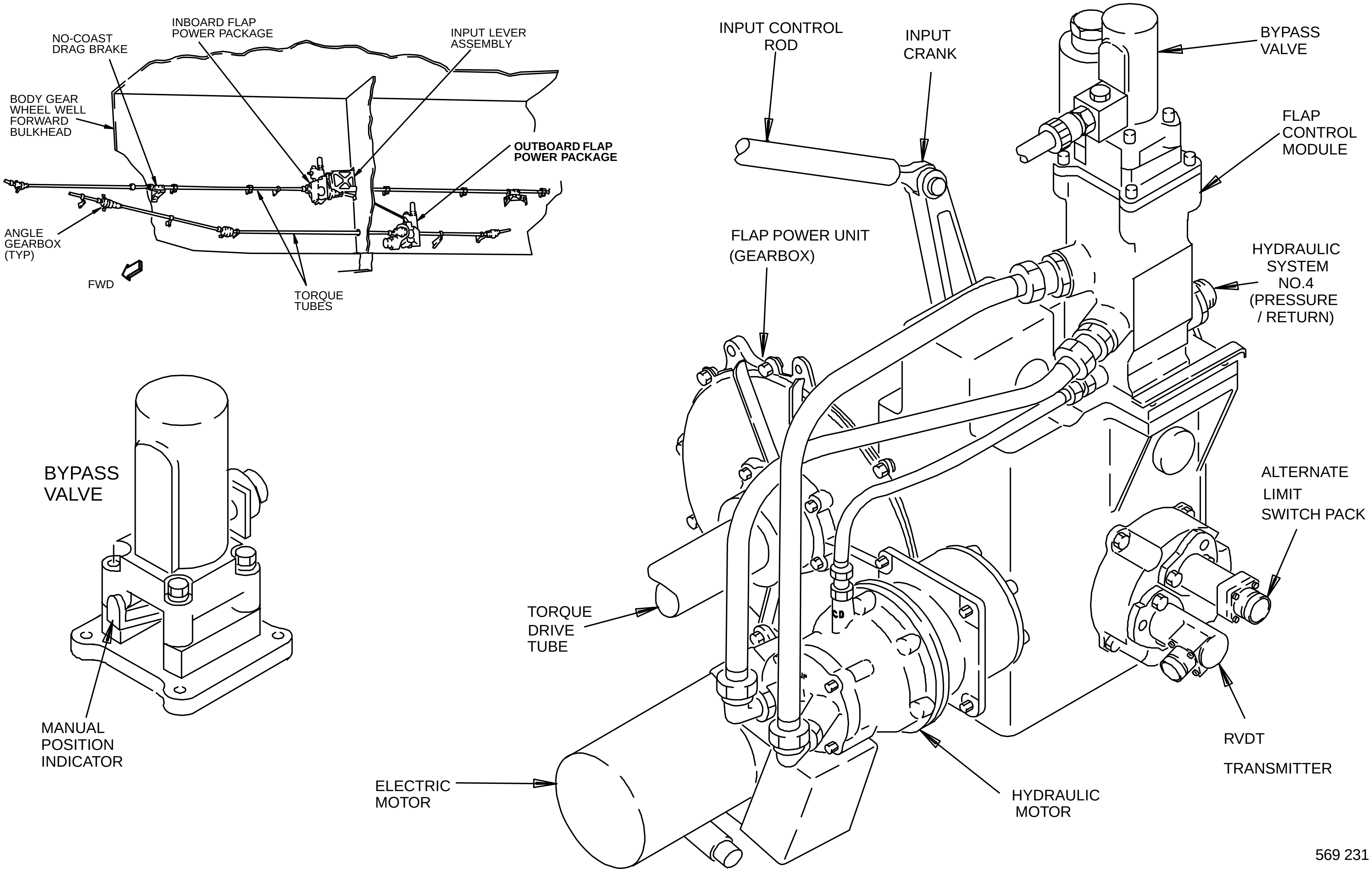


Figure 152 OUTBOARD FLAP POWER CONTROL PACKAGE

FLAP POWER PACKAGE

DESCRIPTION

POWER PACKAGE CONTROL VALVE

- wird zur Ansteuerung über Input Crank und Summing Lever ausgelenkt
- wird für Follow Up Mechanism nach Neutral betätigt
- Neutral Position
  - kann an Index Surface überprüft werden
  - kann an Adjustable Follow Up Rod justiert werden
- wird für Follow Up über Follow Up Cam, Follower Arm, Adjustable Follow Up Rod und Summing Lever nach Neutral betätigt.

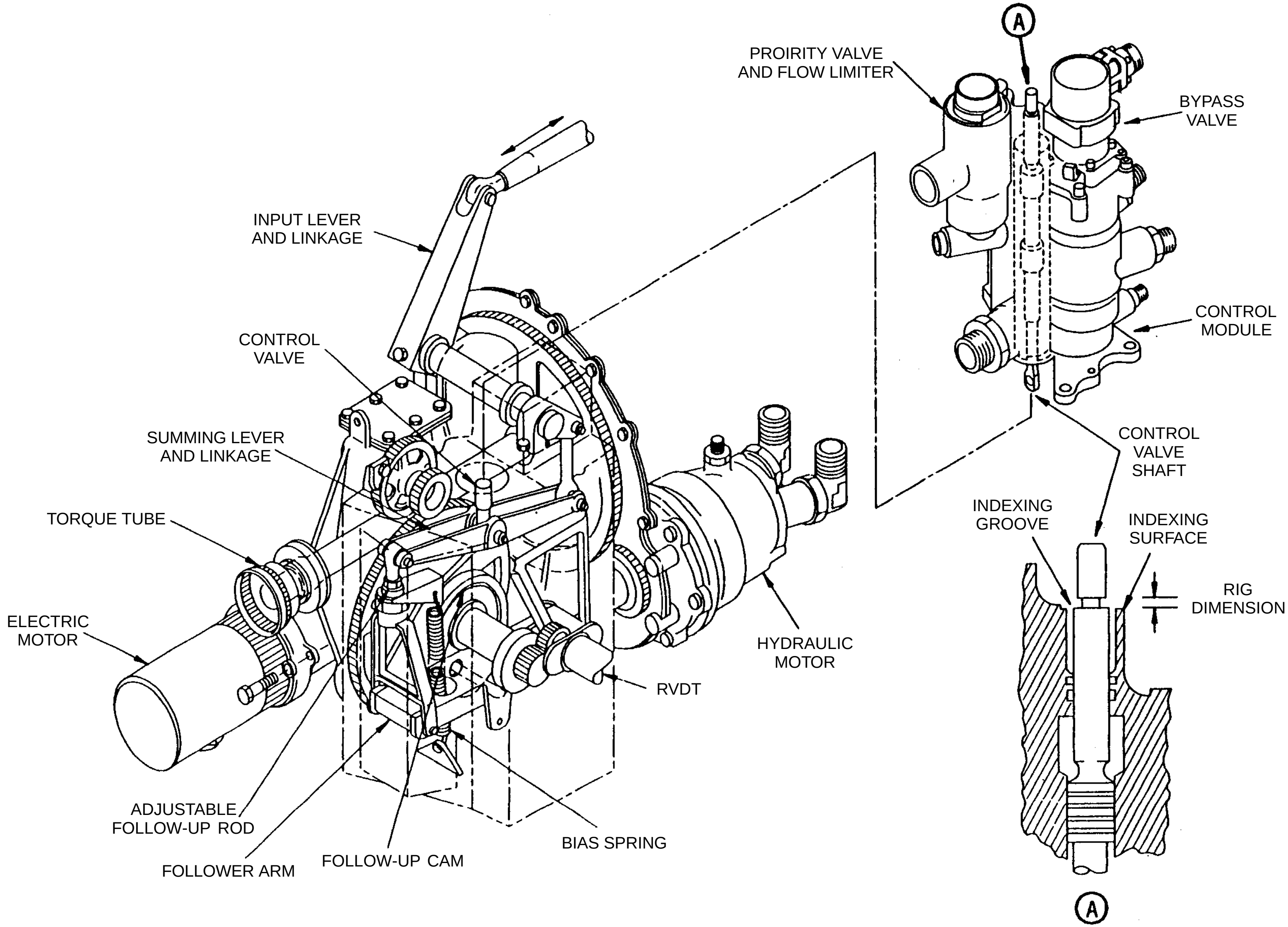


Figure 153 FLAP POWER PACKAGE

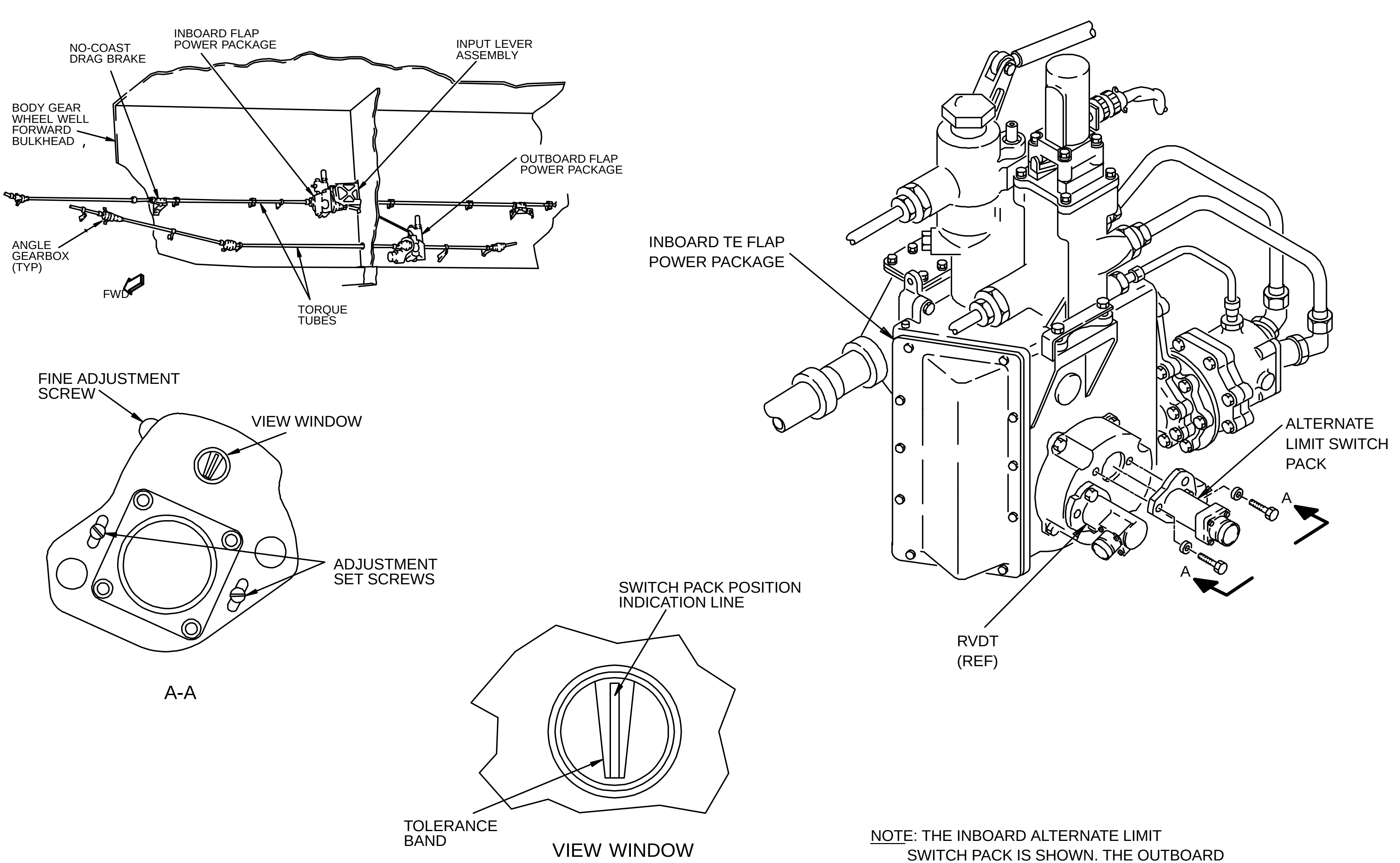
ALTERNATE LIMIT SWITCH PACK

DESCRIPTION

An alternate flaps limit switch pack is mounted on the flap control assembly. The pack contains two limit switches, one for flaps full up and one for flaps 25-units detent. One of the switches opens at flaps full up and the other opens at full alternate extension (25-unit detent) to cause the alternate electric system to disengage power to the electric motors. The limit switch pack may be removed without removal or dissasembly of the flap control assembly.

SUMMARY :

- nur aktiv, wenn das Trailing Edge Flap System in der ALTERNATE ELECTRIC MODE betrieben wird
- schaltet die Stromversorgung zu dem Electric Motor in der jeweiligen Endposition ab
  - Retract : UP
  - Extend : 25



NOTE: THE INBOARD ALTERNATE LIMIT
SWITCH PACK IS SHOWN. THE OUTBOARD
ALTERNATE LIMIT SWITCH PACK IS EQUIVALENT.

579 043

Figure 154 ALTERNATE LIMIT SWITCH PACK

NO COAST DRAG BRAKE

DESCRIPTION

A no-coast drag brake is incorporated in the inboard flap drive system. The brake prevents the inboard flap from coasting down when the airplane is on the ground and the flap control module bypass valve is in bypass position. The brake consists of a ratchet, pawl gears and brake discs. When power is applied, the power package overcomes the disk brake friction, allowing the flaps to extend. During flap retraction, the brake ratchets to provide minimum resistance to the power unit.

SUMMARY :

COUPLING SLEEVES

- dienen als Torque Tube Verbindungen.
- sind mit Screws gesichert.

NO COAST DRAG BRAKE

- verhindert selbstständiges Extend Fahren der Inboard Flaps bei Hydraulic Power Off.
- Pawl stopt über Ratched Wheel und Brake Discs die Torque Tube Drehbewegung.

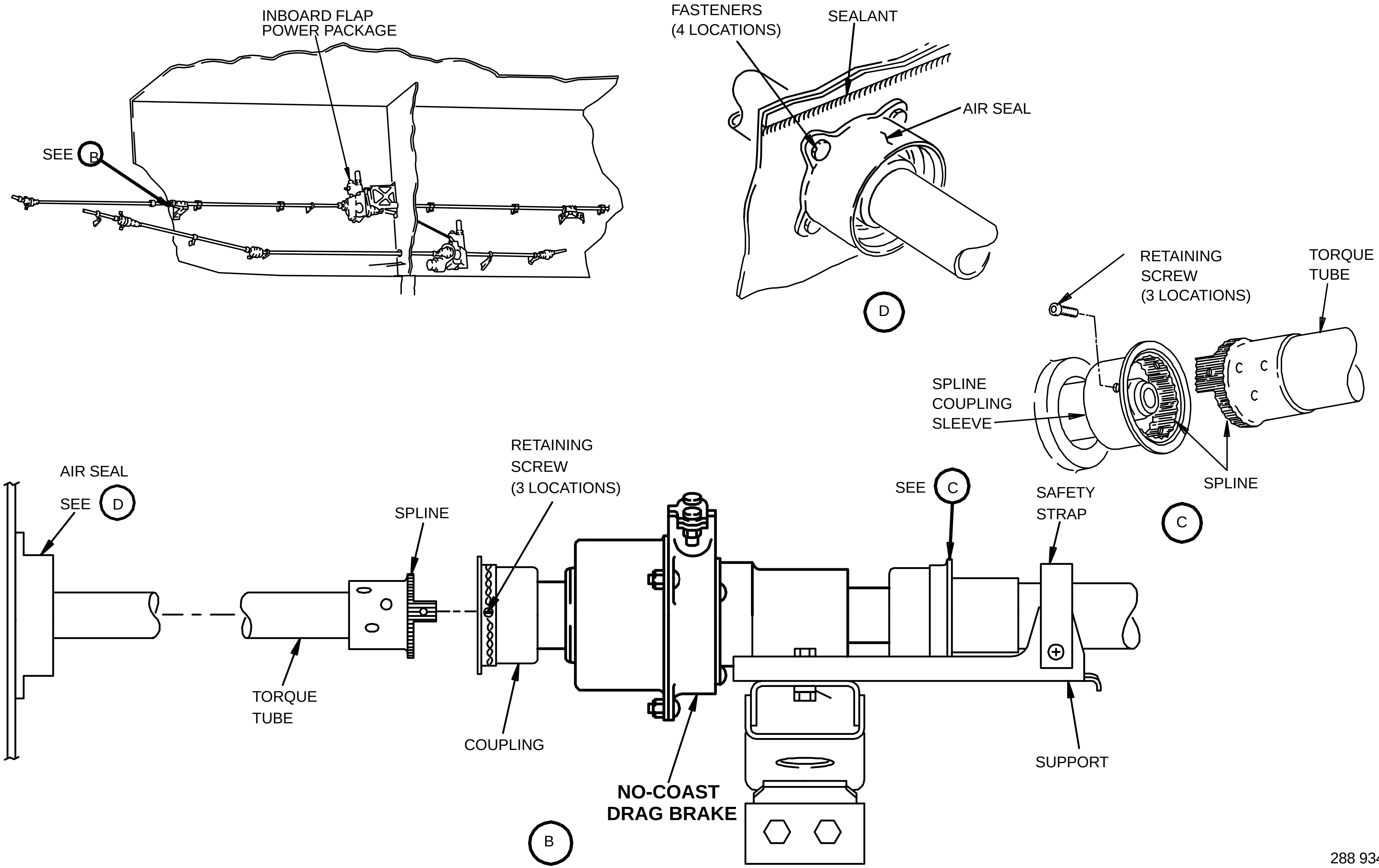


Figure 155 NO COAST DRAG BRAKE

TRANSMISSIONS AND BALL SCREW ASSEMBLIES

DESCRIPTION

Two transmission assemblies at each TE flap convert torque tube rotation to linear motion to extend and retract the flap. Each transmission assembly consists of a transmission gearbox, a universal joint, a ball screw and ball screw nut. The ball nut on each ball screw is trunnion mounted directly to midflap structure. Each transmission assembly is mounted on a flap track. The flap track fairings enclose the transmission assemblies.

The transmission gearbox contains mating bevel gears and a torque limiter. In the event of a jammed flap, the torque limiter locks against the transmission housing which in turn locks the drive system and stalls the flap drive motor. The inboard transmission assembly on each flap also contains a no-back friction brake consisting of a ratchet and a disk brake. The brake disk prevents airloads from retracting the flaps, but when power is applied to retract the flaps, the power unit overcomes the disk brake friction, allowing the flaps to be retracted. The brake disk does not oppose extension of the flaps but ratchets when the flaps are extended.

The ball screws are connected to the transmission gearboxes by a universal joint. There are two separate ball circuits between the ball screw and the grease-packed ball screw nut. Total ball screw travel is restricted by stops on the ball nut and at each end of the ball screw.

SUMMARY :

- **INPUT SHAFT :**
  - wird von der Torque Tube angetrieben
  - treibt den Output Shaft über ein Gear an
- **FILL- AND DRAIN PLUG :**
  - für den Schmierstoff Service (Dauerschmierung mit Fluid 4)
- **TORQUE LIMITER (8) :**
  - ist in jeder Transmission eingebaut
  - die Load Spring legt sich bei Überschreiten des maximalen Torquewertes an das Torque Limiter Housing an und hält dadurch den Output Shaft fest
  - ein Lösen des Torque Limiters erfolgt durch Drehen in der entgegengesetzten Richtung
- **NO-BACK BRAKE (4) :**
  - ist in der jeweiligen inneren Transmission eingebaut
  - verhindert, daß der Staudruck die ausgefahrenen Flaps bei Hydraulic Power Off nach Retract bewegt
  - der Pawl stoppt über das Ratched Wheel die Output Shaft Drehbewegung
  - gleitet beim Extendfahren der Trailing Edge Flaps hörbar über die Ratched Wheel Aussparungen
- **TRAILING EDGE FLAP POSITION TRANSMITTER (4) :**
  - sind an der jeweils äusseren Transmission angebaut
  - übertragen die Flap Position zu den FCU's (siehe Indication Components)
- **BALL SCREWS (8) :**
  - betätigt Ball Screw Nut
  - Up- and Down Stops werden normalerweise nicht erreicht
- **BALL SCREW NUT :**
  - betätigt über das Gimbel Assy die Carriage
  - die Ball Circulation Tubes dienen zum Umlauf der Kugeln

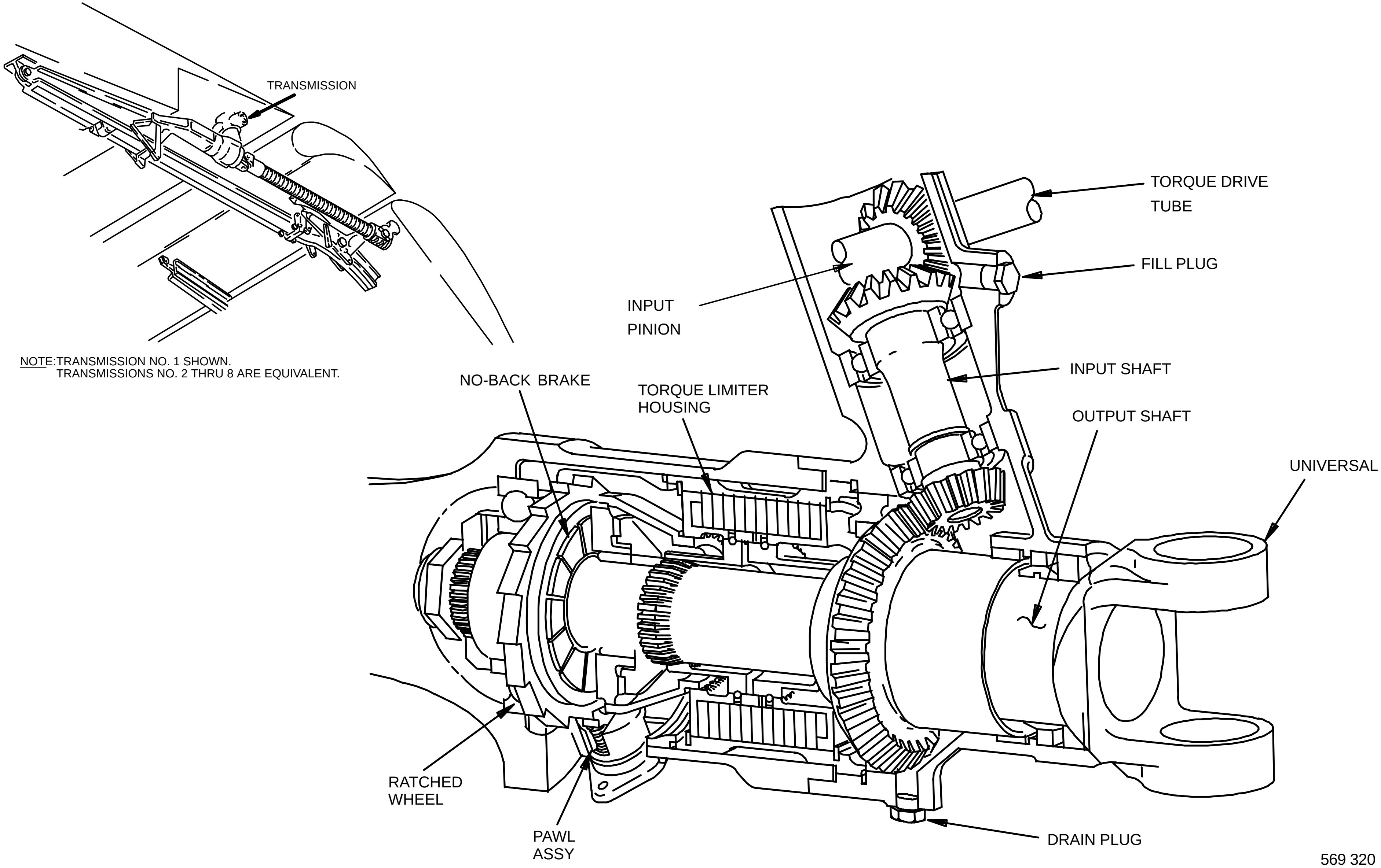


Figure 156 TRANSMISSION AND BALL SCREW ASSEMBLIES

TORQUE TUBE AND ANGLE GEAR BOX

DESCRIPTION

The torque tubes and angle gearboxes transmit torque from the flap power units (gearboxes) to the flap transmissions. The inboard flap and outboard flap torque tube systems are independent.

The torque tubes are aluminum tubes connected with steel sleeve and spline couplings. Safety straps are installed to prevent damage to surrounding airplane systems if a torque tube fails.

The angle gearboxes transmit power from torque tube to torque tube to allow for changes in direction. Each angle gearbox consists of a set of nonreducing, straight bevel gears contained in an aluminum housing. The housing is drained, vented, and has removable access coverplates to allow lubrication of the gears.

SUMMARY :

- stellen ein Winkelgetriebe dar
- besitzen eine Dauerschmierung
- sind auf jeder Seite mittels drei Schrauben mit der Torque Tube verbunden

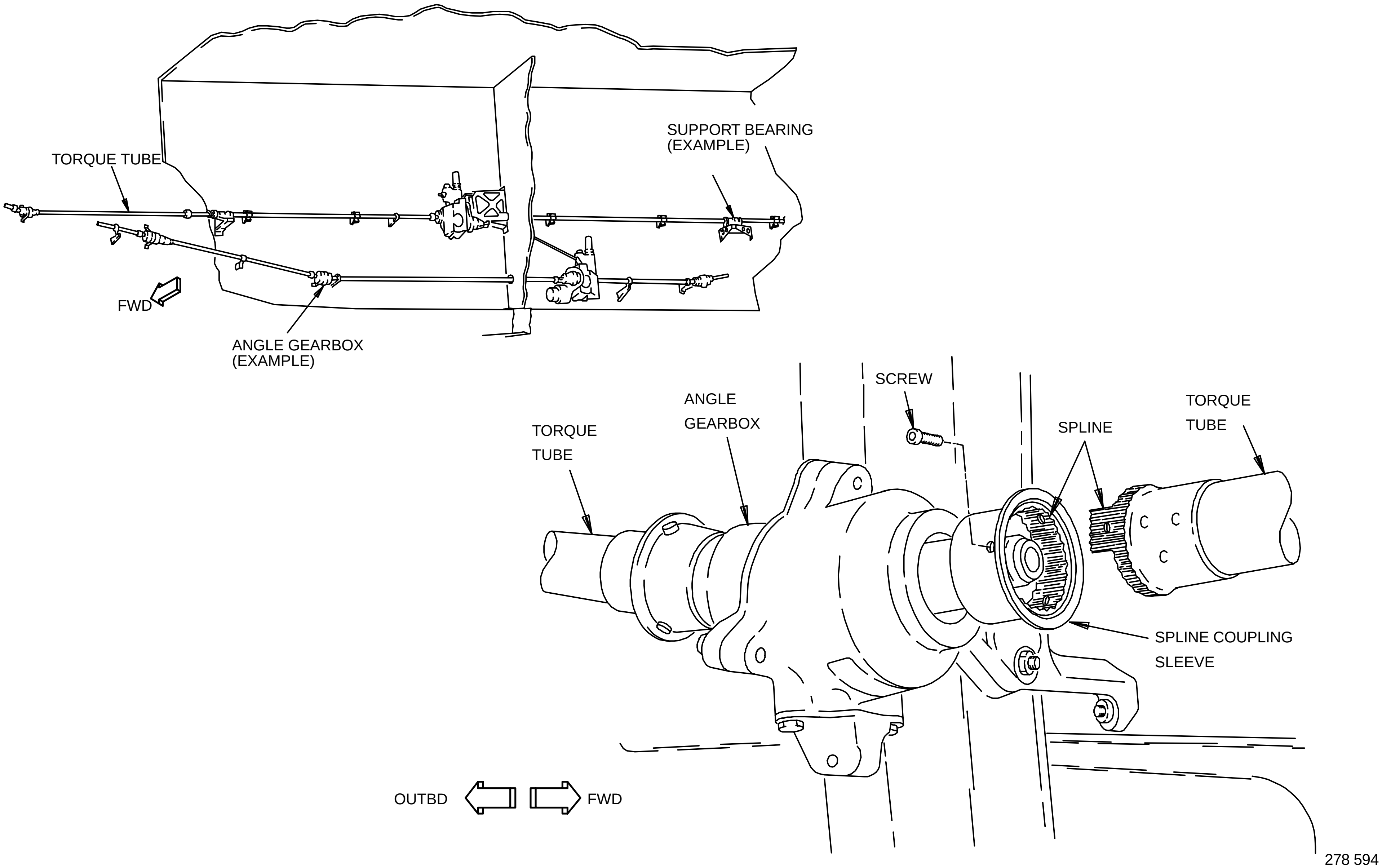


Figure 157 ANGLE GEAR BOX

FLAP BALL SCREW ADJUSTMENT

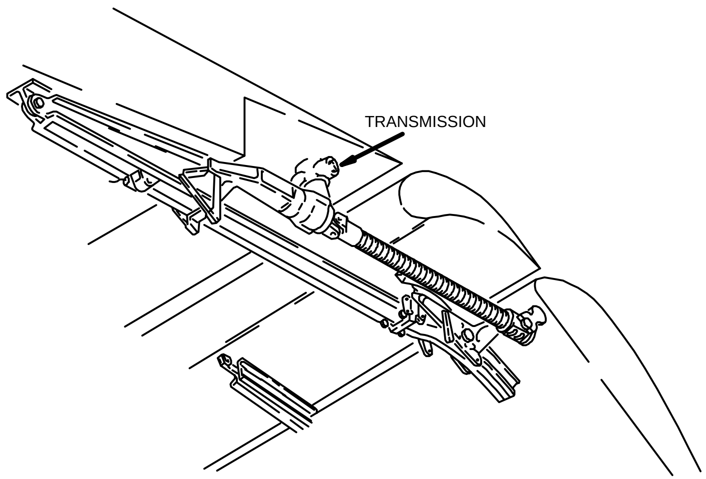
DESCRIPTION

- **DIMENSION "X"**
  - für alle Positionen
  - wird gemessen zwischen den Flanken von der Transmission Universal und der Ball Screw Nut Flanke

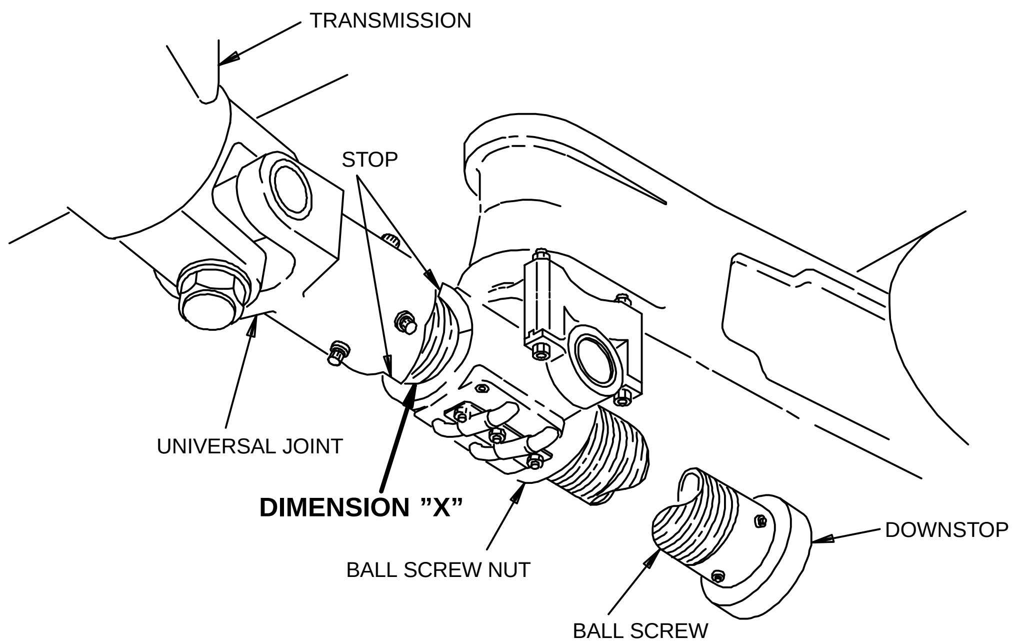
DIMENSION CHART

FLAP LEVER POSITION	EQUIVALENT BALL SCREW POSITION (INCHES)	
	INBOARD	OUTBOARD
	X	X
0 - UNITS	0.72	0.59
1 - UNIT	0.72	0.59
5 - UNITS	50.79	36.17
10 - UNITS	57.32	40.90
20 - UNITS	66.67	46.58
25 - UNITS	70.66	48.91
30 - UNITS	76.72	52.05

NOTE :
THE DEMENSIONS LISTED ARE FOR REFERECE ONLY,
THEY MAY VARY MORE THAN AN INCH,
DEPENDING ON TOLERANCE BUILDUP.



NOTE: TRANSMISSION NO. 1 SHOWN.
TRANSMISSIONS NO. 2 THRU 8 ARE EQUIVALENT.



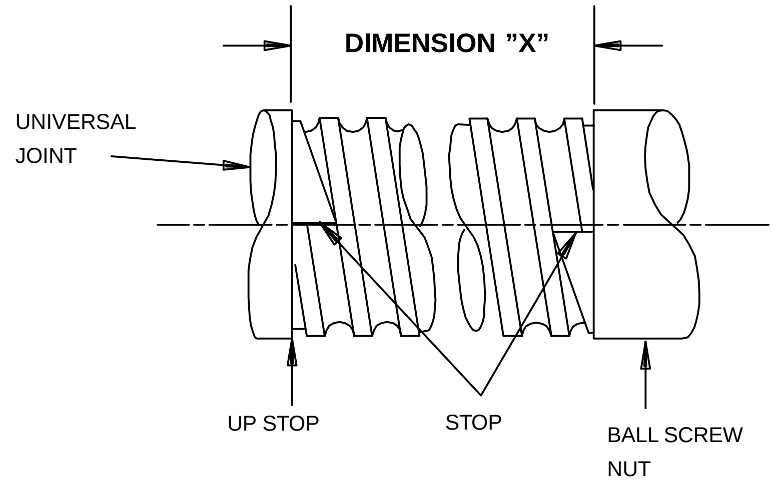


Figure 158 FLAP BALL SREW ADJUSTMENT

TRAILING EDGE FLAPS FLAPS OVERVIEW

DESCRIPTION

FLAP TRACKS AND FAIRING

Each flap is mounted to two flap tracks. The flap tracks are curved, forged steel beams which attach to the lower surface of the wing. A flap transmission is mounted on each flap track. The flap tracks and transmissions are housed in aerodynamic fairings.

Each fairing consists of two parts. The forward section is rigidly attached to the wing. The aft section rotates about a hinge support on the flap track. The fairings are constructed of aluminum frames covered with epoxy reinforced fiberglass honeycomb. The fairings are actuated by a fairing drive mechanism linkage and control rod. As the flaps move, the drive mechanism pivots about the end of the flap track and positions the fairing in the proper relationship with the flap. Access panels are provided on the fairing to facilitate system adjustment.

TRAILING EDGE FLAPS

Each flap assembly is a triple-slotted flap which consists of a foreflap, midflap, and aftflap. The three flap segments are mechanically separated to form three slots as the flaps are extended. Each midflap is attached to and is supported by two flap carriages which travel on the flap tracks. The midflap is attached to two ball screw and ball nut assemblies which are each driven by a transmission to extend or retract the flap.

FOREFLAPS

The foreflaps consist of front and rear spars connected by skin panels, a curved nose skin section, and a trailing edge. The foreflaps are supported by a track which extends into the midflap where it contacts rollers. The position of the foreflap is established by sequencing carriages attached to this surface. The foreflap extends with the midflap until the sequencing carriages contact detents in the flap tracks. At this point, the foreflaps and midflaps separate and the foreflaps do not extend further aft but are rotated relative to the midflap by cam action of the sequence carriages against the flap carriages.

MID FLAPS

The midflaps consist of three spars and honeycomb skin panels. The midflaps are connected directly to flap carriages which ride on the flap tracks. The midflaps are also connected to the flap transmission ball screw. Additional rollers on the ends of the midflap contact tracks on wing structure to provide deflection control.

