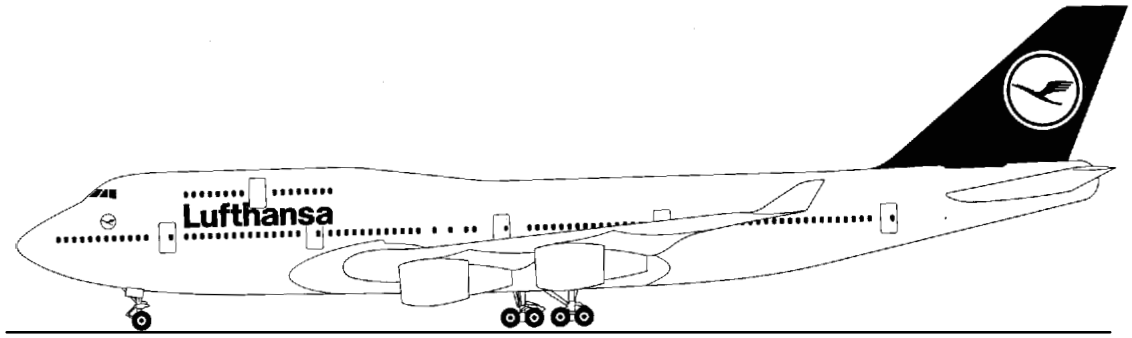
Lufthansa Technical Training

Training Manual B 747-400



ATA 22-22
AFDS

Auto Stabilizer Trim System

Level III

Book No:

Lufthansa
Technical Training GmbH
Lufthansa Base

Issue: May 2001

Lufthansa Technical Training

Lufthansa Technical Training GmbH

Lufthansa Base Frankfurt

D-60546 Frankfurt/Main

Tel. +49 69 / 696 41 78

Fax +49 69 / 696 63 84

Lufthansa Base Hamburg

Weg beim Jäger 193

D-22335 Hamburg

Tel. +49 40 / 5070 24 13

Fax +49 40 / 5070 47 46

ATA 22-22 AUTO STAB TRIM SYSTEM

AUTOMATIC STABILIZER TRIM SYSTEM INTRODUCTION

The automatic stabilizer trim system maintains the airplane in a trimmed condition around the pitch axis with changes in the stabilizer angle-of-attack.

When the stabilizer leading edge is moved up, the result is airplane nose-down trim. When the stabilizer leading edge is moved down, there is airplane nose-up trim.

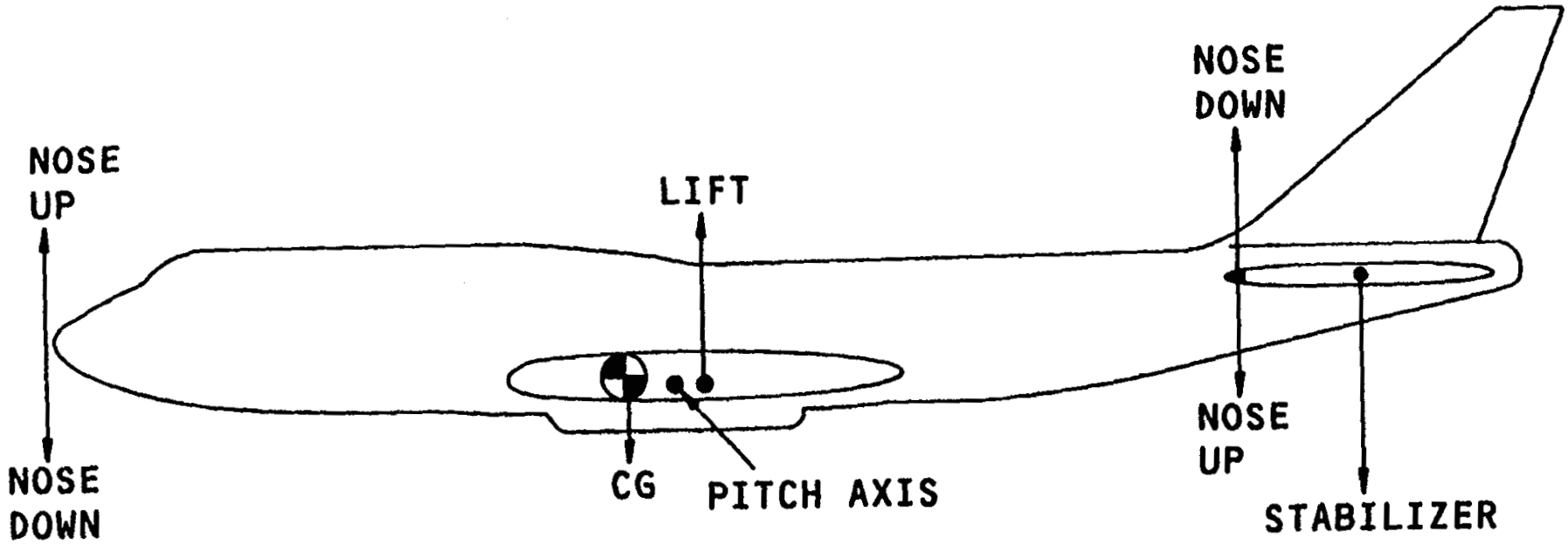


Figure 1 AUTOMATIC STABILIZER TRIM SYSTEM INTRODUCTION

AUTOMATIC STABILIZER TRIM SYSTEM

General

The functions of the automatic stabilizer trim system (ASTS) are trim functions and auxiliary functions.

Trim Functions

The stabilizer trim functions are:

- Manual trim
- FCC autotrim
- Speed trim
- Alternate trim

Auxiliary Functions

The auxiliary functions of the stabilizer trim system are:

- Stabilizer shutdown
- Stabilizer rate control
- Fault annunciation
- Tests and fault storage

System Interface

The flight control electronics power supply modules (FCEPSMs) send power to the SRMs.

The subsystems and components which interface with the stabilizer trim system include:

- Air data computers
- Flight control computers (FCCs)
- Air/ground relay
- Flap control unit (stabilizer position)
- Landing gear
- Central maintenance computers
- Engine indicating and crew alerting system (EICAS)

The interface with the rudder ratio changer and aileron lockout actuators will not be discussed.