AFT FLAPS

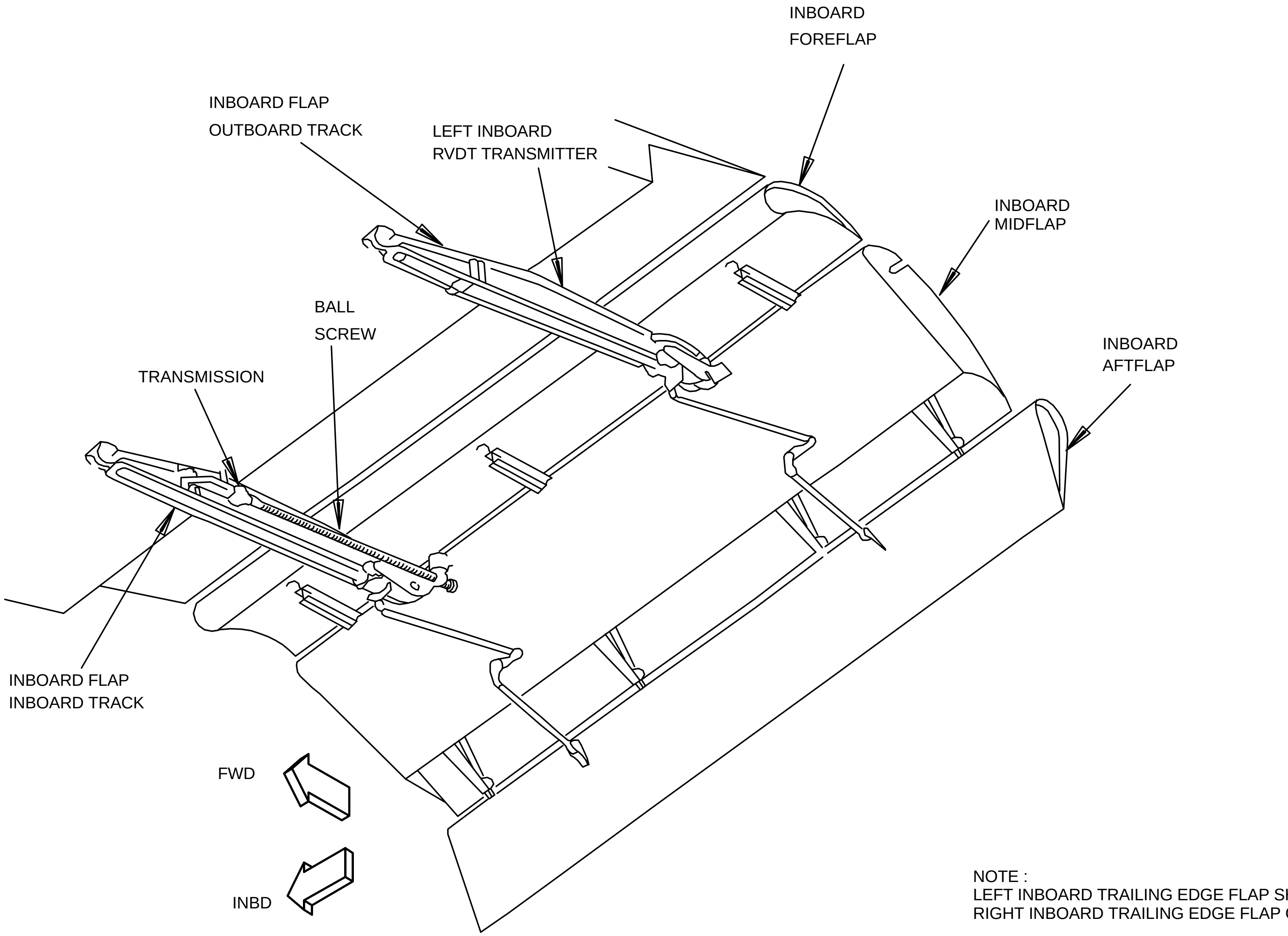
The aftflaps are constructed in the same manner as the foreflaps. The aftflaps are supported by trunnion-mounted tubes which are connected through fittings to the midflap rear spar.

FLAP CARRIAGE

Two flap carriages support each trailing edge flap. The aft end of the flap carriages extends into the nose of the midflap. The flap carriage is positioned in the midflap by two steel bearings. The aft bearing is adjustable to control the flap trailing edge vertical position and is not rigid, which allows the carriage to move relative to the midflap during flap operation. The carriage is retained by thrust collars, washers, and nuts. As the flaps are driven by the transmissions, the flap carriages travel along the flap tracks on roller bearings holding the flaps in the desired position.

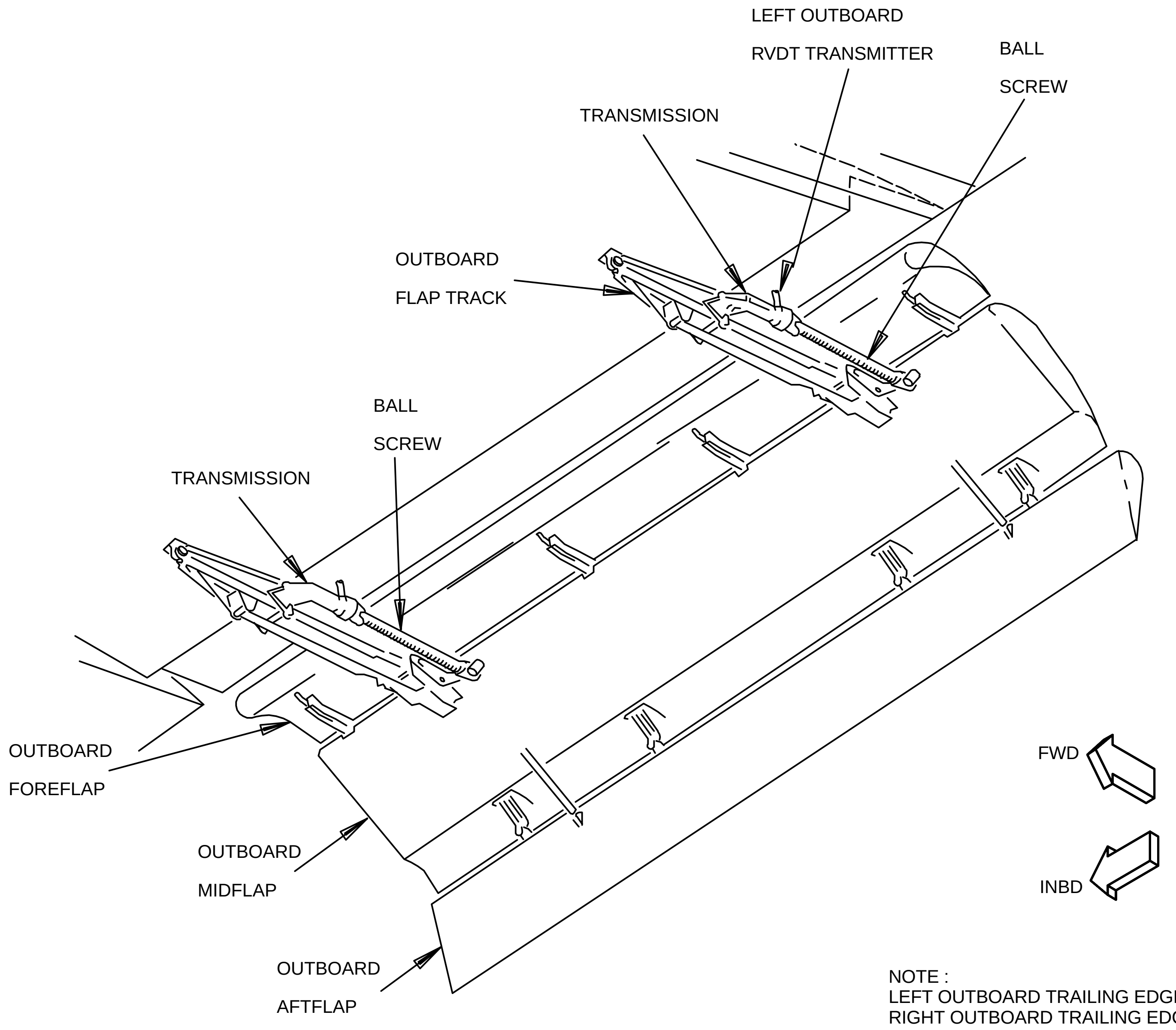
FLAP SEQUENCE CARRIAGE

Two sequence carriages are attached to each foreflap. The sequence carriages are constructed of aluminum and steel forgings. The sequence carriages travel on roller bearings on the upper flange of the flap tracks. As the flaps extend, the sequence carriages are held in position by detent in the flap carriages and travel with them. At approximately 5 degrees of flap extension, the sequence carriages contact stops on the flap tracks. The stops prevent further aft travel of the foreflap causing the foreflap and midflap to separate. Cam rollers on the sequence carriages follow cam tracks on the flap carriage thereby rotating the foreflap relative to the midflap.



NOTE :
LEFT INBOARD TRAILING EDGE FLAP SHOWN,
RIGHT INBOARD TRAILING EDGE FLAP OPPOSIDE.

Figure 159 INBOARD TRAILING EDGE FLAPS OVERVIEW



NOTE :
LEFT OUTBOARD TRAILING EDGE FLAP SHOWN,
RIGHT OUTBOARD TRAILING EDGE FLAP OPPOSIDE.

Figure 160 OUTBOARD TRAILING EDGE FLAPS OVERVIEW

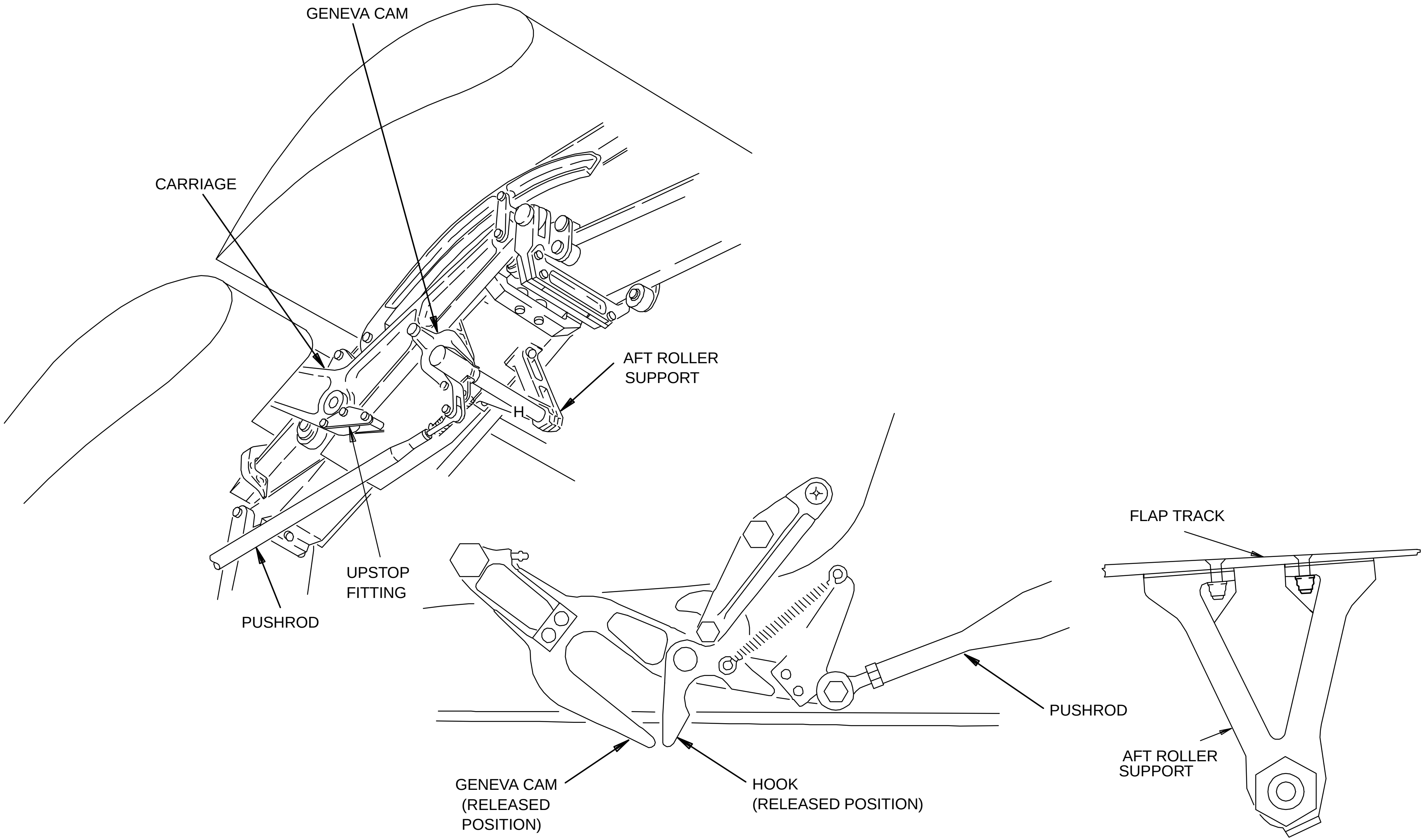


Figure 161 AFT FLAP DRIVE MECHANISM ASSEMBLY

TRAILING EDGE FLAP OPERATIONS

DESCRIPTION

Auf den folgenden drei Seiten finden Sie die Trailing Edge Flap Operation in drei verschiedenen Positionen :

- TE Flaps : UP
- TE Flaps : 5 Units
- TE Flaps : 30 Units

aus denen Sie das Zusammenwirken der einzelnen Bauteile des Trailing Edge Flap Systemes erkennen können.

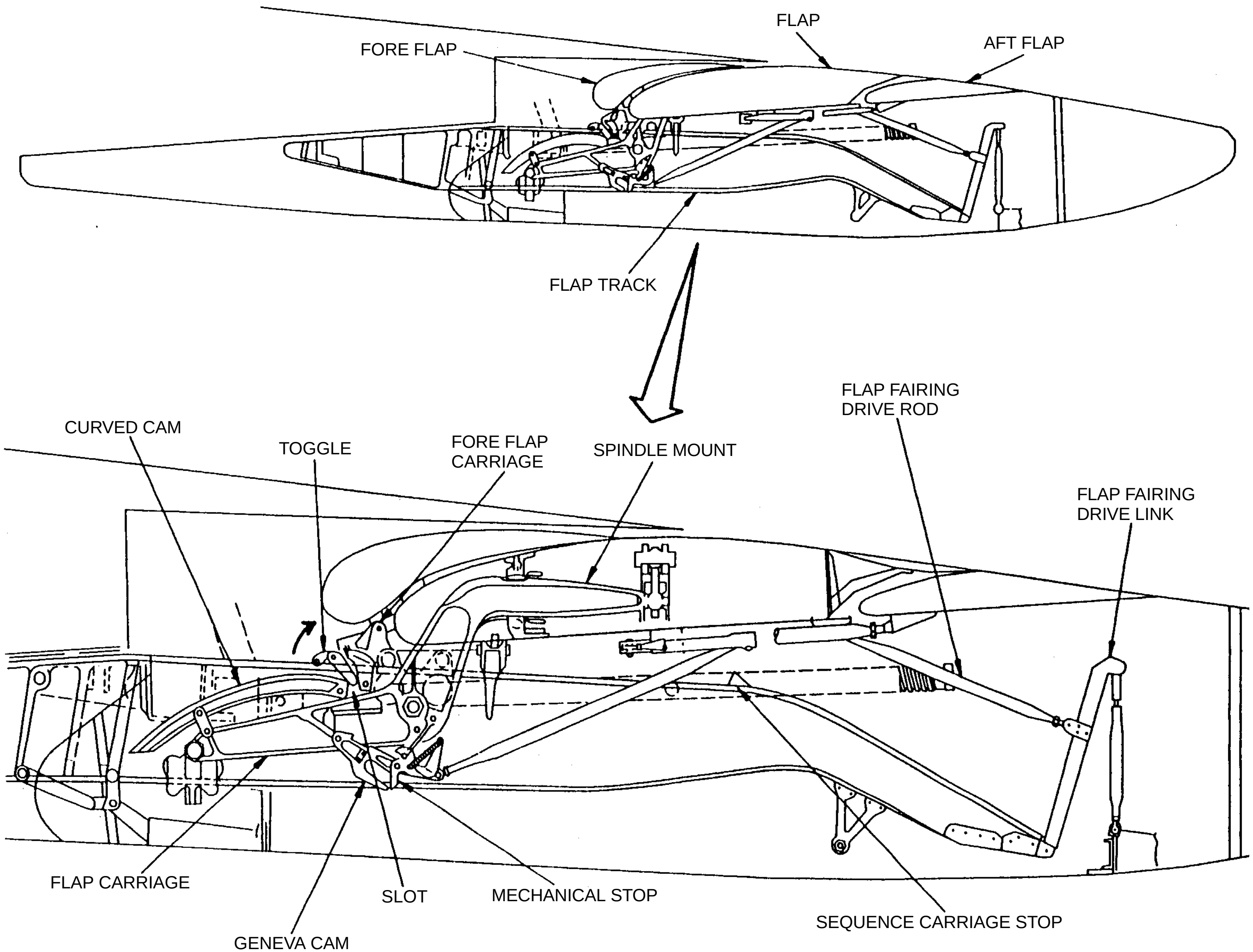


Figure 162 TRAILING EDGE FLAPS OPERATION - UP

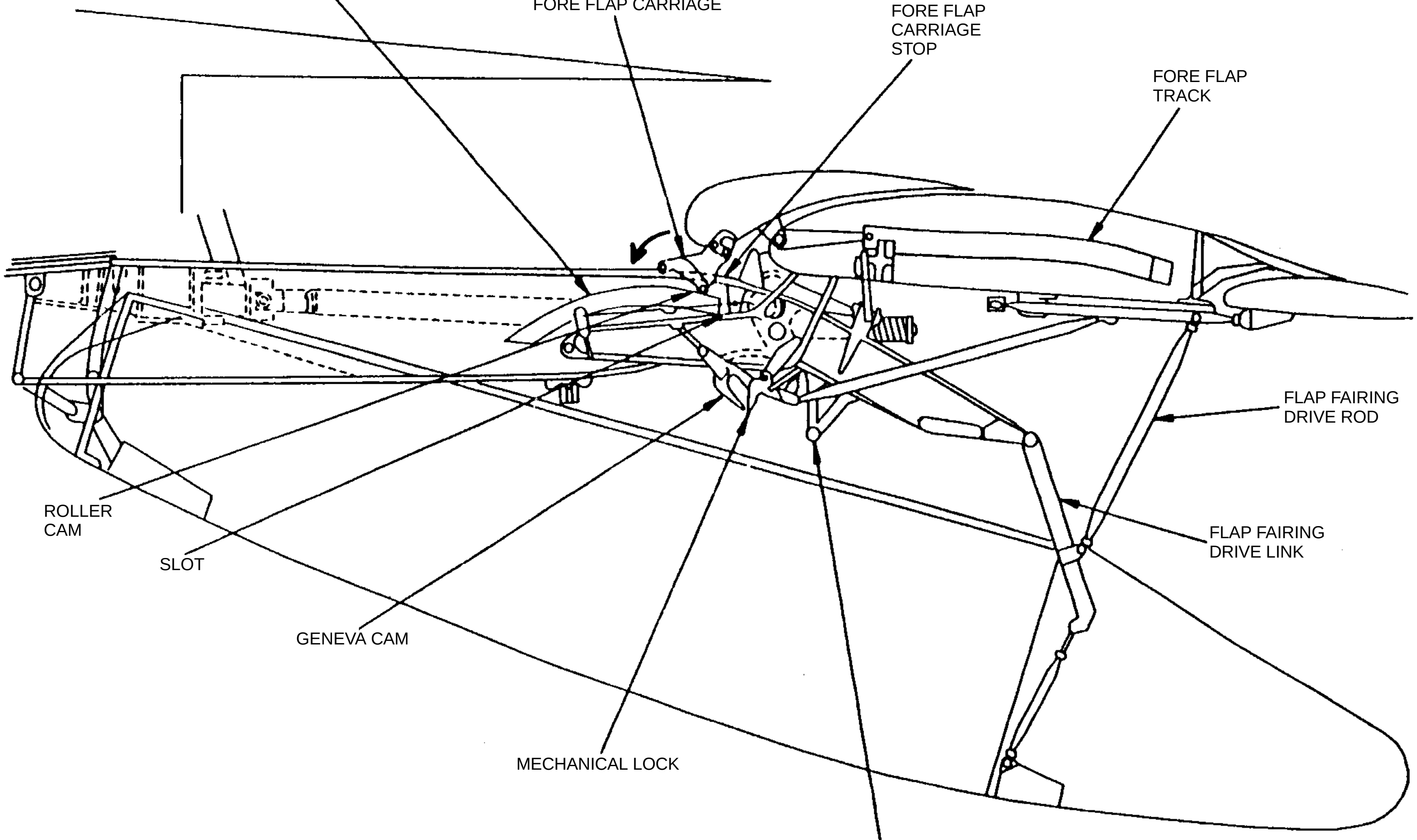


Figure 163 TRAILING EDGE FLAPS OPERATION - 5 UNITS

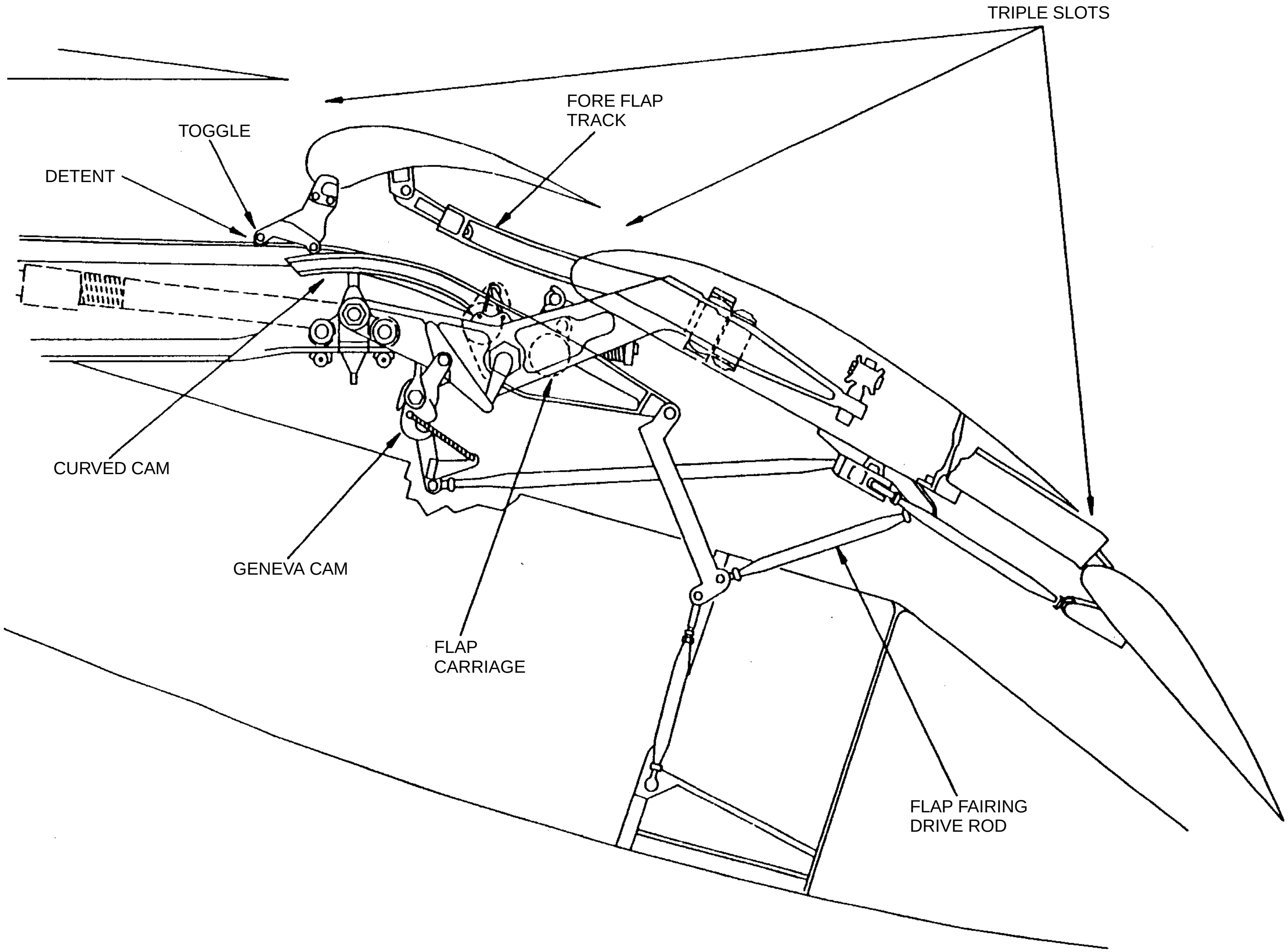


Figure 164 TRAILING EDGE FLAPS OPERATION - 30 UNITS

POWER PACK RVDT TRANSMITTER

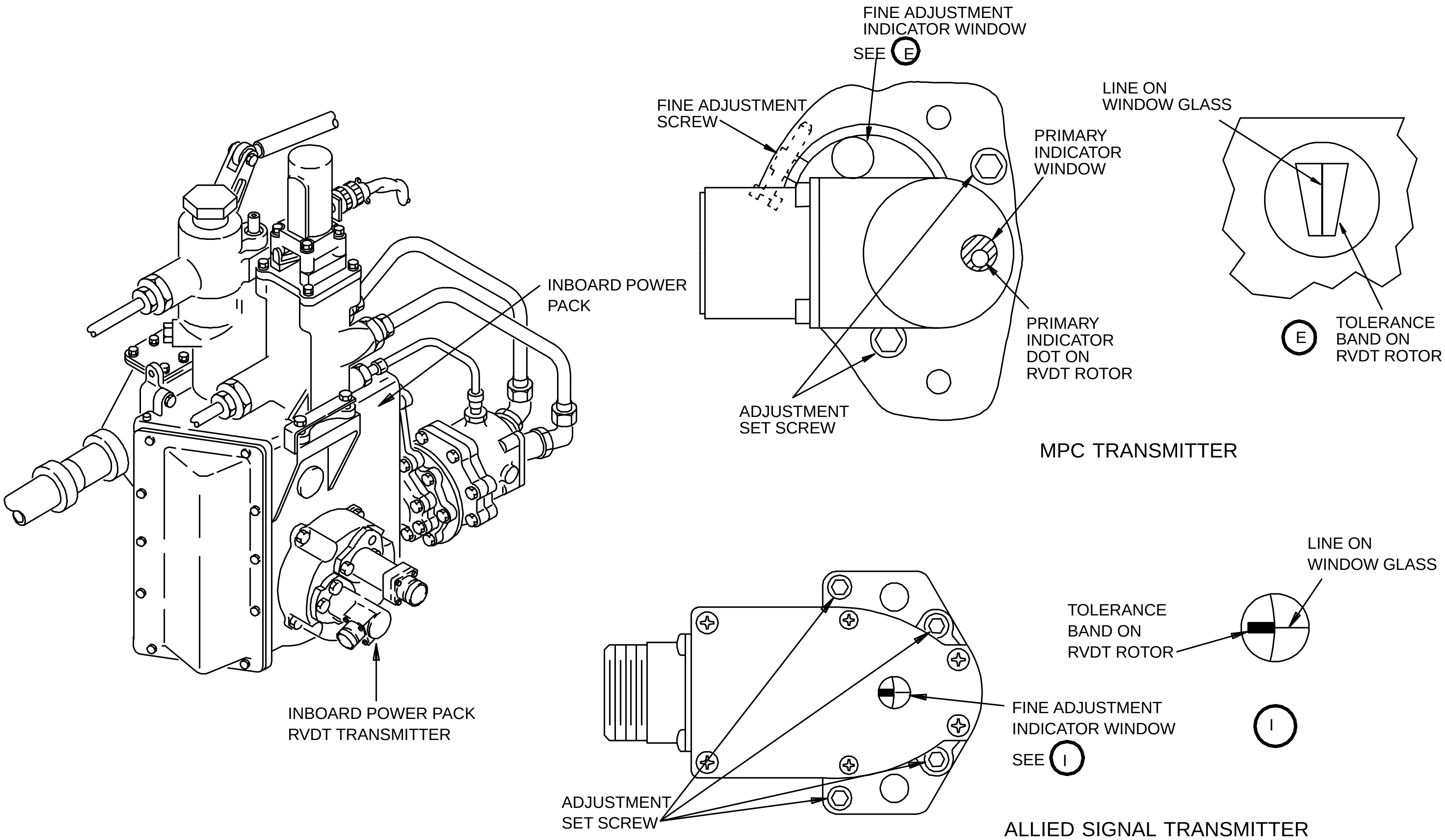
DESCRIPTION

GENERAL

The trailing edge flap position indicating system provides visual indication on the flight deck of the displacement of the trailing edge flaps. The FLAPS display appears on the main EICAS whenever the flap lever is not in the full UP detent or any flap is not fully retracted.

Components used by the trailing edge flap position indicating system are the 6 TE flap position RVDT transmitters, the TE flap actuator (with integral RVDT transmitter), the 3 flap control units, and the EIU's and EICAS display.

The system is powered through the flap control units by the 4 FCE power supply modules (Ref 27-09-00).



NOTE :
INBOARD POWER PACK RVDT TRANSMITTER SHOWN,
OUTBOARD POWER PACK RVDT TRANSMITTER SIMILAR.

299 526
579 071
639 389

Figure 165 POWER PACK RVDT TRANSMITTER

TRAILING EDGE FLAPS POSITION RVDT TRANSMITTER

DESCRIPTION

GENERAL

The trailing edge flap position indicating system provides visual indication on the flight deck of the displacement of the trailing edge flaps. The FLAPS display appears on the main EICAS whenever the flap lever is not in the full UP detent or any flap is not fully retracted.

Components used by the trailing edge flap position indicating system are the 6 TE flap position RVDT transmitters, the TE flap actuator (with integral RVDT transmitter), the 3 flap control units, and the EIU's and EICAS display.

The system is powered through the flap control units by the 4 FCE power supply modules (Ref 27-09-00).

TRAILING EDGE FLAP POSITION RVDT TRANSMITTER

The trailing edge flap position RVDT transmitters sense TE flap position. There is an RVDT transmitter mounted on the outboard transmission on each inboard and outboard flap, and an RVDT transmitter located in the inboard and in the outboard TE flap power drive unit. There is also an integral RVDT transmitter in the TE flap actuator.

The RVDT transmitters are preset to the zero (rigging) position when they are installed. There is no transmitter adjustment.

FAILURE INDICATION OF THE FLAP RVDT :

For example :

Whenever a fault is detected at the flap RVDT on the EICAS display following is indicated :

the status message :

FLAP SYS MONITOR

and on the MCDU is shown the reason for the EICAS message :

CMC message :

LEFT OUTBOARD RVDT FAIL 27 636.

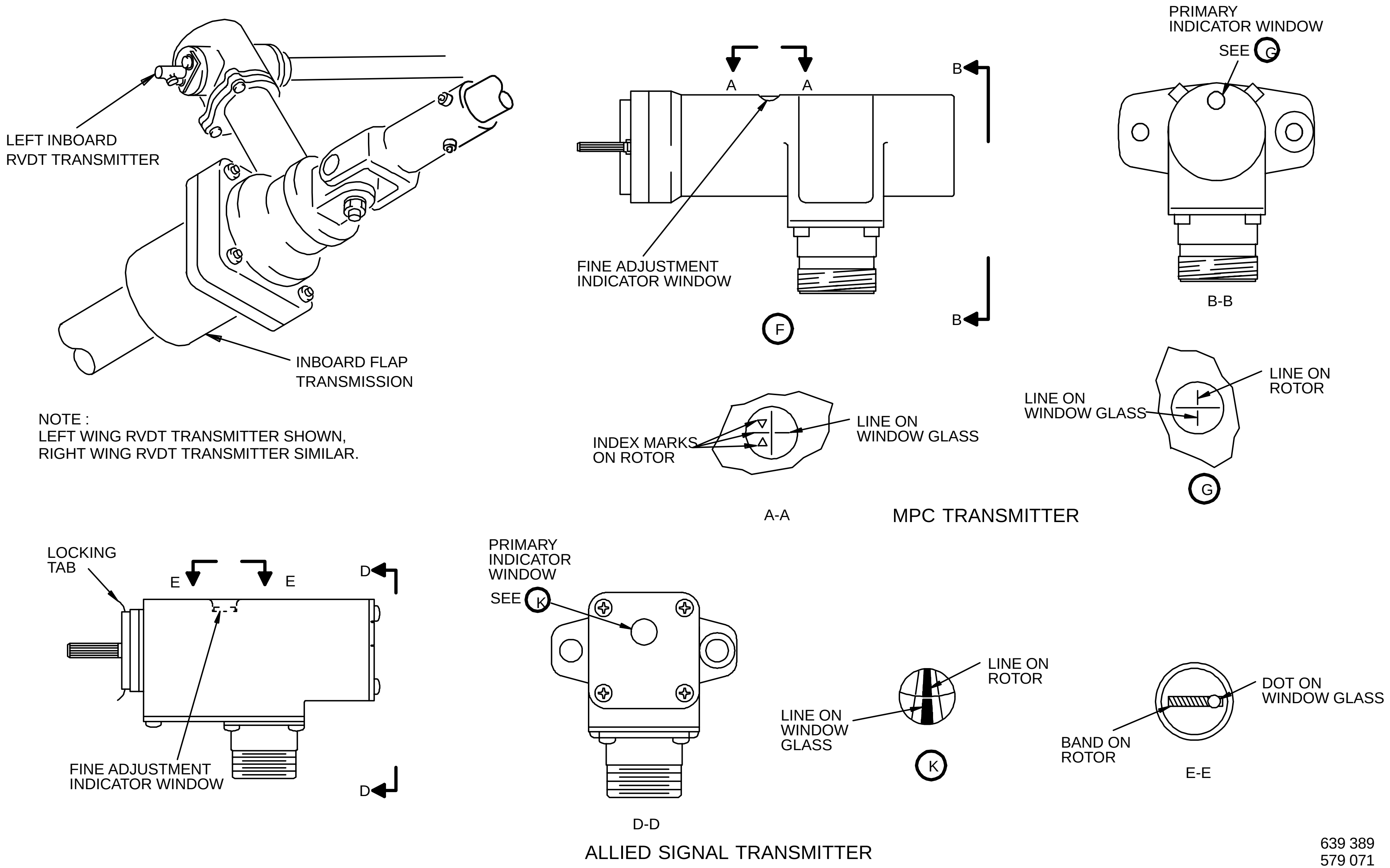


Figure 166 TRAILING EDGE FLAPS POSITION RVDT TRANSMITTER

TRAILING EDGE FLAPS POSITION INDICATING SYSTEM SCHEMATIC

FUNCTIONAL DESCRIPTION

When the trailing edge flaps are extended, each RVDT transmitter is rotated from its zero position. The transmitter electrical output varies as the RVDT rotates. The RVDT output signal passes to the flap control units which process the signal and route it to the EIU's for display on EICAS.

The FLAPS display appears on the main EICAS whenever flaps are not fully retracted. The normal FLAPS display appears for normal flap configurations and disappears 15 seconds after flaps are retracted. One of two multiple FLAPS displays appear for non-normal flap configurations.

The normal FLAPS display consists of a single white tape which represents TE flap position and a bar across the tape which indicates position of the flap lever. A number appears next to the bar when the flap lever is in one of the detented positions. The white tape moves with the slowest TE flaps during extension or retraction until the flaps reach the selected flap lever position. The bar and number are magenta in color when flaps are in transit, and change to green when all TE and LE flaps agree with flap lever position.

The expanded FLAPS display appears automatically when primary electric flaps are enabled, when there is flap asymmetry or disagreement with flap lever position, or when any LE or TE flap position data are determined to be invalid. This display consists of 4 white tapes which indicate position of each TE flap, a split bar across the tapes with a number which indicates position of the flap lever, and 6 box-shaped symbols above the tapes which indicate position of the LE flaps.

The tapes and bar with number function the same as for the normal FLAPS display, except that the tape appears in amber if that TE flap is in asymmetry or disagrees with the flap lever position. If position data for any TE flap is invalid (RVDT failure, interface failure, or loss of excitation), the letter x will appear in amber inside the tape for that flap.

The alternate FLAPS display appears automatically when alternate flaps are selected with the flap ALT ARM switch or when all 3 flap control units fail. This display is the same as the expanded flaps display except that the flap lever position bar and number do not appear, and flap position scales appear next to the outer tapes.

The standby power system provides excitation to the RVDT transmitters on the right wing but not on the left wing. If standby power is used, the multiple flap display will appear with an amber x in the left wing display tapes.

CONTROL

Operation of the trailing edge flap position indicating system is automatic. The FLAPS display appears on the main EICAS when the flap lever is not in the full UP detent or any flap is not fully retracted.

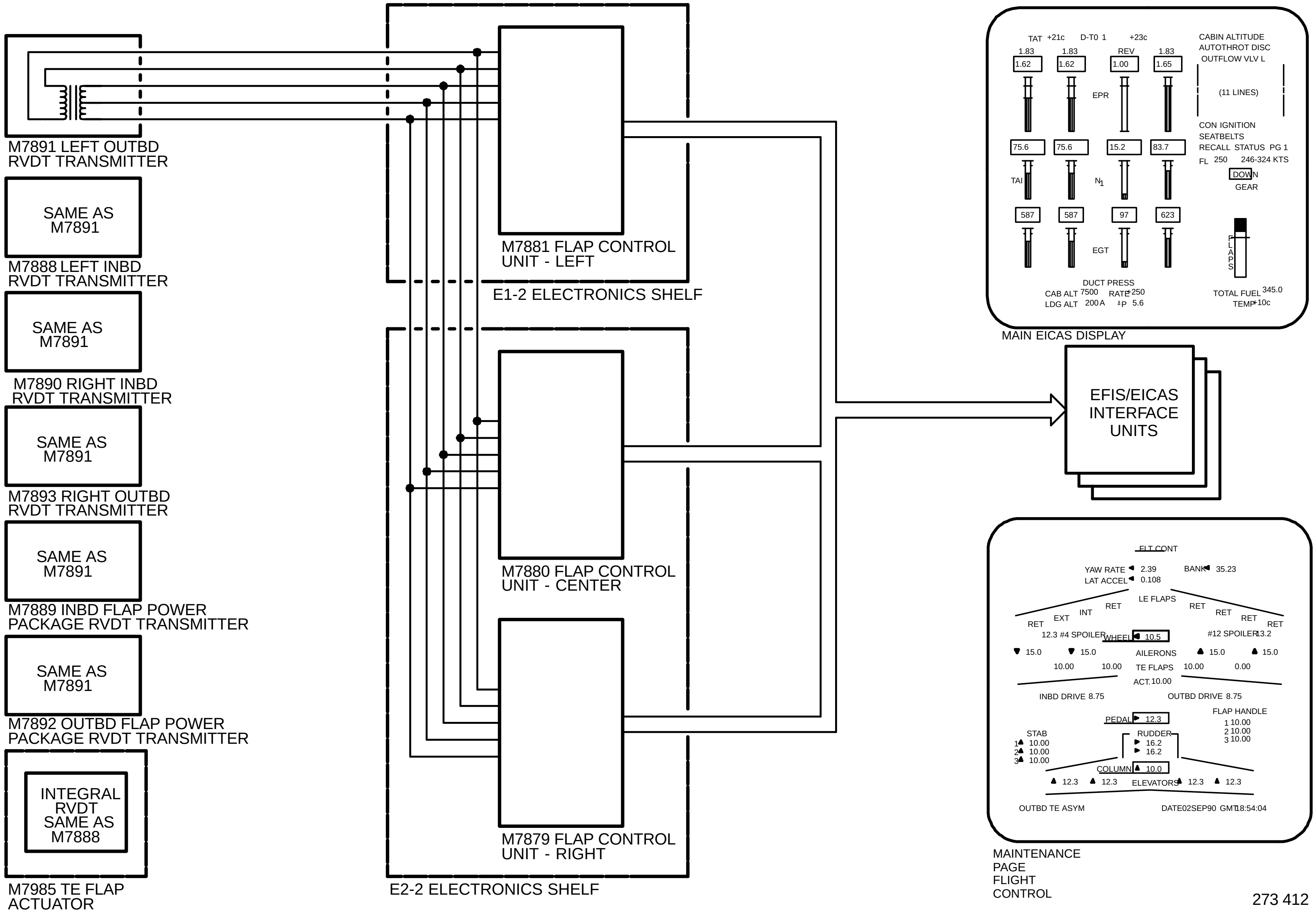


Figure 167 TRAILING EDGE FLAPS POSITION INDICATING SYSTEM SCHEMATIC

27-80 LEADING EDGE FLAPS

LEADING EDGE FLAP OVERVIEW

LEADING EDGE FLAP SYSTEM

Additional lift is provided during takeoff and landing by 28 leading edge (LE) flaps operating with the trailing edge (TE) flaps. Extension of the wing flaps changes wing camber to produce the desired lift. The 11 outboard and midwing flaps in each wing are variable camber flaps with the camber being changed as the flaps are extended. The remaining three flaps in each wing are Krueger flaps. Primary pneumatic power to position all LE flaps is provided by pneumatic motors. Electric motors provide power to position LE flaps in alternate or primary electrical operations.

For normal flap extension operation, the LE flaps are controlled automatically by the flap control units (FCU's). For normal flap retraction operation, the LE flaps are controlled by the FCU's and the TE flaps positions. Primary pneumatic power for the power drive units (PDU's) is provided by pneumatic motors; primary electric and alternate power by electric motors. The LE flaps are driven by the PDU's through a torque tube system. The flaps are then positioned by rotary actuators. All LE flaps are designed as two position surfaces, either full up or full down. In the non-normal flap configurations, the LE flap indication displays the flaps in full up, full down, disagree, or in transit position for inboard, midspan, or outboard LE flaps.

The LE flaps are extended in two groups. Group A LE flaps, consisting of flaps No. 6 through 13 in the left wing and No. 14 through 21 in the right wing, will extend together when the flap control lever is moved to the 1 unit detent. The remaining LE flaps, group B, will extend when the flap control lever is moved to the 5 unit detent.

The LE flaps are sequenced to retract in two groups. Group A LE flaps will retract when the flap control lever is moved to the full UP detent and after the outboard TE flaps is fully retracted. Group B LE flaps will retract when the flap control lever is moved to the 1 unit or full UP detent and the inboard TE flaps are less than 5 units.

All LE flaps are two-position flaps, intended to be either full up or full down. Normal extension or retraction of either group of the LE flaps by pneumatic motors requires approximately 10 seconds. If the flaps fail to respond in the pneumatic mode, the affected group of flaps are automatically driven to the commanded position by electric motors. The primary electric operation requires approximately 85 seconds. During normal operation, the LE flaps Group A will be automatically retracted after landing upon application of reverse thrust and extended when the reverse thrust levers are returned to normal.

Alternate operation of the LE flaps is accomplished by an electric motor installed on each of the flap PDU's. These motors are controlled by an ALTN FLAPS ARM switch and an ALTN FLAPS EXT/RET switch located on the pilots' center panel. The ALTN FLAPS ARM switch provides power to the electric drive motors. These motors automatically drive the LE flaps to the position selected on the ALTN FLAPS EXT/RET switch. The LE flaps are extended or retracted using the same drive components as used with the pneumatic system. Alternate extension or retraction of the LE flaps requires approximately 85 seconds. The inboard TE flaps must be fully retracted for the LE flaps to retract in alternate mode.

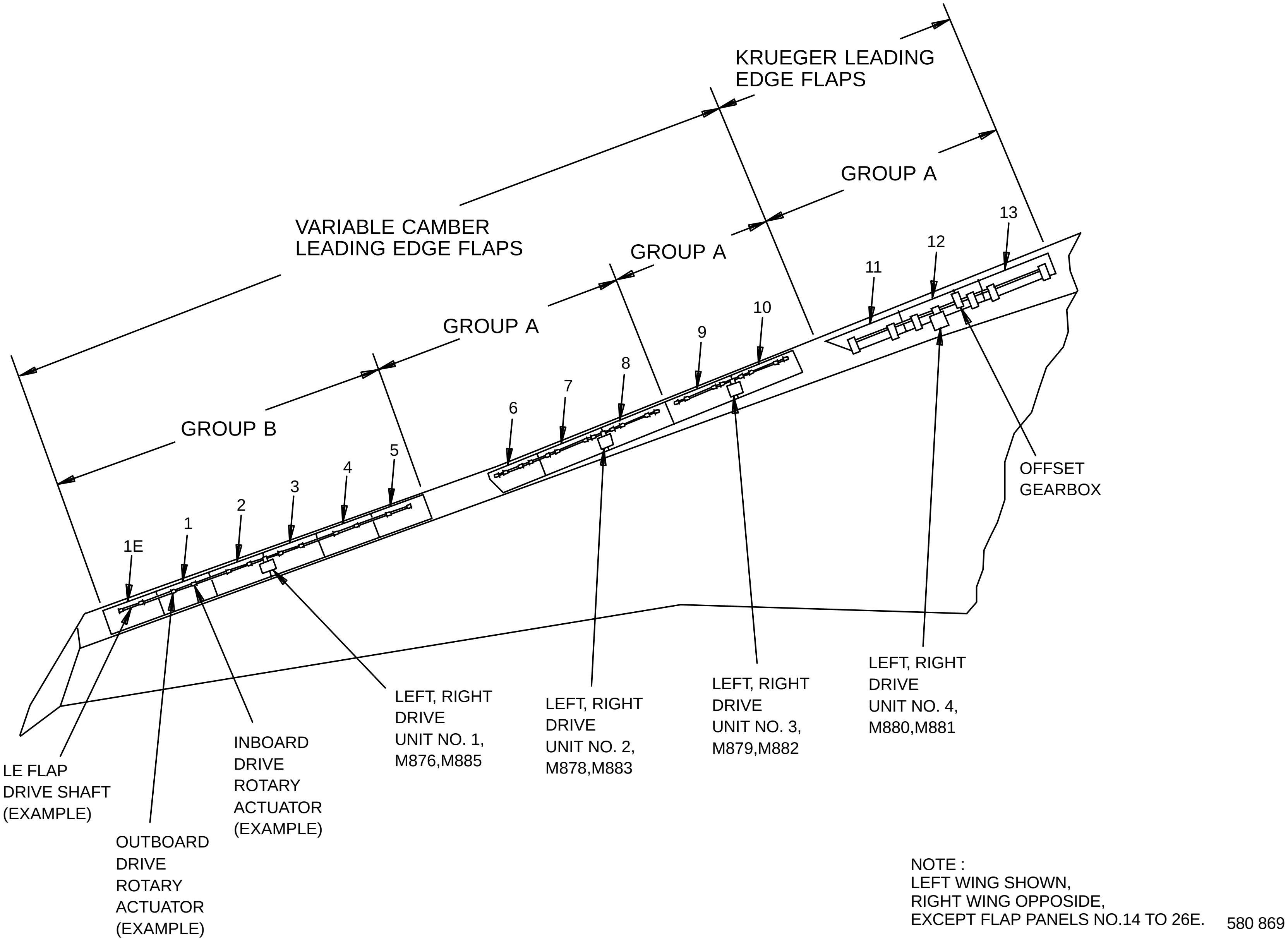


Figure 168 LEADING EDGE FLAPS OVERVIEW

LIFT AUGMENTING INDICATION MAIN EICAS DISPLAY

DESCRIPTION

Die Leading Edge Flap Position Indication erfolgt in Abhängigkeit der Betriebsart auf dem Main EICAS Display wie folgt :

FLAP LEVER UP und LE FLAPS RETRACTED :

- die Flap Indication erlischt 15 sec. nachdem alle Flaps FULLY RETRACT melden

PRIMARY PNEUMATIC :

- Keine Indication

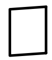
PRIMARY ELECTRIC
und
ALTERNATE ELECTRIC :

- Die Einzelanzeigen der Drive Units erfolgt bei :
  - automatischen Umschalten auf Primary Electric

    oder
  - betätigen des Alternate Flap Arming Switches nach ARM

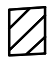
    oder
  - bei LE Drive Unit EXTEND und ein LE FLAP Sensor meldet NOT EXTEND
- Die Drive Unit No.1 und No.4 haben je ein Symbol, für die Drive Units No.2 und No.3 erfolgt die Indication in einem gemeinsamen Symbol.

INDICATION :



- White
- LE Flaps (Drive Unit) FULLY RETRACTED

- green
- LE Flaps (Drive Unit) FULLY EXTENDED



- White
- LE Flaps (Drive Unit) IN TRANSIT

- Box: White, Cross: Amber
- LE Flaps (Drive Unit) Data Invalid (LE Flap Drive Unit) Position Switches meldet gleichzeitig Retract und Extend
- gleichzeitig erscheint die Advisory Message :

  LE DISAGREE

- Amber
- jedes der drei Symbole erscheint in amber, wenn ein Disagreement zwischen dem Flap Control Lever und den LE Flaps besteht.

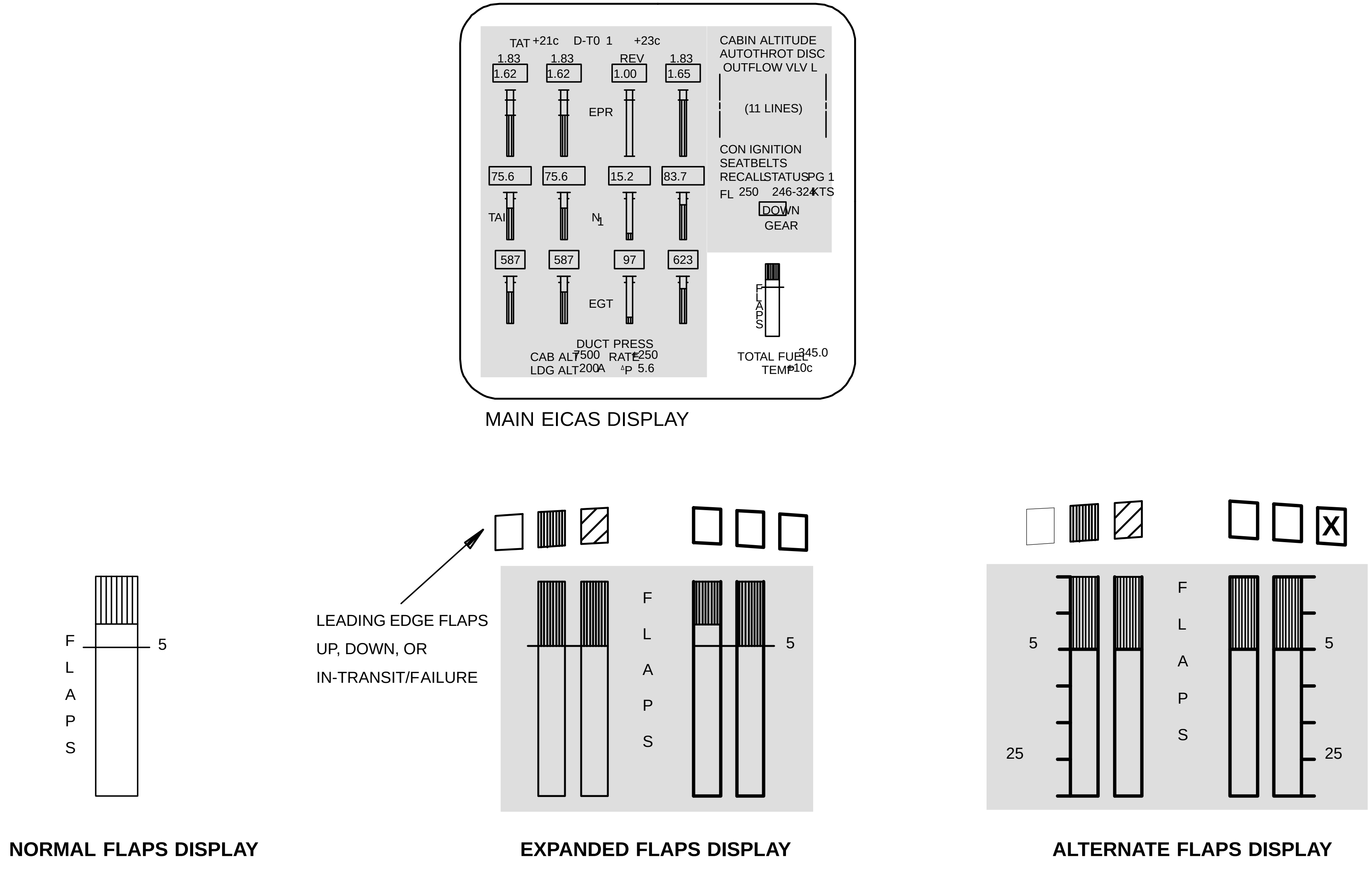


Figure 169 LIFT AUGMENTING INDICATION MAIN EICAS DISPLAY

LIFT AUGMENTING INDICATION FLIGHT CONTROL MAINTENANCE PAGE

DESCRIPTION

Die Maintenance Page für das Flight Control System ist über das Central Maintenance Computer System (CMCS) folgendermaßen aufrufbar :

- CMC
- MENü
- MAINTENANCE PAGE
- ATA 27
- DISPLAY.

Die Anzeigen:

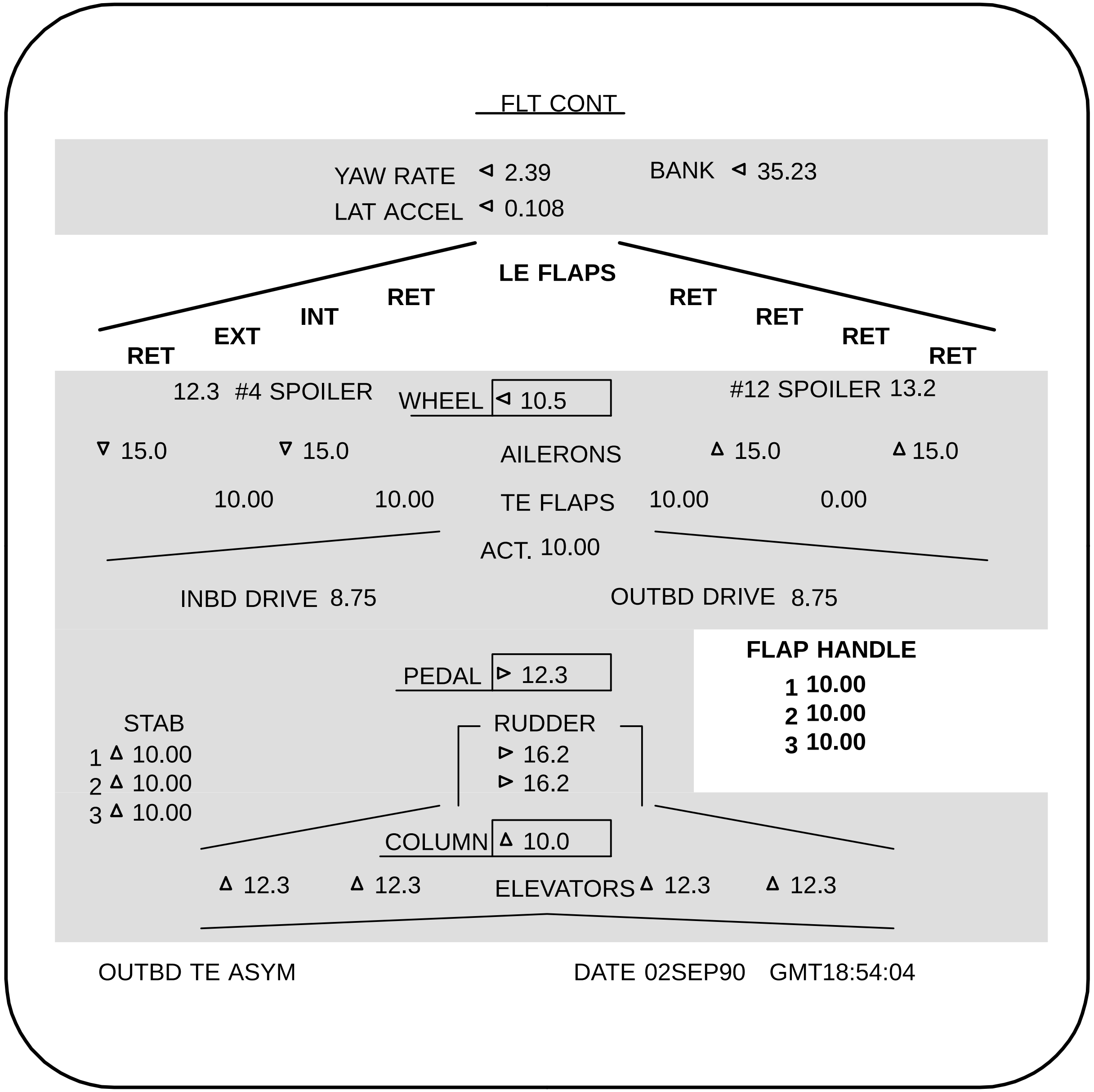
- des Flap Control Handles (3 RVDT's)
  - erfolgt in ° .
  - Die Anzeige erfolgt in Steps von $^{1}/_{10}$ ° .
- der LE Flaps (8)
  - Die Anzeige erfolgt in Positionen : RET, INT und EXT.

FLAP HANDLE :

Es werden die drei Flap Handle Position RVDT's angezeigt, d.h. die vorgewählte Position des Flap Control Levers

DRIVE UNIT POSITION :

- **EXT :**
  LE Flap Drive Unit FULLY EXTENDED
- **INT :**
  die LE Flap Drive Unit befindet sich im TRANSIT
- **RET :**
  LE Flap Drive Unit FULLY RETRACTED



MAINTENANCE
PAGE
FLIGHT
CONTROLS

Figure 170 LIFT AUGMENTING INDICATION FLIGHT CONTROL MAINTENANCE PAGE

FLAP CONTROL COMPONENTS

DESCRIPTION

FLAP CONTROL LEVER :

- dient zur Steuerung der Leading Edge Flaps in :
  - der Primary Pneumatic Mode
  - der Primary Electric Mode

EXTEND :

- **UP**
  - All Flaps Retracted
- **1** (with Gate)
  - Trailing Edge Flaps UP
  - Leading Edge Group A fährt Extend
- **5**
  - Trailing Edge Flaps fahren auf Position 5
  - Leading Edge Group B fährt Extend
- **10**
  - Trailing Edge Flaps fahren auf Position 10
  - Take Off Position
- **20** (with Gate)
  - Trailing Edge Flaps fahren auf Position 20
  - maximale Take Off Position
- **25** und **30**
  - Trailing Edge Flaps fahren auf Position 25 bzw. 30
  - Landing Positionen

RETRACT :

- Leading Edge Group B
  - Flap Control Lever to Unit 1 or UP and INBOARD TE Flaps < Units 5
- Leading Edge Group A
  - Flap Control Lever UP und nachdem die Outboard TE Flaps UP melden

ALTERNATE FLAP ARMING SWITCH :

- armiert den Alternate Flap Control Switch
- steuert das Bypass Valve an der Flap Control Unit nach BYPASS
- schaltet die Primary Modes ab

PUSH - OFF :

- Primary Modes aktiv
- Bypass Valve in der NORMAL-Position

PUSH - ON :

- Primary Modes abgeschaltet
- Alternate Flap Control Switch für Alternate Mode aktiv
- Bypass Valve in BYPASS - Position

ALTERNATE FLAP CONTROL SWITCH :

- steuert alle Leading Edge Flaps (Group A und B zusammen)
- steuert die Electric Motore an den Leading Edge Flap Electropneumatic Drive Units an
- **RET :**
  - Ansteuerung der LE Flaps nach RETRACT
  - Fixed Position
- **OFF :**
  - Normal Position
  - Fixed Position
- **EXT :**
  - Ansteuerung der LE Flaps nach EXTEND
  - Fixed Position

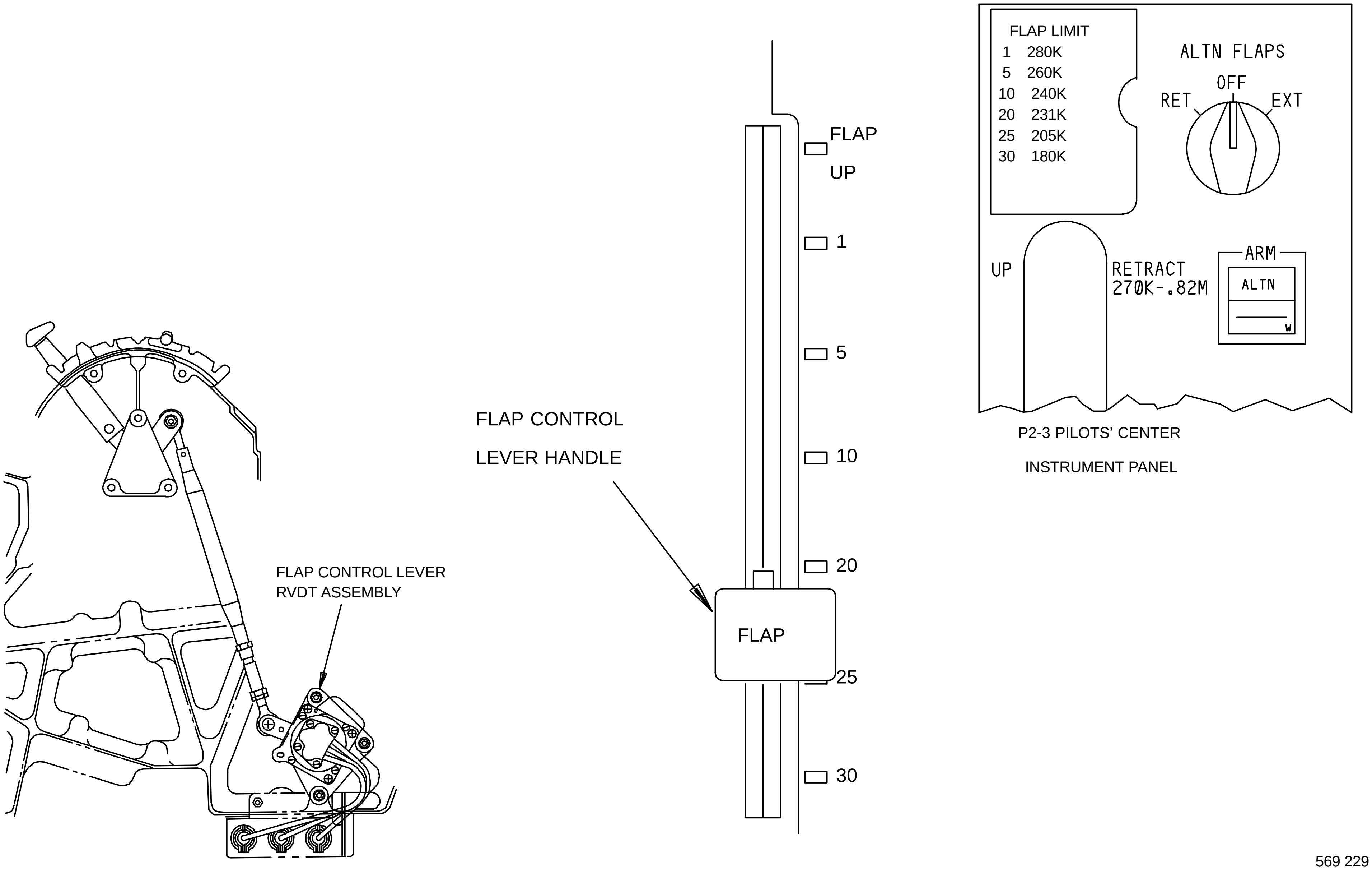


Figure 171 LIFT AUGMENTING BASIC SCHEMATIC

LIFT AUGMENTING BASIC SCHEMATIC

DESCRIPTION GENERAL

Additional lift is provided during takeoff and landing by 28 leading edge (LE) flaps operating with the trailing edge (TE) flaps. Extension of the wing flaps changes wing camber to produce the desired lift. The 11 outboard and midwing flaps in each wing are variable camber flaps with the camber being changed as the flaps are extended. The remaining three flaps in each wing are Krueger flaps. Primary pneumatic power to position all LE flaps is provided by pneumatic motors. Electric motors provide power to position LE flaps in alternate or primary electrical operations.

For normal flap extension operation, the LE flaps are controlled automatically by the flap control units (FCU's). For normal flap retraction operation, the LE flaps are controlled by the FCU's and the TE flaps positions. Primary pneumatic power for the power drive units (PDU's) is provided by pneumatic motors; primary electric and alternate power by electric motors. The LE flaps are driven by the PDU's through a torque tube system. The flaps are then positioned by rotary actuators. All LE flaps are designed as two position surfaces, either full up or full down. In the non-normal flap configurations, the LE flap indication displays the flaps in full up, full down, disagree, or in transit position for inboard, midspan, or outboard LE flaps.

The LE flaps are extended in two groups. Group A LE flaps, consisting of flaps No. 6 through 13 in the left wing and No. 14 through 21 in the right wing, will extend together when the flap control lever is moved to the 1 unit detent. The remaining LE flaps, group B, will extend when the flap control lever is moved to the 5 unit detent.

The LE flaps are sequenced to retract in two groups. Group A LE flaps will retract when the flap control lever is moved to the full UP detent and after the outboard TE flaps is fully retracted. Group B LE flaps will retract when the flap control lever is moved to the 1 unit or full UP detent and the inboard TE flaps are less than 5 units.

All LE flaps are two-position flaps, intended to be either full up or full down. Normal extension or retraction of either group of the LE flaps by pneumatic motors requires approximately 15 seconds. If the flaps fail to respond in the pneumatic mode, the affected group of flaps are automatically driven to the commanded position by electric motors. The primary electric operation requires approximately 85 seconds. During normal operation, the LE flaps Group A will be automatically retracted after landing upon application of reverse thrust and extended when the reverse thrust levers are returned to normal.

Alternate operation of the LE flaps is accomplished by an electric motor installed on each of the flap PDU's. These motors are controlled by an ALTN FLAPS ARM switch and an ALTN FLAPS EXT/RET switch located on the pilots' center panel. The ALTN FLAPS ARM switch provides power to the electric drive motors. These motors automatically drive the LE flaps to the position selected on the ALTN FLAPS EXT/RET switch. The LE flaps are extended or retracted using the same drive components as used with the pneumatic system. Alternate extension or retraction of the LE flaps requires approximately 85 seconds. The inboard TE flaps must be fully retracted for the LE flaps to retract in alternate mode.

During normal flap operation, there is no separate indication on the flight deck of the position of the LE flaps. The expanded FLAPS display appears automatically on the main EICAS for non-normal configurations such as alternate flaps, flap asymmetry, and LE or TE flaps disagreement with flap control lever position. The expanded display has 6 leading edge symbols above the TE flap position tapes which indicate status of the inboard, midspan, and outboard groups of LE flaps on each wing. The leading edge symbol for LE flaps fully retracted is a white box outline. The leading edge symbol for LE flaps in transit is a white box outline filled with white diagonal cross-hatching. The leading edge symbol for LE flaps fully extended is a solid green box. Any of the three symbols appears in amber to indicate a failure with that group of LE flaps.
For a complete description of LE flap indication refer to 27-88-00/001.

R E F E R T O D I N A 3 P A G E

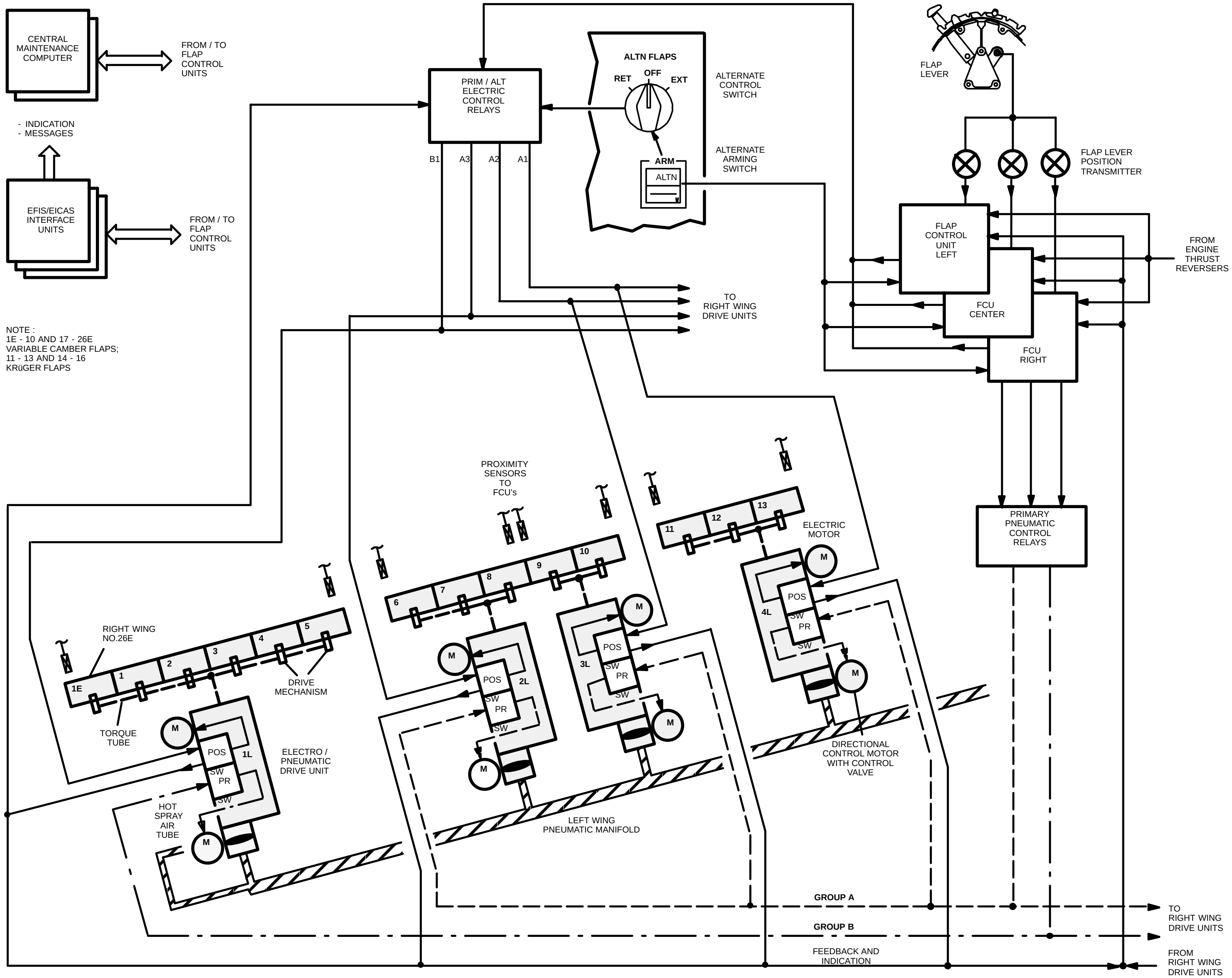


Figure 172 LIFT AUGMENTING BASIC SCHEMATIC

FUNCTION SCHEMATIC

PRIMARY CONTROL

DRIVE SEQUENCE :

- Flap Lever >Up: Group A Extend
- Flap Lever >1: Group B Extend
- Flap Lever 1 und Inboard TE Flaps <4.5: Group B Retract
- Flap Lever Up und Outboard TE Flaps Up: Group A Retract

PRIMARY PNEUMATIC :

Für Pneumatic Control wird von den FCU's über Primary Pneumatic Control Relays der Direction Control Motor angesteuert. Dieser öffnet das Control Valve und Druckluft betätigt die Drive Unit. Die Fahrzeit beträgt 10 sec.

Die Extend/Retract Position wird von den Drive Unit Position Switches zu den FCU's übertragen; zum Abschalten vom Direction Control Motor und für Indication.

Bei Betätigung des Reverser 1 und 4 **oder** 2 und 3 bekommt die LE Group A ein Retract - Signal; die LE Group A fährt wieder EXTEND, wenn die Reverser STOW melden.

PRIMARY ELECTRIC :

Erfolgt nach der Ansteuerung kein pneumatisches Fahren, so wird von den FCU's über Electric Control Relays auf Primary Electric umgeschaltet.

Time Delays:	Extend:	15 sec On Ground, 35 sec in Air;
	Retract:	15 sec On Ground, 25 sec in Air.

Die Fahrzeit beträgt ca.85 sec.

Die o. g. Umschaltung erfolgt auch, wenn im Transit bei Pneumatic Betrieb eine Power Unit durch einen Fehler stehen bleibt, z. B. wenn während Transit der Pressure Switch Overpressure (>25 psi) meldet.

Die Drive Unit Position Switches dienen über die FCU's für die Endabschaltung und für Position Indication. Das Time Delay während Primary Electric Operation beträgt für Extend und Retract 135 sec, d.h. nach dieser Zeit schalten die FCU's ab.

ALTERNATE ELECTRIC CONTROL :

- erfolgt über Arming Switch, Control Switch und Electric Control Relays. Die Endabschaltung geschieht durch die Drive Unit Limit Switches.
- Switch EXT: Group A und B fahren Extend
- Switch RET: Group A und B fahren Retract, wenn die Inboard TE Flaps Up melden.

INDICATION :

Bei fehlerfreiem pneumatischen Betrieb erfolgt keine besondere Anzeige. Bei einem Fehler bzw. Umschalten auf Primary- oder Alternate Electric erfolgt Expanded Indication.