Automatic stabilizer trim is accomplished by inputs from the flight control computers (FCCs) and air data computers (ADCs) to the stabilizer trim/rudder ratio module (SRMs). Control of the stabilizer is performed through the stabilizer trim control modules (STCMs). The STCMs control the hydraulic motors on the stabilizer ballscrew assembly. The stabilizer is automatically trimmed inflight by two methods:

- In the FCC autotrim mode when any autopilot channel is engaged.
- In the speed trim mode when no other trim mode is engaged.

Automatic stabilizer trim modes are related to manual and alternate stabilizer trim modes and they use common components. Because of this, components and operation of the stabilizer trim system (not just automatic trim) will be discussed.

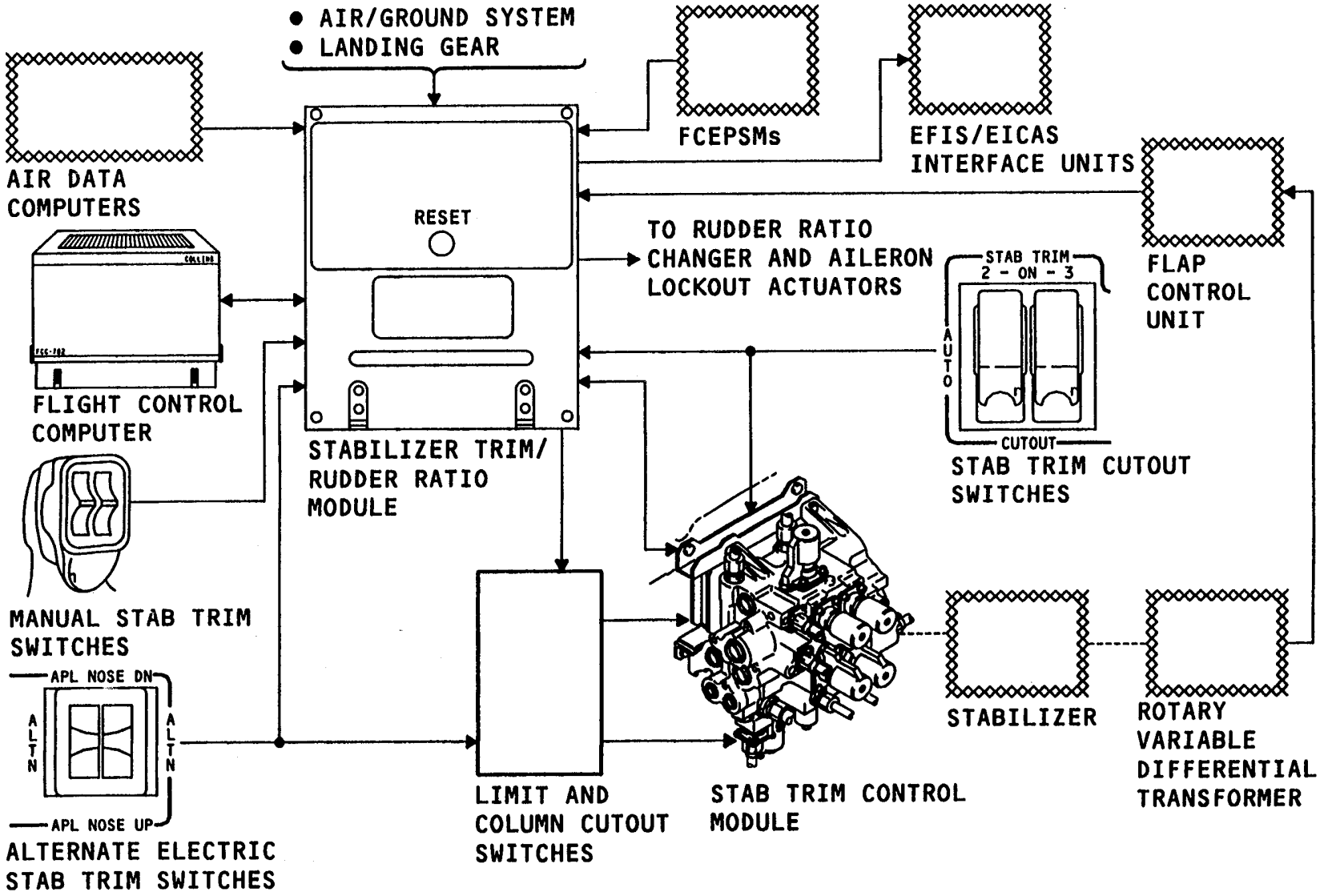


Figure 2 AUTOMATIC STABILIZER TRIM SYSTEM

COMPONENT LOCATIONS - FLIGHT DECK

The stabilizer trim system components located in the flight deck are:

- Captain's and first officer's manual stab trim switches
- Captain's and first officer's stabilizer position indicators
- Stab trim cutout switches
- Alternate electric stab trim switches
- Circuit breakers