R E F E R T O D I N A 3 P A G E

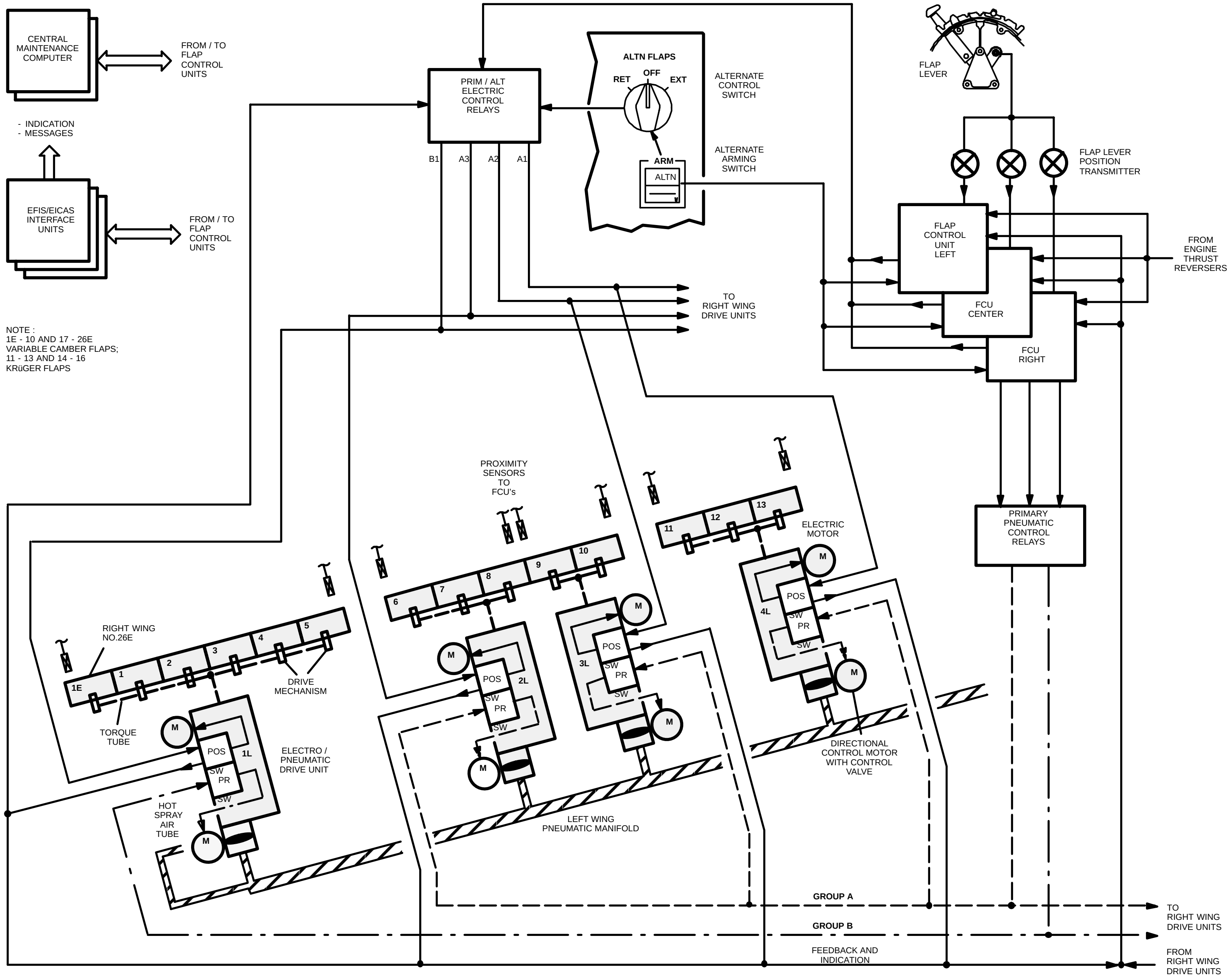


Figure 173 LIFT AUGMENTING BASIC SCHEMATIC

PRIMARY PNEUMATIC DRIVE SYSTEM

FUNCTIONAL DESCRIPTION - HIGH LIFT SYSTEM

The high lift system is normally driven by hydraulic power for the TE flaps and pneumatic power for the LE flaps. Hydraulic system 1 provides power for the inboard TE flaps, and hydraulic system 4 provides power for the outboard TE flaps.

The flaps are controlled in 4 groups: TE inboard, TE outboard, LE group A (the 8 inboard LE flaps on each wing), and LE group B (the 6 outboard LE flaps on each wing). Each group can be independently driven by electric motors if the group fails to move under hydraulic or pneumatic power.

Each flap group can operate independently in the primary hydraulic/pneumatic mode, or the primary electric mode, or together in the alternate electric mode. In either of the primary operating modes, flap movement is controlled by the FCU based on the position of the flap control lever. In alternate electric mode, flap movement is controlled from the alternate flaps control switches.

PRIMARY PNEUMATIC MODE

The flaps are normally operated in primary pneumatic mode. In this mode, the flaps are controlled from the flap control lever. Movement of the flap control lever rotates the shaft of the flap control lever RVDT assembly. The electrical output of the RVDT assembly is monitored by the FCU, which moves the flaps until flap position agrees with flap control lever position.

To move the LE flaps by pneumatic power, the FCU activates the shutoff valve and directional control motor in each LE flap power drive unit.

The flaps extend in a specific sequence as the flap control lever is moved aft from the UP detent:

- **At the 1-unit detent,** the group A LE flaps extend fully, and the TE flaps do not move. The group A LE flaps remain extended as the flap control lever is moved farther aft.
- **At the 5-unit detent,** the group B LE flaps extend fully, and the TE flaps extend to the 5-unit position. The group B LE flaps remain extended as the flap control lever is moved farther aft.
- **At the 10, 20, 25, and 30-unit detents,** the TE flaps extend to the corresponding position. The TE flaps extend fully when the flap control lever is at the 30-unit detent.

The flaps retract in a specific sequence as the flap control lever is moved forward:

- **At the 25, 20, 10, or 5-unit detent,** the TE flaps retract to the corresponding position.
- **At the 1-unit detent, the TE flaps retract fully.** The group B LE flaps retract as soon as the inboard TE flaps retract to less than 4.5 units.
- **At the UP detent,** the group A LE flaps retract as soon as **the outboard TE flaps are fully retracted.**

PRIMARY PNEUMATIC CONTROL SUMMARY :

Für Extend- bzw. Retract Control wird durch die FCU's Masse für das Extend- bzw. Retract Relay geschaltet und es erfolgt die Ansteuerung vom Primary Pneumatic Solenoid Valve und vom Direction Control Motor und der Fahrvorgang beginnt.

Bei Erreichen der jeweiligen Endstellung wird durch die Limit Switches von den FCU's das Steuerungssignal abgeschaltet.

Beträgt die Fahrzeit einer Drive Unit mehr als 15 sec, dann schalten die FCU's Pneumatic Disable, d.h. das Pneumatic Disable Relay zieht an, und dadurch wird Primary Pneumatic abgeschaltet.

Bei Reverser 1 und 4 **oder** 2 und 3 Betätigung erfolgt durch die FCU's Retract Ansteuerung <u>nur für die Group A</u>. Nach Beendigung von Reverse erfolgt bei vorhandenem Ansteuerungssignal wieder Extend.

REFER TO DIN A3 PAGE

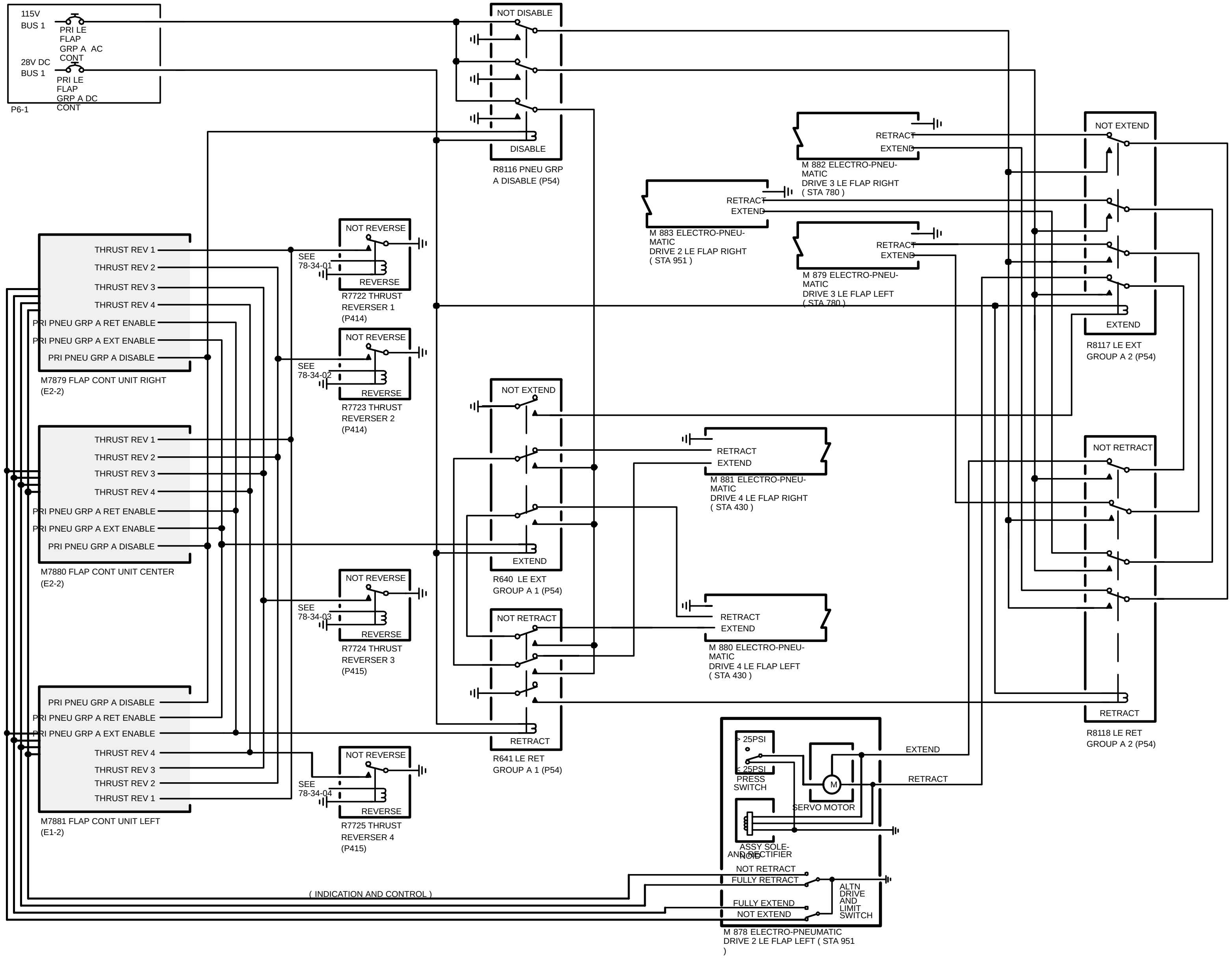


Figure 174 PRIMARY PNEUMATIC DRIVE SYSTEM (GROUP A) - SIMPLIFIED SCHEMATIC

PRIMARY / ALTERNATE ELECTRIC DRIVE SYSTEM

PRIMARY ELECTRIC MODE

If a group of flaps does not move within a certain amount of time after the flap control lever is moved, the FCU sets a disagree. The FCU then switches that flap group to primary electric mode and activates the flap drive electric motors.

In primary electric mode, the flaps respond to the flap control lever in the same sequence as they do for primary pneumatic mode. Flap movement is much slower under electric power than under pneumatic power. A LE flap group (group A or B) in primary electric mode will return to primary pneumatic mode as soon as the flap group reaches the commanded position.

If the FCU sets a disagree while a flap group is in primary electric mode, the FCU will continue to energize the electric motors, even though there may be no flap movement.

The times delays for the FCU to set a disagree are:

1)	LE Pneumatic	- Extend :	35 sec in air, 15 sec on ground
		- Retract :	25 sec in air, 15 sec on ground
2)	LE Electric	- Extend:	135 sec, or 5 sec to leave retracted position on ground
		- Retract:	135 sec

ALTERNATE ELECTRIC MODE

In alternate electric mode, the flap drive electric motors are under manual control independent of the FCU's. The flaps are controlled from two switches on the pilots' center instrument panel. The ALTN FLAPS ARM switch is pressed to enable the alternate system.

The ALTN FLAPS EXT/RET switch is placed in the EXT or RET position to activate the relays which power the electric motors. The relays are deactivated when the limit switches in the LE power drive units open at flaps fully extended or retracted. The flaps may be stopped at any intermediate position by placing the ALTN FLAPS EXT/RET switch to OFF.

FLAP UNCOMMANDED MOTION / MOVING AWAY / ASYMMETRY

If a flap group moves when not commanded, or moves in the opposite direction of that commanded (flaps moving away), the FCU sets an uncommanded motion. If the uncommanded motion is set when the group is in primary pneumatic mode, the FCU switches that group to primary electric mode. If the uncommanded motion is set while the flap group is in primary electric mode, the FCU will shut down that group. The group will remain shut down until power to the FCU's is cycled off and on following the flight.

The times delays for the FCU to set an uncommanded motion are:

1) LE Pneumatic: 0.3 sec
2) LE Electric:3.0 sec

PRIMARY ELECTRIC CONTROL SUMMARY :

Bei Primary Pneumatic Fail wird durch die FCU's Primary Pneumatic Disable geschaltet und das L. E. Flap Protection Relay zieht an. Dadurch sind die Prim./Alt. Electric Solenoid Valves und das Retract/Extend Relay stromversorgt.

Die FCU's schalten nun Primary Electric Retract bzw. Extend, das Retract- bzw. Extend Relay zieht an und über die Drive Relays erfolgt die Ansteuerung des Electric Motors, die Electric Motor Brake wird gelöst und die Drive Unit betätigt die Leading Edge Devices.

Bei Erreichen der Endposition wird durch die Limit Switches über die FCU's abgeschaltet.

ALTERNATE ELECTRIC CONTROL SUMMARY :

Durch Betätigen vom Arming Switch zieht das Alt. Flap Relay an, der Control Switch ist armiert, die FCU's schalten Primary Inhibit und Pneumatic Disable und das L. E. Flap Protection Relay zieht an. Dadurch sind die Prim./Alt. Electric Solenoid Valves und das Retract/Extend Relay stromversorgt.

Durch Betätigen vom Control Switch zieht das Retract- bzw. Extend Relay an und über die Drive Relays erfolgt die Ansteuerung des Electric Motors, die Electric Motor Brake wird gelöst, und die Drive Unit betätigt die Leading Edge Devices.

Bei Erreichen der Endposition wird durch die Limit Switches über die Drive Relays abgeschaltet.

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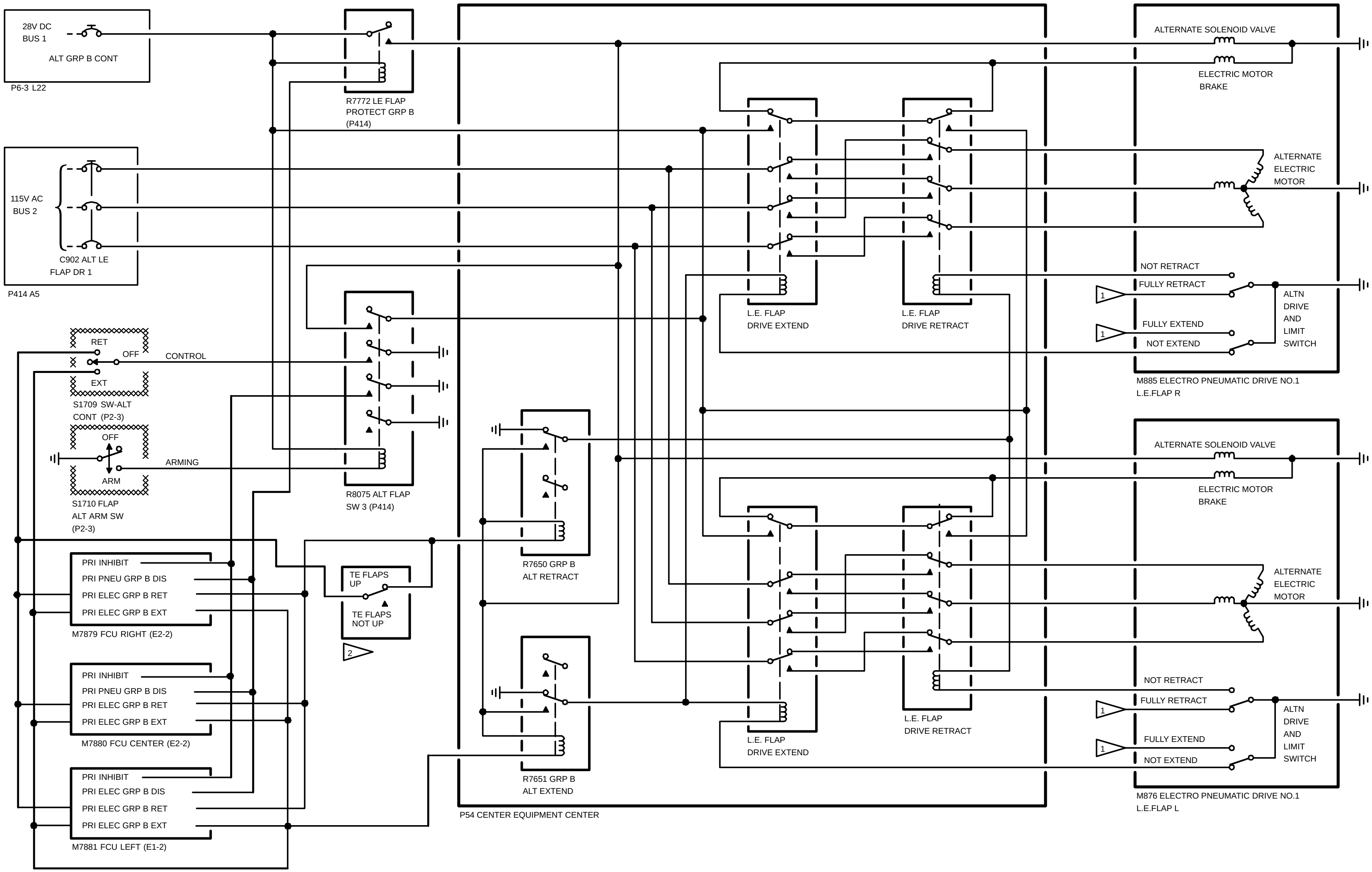


NOTE: DRIVE CIRCUIT NO.1 SHOWN, DRIVE CIRCUITS 2,3 AND 4 ARE SIMILAR

1 TO EICAS (27-88-00)

2 ALTERNATE LE FLAP RETRACT INTERLOCK RELEAY (SEE TE FLAPS CONTROL)

Figure 175 PRIMARY / ALTERNATE ELECTRIC DRIVE SYSTEM - SIMPLIFIED SCHEMATIC

KRÜGER FLAPS OVERVIEW

DESCRIPTION

Each of the three Krueger flaps installed in each wing is of fiberglass construction. Each has an attached folding nose which increases the effective area when the flap is extended and which folds above the flap when the flap is retracted to the faired position. The nose is hinged to the flap and positioned by links. The flap is supported by two hinges which attach to fittings in the fixed wing leading edge. The hinges also attach to rotary actuators which position the flap. Bulb seals are provided at the forward and lateral edges to eliminate gaps between flaps and between the flap and wing structure.

KRüGER FLAPS SUMMARY :

- Drive Unit
  - treibt über Drive Shaft und Offset Gear Box die Torque Tube
- Offset Gear Box
  - untersetzt Drive Shaft Drehzahl
  - Grease Lubricated
- Rotary Actuator
  - betätigt Drive Arm
- Drive Arm
  - betätigt über Actuator Link das Krueger Flap
- Extend Stop
  - ist nicht auf Anschlag
- Retract Stop
  - Adjustable
  - Bolt ist bei Retract nicht auf Anschlag
  - Indicator Pin

    dient zum Überprüfen vom Maß ”X”

    ist im Stop Bolt geführt.

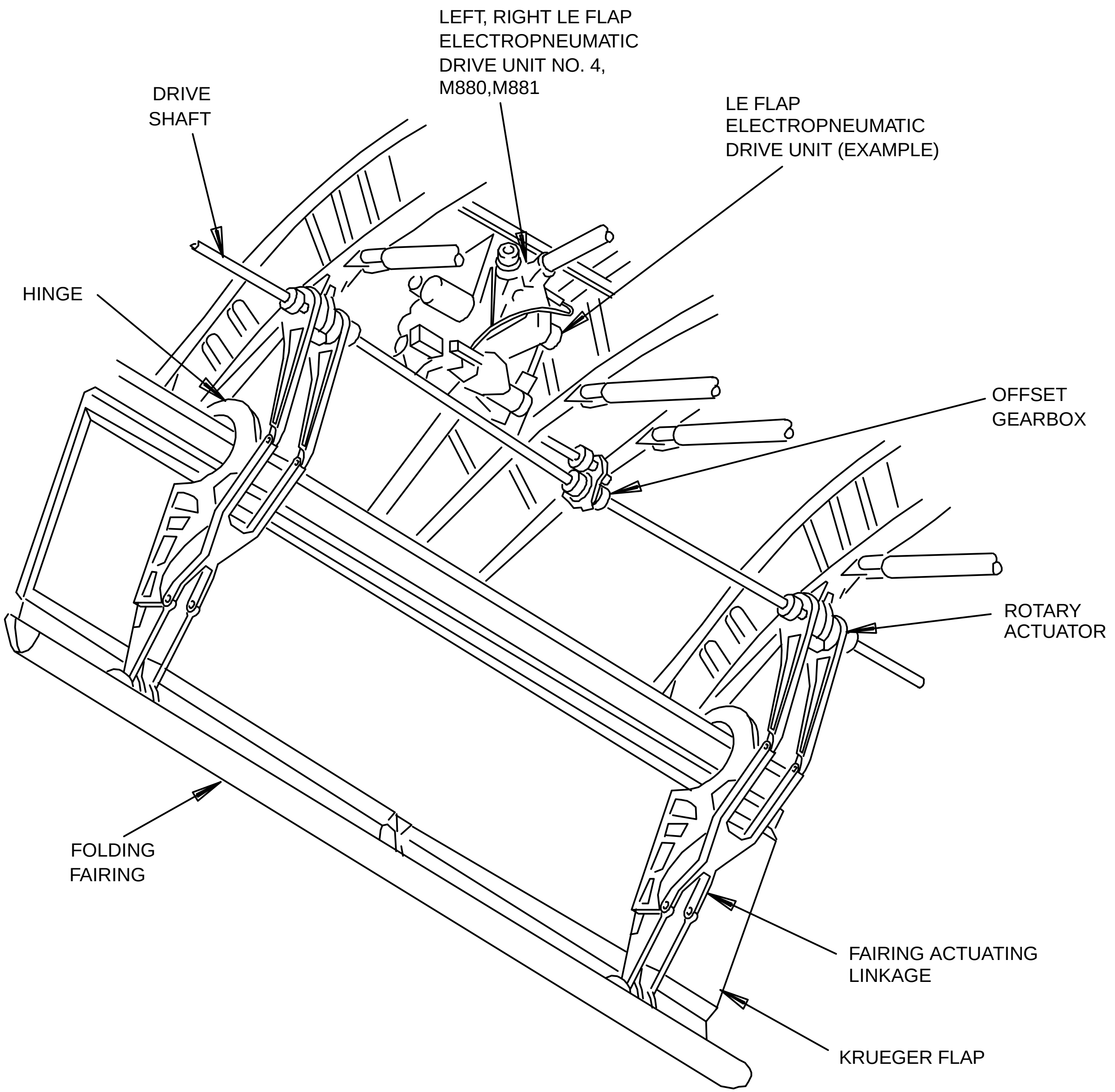


Figure 176 KRüGER FLAPS OVERVIEW

OFFSET GEAR GEAR

DESCRITION

An offset gearbox is located adjacent to each Krueger flap PDU. The gearboxes reduce the motion from the PDU's and transfer the motion to the rotary actuators. Each gearbox has a single stage gear reduction of 3.5 to 1. The input and output shafts are offset.

SUMMARY :

- Untersetzungsgetriebe : 3.5 zu 1
- untersetzt die Drehzahl von der Drive Unit zu dem Rotary Actuator
- Grease Lubricated

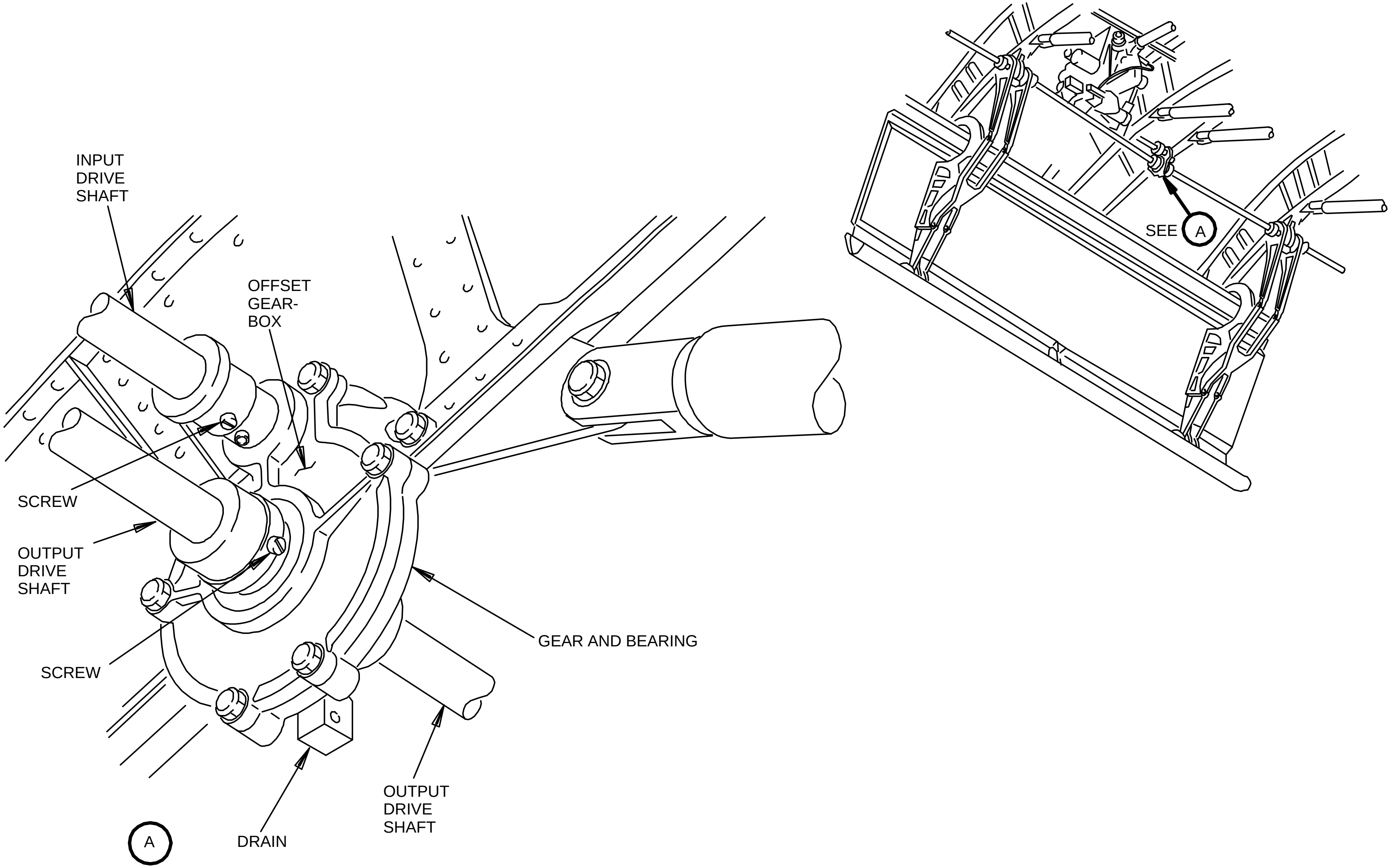


Figure 177 OFFSET GEAR BOX

KRÜGER FLAPS ADJUSTMENT AND RIGGING

SUMMARY :

- RETRACT STOP :
  - Adjustable mit washer
  - Bolt liegt bei Fully Retract NICHT an der Structure an
  - der Indicator Pin dient zum Überprüfen des Abstandsmaßes : 0.04 - 0.10 inch
  - ist im Retract Stop Bolt geführt

- EXTEND STOP :
  - Non Adjustable

    (indirekt durch die Umdrehungszahl der Drive Unit: 88.7)
  - der Drive Arm und die Actuator Link dürfen bei Fully Extend nicht auf Anschlag sein (Drive Unit schaltet vorher ab)

DRIVE REPLACEMENT AND RIGGING INSTRUCTIONS (DRIVE UNIT NO. 4)

REPLACEMENT

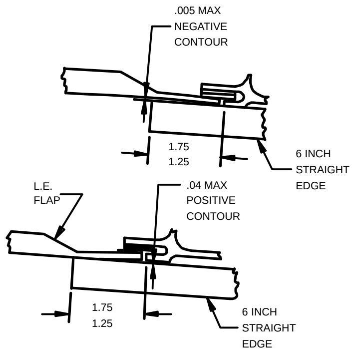
1. INSTALL DRIVE UNIT ADJUSTED TO 88.7 REVOLUTIONS AND SECURE ALL PNEUMATIC AND ELECTRICAL CONNECTORS. DO NOT CONNECT DRIVE SHAFT.

RIGGING

1. CYCLE DRIVE UNIT WITH PRIMARY PNEUMATIC POWER FOR ONE RETRACT AND ONE EXTEND CYCLE. END CYCLE AT THE PNEUMATIC EXTEND POSITION.
   NOTE! IF RETRACT STOP BOLTS ON ROTARY ACTUATORS ARE FITTED WITH INDICATOR PINS, SET PINS TO ZERO PROTRUSION 'X' (FIG. 1).
2. EXTEND FLAPS BY HAND UNTIL EXTEND STOPS ARE IN CONTACT. ROTATE OFFSET GEARBOX INPUT SHAFT 3 TURNS IN RETRACT DIRECTION AND CONNECT TO PNEUMATIC DRIVE UNIT.
3. RETRACT FLAPS USING PRIMARY PNEUMATIC POWER. THE LOWER SURFACE OF FLAP 12 OR 15 ONLY, MUST BE WITHIN WING CONTOUR, MEASURED IN LINE WITH ACTUATING LINKAGES AS SHOWN BELOW.
4. IF PROFILE REQUIRES ADJUSTMENT, PROCEED AS FOLLOWS:
   (a) EXTEND FLAPS USING PRIMARY PNEUMATIC POWER.
   (b) DISCONNECT DRIVE SHAFT AT DRIVE UNIT AND ROTATE IN DIRECTION REQUIRED FOR CORRECTION.
   (c) ONE SPLINE TOOTH = .015 APPROX TRAVEL AT AFT EDGE OF FLAPS.
5. SET PROTRUSION 'X' (FIG, 1) OF INDICATOR PINS 15-20.
   (a) RETRACT FLAPS USING PRIMARY PNEUMATIC POWER.
   (b) EXTEND FLAPS USING PRIMARY PNEUMATIC POWER.
   (c) CHECK PROTRUSION 'X' (FIG. 1) TO VERIFY THAT STOP GAPS (FIG. 2) MEASURE .04-.10 INCH.
   NOTE! IF RETRACT STOP BOLTS ON ROTARY ACTUATORS ARE NOT SUPPLIED WITH INDICATOR PINS, PUTTY MAY BE USED TO CHECK STOP GAPS.
6. RELOCATE WASHERS ON BOLTS (FIG. 1) IF REQUIRED TO OBTAIN STOP GAP (5C). REPEAT STEP (5) TO VERIFY ADJUSTMENT. LOCKWIRE COUPLING.
7. RESET ALL INDICATOR PINS TO ZERO PROTRUSION 'X' (FIG. 1).
8. PREFORM FUNCTIONAL TEST PER MAINTENANCE MANUAL-SECTION 27-81-03

CAUTION

DO NOT USE ALTERNATE ELECTRICAL POWER UNTIL RIGGING IS COMPLETE.



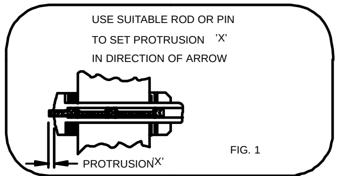


FIG. 1

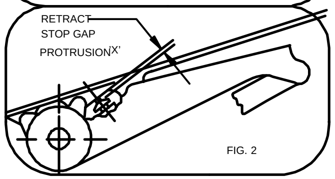


FIG. 2

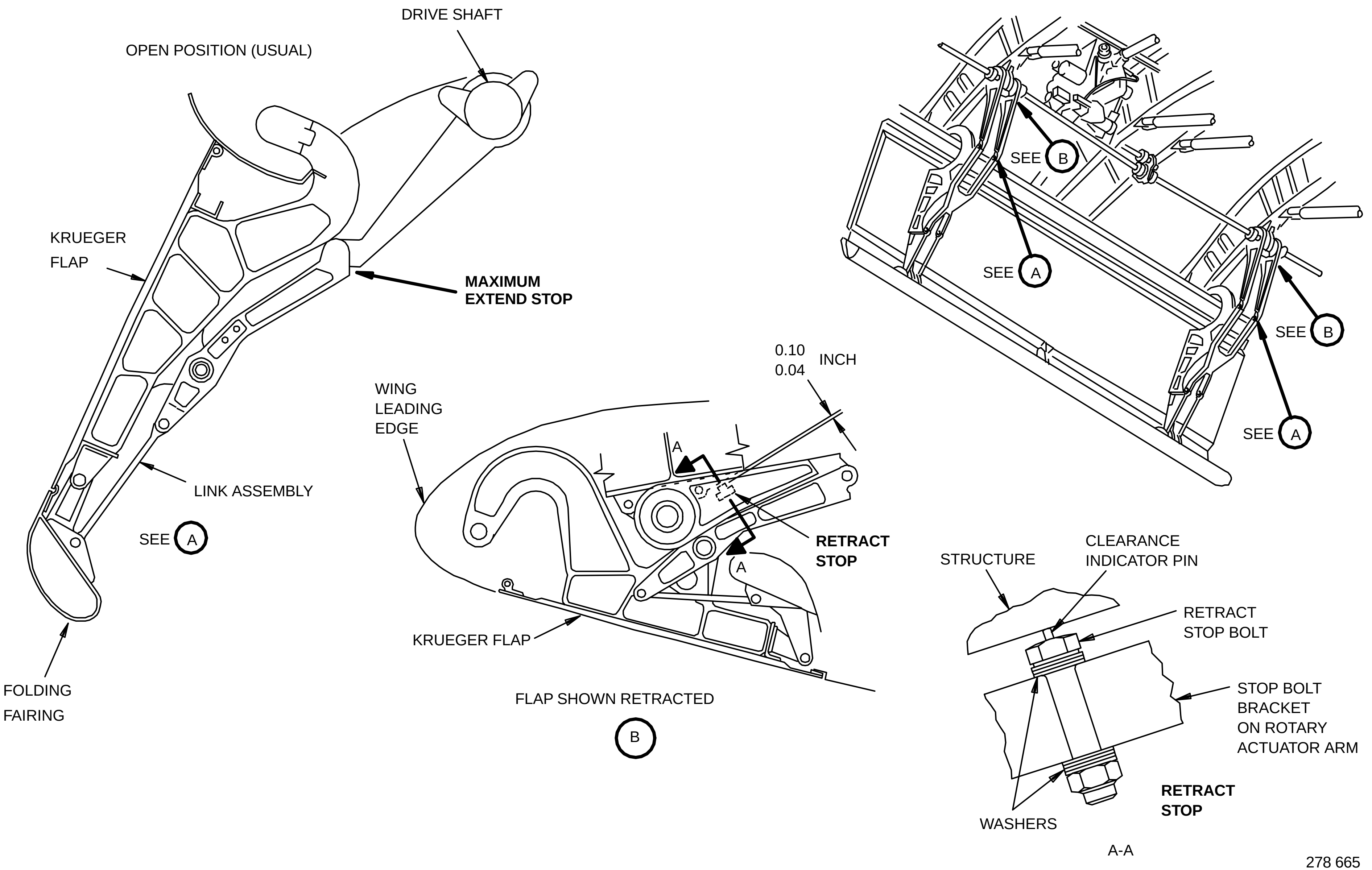


Figure 178 KRüGER FLAPS ADJUSTMENT AND RIGGING

VARIABLE CAMBER FLAPS OVERVIEW

DESCRIPTION

The 11 variable camber flaps in each wing provide more efficient lift characteristics by being warped to contour as they are extended prior to takeoff and landing. The flexible surfaces are made of fiberglass. The area of each flap is increased by a folding nose which is positioned at the flap aerodynamic leading edge as the flap is extended. This folding nose is rotated and positioned above the flap when the flap is retracted to the faired position. Each flap is supported by two flap linkages which extend and contour the flap and extend the folding nose. Each linkage attaches to the flap at three points and to the folding nose at one point. One support point also serves as the hinge point for the folding nose. The edges of the fiberglass panels are protected by a cap bonded to the surface. Adjustable seals are installed on the sides and aft edges of each flap panel for aerodynamic sealing. Mating seals are installed on wing structure except aft of flap panels 5, 7, 20 and 22. These seals are omitted for venting of the flap cavity.