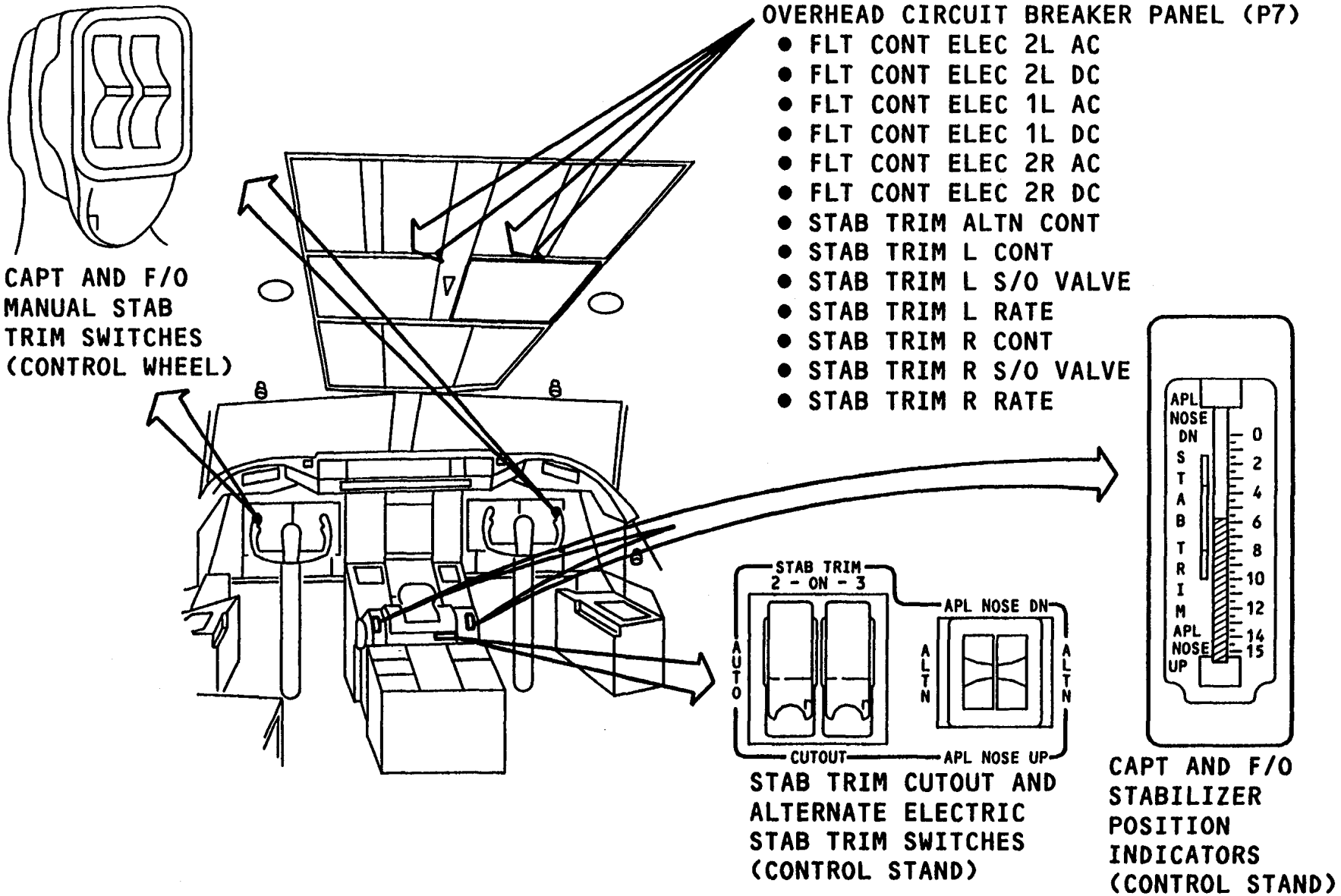


Figure 3 COMPONENT LOCATIONS - FLIGHT DECK

COMPONENT LOCATIONS - MEC

The stabilizer trim system components located in the main equipment center are:

- Left and right stabilizer trim/rudder ratio modules
- Flight control electronics power supply modules (FCE PSM)

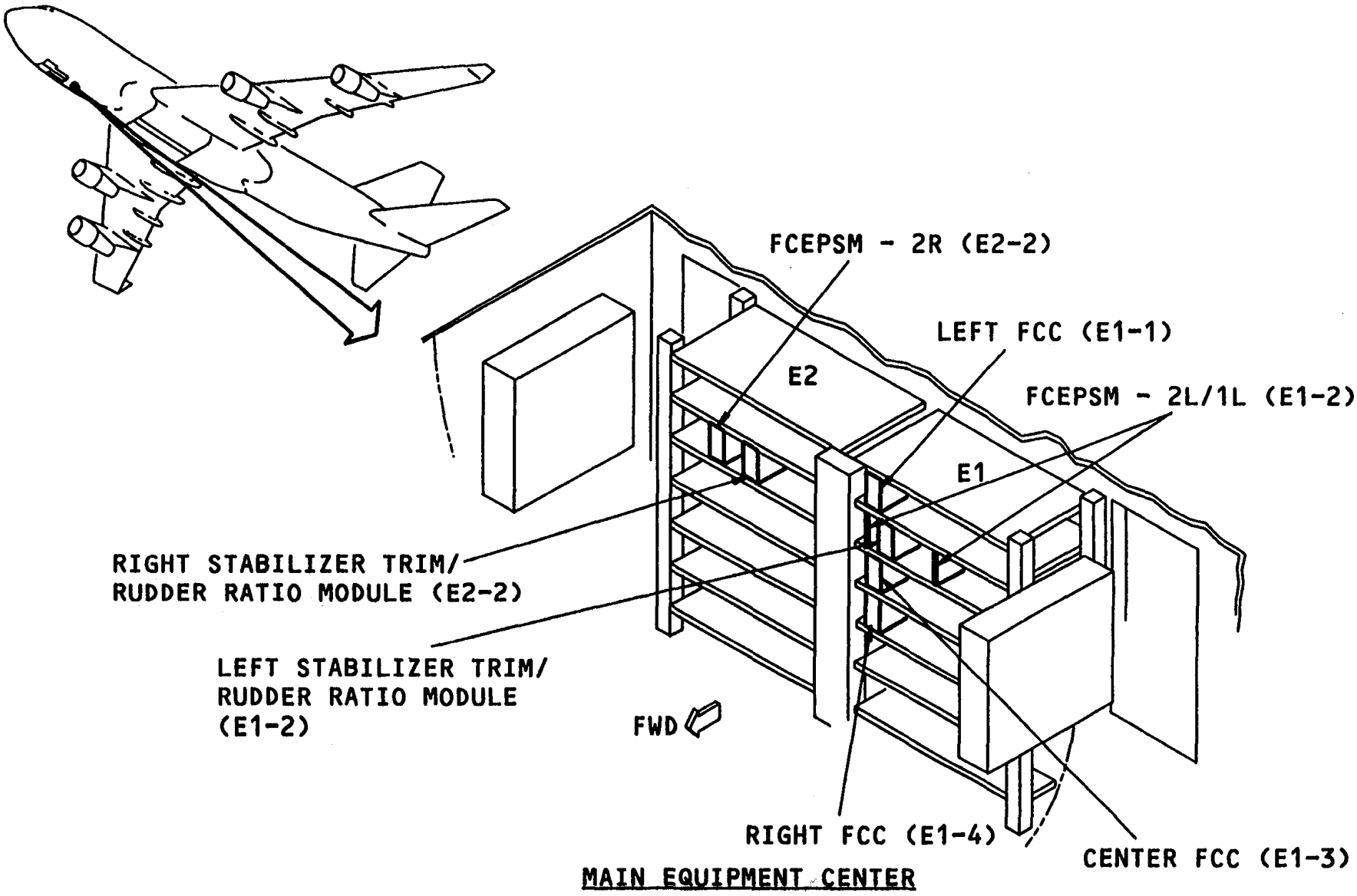


Figure 4 COMPONENT LOCATIONS - MEC

ASTS-COMPONENT LOCATIONS - SECTION 48

The stabilizer trim system components located in section 48 are:

- left and right stabilizer trim control modules
- Rate control solenoid
- Nose down arm solenoid
- Nose up arm solenoid
- Pressure switch
- Nose up control solenoid
- Nose down control solenoid
- Motor operated valve
- Left and right stabilizer trim limit switches