VARIABLE CAMBER FLAP SUMMARY :

- Drive Unit
  - gibt Drehbewegung über Torque Tubes auf die Rotary Actuators
- Rotary Actuator
  - Input Shaft ist mit Torque Tube verbunden
  - untersetzt Torque Tube Drehzahl
  - Housing ist an Wing Stucture angelenkt
  - Output Shaft ist mit Drive Arm verbunden
  - Grease Lubricated
- Drive Arm
  - betätigt über Links das Flap
- Extend Stop
  - ist nicht auf Anschlag
- Retract Stop
  - ist auf Anschlag und justierbar

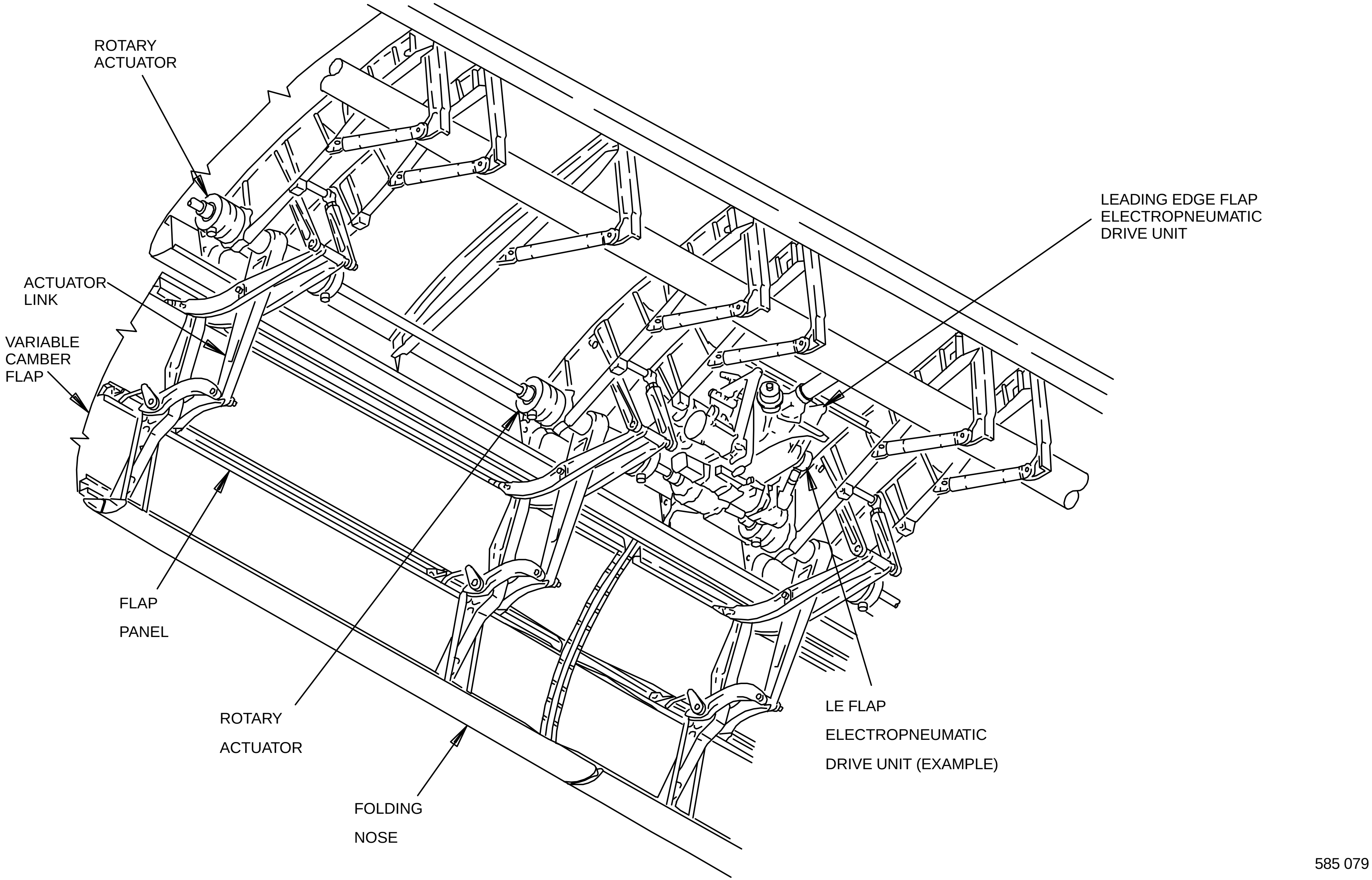


Figure 179 VARIABLE CAMBER FLAPS OVERVIEW

ROTARY ACTUATOR

DESCRIPTION

VARIABLE CAMBER FLPAS ROTARY ACTUATORS

Each rotary actuator is a gearbox which reduces the motion from the LE flap PDU's. The actuators which position outboard flaps No. 1E through 5 and 22 through 26E have a gear ratio of approximately 239 to 1.
The actuators which position the center flaps, No. 6 through 10 and 17 through 21, have a gear ratio of approximately 250 to 1. Different spacing in mounting bolt holes prevent interchanging the two configurations.

SUMMARY :

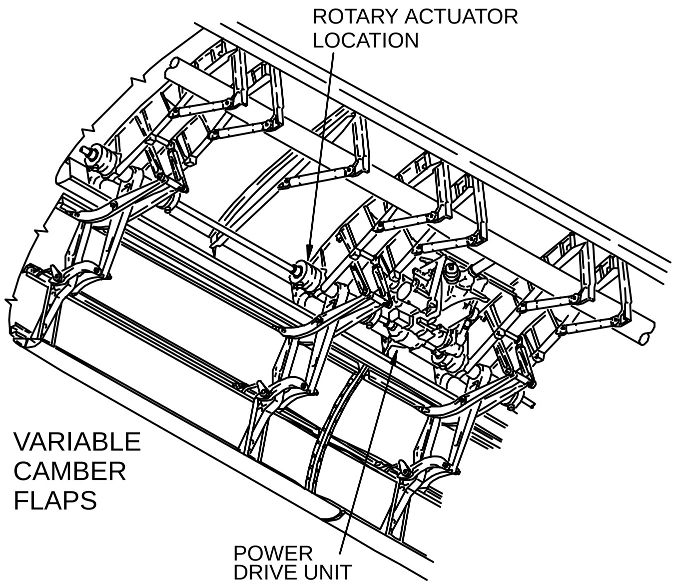
- ein Untersetzungsgetriebe
- LE Flap 1E bis 5 und 22 bis 26E : 239 zu 1
- LE Flap 6 bis 10 und 17 bis 21 : 250 zu 1
- untersetzt die Drehzahl von der Drive Unit zum Actuator

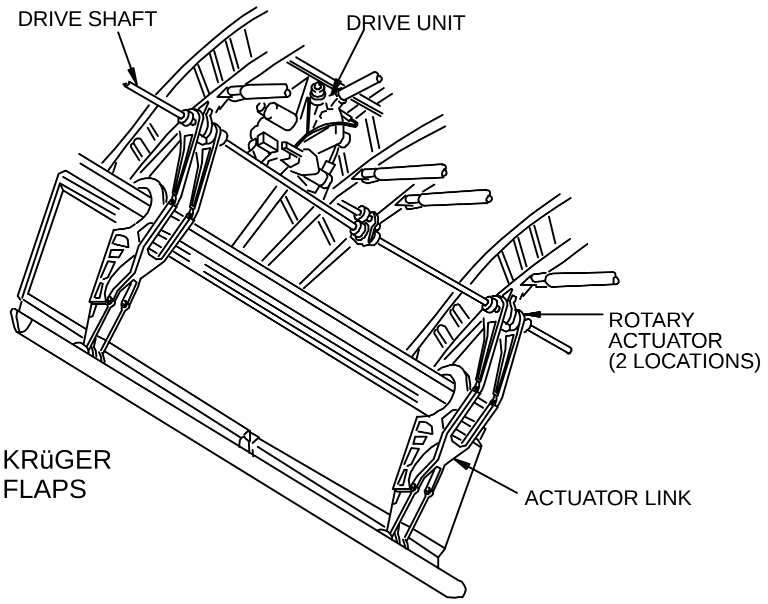
KRüGER FLAPS ROTARY ACTUATORS

Each Krueger flap is actuated by two rotary actuators which reduces drive shaft motion. Each actuator has a gear reduction of 60 to 1. The gears are enclosed in a housing that attaches to fixed wing structure. The input shaft extends through the actuator and is splined at both ends.

SUMMARY :

- ein Untersetzungsgetriebe
- Untersetzungsverhältnis: 60 zu 1
- untersetzt die Drehzahl von der Drive Unit zum Actuator Link





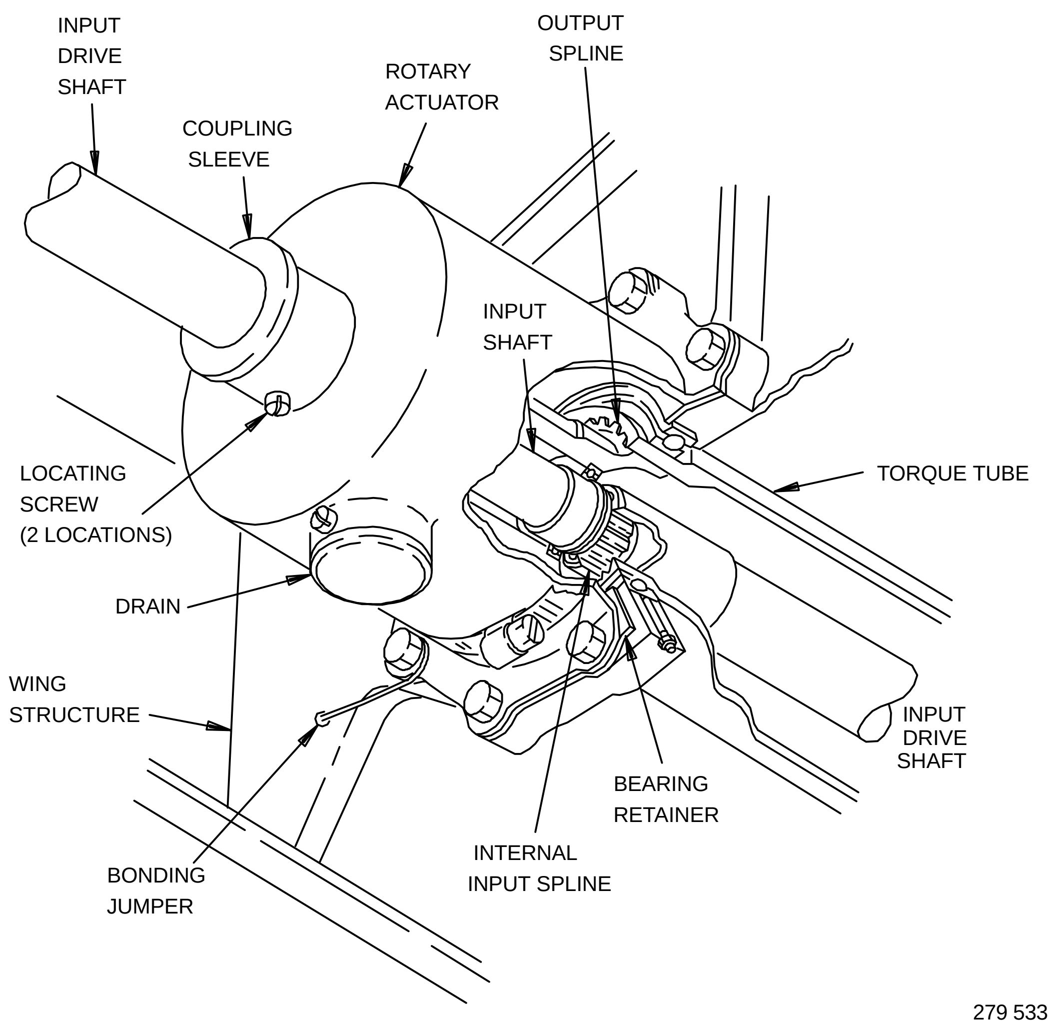


Figure 180 ROTARY ACTUATOR

VARIABLE CHAMBER FLAP ADJUSTMENT AND RIGGING

SUMMARY :

- RETRACT STOP :
  - Adjustable with Screw
  - Screw liegt bei Fully Retract an der Structure an
  - Adjustable Screw kann über die herausgeschraubte Stop Access Screw justiert werden, z.B. nach einem Panelwechsel
  - Adjustment siehe MM 27-80

- EXTEND STOP :
  - Non adjustable

    (indirekt durch die Umdrehungszahl der Drive Unit: 88.7)
  - der Drive Arm darf bei Fully Extend nicht auf den Structure Anschlag sein.

DRIVE UNIT REPLACEMENT AND RIGGING INSTRUCTIONS
(DRIVE UNIT NO. 1)

REPLACEMENT:

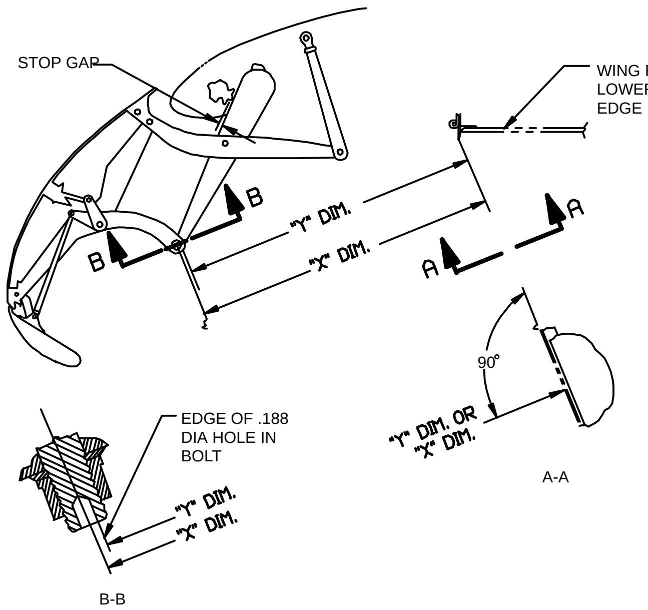
1. INSTALL DRIVE UNIT ADJUSTED TO 88.7 REVOLUTIONS AND SECURE ALL PNEUMATIC AND ELECTRICAL CONNECTORS. DO NOT CONNECT DRIVE SHAFTS

RIGGING:

1. CYCLE DRIVE UNIT WITH PRIMARY PNEUMATIC POWER FOR ONE RETRACT AND ONE EXTEND CYCLE. END CYCLE AT THE PNEUMATIC EXTEND POSITION.
2. SET THE LINKAGE ADJUSTMENT TO EACH SIDE OF THE DRIVE TO EXTENDED RIGGED POSITION AS FOLLOWS:
   A. IF TOOL (TE65B00114) IS AVAILABLE, SET "X" DIM. PER INSTRUCTIONS IN MAINTENANCE MANUAL
   B. IF TOOL (TE65B00114) IS NOT AVAILABLE, SET "Y" DIM. AS SHOWN TO 30.79 $\pm .03$
3. MAINTAIN FLAP RIGGED POSITION, CONNECT DRIVE SHAFTS TO DRIVE UNIT AND LOCKWIRE.
4. PREFORM FUNCTIONAL CHECKOUT PER MAINTENANCE MANUAL, SECTION 27-81-03.
5. WITH FLAPS IN PNEUMATIC EXTENDED POSITION, THE STOP GAP SHALL BE .04 -.12

CAUTION:

DO NOT USE ALTERNATE ELECTRIC POWER UNTIL RIGGING IS COMPLETE.



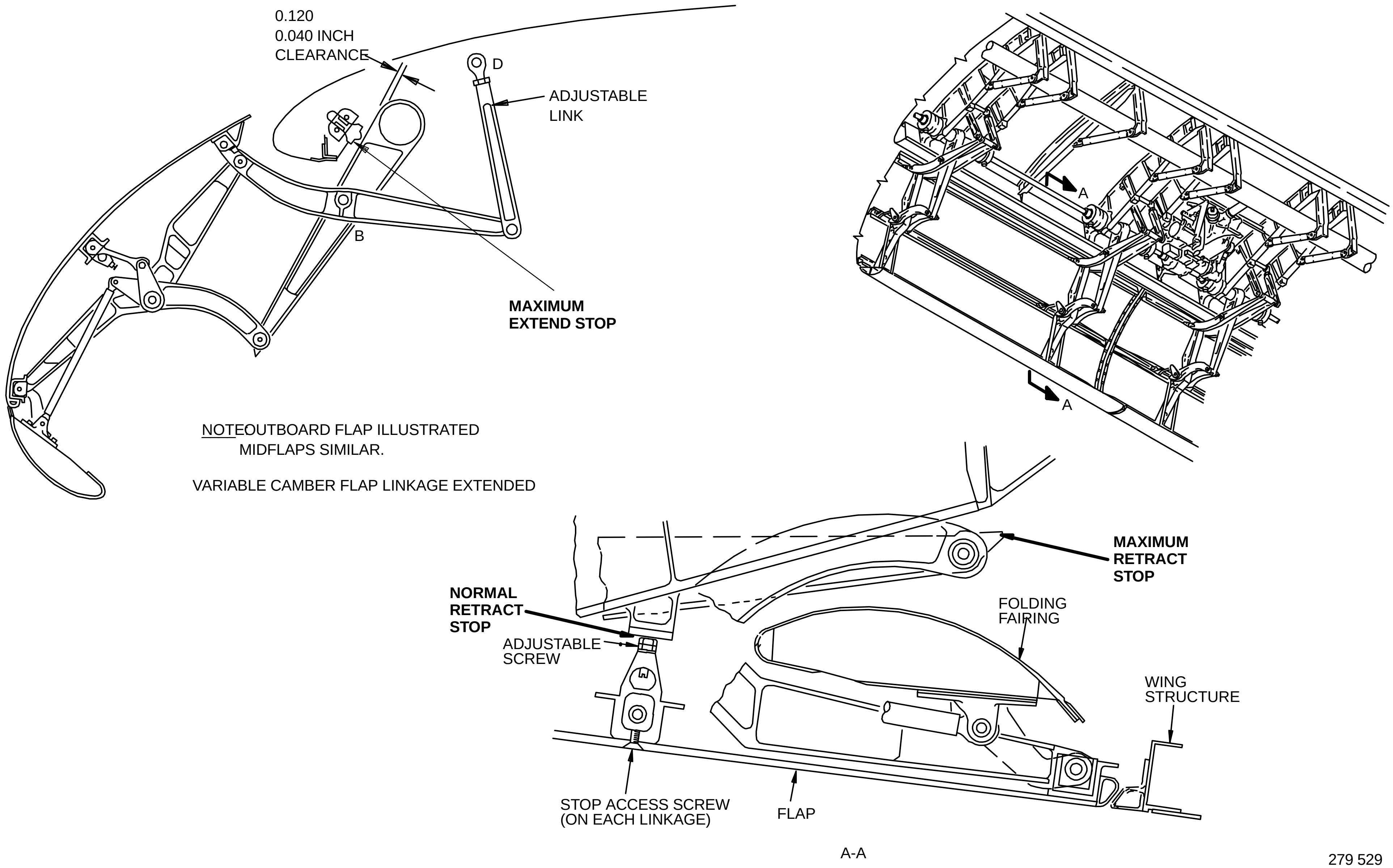


Figure 181 VARIABLE CAMBER FLAP ADJUSTEMT AND RIGGING

LEADING EDGE FLAP ELECTROPNEUMATIC DRIVE UNIT

DESCRIPTION

The four power drive units (PDU's) in each wing provide the power necessary to drive the LE flaps. Primary pneumatic power is provided by the airplane pneumatic system, controlled by inputs from the flap control lever. Primary electric power is provided by 3-phase, 400-Hz, 115-volt electric motors, controlled automatically by the FCU's. Alternate power is provided by same electric motors, controlled manually by switches in the flight compartment.

Each PDU contains two functionally independent power sources geared to a common output shaft through a planetary gear system. The primary pneumatic drive is directly connected to the sun gear and the alternate electric drive is geared to the annular gear of the planetary system. The gears run in an oil bath. Oil level sight glasses on each side of the gear housing provide visible indication of oil level in either the variable camber or the Krueger flap installation.

When installed in the airplane with the flaps extended, the exposed lower side of the PDU provides ready access to electrical power plugs, solenoid valves, the alternate electric motor assembly, primary servomotor and oil drain and filler plugs.

SUMMARY :

- PRESSURE REGULATOR VALVE :
  - regelt den Pneumatic Pressure auf 19 - 21 psi
- OVERPRESSURE SWITCH :
  - schaltet bei > 25psi den Directional Control Motor ab
- DIRECTIONAL CONTROL MOTOR :
  - öffnet das Control Valve
- CONTROL VALVE
  - stellt die Pneumatic dem Air Motor zum Antrieb zur Verfügung
- PRIMARY PNEUMATIC SOLENOID VALVE :
  - öffnet bei Pneumatic Betrieb
  - ist in Reihe (pneumatisch) mit dem Primary Pneumatic Solenoid Valve geschaltet (eines zu, das andere auf)
  - sperrt die Pneumatic bei der Electric Mode ab
- LIMIT SWITCHES :
  - dienen der Indication und Endabschaltung

FAILURE INDICATION OF THE LE FLAP DRIVE UNIT :

For example :

Whenever a fault is detected at the leading edge flap drive unit on the EICAS display following is indicated :

the caution message :

FLAP DRIVE

and

the status message :

LE SINGLE DRIVE

or

the status message :

LE MULT DRIVE

and on the MCDU is shown the reason for the EICAS message :

CMC message :

LE R1 DRIVE FAIL 27 695.

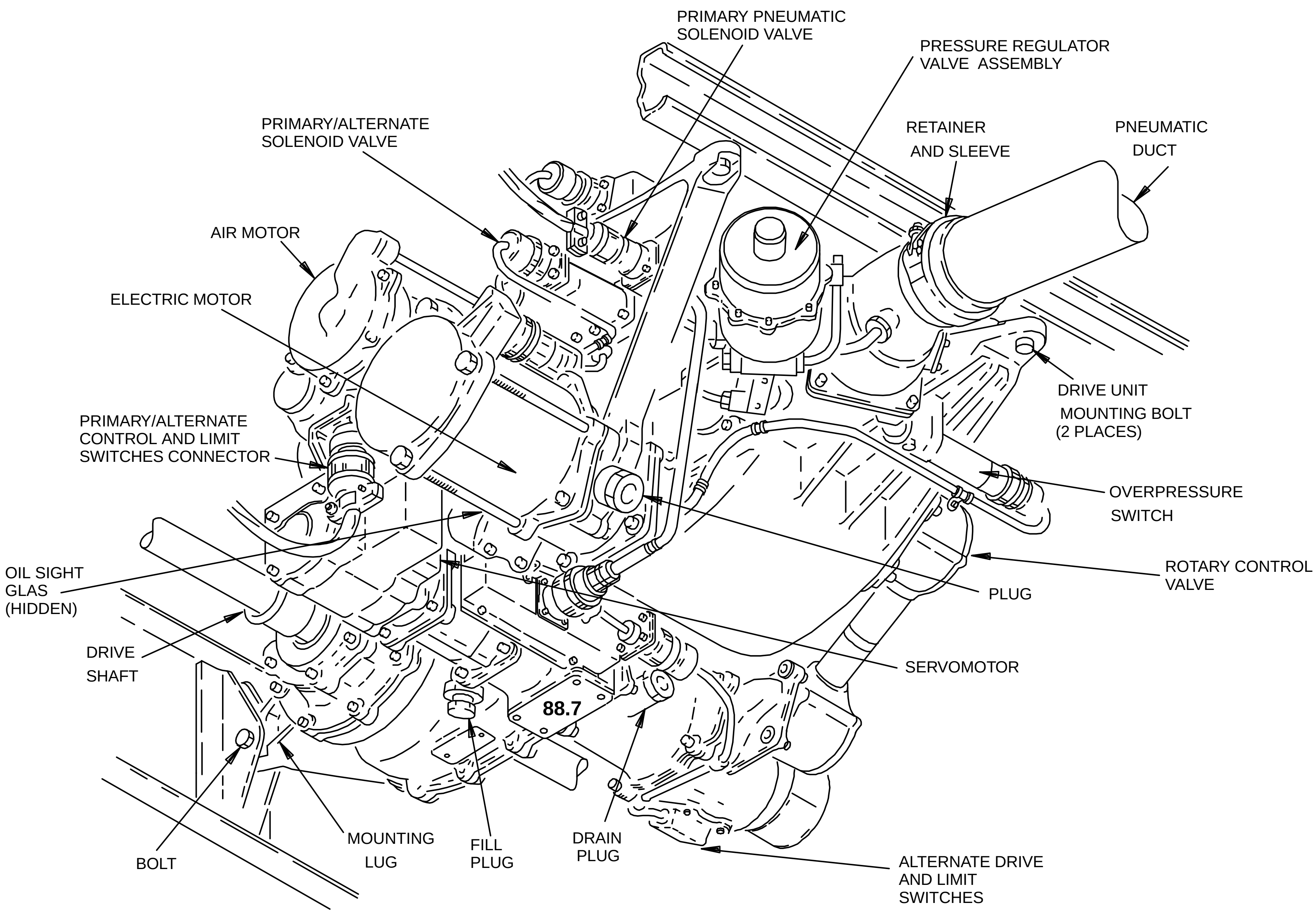


Figure 182 LEADING EDGE FLAP ELECTROPNEUMATIC DRIVE UNIT

EXTENDED LEADING EDGE FLAPS DEACTIVATION AND SAFETY LOCKS INSTALLATION

SPECIAL TOOLS AND EQUIPMENT

(1) 17MIT65B04017 Leading Edge Flap Drive Unit Lock (Receptacle and Plug Cap)

REFERENCES

(1) 36-00-00/201, Pneumatic System

(2) SSM 27-81-01, 27-81-02, 27-81-03, 27-81-04, 27-81-05, 27-81-06

(3) WDM 27-81-11, 27-81-12, 27-81-21, 27-81-22, 27-81-31, 27-81-32, 27-81-41, 27-81-42, 27-81-81, 27-81-82

ACCESS

(1) Location Zone

222Control Cabin, RH

117Electrical and Electronics Compartment - P414 Left Power Distribution Center

118Electrical and Electronics Compartment - P415 Right Power Distribution Center

512Krueger Flap Inboard, LH

523Variable Camber Flap, LH

525Variable Camber Flap, LH

535Variable Camber Flap, LH

612Krueger Flap Inboard, RH

623Variable Camber Flap, RH

625Variable Camber Flap, RH

635Variable Camber Flap, RH

PROCEDURE

(1) Do this task: ”Pneumatic Power Removal” (Ref 36-00-00/201).

(2) Open these circuit breakers and attach DO-NOT-CLOSE tags:

(a) P6 Main Power Distribution Panel

1) 6E3PRI LE FLAP CONT GRP A AC

2) 6E4PRI LE FLAP CONT GRP A DC

3) 6E5PRI LE FLAP CONT GRP B AC

4) 6E6PRI LE FLAP CONT GRP B DC

5) 6L21 LE FLAP ELEC CONT GRP B DRIVE 1

6) 6L22 LE FLAP ELEC CONT GRP A DRIVE 2

7) 6L23 LE FLAP ELEC CONT GRP A DRIVE 3

8) 6L24 LE FLAP ELEC CONT GRP A DRIVE 4

(b) P414 Left Power Distribution Center

1) 414A5 LE FLAP ELEC DRIVE 1

2) 414A2 LE FLAP ELEC DRIVE 4

(c) P415 Right Power Distribution Center

1) 415M35 LE FLAP ELEC DRIVE 2

2) 415B32 LE FLAP ELEC DRIVE 3

(3) Disconnect the electrical connectors from the primary and alternate power receptacles on the drive units.

(4) Install the safety lock (receptacle and plug caps) on the disconnected electrical receptacles and plugs.

(5) Attach an applicable warning streamer to all the disconnected electrical connectors if the safety lock is not available.

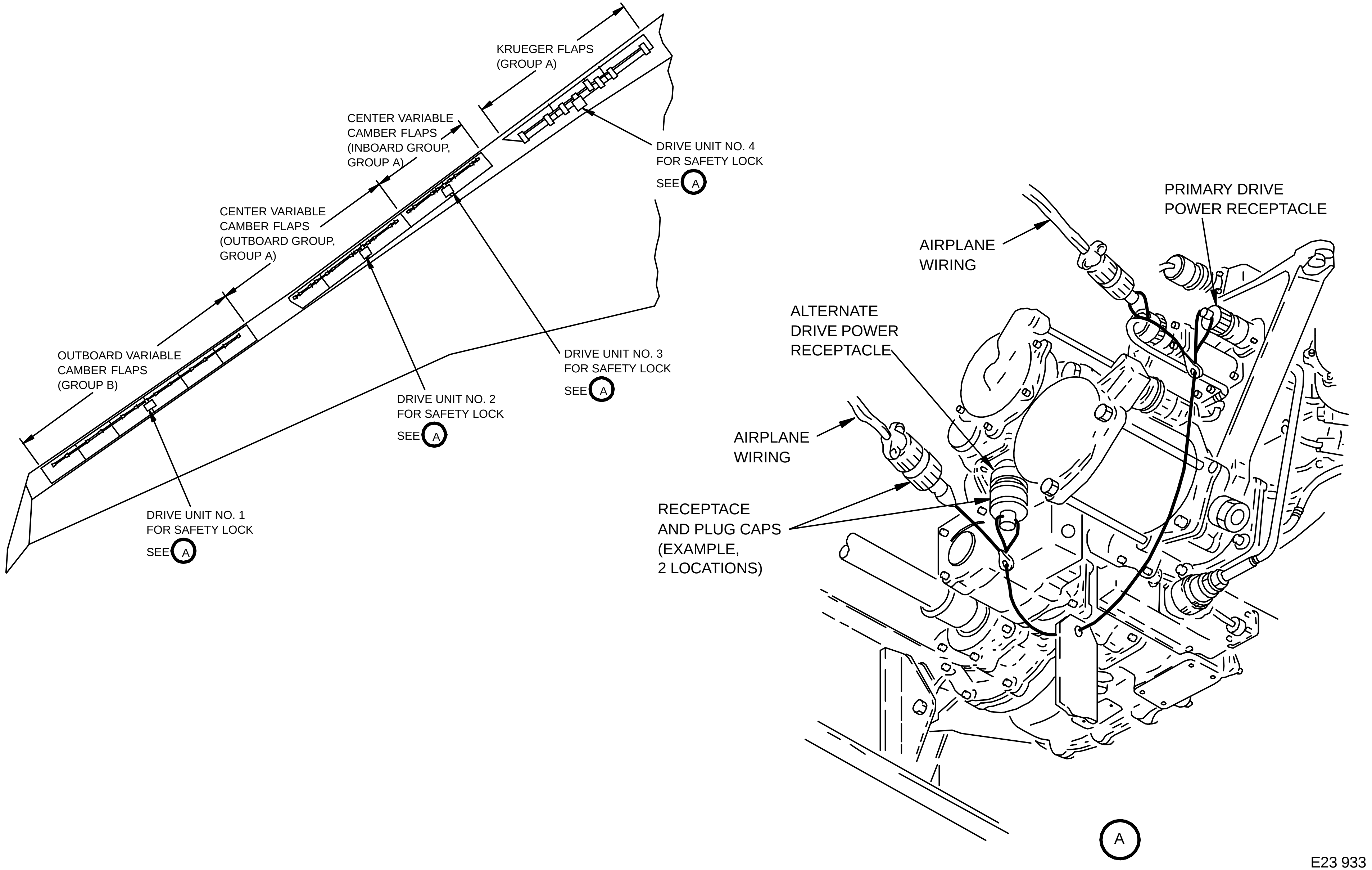


Figure 183 LEADING EDGE FLAP SAFETY LOCK INSTALLATION

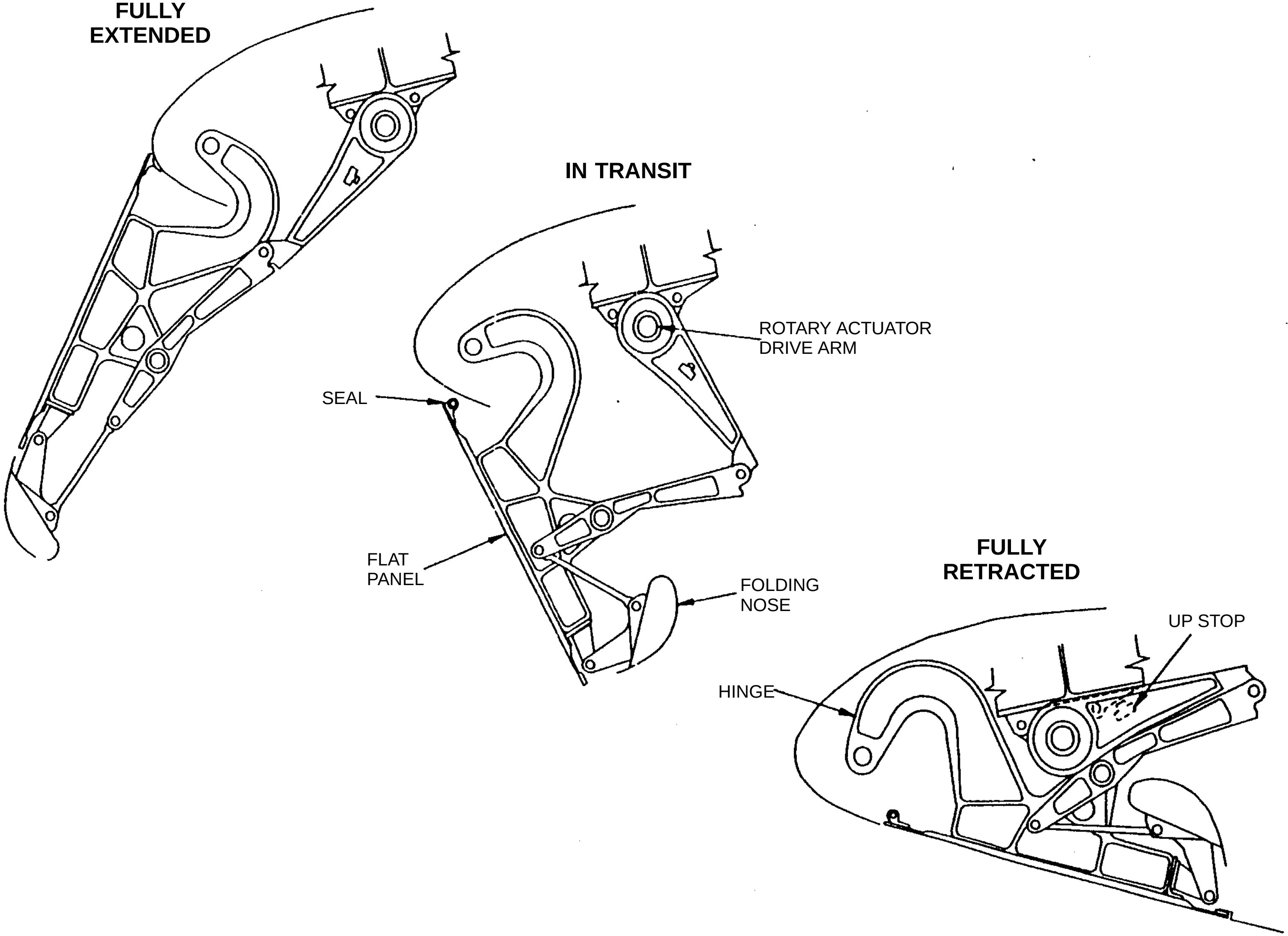


Figure 184 KRüGER FLAPS

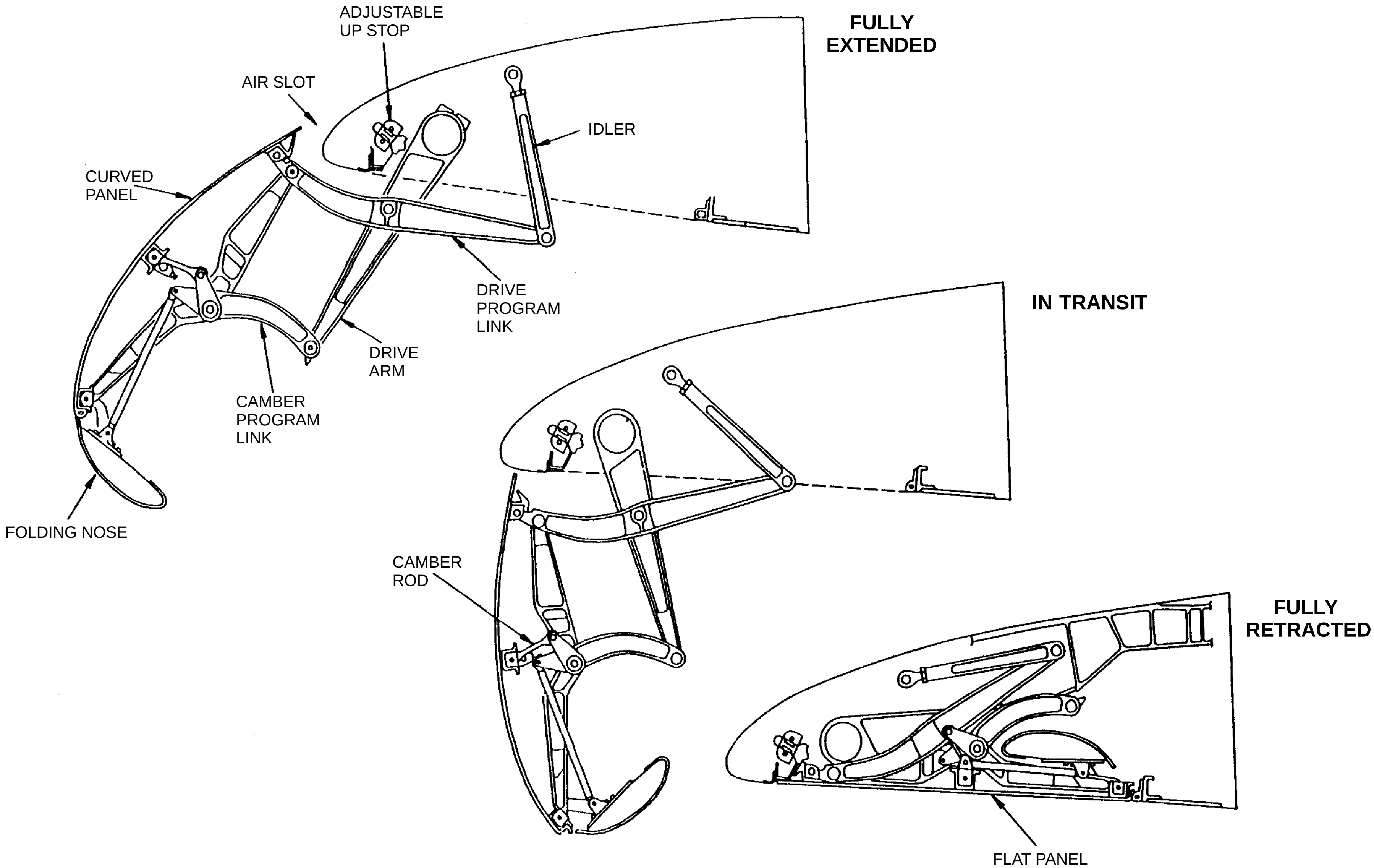


Figure 185 VARIABLE CAMBER LEADING EDGE FLAPS

FLAP EXTENSION WITH PDU UNSERVICEABLE

GENERAL

(1) This procedure is used if the PDU does not operate by pneumatic or electrical power, and the alternate electric motor brake is not serviceable. In this procedure, all the leading edge flaps are extended but those with the unserviceable drive unit.