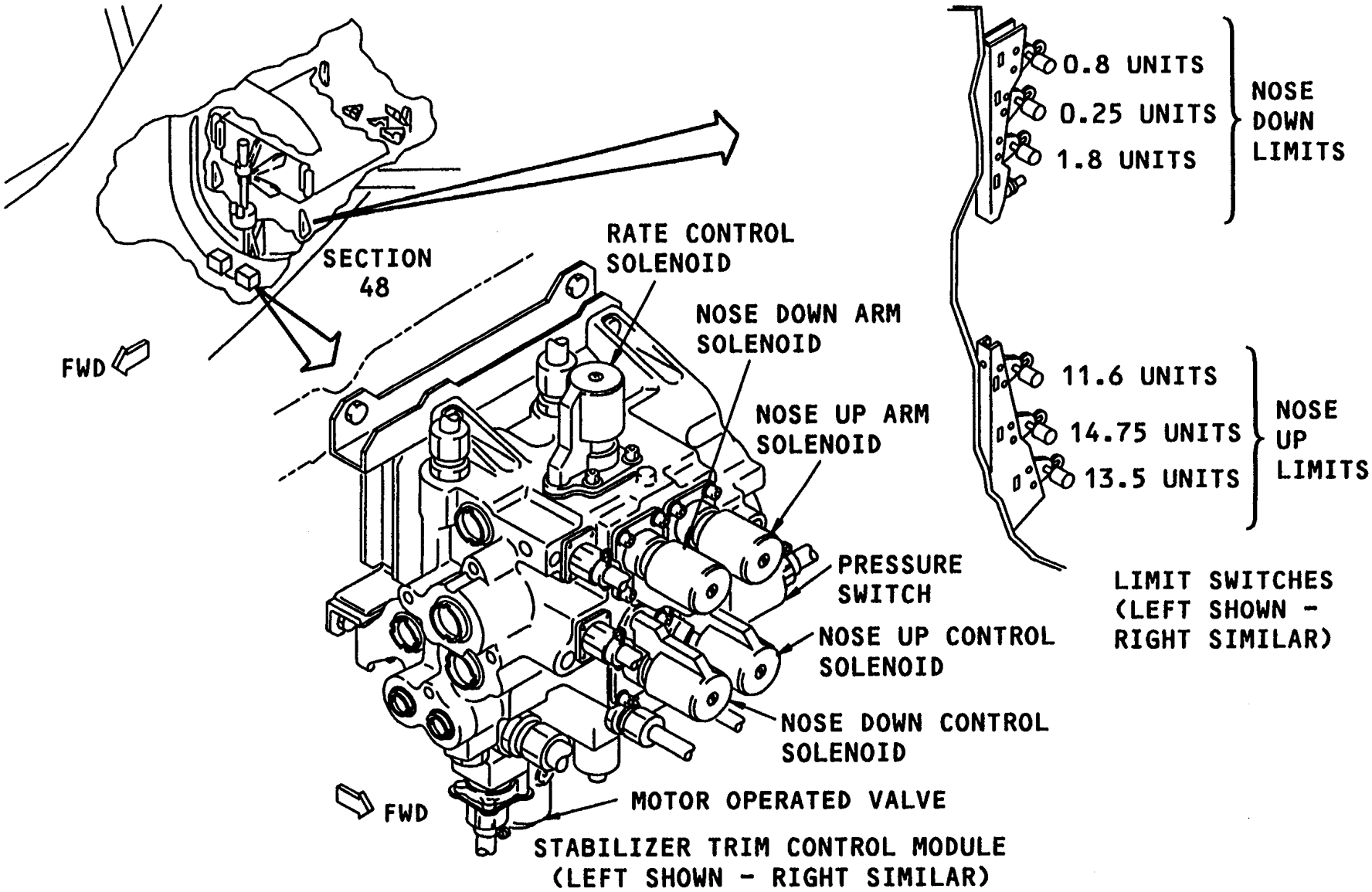


Figure 5 COMPONENT LOCATIONS - SECTION 48

THIS PAGE INTENTIONALLY LEFT BLANK

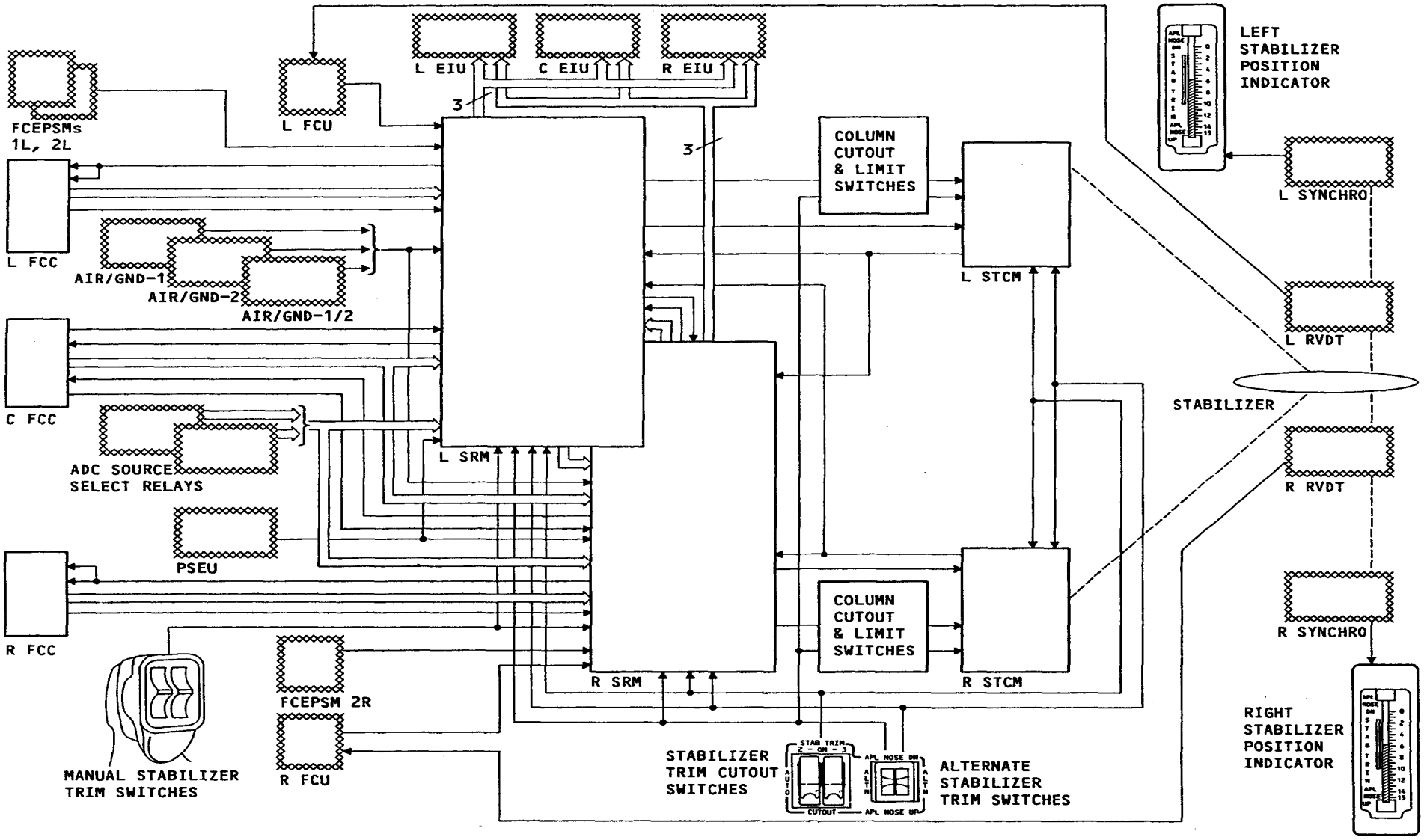


Figure 6 ASTS INTERFACE DIAGRAM

LEFT SRM - POWER DISTRIBUTION

Flight Control Electronics Power Supplies

The left flight control electronics power supply modules (FCE PSMs) receive 115v ac from the standby bus, and 28v dc from the battery bus.

The output of the two power supplies (+5 and +15v dc) are connected together inside the left SRM.

Auxiliary Functions

For stabilizer shutoff, rate and control, the left SRM receives 28v dc from bus 3.

The alternate stabilizer trim function receives 28v dc from the battery bus. The manual stab trim function receives 28v dc from bus 3.

The 28v dc arm and control commands from the left SRM or alternate trim switches, are connected to the eight solenoid valve coils in the left STCM in this way:

- Primary arm up coil, primary control up coil
- Primary arm down coil, primary control down coil
- Alternate arm up coil, alternate control up coil
- Alternate arm down coil, alternate control down coil