(2) There are three procedures to extend the variable camber flaps if the PDU and the alternate flap motor brake are unserviceable. The first procedure is to remove a section of the skin panel above the PDU. The second procedure is to remove a corner of the flap panel below the PDU and pull the panel down for access. The third procedure is to cut slots in the top surface of the skin above the PDU. You can cut the drive shaft through these slots.

DEACTIVATE THE LEADING EDGE FLAP

WARNING: YOU MUST CAREFULLY DO THE STEPS IN THE TASK BELOW TO INSTALL THE LE FLAP SAFETY LOCKS. THE LE FLAPS CAN MOVE QUICKLY IF YOU DO NOT INSTALL THE SAFETY LOCKS CORRECTLY. THIS CAN CAUSE INJURY TO PERSONS OR DAMAGE TO EQUIPMENT.

EXTEND THE UNSERVICEABLE KRüGER FLAP

(1) Extend the unserviceable krueger flaps:

(a) Loosen four captive bolts on the leading edge access panel adjacent to the inboard end of the krueger flaps.

(b) Open the panel to get access through the opening to PDU No. 4.

(2) Disconnect the drive shaft from the PDU.

(3) Pull the flap panel open.

(4) Close the leading edge cavity access panel.

(5) Tighten four captive bolts.

EXTEND THE UNSERCICABLE VARIABLE CAMBER FLAP

(1) Extend the unserviceable variable camber flaps by the skin panel removal procedure:

(a) Remove a section of the leading edge skin panel above the PDU with rib on each side of the PDU.

(2) Extend the unserviceable variable camber flaps by the flap panel removal procedure:

(a) Drill the forward corner of the fasteners that attach the flap panel to its stringers.

NOTE: The forward inboard corner fasteners in the flap panels No. 2, 7 or 9 give access to the left wing PDU's No. 1, 2 or 3. The forward outboard corner fasteners in the flap panels No. 17, 19 or 24 give access to the right wing PDU's No. 3, 2 or 1.

(b) Pull the corner of the flap down a maximum of 4 inches for access to the drive shaft (Ref SRM 57-30-03).

(3) Extend the variable camber flaps by the skin panel slotting procedure:

(a) Cut the slots in the leading edge skin panel above the PDU.

CAUTION: IF THE SLOTS ARE CUT IN THE SKIN, DO NOT MAKE THE SLOTS LARGER THAN NECESSARY WHEN YOU CUT THE DRIVE SHAFT. THERE IS A LIMIT FOR THE PERMITTED HOLE DIMENSION IN THE SKIN PANEL WHICH YOU CAN REPAIR.

(4) Disconnect or cut the drive shafts on each side of the PDU.

NOTE: Drive shafts must be cut if you use the skin panel slotting procedure.

(5) Pull the flap panel open.

(6) Do these tasks to replace the PDU: ”Power Drive Unit Removal” and ”Power Drive Unit Installation”.

(7) Connect the disconnected drive shafts or do these tasks to replace the cut drive shafts : ”Drive Shaft Removal” and ”Drive Shaft Installation”.

(8) If you removed the variable camber flap panel from the stringers for access to the drive unit, replace the flap to the stringer fasteners.

(9) If you removed the skin panel section for access to the variable camber flap PDU, replace the skin panel.

(10) If you cut the slots in the leading edge skin panel above the variable camber flap PDU, repair the skin panel.

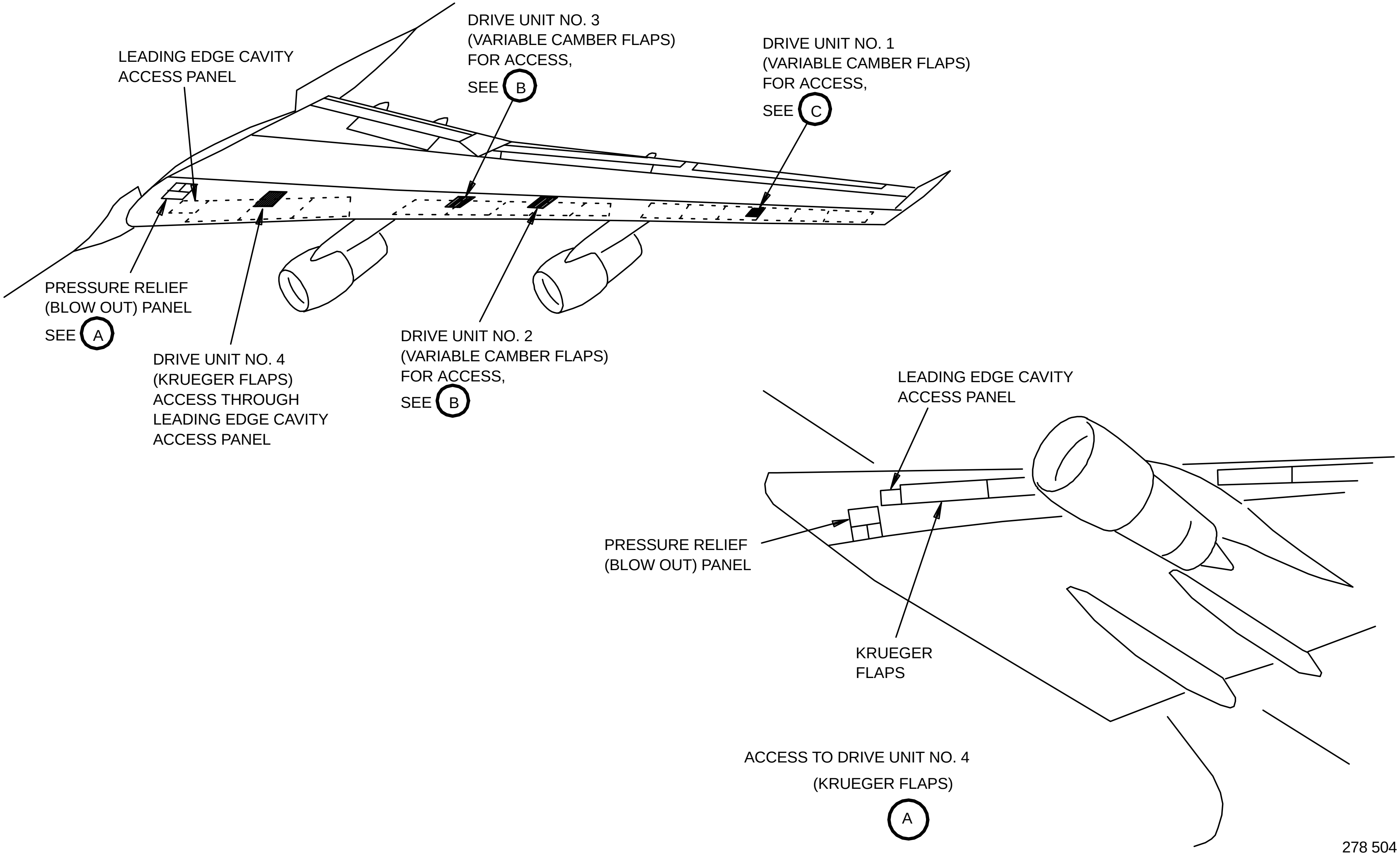


Figure 186 DRIVE UNIT ACCESS (PRIMARY AND ALTERNATE CONTROLS INOPERATIVE)

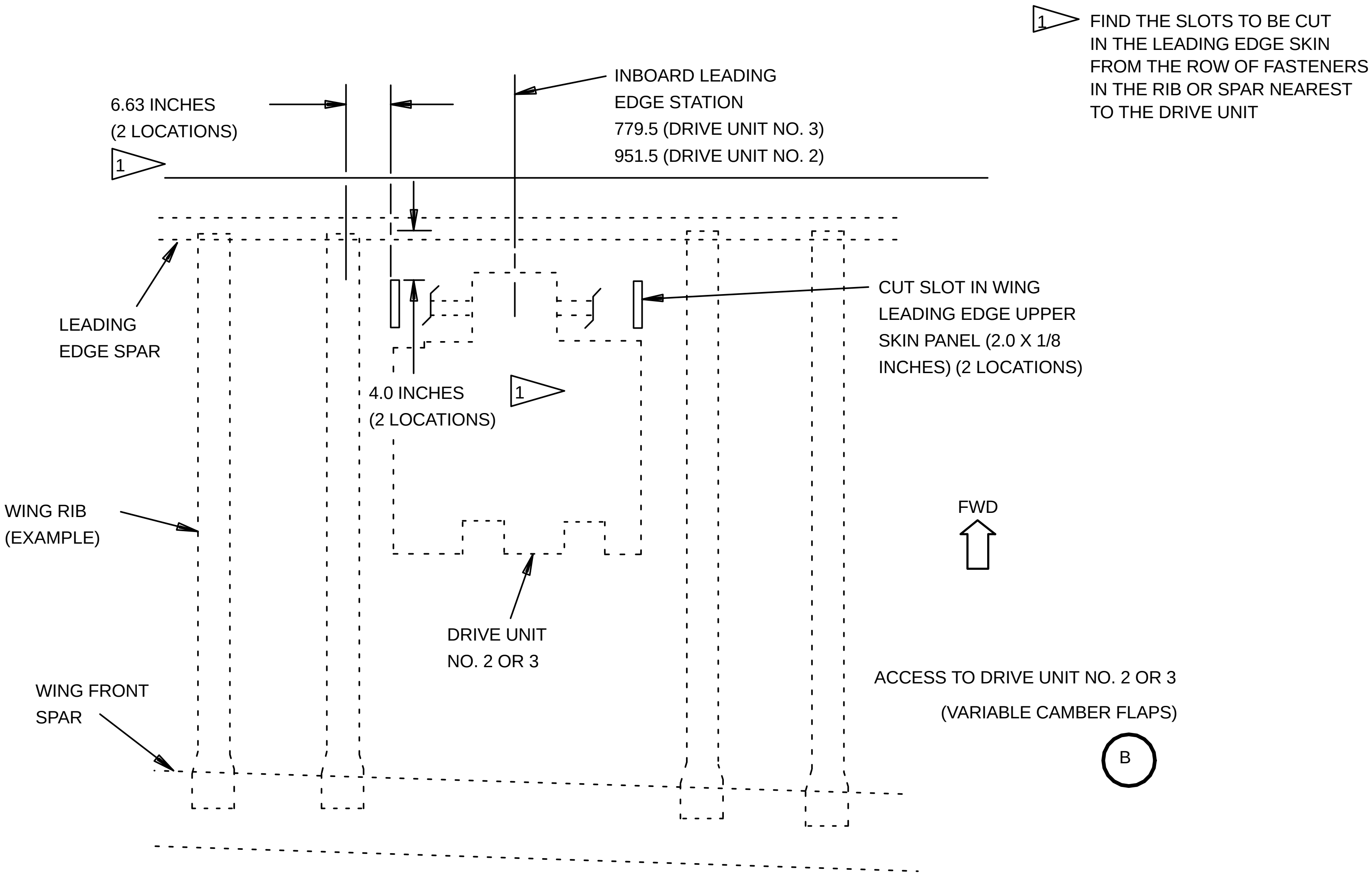


Figure 187 DRIVE UNIT ACCESS (PRIMARY AND ALTERNATE CONTROLS INOPERATIVE)

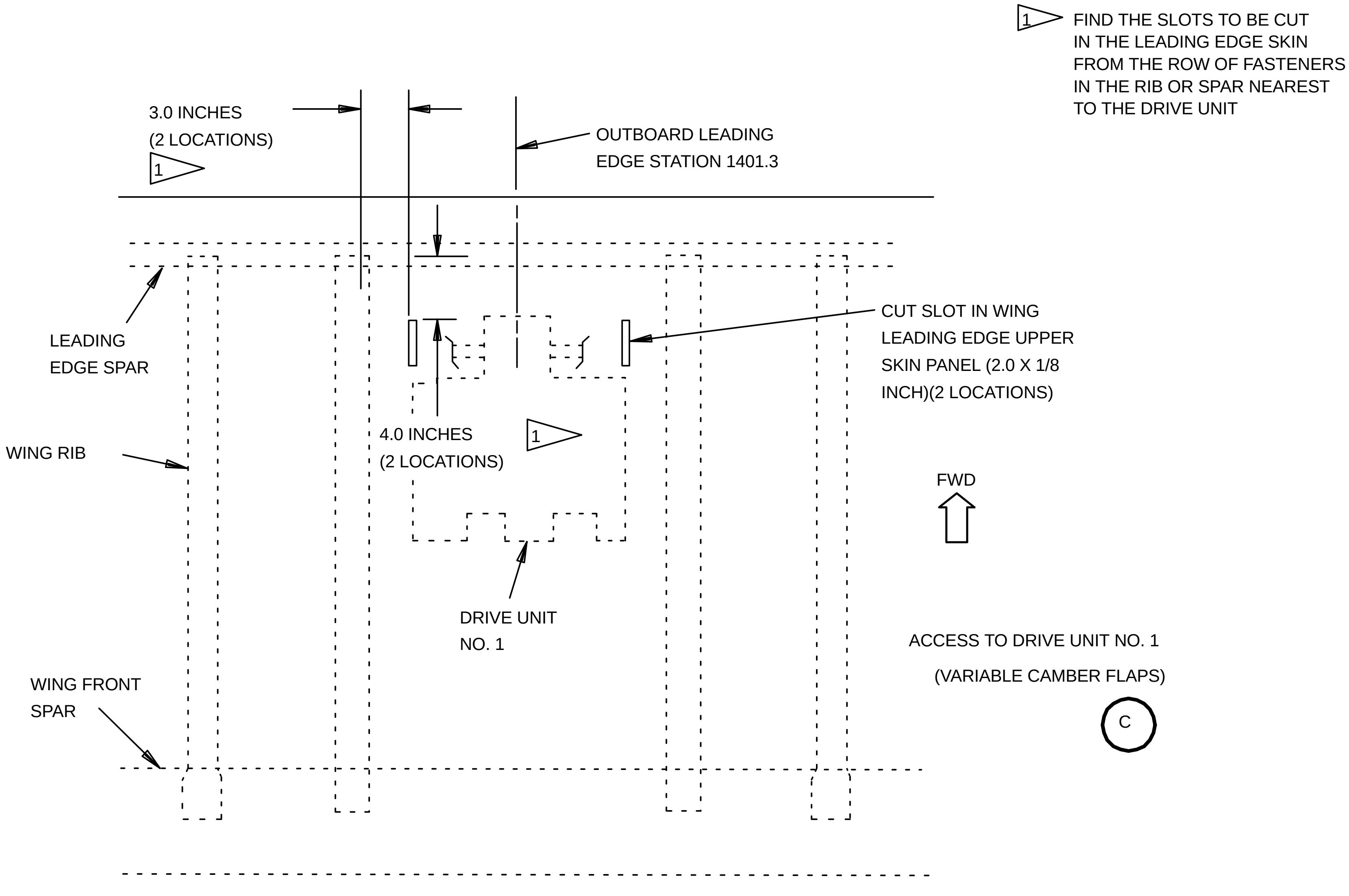


Figure 188 DRIVE UNIT ACCESS (PRIMARY AND ALTERNATE CONTROLS INOPERATIVE)

LEADING EDGE FLAP POSITION INDICATING SYSTEM

DESCRIPTION

LIMIT SWITCH ASSEMBLY

There is a limit switch assembly in each of the 8 leading edge flap power drive units (PDU). The assembly contains two limit switches. One limit switch closes to ground when the PDU is in the flap retracted position, and the other switch closes to ground when the PDU is in the flap extended position. When the leading edge flaps are in transit, both limit switches are open.

SUMMARY :

- dienen der Position Indication auf dem Main EICAS Display und der Maintenance Page FLIGHT CONTROL
  (siehe Lift Augmenting Indication)
- dienen gleichzeitig der Endabschaltung in den Betriebsmodes
- in EXTEND oder RETRACT ist der entsprechende Limit Switch CLOSED
- im TRANSIT sind beide Limit Switches OPEN

NOTE: LEFT WING LE FLAP INDICATING SYSTEM SHOWN.
RIGHT WING SIMILAR.

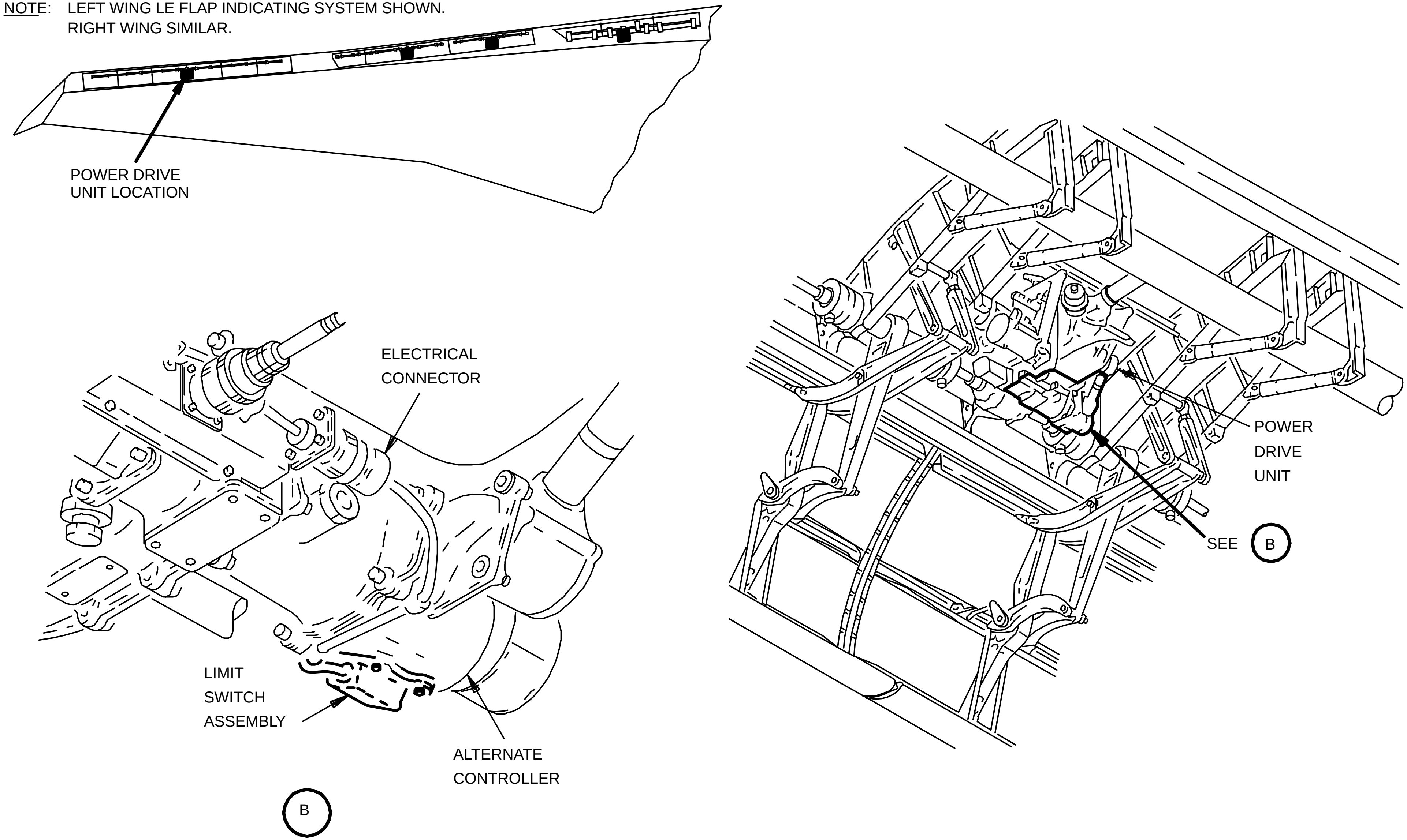


Figure 189 LEADING EDGE FLAP POSITION INDICATING SYSTEM

LEADING EDGE FLAP POSITION INDICATING SYSTEM

FUNCTIONAL DESCRIPTION

The FLAPS display appears on the main EICAS whenever flaps are not fully retracted and disappears 15 seconds after flaps are retracted. The normal FLAPS display appears for normal flap configurations and does not show LE flap position. LE flap position is shown in either of two multiple flap displays which appear for non-normal flap configurations.

The multiple flap-primary FLAPS display appears automatically when primary electric flaps are enabled, when there is flap asymmetry or disagreement with flap lever position, or when any LE or TE flap position data are determined to be invalid. This display consists of 4 white tapes which indicate position of each TE flap, a split bar across the tapes with a number which indicates position of the flap lever, and 6 box-shaped symbols above the tapes which indicate position of the LE flaps.

The 6 box-shaped symbols above the tapes indicate status of the inboard, midspan, and outboard groups of LE flaps on each wing. The box outline appears alone in white for LE flaps fully retracted, the entire box is shaded green for LE flaps fully extended, and the box is crosshatched in white for LE flaps in transit. Any of these symbols appears in amber to indicate a disagreement with flap lever position.

When any LE position data is invalid (LE flap position switch indicates extended and retracted simultaneously), the corresponding LE indicator box outline will appear in white with an amber x inside.

The multiple flap-alternate FLAPS display appears automatically when alternate flaps are selected with the flap ALT ARM switch or when all 3 flap control units fail. This display is the same as the multiple flap-primary display except that the flap lever position bar and number do not appear, and flap position scales appear next to the outer tapes.

CONTROL

Operation of the leading edge flaps indication system is automatic. The expanded FLAPS display appears on the main EICAS during non-normal flap configurations.

The flight controls maintenance page may be called up on the auxiliary EICAS display. This page displays position of each of the eight LE flap PDU’s as RET (retracted), EXT (extended), or INT (in transit).

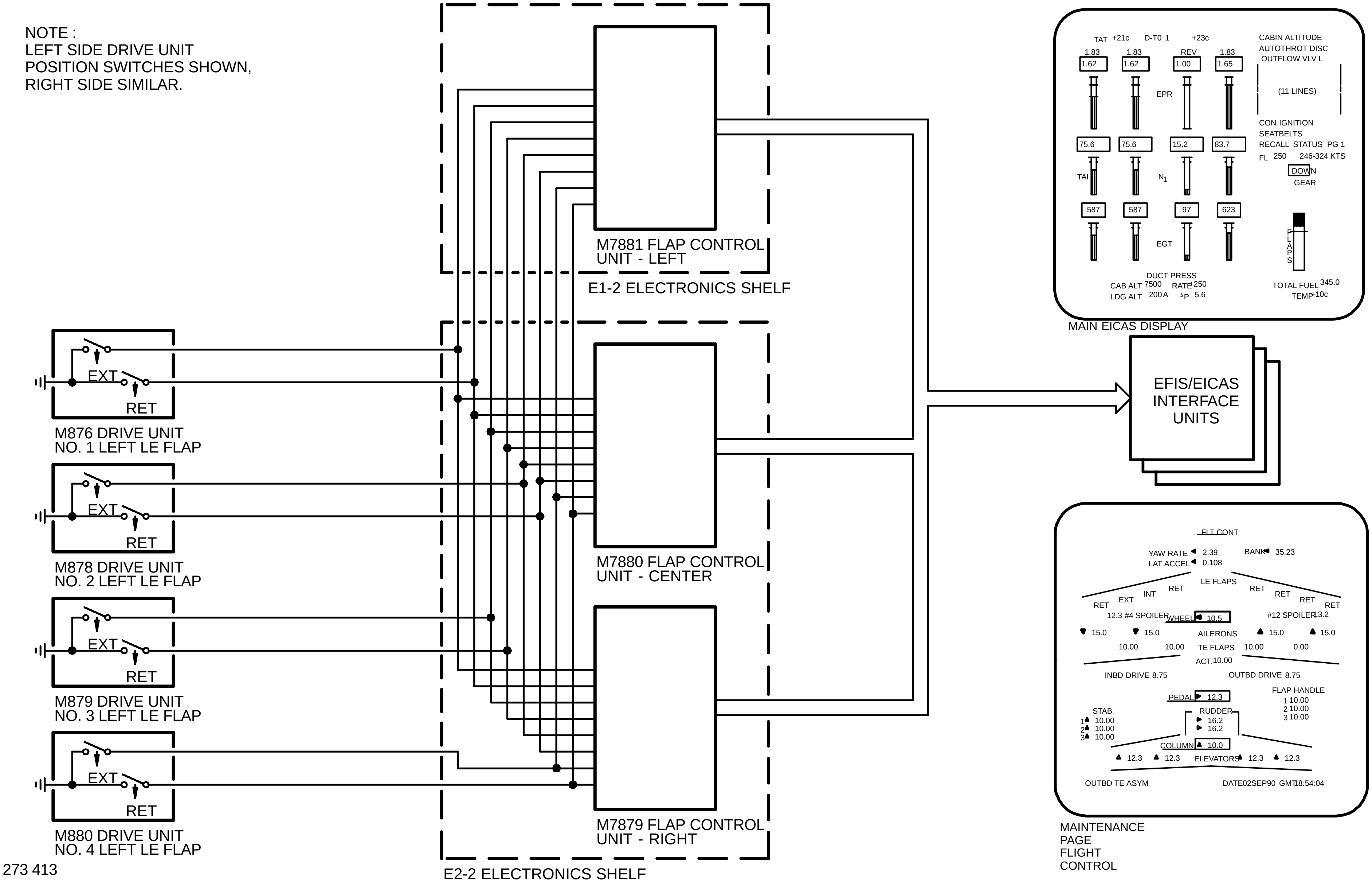


Figure 190 LEADING EDGE FLAP POSITION INDICATING SYSTEM SCHEMATIC

27-88 LEADING EDGE FLAPS PROXIMITY SWITCH SYSTEM

LEADING EDGE FLAPS PRIXIMITY SWITCH SYSTEM

DLH 001-199 ONLY;

DESCRIPTION

The leading edge flap position indicating system provides visual indication on the flight deck of leading edge flap position when flaps are in non-normal configurations. During normal flap operation, there is no separate indication of the position of the leading edge flaps.

Components used by the leading edge (LE) flap position indicating system are the limit switch assemblies, the LE flap proximity switches (DLH 001-199), the 3 flap control units (FCUs), and the EIU's and EICAS display. The system is energized when the FCUs and the EICAS are powered.

FUNCTIONAL DESCRIPTION

At the speed of less than 40 knots, an EICAS message of LE FLAP DIS will display when there is a disagreement of the LE flap actuator arm position. The positions of the LE flap actuator arm are provided by the proximity switch electronics unit (PSEU) which receives the inputs from the LE flap proximity switch on the LE flap actuator arm.

SUMMARY :

- das System ist aktiviert, wenn :
  - die FCU's stromversorgt sind

    und
  - das EICAS System stromversorgt ist

    und
  - die Ground Speed < 40 Kts beträgt
- bei einem Disagreement zwischen einem der 16 Leading Edge Flap Actuator Arms und der FCU (Ansteuerungssignal vom dem Flap Lever) erscheint die

  Advisory Message

> LE FLAP DIS (27 80 09 00)

NOTE: Wenn der CB: LEADING EDGE FLAP INDICATOR (P6-3 L 25) gezogen ist oder die Circuit Card in der PSEU (A11) nicht stromversorgt ist, erscheint die
Adivisory Message :
> LE FLAP DIS (27 80 09 00)
und die
CMCS Message :
LE FLAPS POWER (PSEU) (32 525).

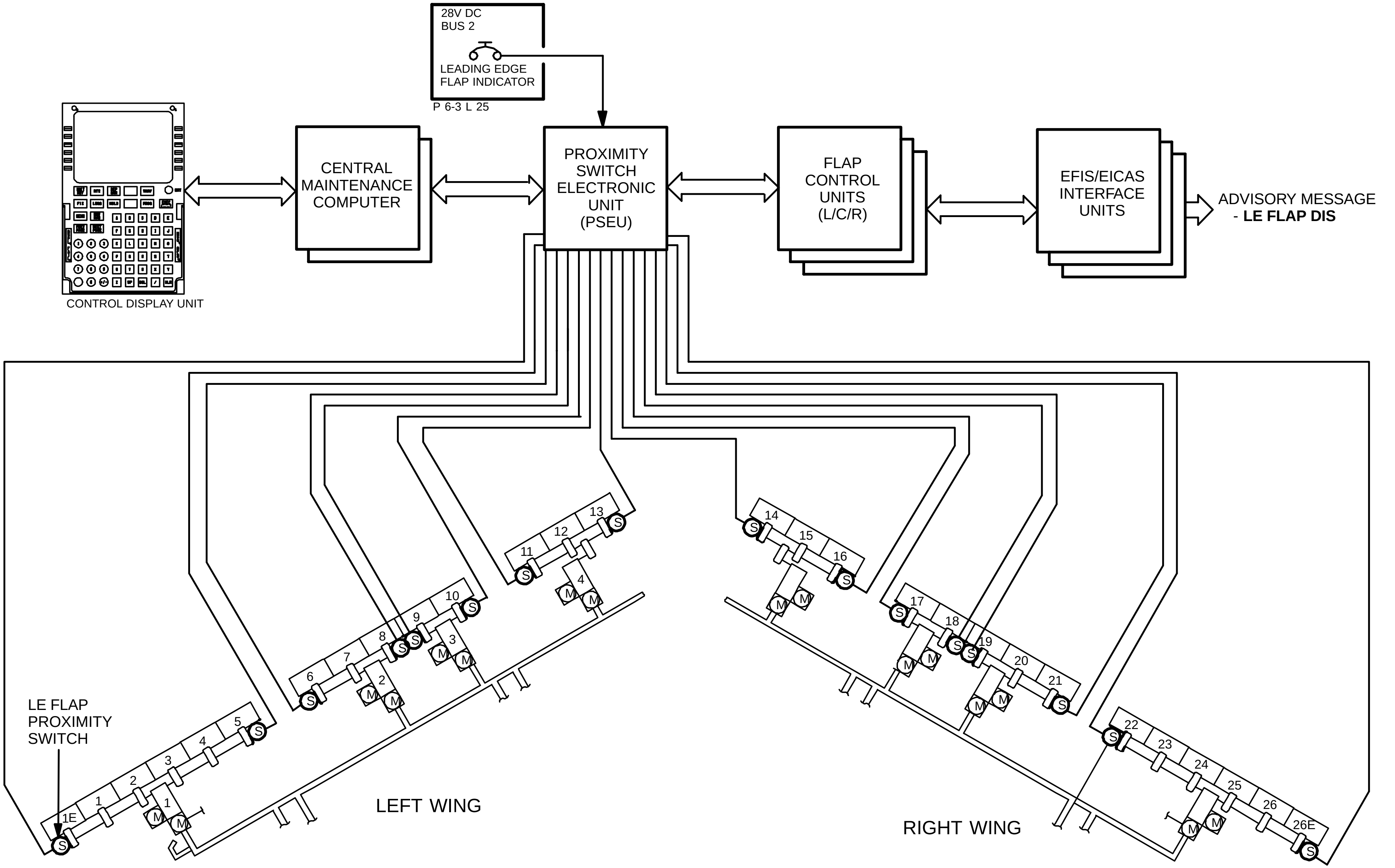


Figure 191 LEADING EDGE FLAP PROXIMITY SWITCH SYSTEM

LEADING EDGE FLAP PROXIMITY SWITCH

DESCRIPTION

DLH 001-199;

There are 16 LE flap proximity switches on the LE flap actuator arms. The switches provide the LE flap actuator arm disagreement indication on the EI-CAS.

For example :

FAILURE INDICATION OF A COMPONENT OF THE PROXIMITY SWITCH SYSTEM

Whenever a fault is detected for the LE flap proximity switch the advisory massage

> LE FLAPS DIS 27 80 09 00

appears

and on the MCDU is shown the reason for the EICAS message

CMC message :

LE FLAP PANEL 10-R PROX SWITCH TARGET FAIL (PSEU OR CMC)
32 851.

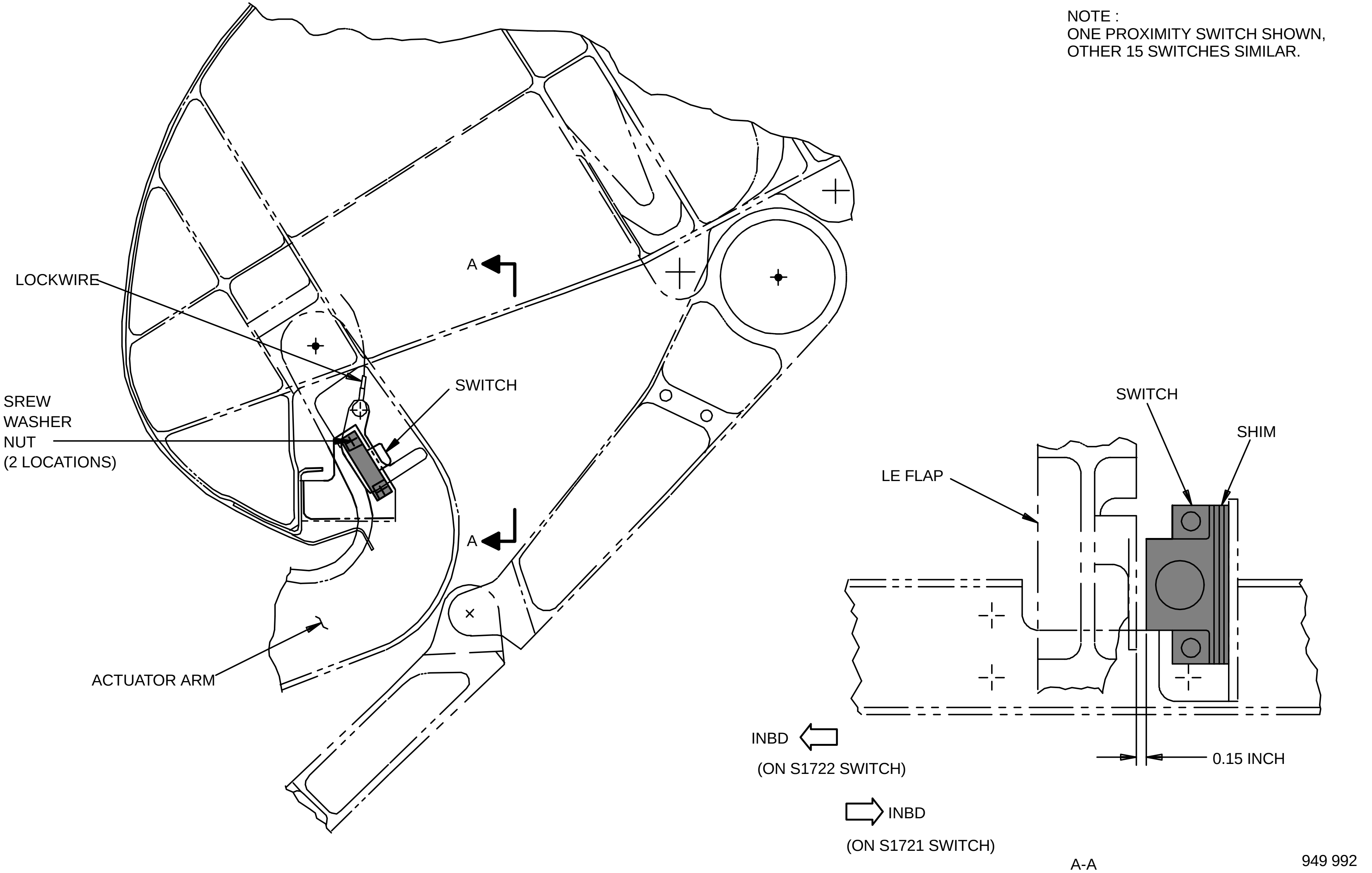


Figure 192 LEADING EDGE FLAP PROXIMITY SWITCH

DLH 001-199;

GROUND TEST - LEADING EDGE FLAP PROXIMITY SWITCHES

GENERAL

This is a test of the BITE functions of the leading edge flap proximity switches. This procedure is applicable to all switches. You must not use this test to troubleshoot the "LE FLAP PROX SWITCH TARGET FAIL" messages with the LE flaps retracted.