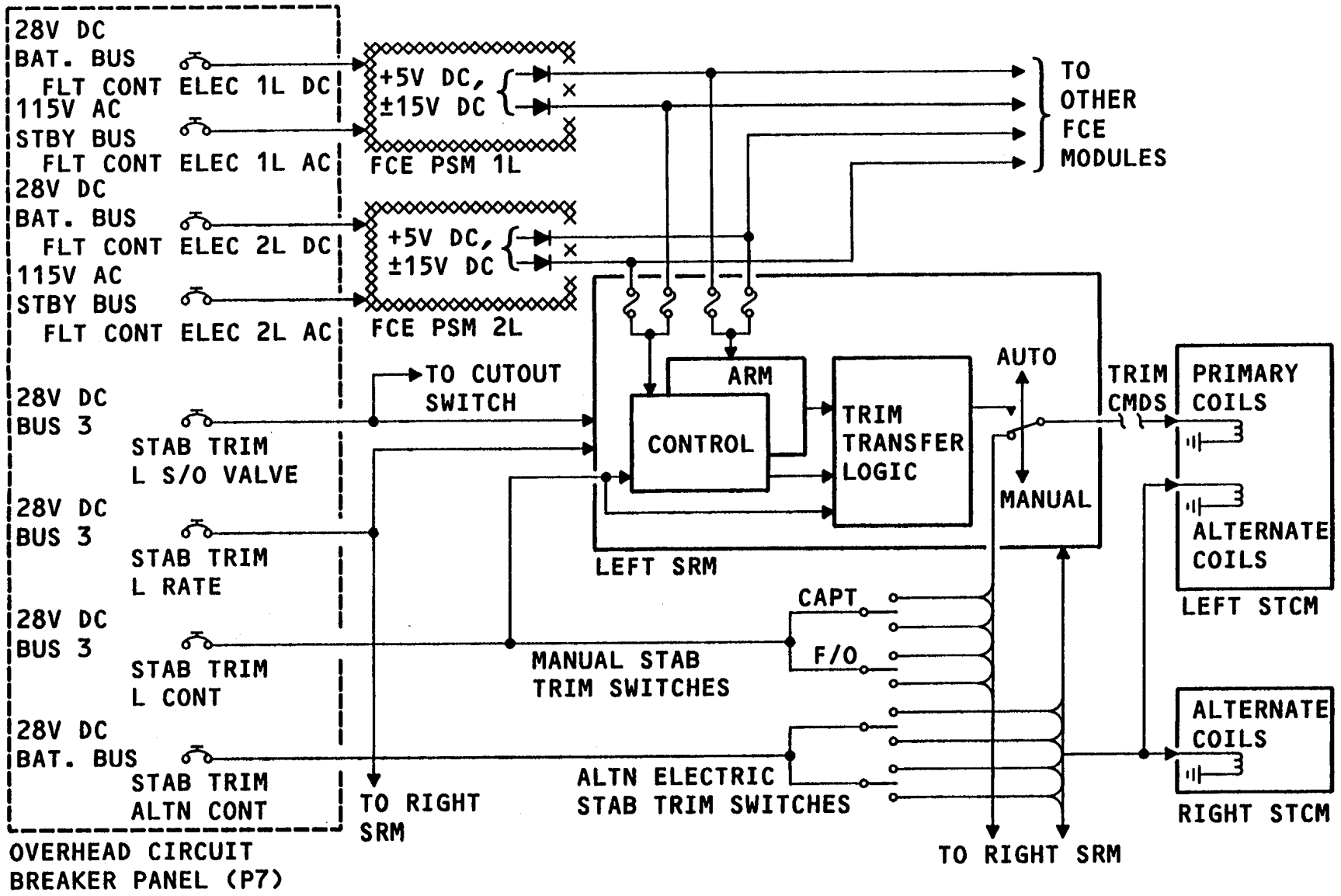


Figure 7 LEFT SRM - POWER DISTRIBUTION

RIGHT SRM - POWER DISTRIBUTION

Flight Control Electronics Power Supplies

The right SRM receives +5 and +-15v dc from only the 2R PSM.
The 2R PSM receives 115v ac from bus 2 and 28v dc from bus 2.

Auxiliary Functions

For stabilizer shutoff, rate and control, the right SRM receives 28v dc from bus 2.
The 28v dc arm and control commands to the right STCM are connected similarly to those for the left STCM.

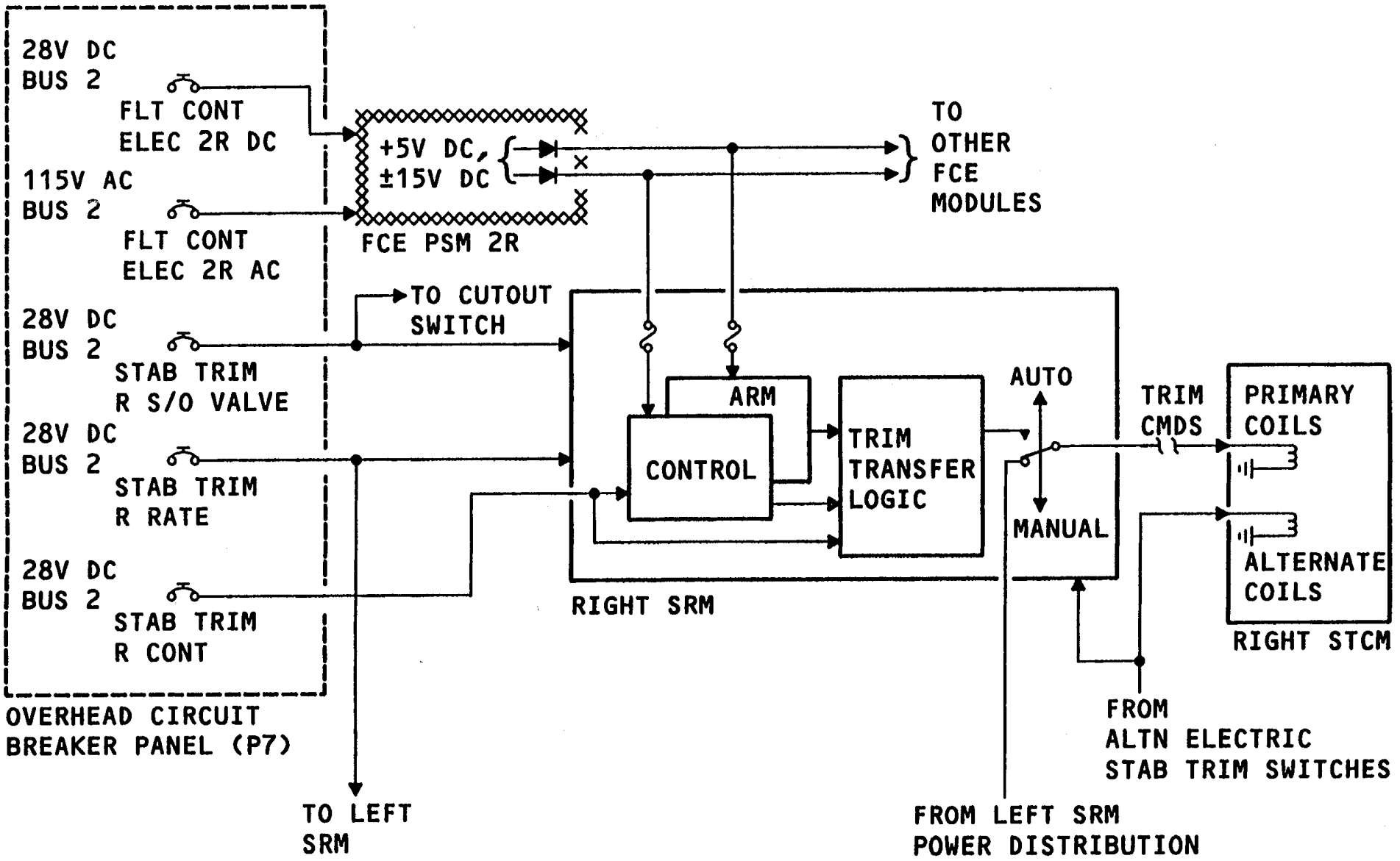


Figure 8 RIGHT SRM - POWER DISTRIBUTION

INPUTS

General

The stabilizer trim/rudder ratio module (SRM) receives inputs from many airplane systems to determine if autotrim is necessary and applicable.