REFERENCES

(1) 24-22-00/201, Manual Control

(2) 27-81-00/201, Leading Edge Flap System

ACCESS

(1) Location Zones

221Control Cabin, LH

222Control Cabin, RH

PREPARE FOR THE TEST

(1) Do this task: "Leading Edge Flap Extension" (Ref 27-81-00/201).

S 865-021

WARNING: YOU MUST CAREFULLY DO THE STEPS IN THE TASK BELOW TO INSTALL THE LE FLAP SAFETY LOCKS. THE LE FLAPS CAN MOVE QUICKLY IF YOU DO NOT INSTALL THE SAFETY LOCKS CORRECTLY. THIS CAN CAUSE INJURY TO PERSONS OR DAMAGE TO EQUIPMENT.

(2) Do this task: "Extended Leading Edge Flap Deactivation and Safety Lock Installation" (Ref 27-81-00/201).

(3) Supply electrical power (Ref 24-22-00/201).

(4) Set the GND TESTS switch on the overhead maintenance panel, P461, to the ENABLE position.

(5) Prepare the CDU for the test:

(a) Push the MENU key on the CDU to show the MENU.

(b) Push the line select key (LSK) that is adjacent to <CMC to show the CMC MENU.

(c) If <RETURN shows after you push the LSK, push the LSK that is adjacent to <RETURN until you see the CMC MENU.

(d) Push the LSK that is adjacent to <GROUND TESTS to show the GROUND TESTS menu.

(e) Push the NEXT PAGE key until you find <27 FLAP CONTROL.

(f) Push the LSK that is adjacent to <27 FLAP CONTROL to show the GROUND TESTS menu for the leading edge flap proximity switches.

(g) Push the NEXT PAGE key until you find <LE FLAPS PROX SYS.

NOTE: If INHIBITED shows above <LE FLAPS PROX SYS, the test will not operate.

(h) If INHIBITED shows above <LE FLAPS PROX SYS:

1) Push the LSK that is adjacent to the test prompt.

2) Do the steps shown on the CDU.

3) Push the LSK that is adjacent to <RETURN to show the ground test menu again.

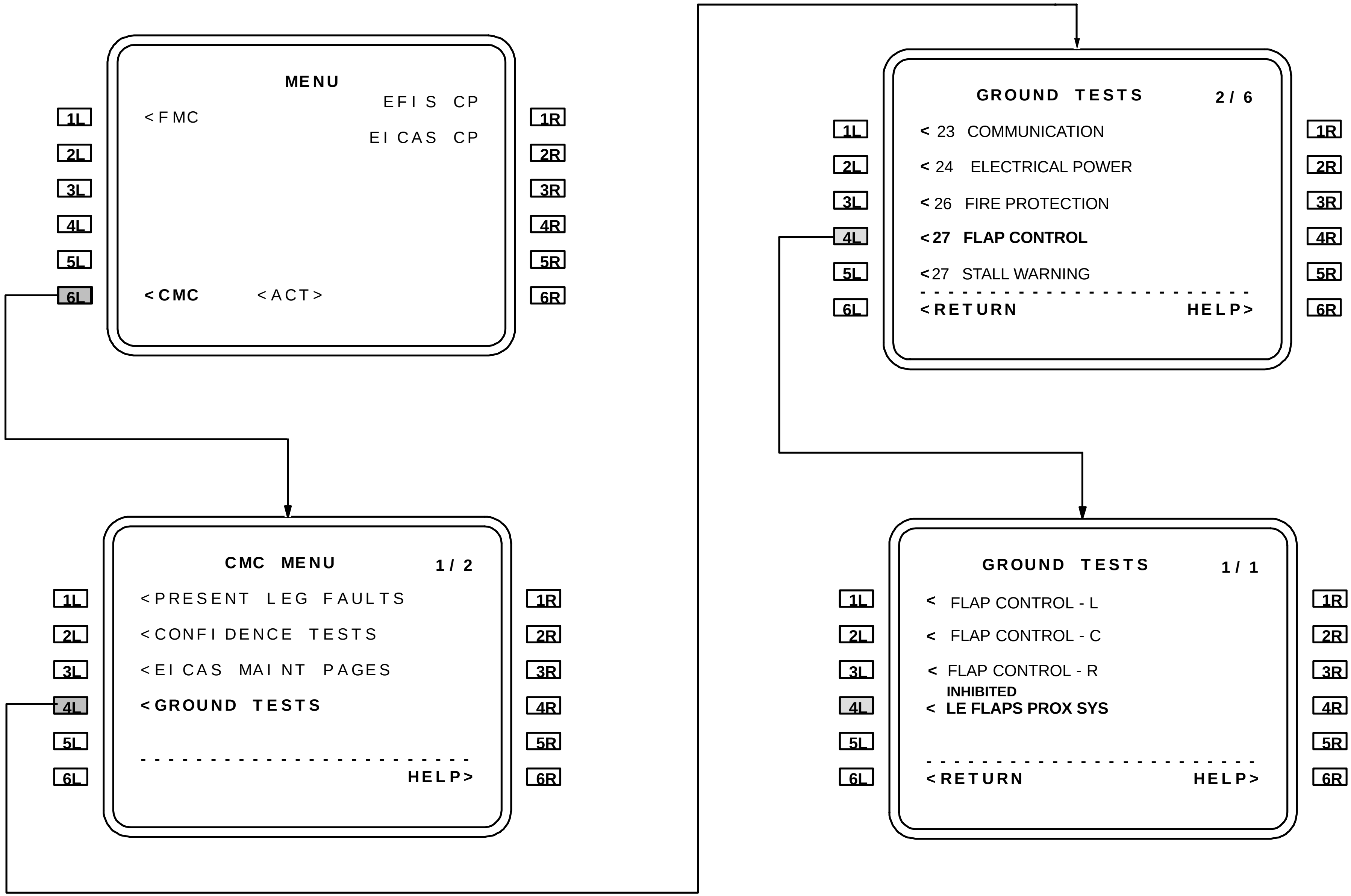


Figure 193 LEADING EDGE FLAP PROXIMITY SWITCHES GROUND TEST

LEADING EDGE FLAP PROXIMITY SWITCHES GROUND TEST

(1) Push the LSK that is adjacent to <LE FLAPS PROX SYS.

(a) When the TEST PRECONDITIONS page shows, make sure each instruction on the page is completed. (Push the NEXT PAGE key to see subsequent pages.)

(b) Push the LSK that is adjacent to START TEST>.

NOTE: IN PROGRESS shows during the test.

(2) When IN PROGRESS goes out of view, look for PASS or FAIL> adjacent to <LE FLAPS PROX SYS.

NOTE: NOTE: If a PASS indication shows, no failures occurred during the test.

(a) If FAIL> shows:

1) Push the LSK that is adjacent to FAIL> to see the GROUND TEST MSG pages for the failure.

2) Push the NEXT PAGE key until you find all the GROUND TEST MSG pages.

3) Make a list of all CMCS messages, CMCS message numbers, and ATA numbers that show on the GROUND TEST MSG pages.

4) Go the the CMCS Message Index of the Fault Isolation Manual (FIM) to find the corrective action for each CMCS message.

PUT THE AIRPLANE IN ITS USUAL CONDITION

(1) Set the GND TESTS switch to the NORM position.

(2) Remove the electrical power if it is not necessary (Ref 24-22-00/201).

WARNING: YOU MUST CAREFULLY DO THE STEPS IN THE TASK BELOW TO REMOVE THE LE FLAP SAFETY LOCKS. THE LE FLAPS CAN MOVE QUICKLY IF YOU DO NOT DO THE STEPS CORRECTLY. THIS CAN CAUSE INJURY TO PERSONS OR DAMAGE TO EQUIPMENT.

(3) Do this task: ”Safety Lock Removal and Leading Edge Flap Activation” (Ref 27-81-00/201).

(4) Do this task: ”Leading Edge Flap Retraction” (Ref 27-81-00/201).

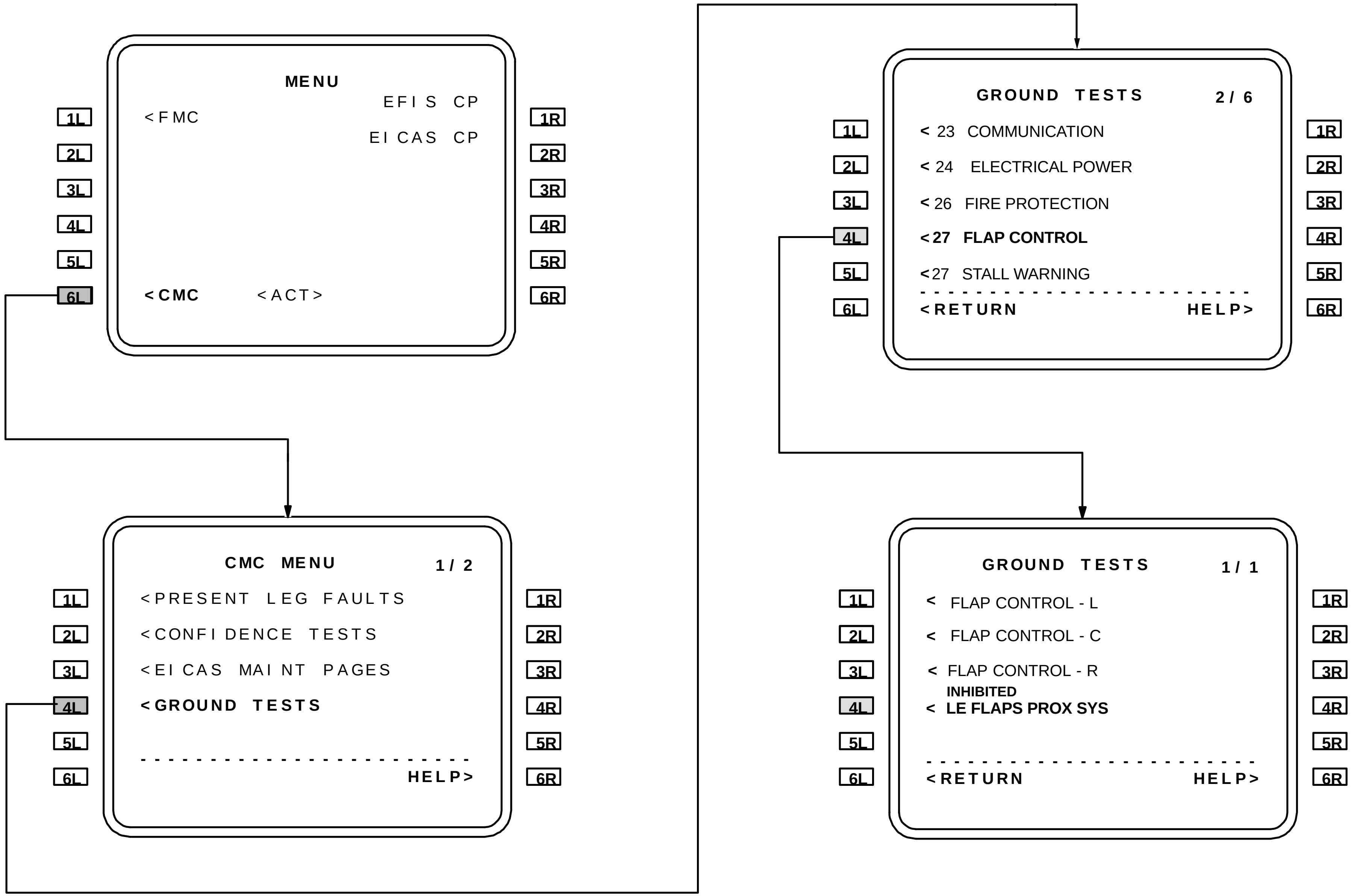


Figure 194 LEADING EDGE FLAP PROXIMITY SWITCHES GROUND TEST

ATA 31 INSTRUMENTS

31 - 52 AURAL WARNING SYSTEM

TAKE-OFF CONFIGARATION WARING

DESCRIPTION

Takeoff configuration warning is armed when the airplane is on the ground and either inboard engine is accelerated towards takeoff thrust.
The takeoff warning is given if
- the leading edge flaps are not fully extended,
- the trailing edge flaps are not in the 10 or 20 detent,
- flap position disagrees with flap lever position,
- stabilizer position is outside of takeoff range,
- the parking brake is set,
- the body steering is not locked or if
- the speed brake handle is not in down detent.

The takeoff configuration warning consists of the illumination of the master warning lights, activation of the aural warning siren, and the appropriate EICAS message.

The warning is issued if N1 of engine #2 or #3 exceeds a predetermined level, three or more fuel switches are in the "RUN" position and any unsafe condition exists.

The warning is non-resettable until all unsafe conditions are corrected.

When the MSTR WARN/CAUTION LT is pressed, the light goes out but the siren will be heard until the unsafe condition is corrected or throttles are pulled back.

Selecting the takeoff configuration warning confidence test through the CMC simulates accelerating an engine to takeoff power. No warnings occur when testing an airplane properly configured for takeoff. If the airplane is not properly configured for takeoff a configuration warning results.

SUMMARY :

Die TAKE-OFF CONFIGURATION WARNING wird ausgelöst, wenn :
- Speed Brake Lever : NOT DOWN DETENT
  oder
- Park Brake : SET
  oder
- T. E. Flaps : NOT 10 or 20
  oder
- L. E. Devices : NOT FULLY EXTENDED
  oder
- Disagree between : FLAP LEVER AND FLAP POSITION
  oder
- Stabilizer : NOT IN GREEN BAND
  oder
- Body Gear Steering Actuators : NOT LOCKED
  und
- Flugzeug : ON GROUND
  und
- drei oder mehr Fuel Switches : RUN
  und
- Engine 2 oder 3 : N1 >75% RPM

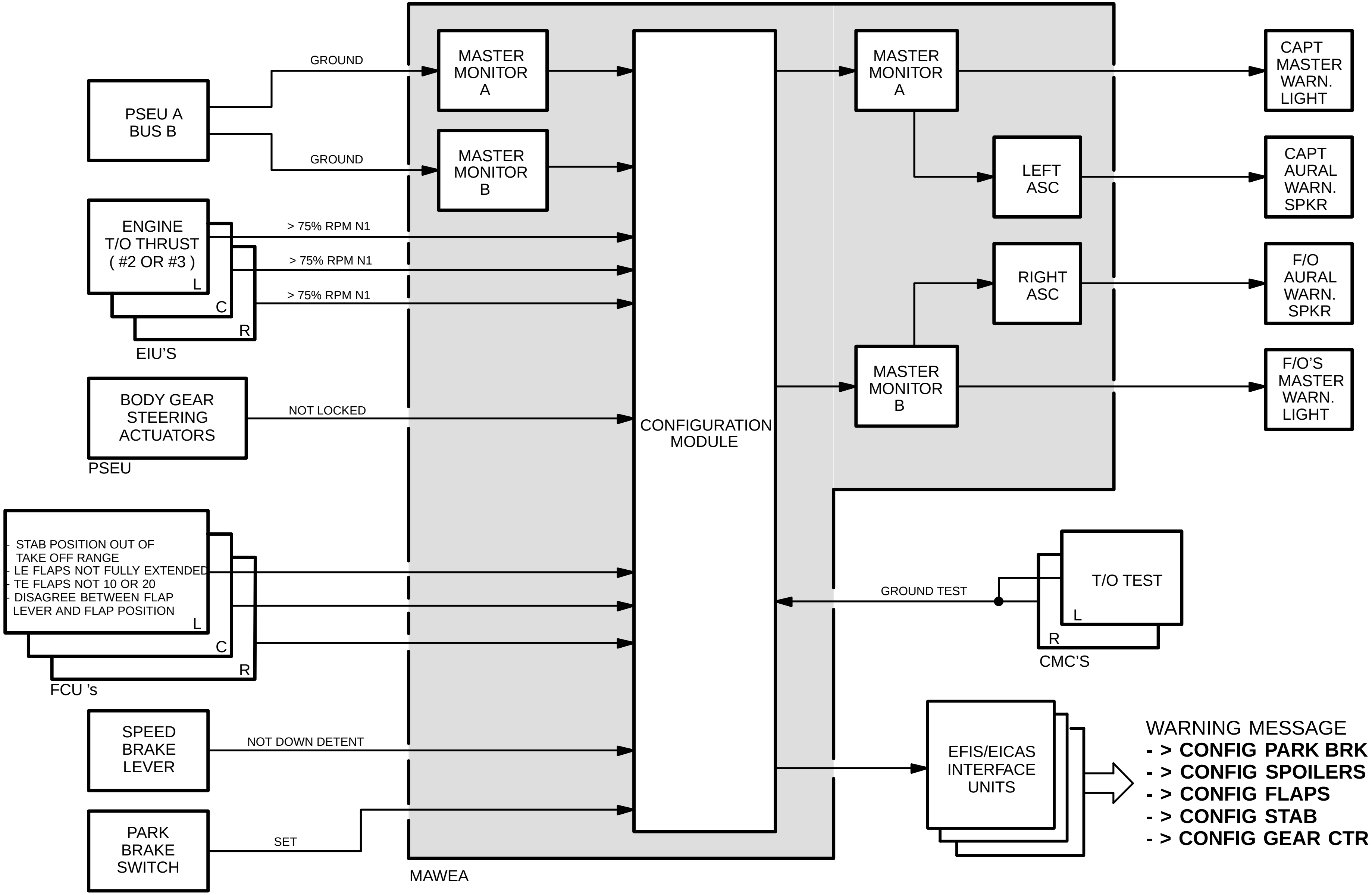


Figure 195 TAKE-OFF CONFIGURATION WARNING

SPEED BRAKE ALERT WARNING

DESCRIPTION

An alert is generated if
- the speed handle is moved beyond armed detent
- and if at least two throttles are advanced beyond 7.5 degrees TLA
- or if flaps are in landing range and altitude is more than 15 feet
- or if the airplane is at an altitude of between 800 and 15 feet.

The alert consists of a caution aural, master caution lights and an EICAS message, ”>SPEEDBRAKE EXT”.

SUMMARY :

Die SPEED BRAKE ALERT WARNING wird ausgelöst, wenn :

- Radio Altitude > 15ft und < 800ft

  und
- der Speed Brake Lever : >15°

  oder

- Radio Altitude > 15ft und < 800ft

  und
- T. E. Flaps in Landing Position 25 oder 30 (Left- oder Right FCU Input)

  und
- der Speed Brake Lever : >15°

  oder

- Radio Altitude SSM = NCD (gültig)

  oder
- Altitude : > 15ft

  und
- der Speed Brake Lever : >15°

  und
- zwei oder mehr Throttle Lever : >7.5° TLA (Left- oder Right EIU Input)

Speed Brake Alert ist Non Resettable.