Flight Control Computer Inputs

The FCCs send data on a data bus and also analog discrete inputs. The trim commands (trim up or trim down) and engage discretes are on an ARINC 429 data bus. The analog discrete is autotrim arm.

The left FCC has an interface with the left SRM and the right FCC has an interface with the right SRM. The center FCC has interfaces with the left and right SRMs.

Air Data Input

Each crew selected ADC has interfaces with the left and right SRMs. The data used is computed airspeed.

SRM Data Input

The SRMs send data on a data bus to each other. Rate control valid data is included.

Manual and &Alternate Trim Input

Manual trim commands come from the manual stab trim switches. Alternate trim commands come from the alternate electric stab trim switches. The alternate trim commands go through the alternate trim limit switches. They then go to both stabilizer trim control modules (STCMs) to operate separate coils on the trim solenoids. This gives full-rate trim.

Other Analog Inputs

other analog inputs are:

- Air/ground logic from the air/ground system
- Landing gear down discrete from PSEU
- Stabilizer and flap position from the flap control units
- Brake release discrete from each STCM

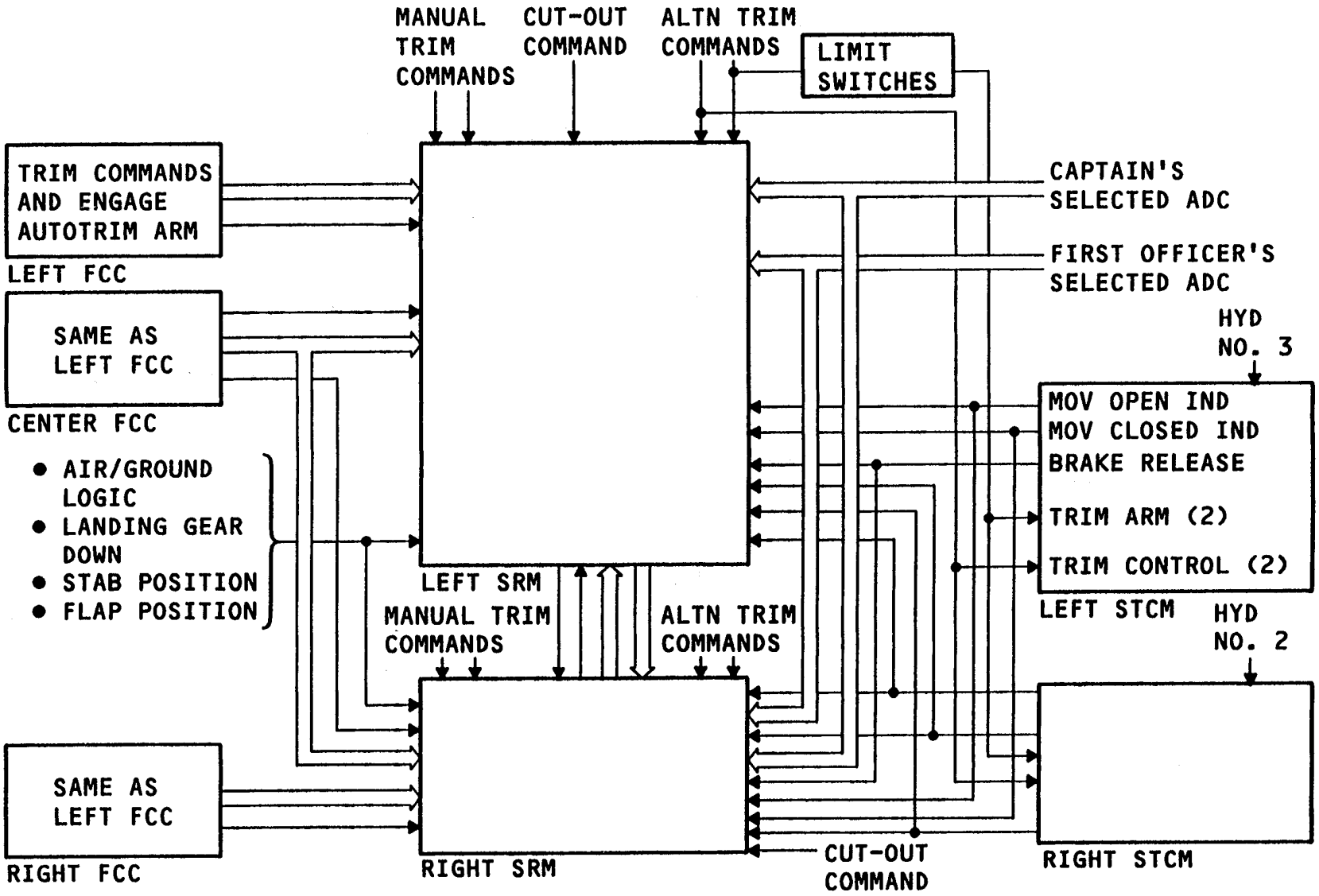


Figure 9 INPUTS

OUTPUTS

General

The SRM primary outputs are sent to the STCM. They consist of trim arm and control signals. Additionally# the SRM sends valid data to the FCCs.

SRM Stab Trim Outputs

The outputs to the STCM, to trim the airplane are trim arm and trim control signals. The arm signals go through stabilizer position limit switches before they reach the STCM.

The control signals go through the column cutout switches. The column cutout switches will remove the control signal if the pilot moves the control column at least 4.5 degrees opposite to the direction of the trim signal.

SRM Control Outputs

The SRM control signals are a rate control and motor operated valve (MOV) open and close control.

Both SRMs can send open or close commands to either of the MOVs.

The MOVs can be operated by the flight crew# using the stab trim cutout switches in the ON or CUTOUT positions. In AUTO the valves are closed by the SRMs when an unscheduled trim command occurs.