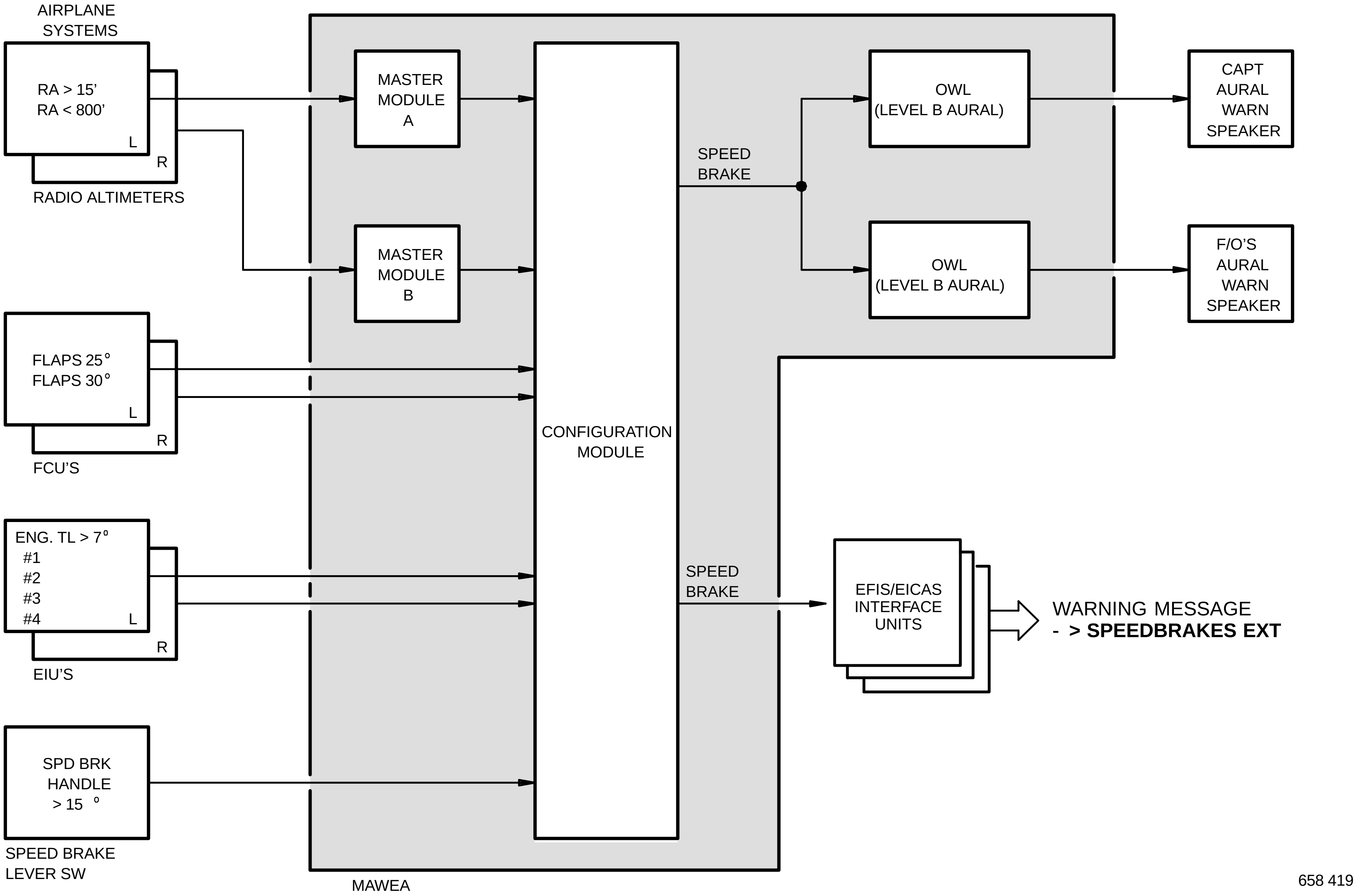


Figure 196 SPEED BRAKE ALERT CONFIGURATION WARNING

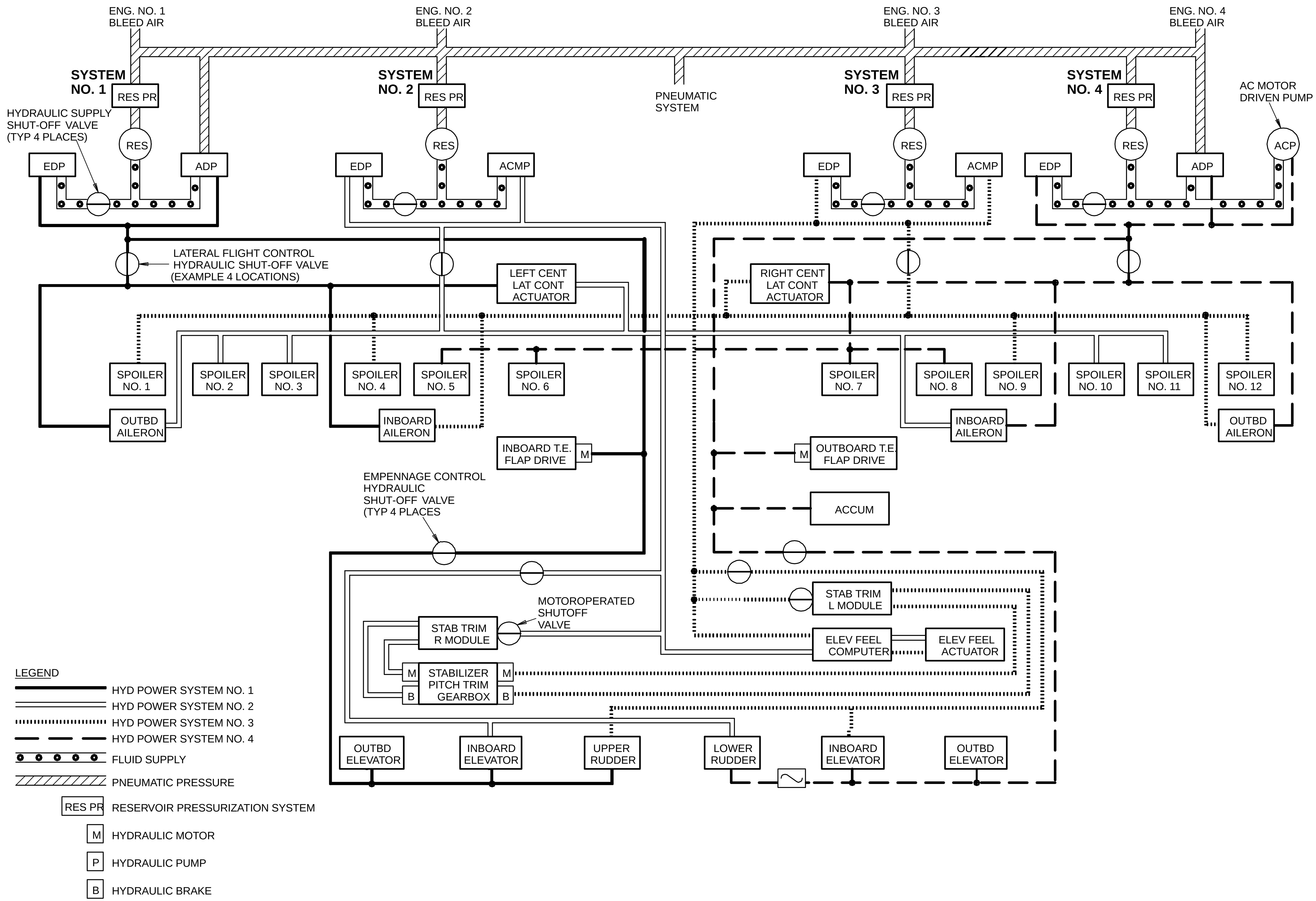


Figure A FLIGHT CONTROL HYDRAULIC SYSTEM SCHEMATIC

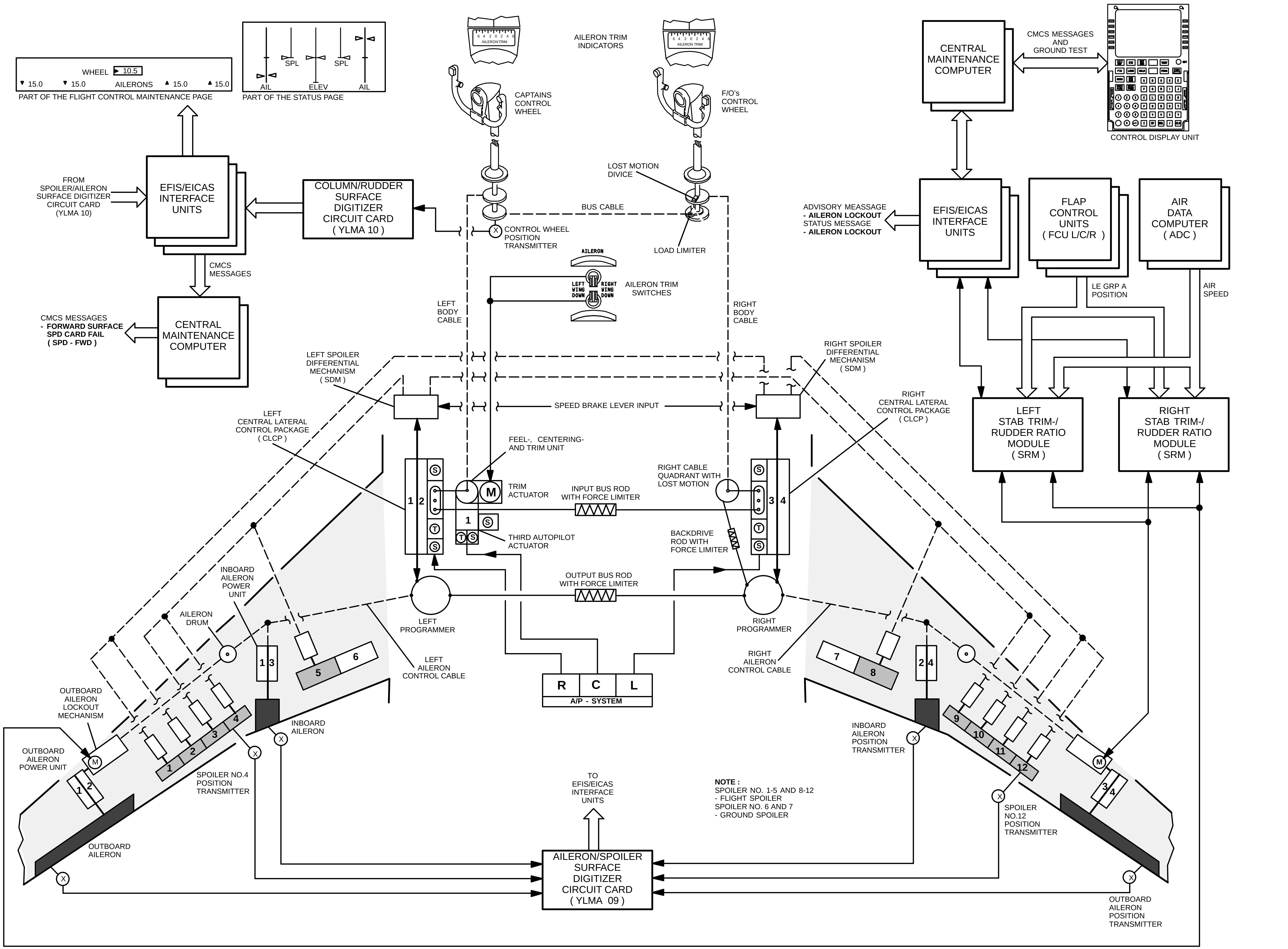


Figure B AILERON SYSTEM BASIC SCHEMATIC

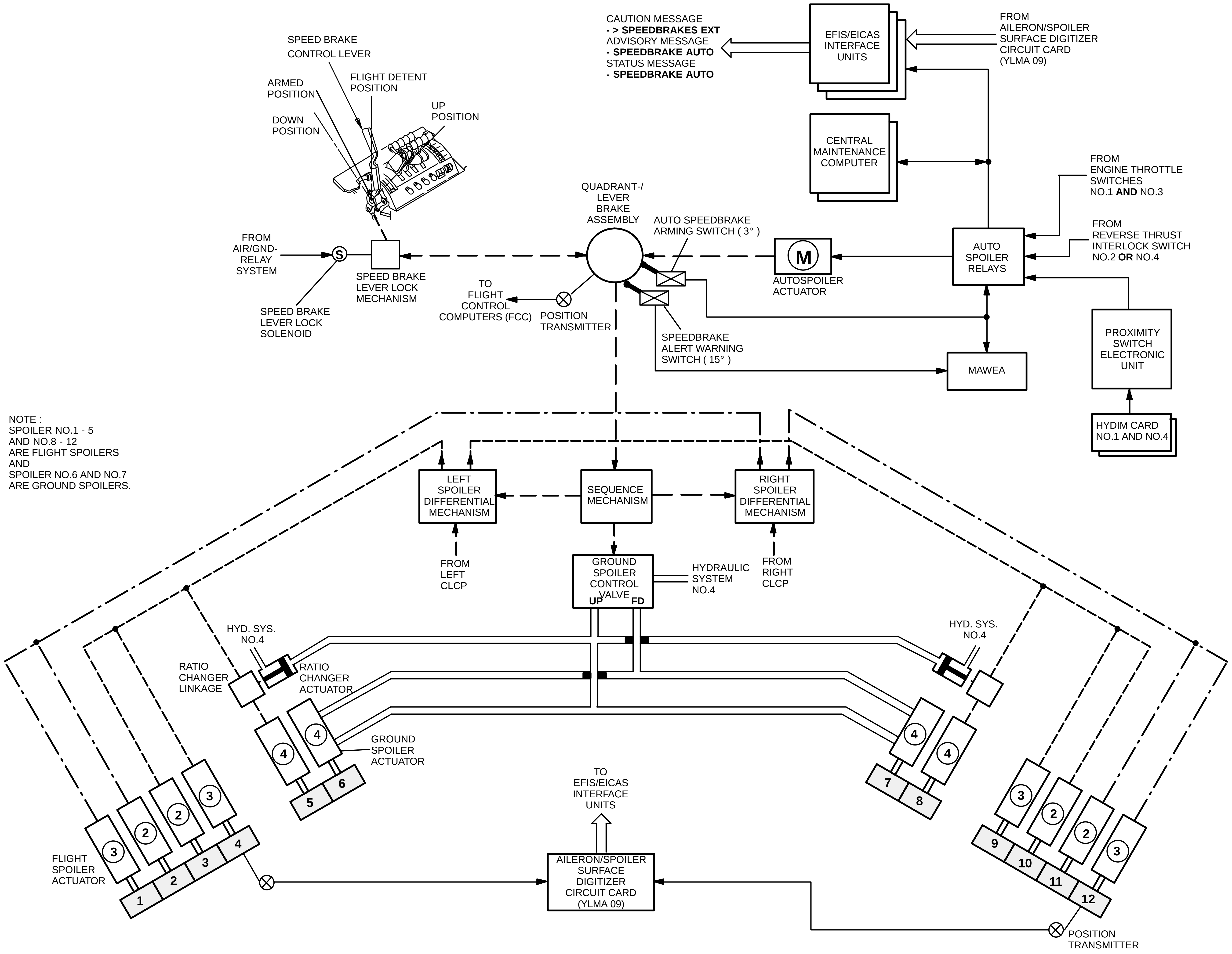


Figure C BASIC SCHEMATIC SPOILER AND DRAG DIVICES

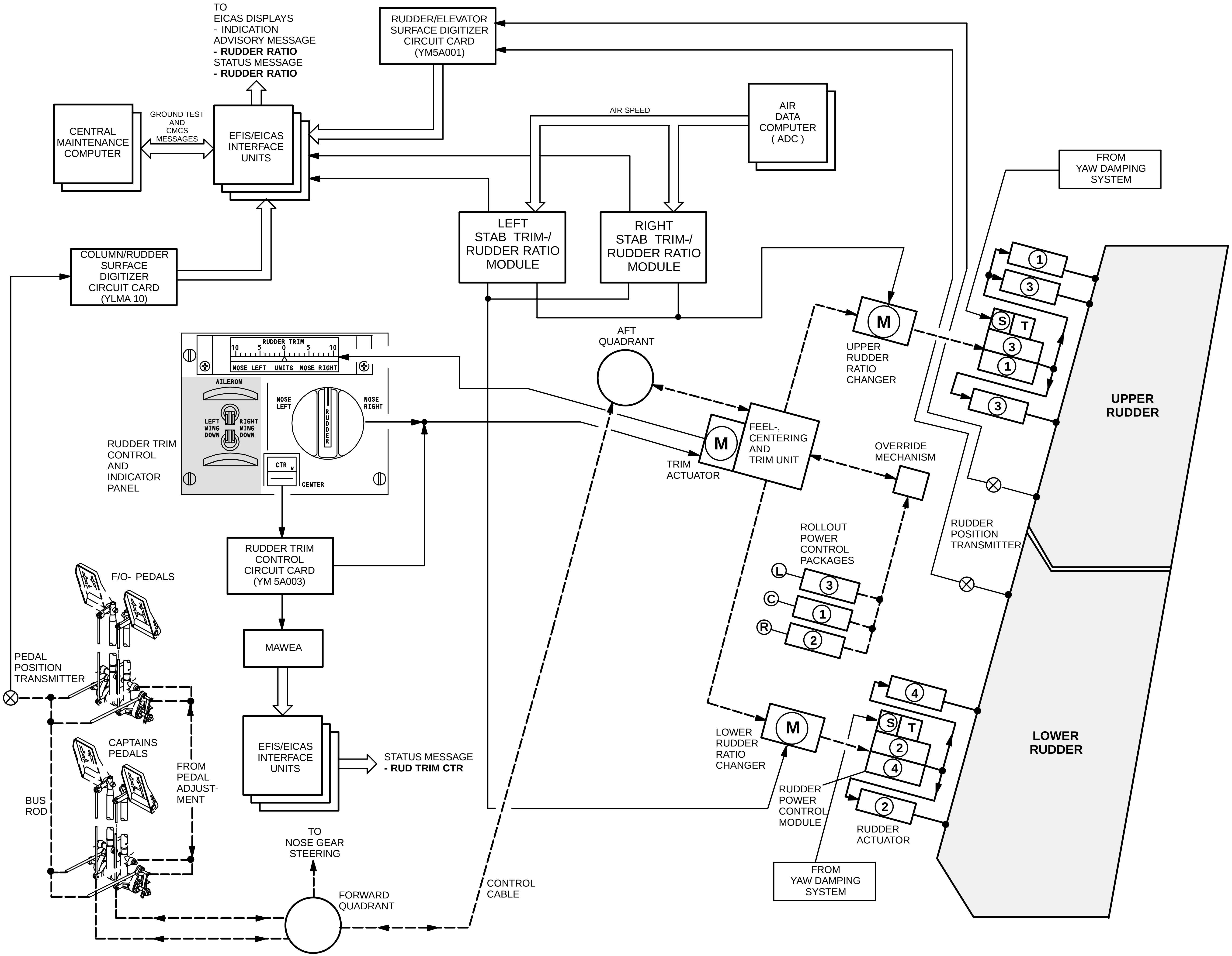


Figure E BASIC SCHEMATIC RUDDER SYSTEM

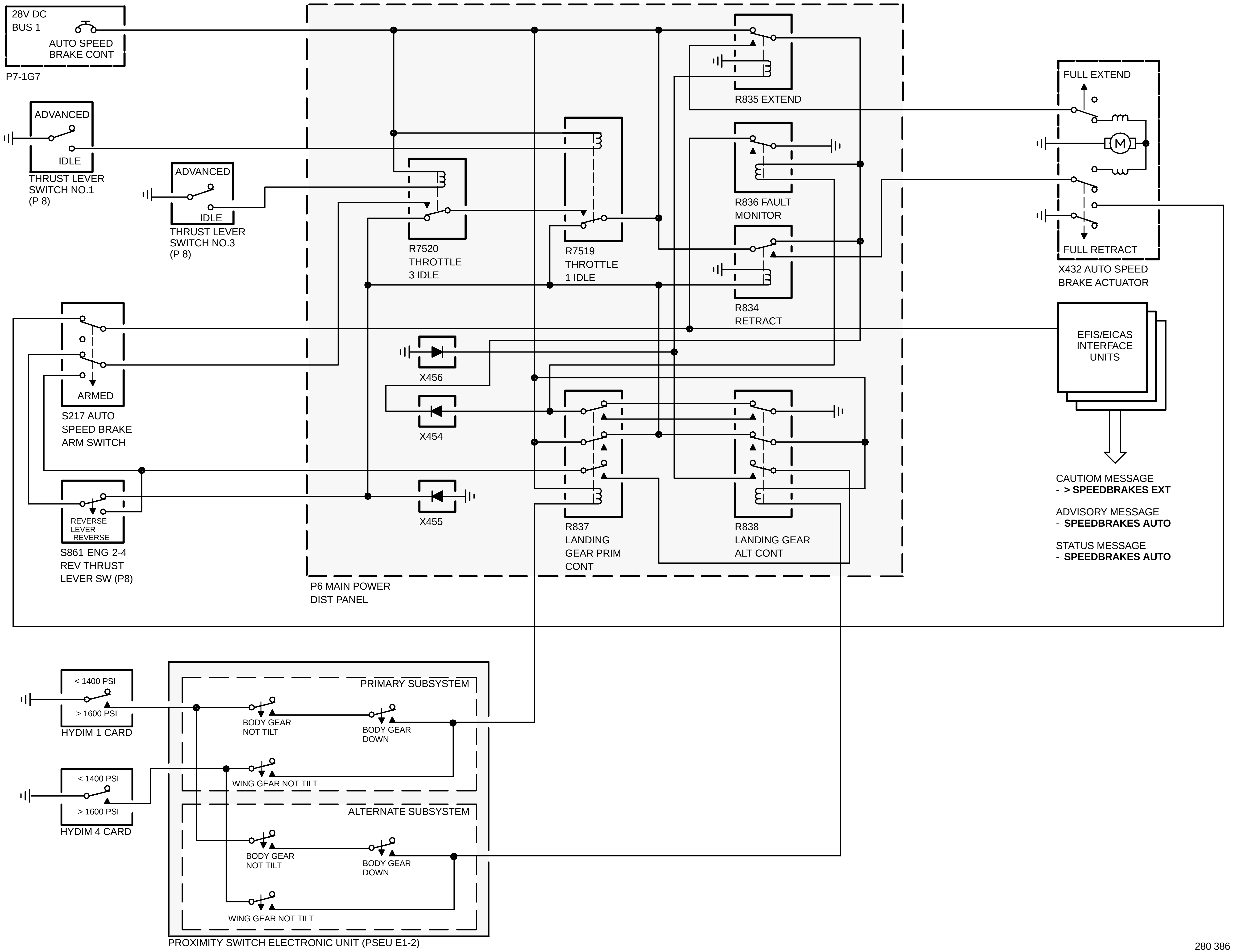


Figure D   AUTO SPEED BRAKE ELECTRICAL SCHEMATIC

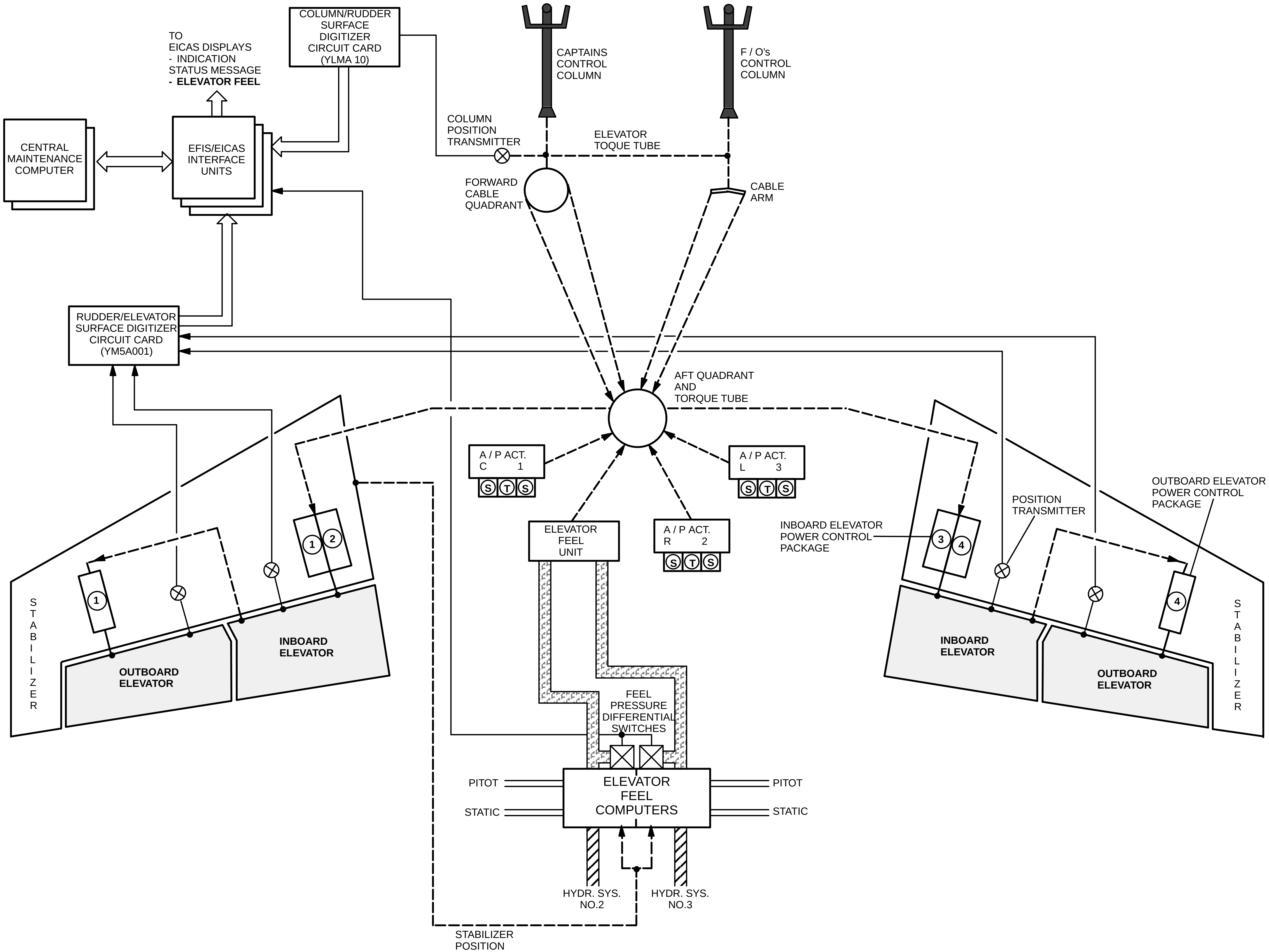


Figure F BASIC SCHEMATIC ELEVATOR SYSTEM

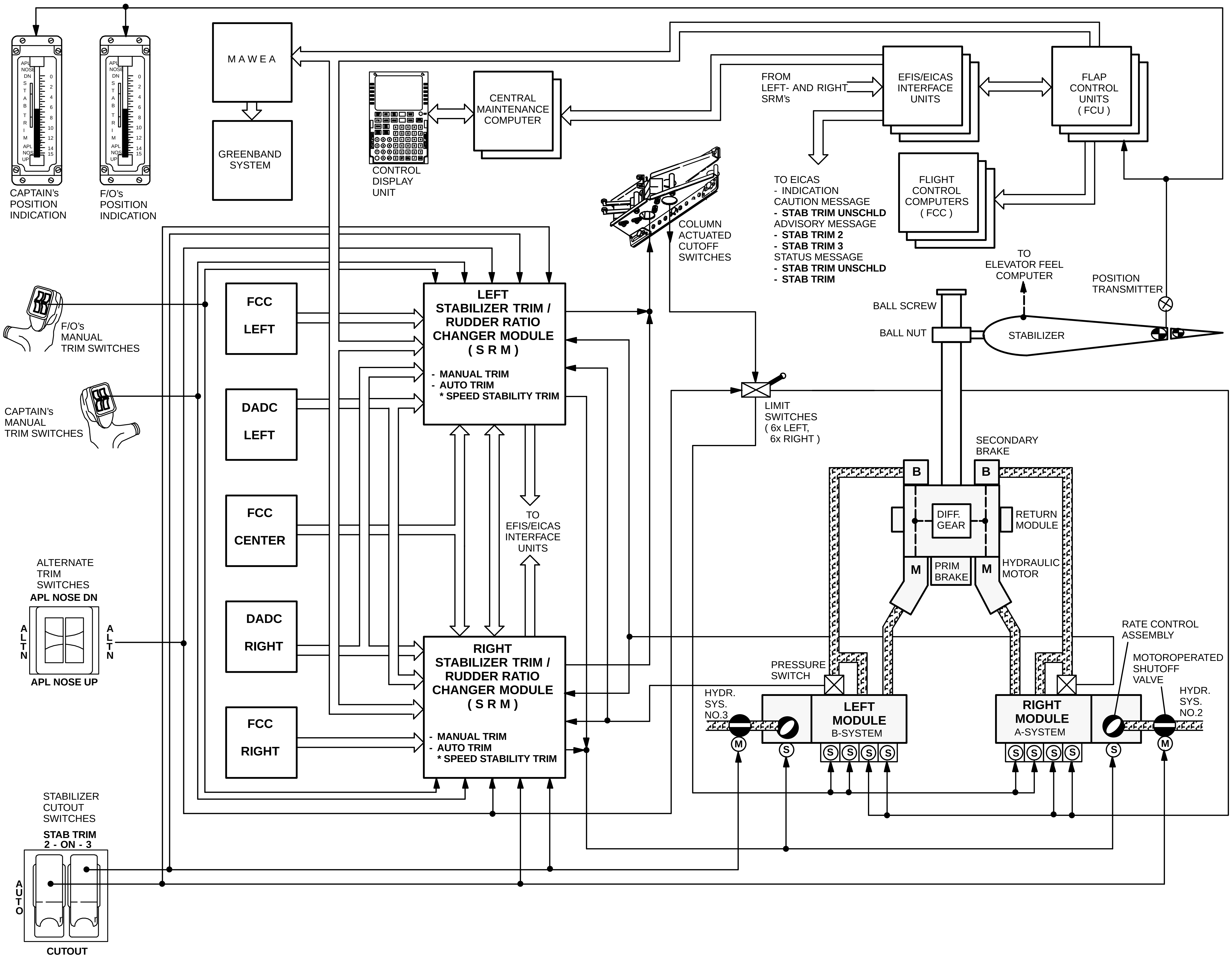


Figure G HORIZONTAL STABILIZER BASIC SCHEMATIC

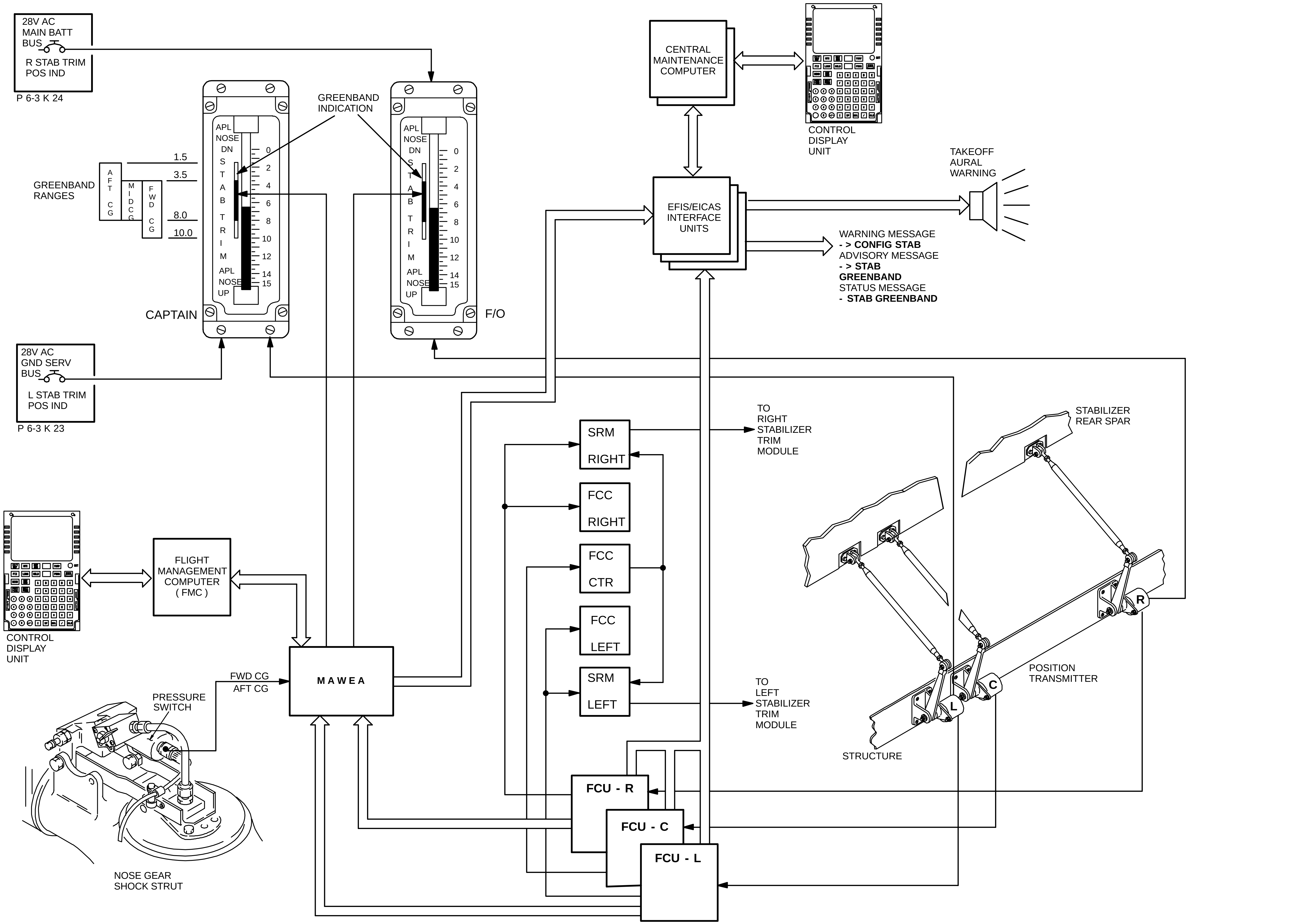


Figure H HORIZONTAL STABILIZER GREEN BAND SYSTEM SCHEMATIC

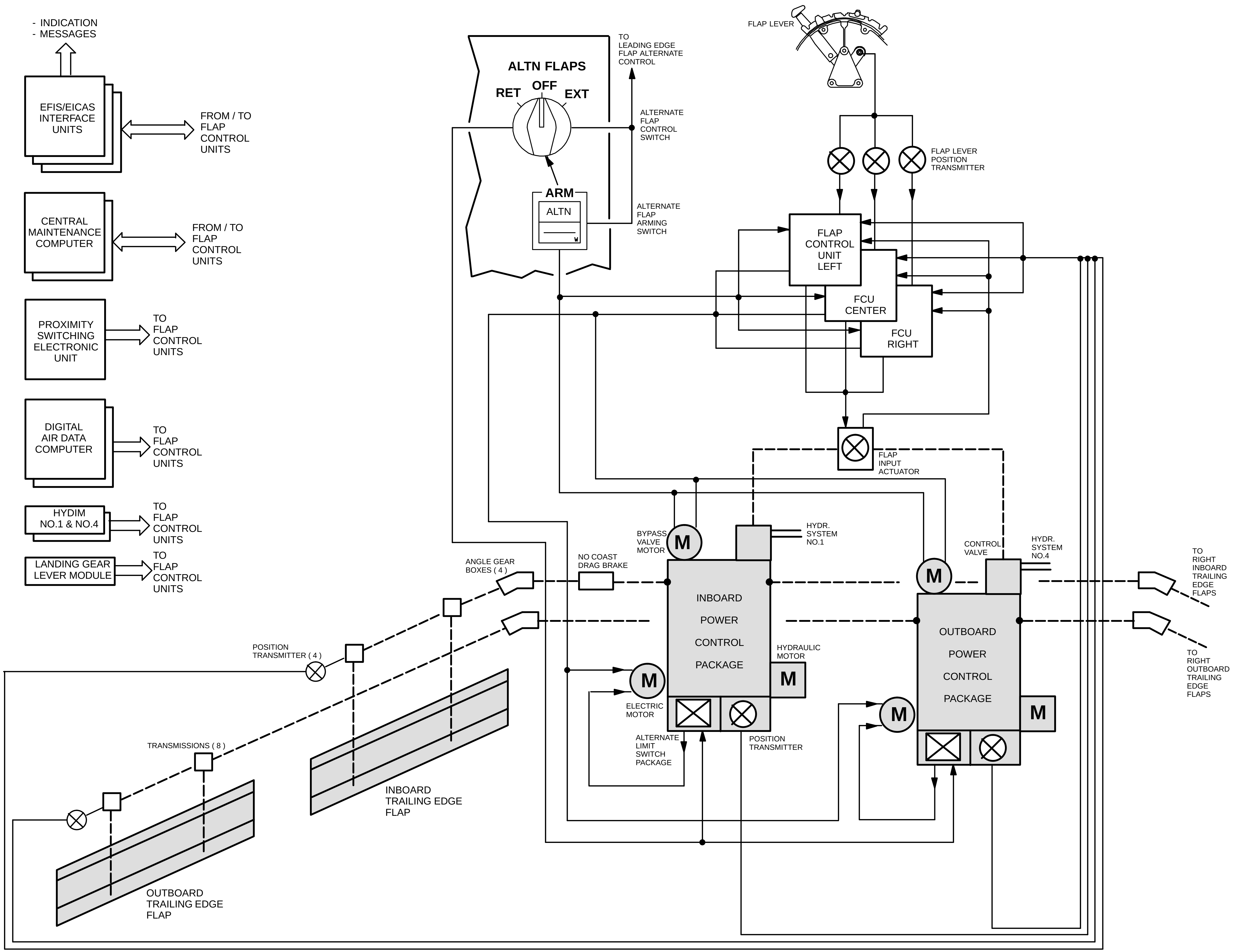


Figure I   TRAILING EDGE FLAPS BASIC SCHEMATIC

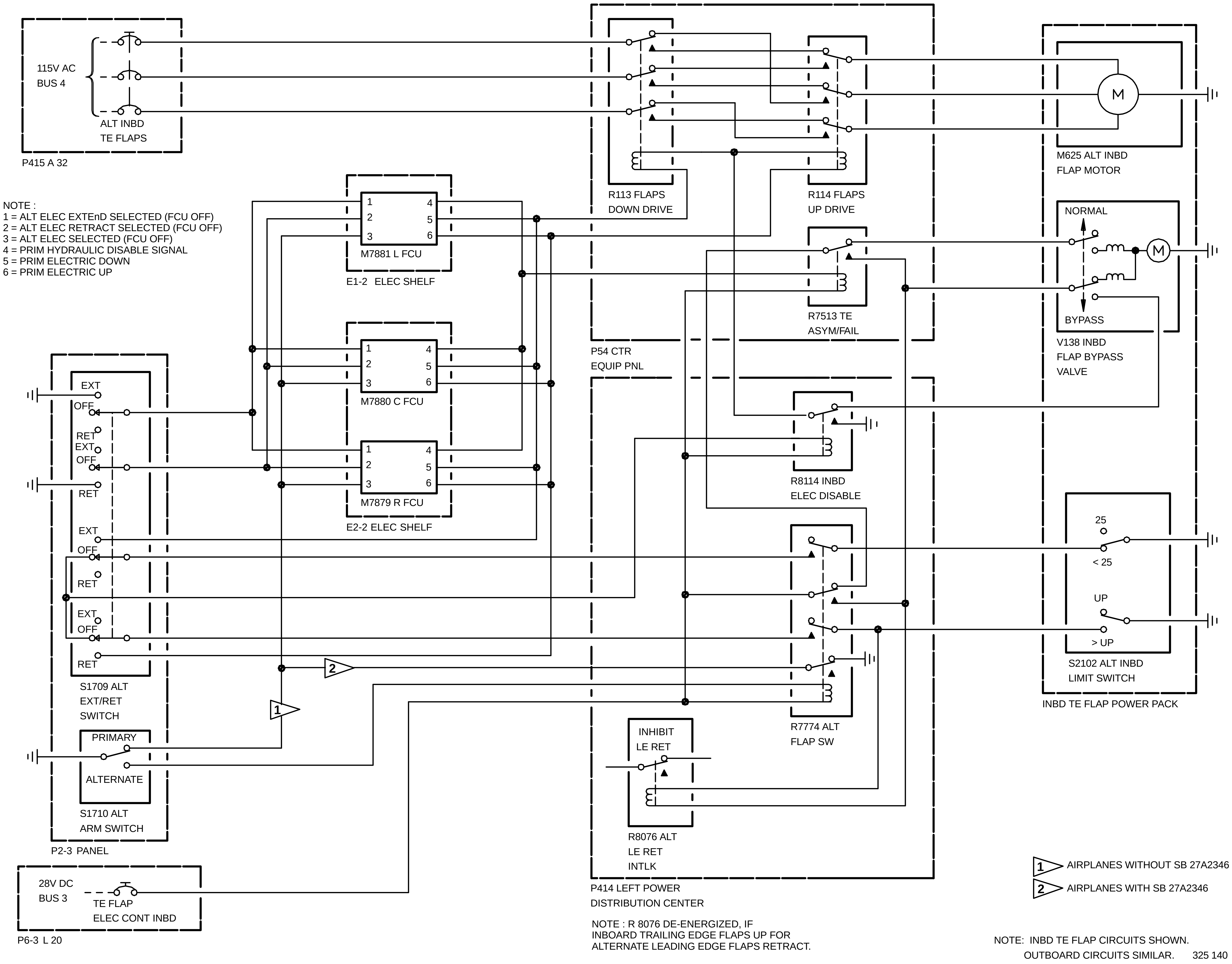


Figure J TRAILING EDGE FLAPS PRIMARY/ALTERNATE ELECTRIC CONTROL SCHEMATIC

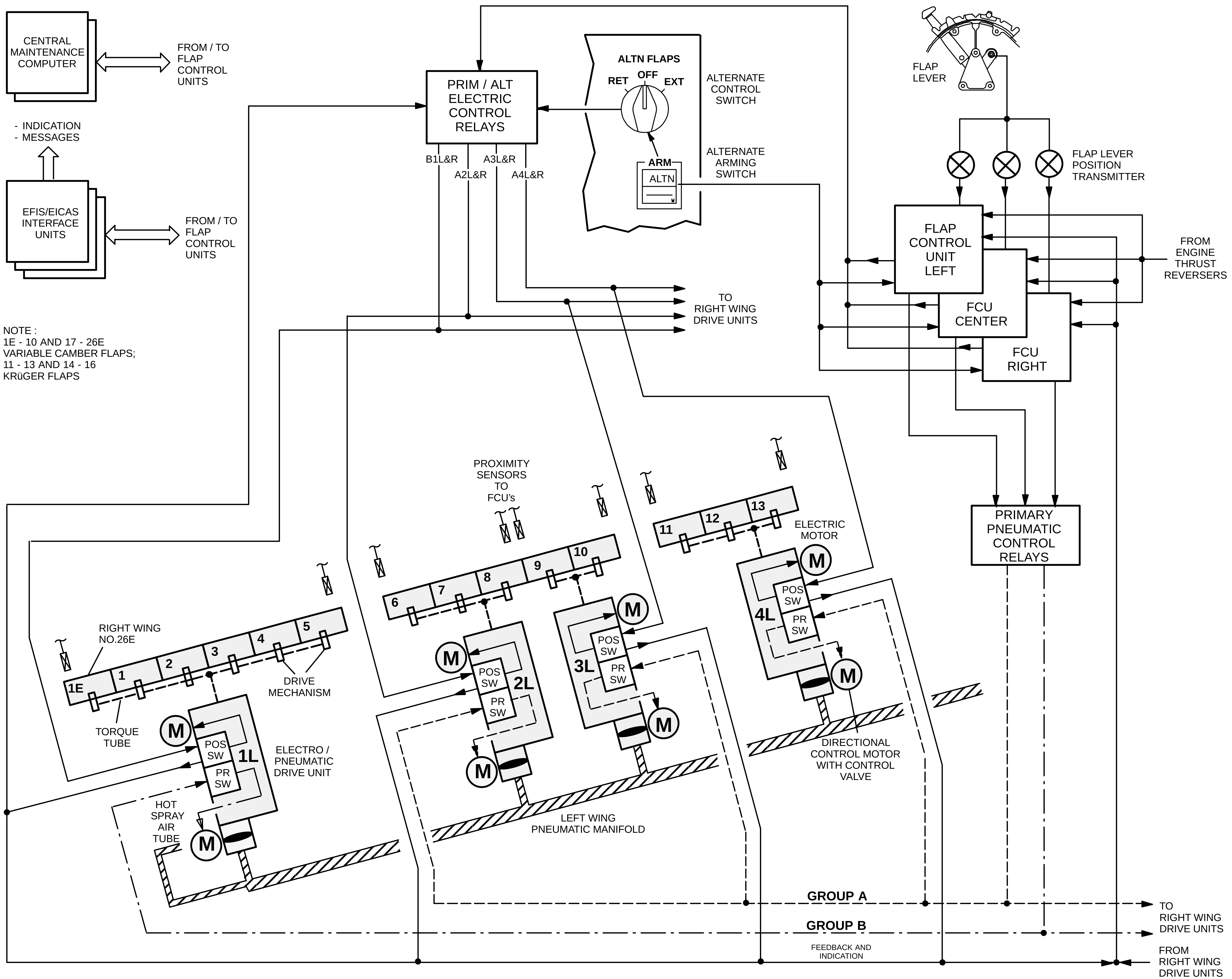


Figure K LIFT AUGMENTING BASIC SCHEMATIC

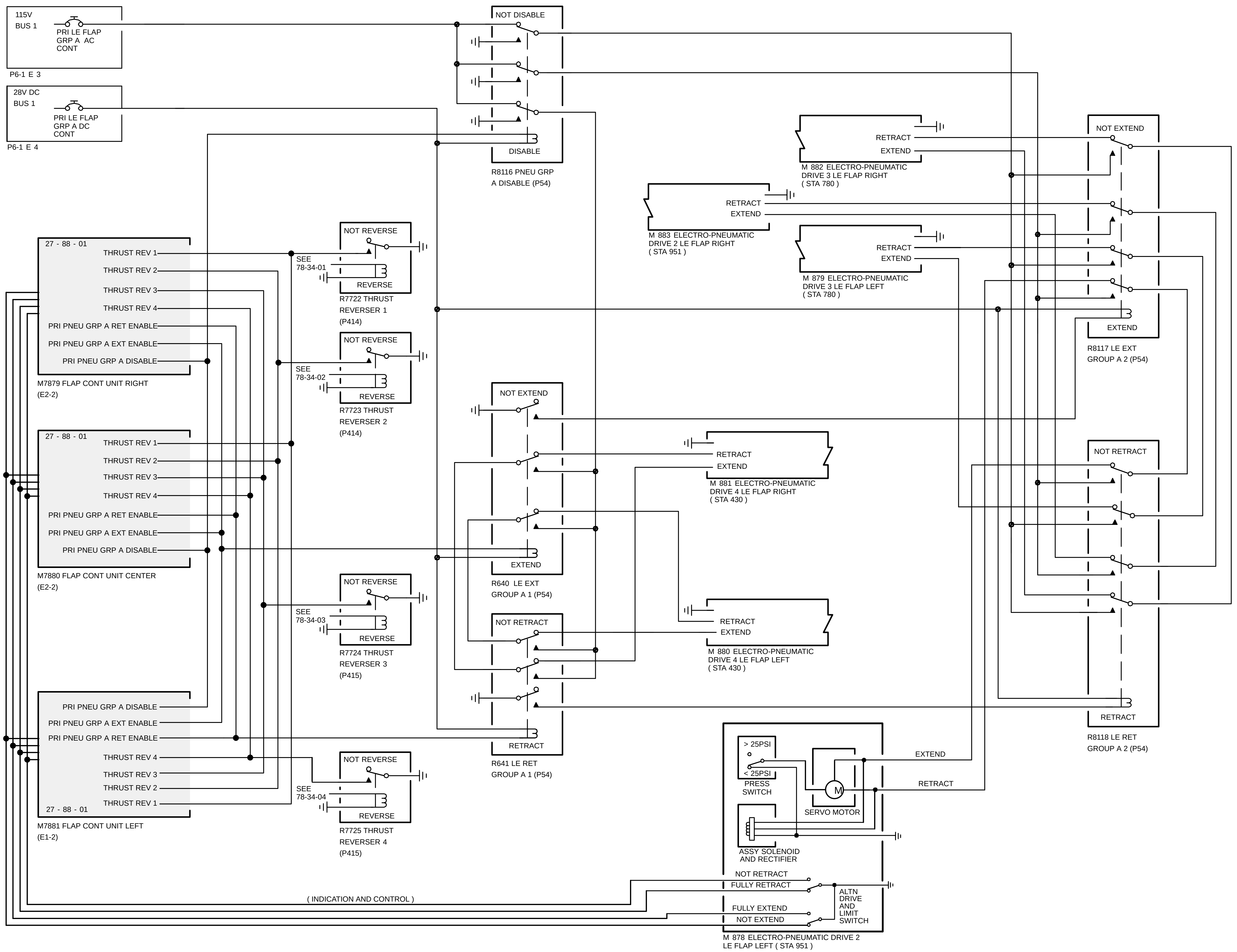


Figure L PRIMARY PNEUMATIC DRIVE SYSTEM (GROUP A) - SIMPLIFIED SCHEMATIC

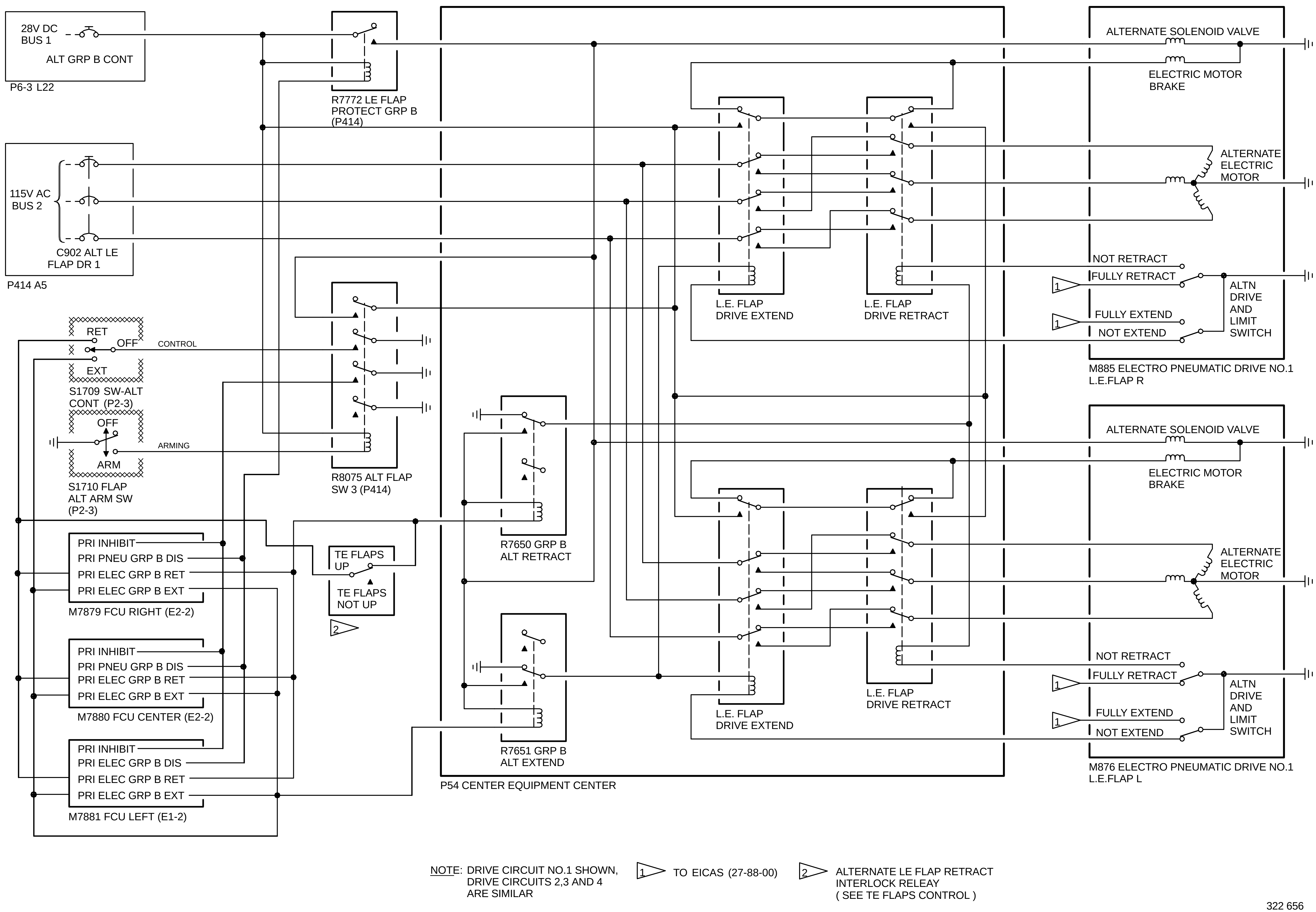


Figure M PRIMARY / ALTERNATE ELECTRIC DRIVE SYSTEM - SIMPLIFIED SCHEMATIC