Any time the SRM is powered up with the stab trim cutout switches in AUTO or anytime the stab trim cutout switches are moved to AUTO the SRMs will send an open command to the MOVs.

Autotrim valid Outputs

The autotrim valid signals tell the FCC if the SRM is not valid or if manual trim switches are in use.

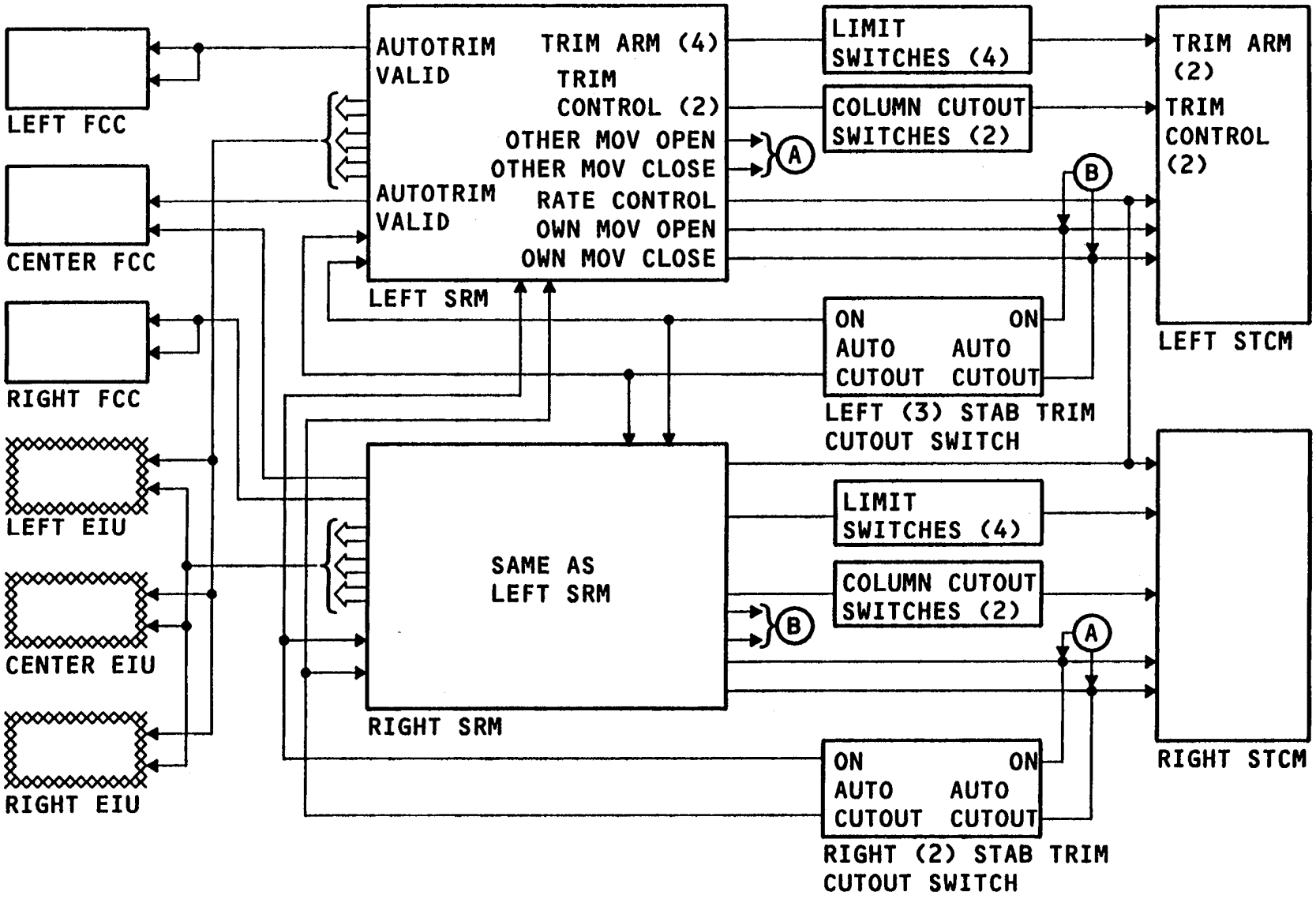


Figure 10 OUTPUTS

SRM & FCEPSM

General

The stabilizer trim/rudder ratio module (SRM) has seven functions. They are:

- Manual trim
- FCC autotrim
- Speed trim
- Stabilizer rate control
- Automatic shutdown control
- Rudder ratio control
- Aileron lockout control

Only the first five functions will be discussed here.

The flight control electronics (FCE) power supply modules supply power to all of the FCE modules.

SRM General Description

The SRM contains two microprocessors on two cards (ARM and CONTROL). Each has its own software and instructions. All functions (logic and commands) are processed by both microprocessors. The SRM has one ARINC 429 transmitter with four drivers. It has six ARINC 429 receivers for both the arm and control microprocessors. The SRM power consumption is less than 50 watts and it weighs less than 20 pounds. Cooling is per ARINC 600.

SRM Built-In Test and Monitor

The SRM has continuous built-in test and monitors to detect and isolate faults in the SRM function and in the interfacing DRUG.

SRM Maintenance Reset

Some SRM faults are latched and do not clear when the fault clears. The maintenance reset switch does the same function as a power-up reset and clears all fault memory in the SRM. However, any active faults return.

CAUTION: CAUTION STATIC SENSITIVE. DO NOT HANDLE BEFORE READING PROCEDURE FOR HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (REF 20-41-02/201). CONTAINS DEVICES THAT CAN BE DAMAGED BY STATIC DISCHARGE.

FCE Power Supply Module general Description

The FCE power supply modules send +15v dc and +5v dc to the SRM for both the arm and control microprocessors.

CAUTION: CAUTION: STATIC SENSITIVE. DO NOT HANDLE BEFORE READING PROCEDURE FOR HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (REP 20-41-02/201). CONTAINS DEVICES THAT CAN BE DAMAGED BY STATIC DISCHARGE.

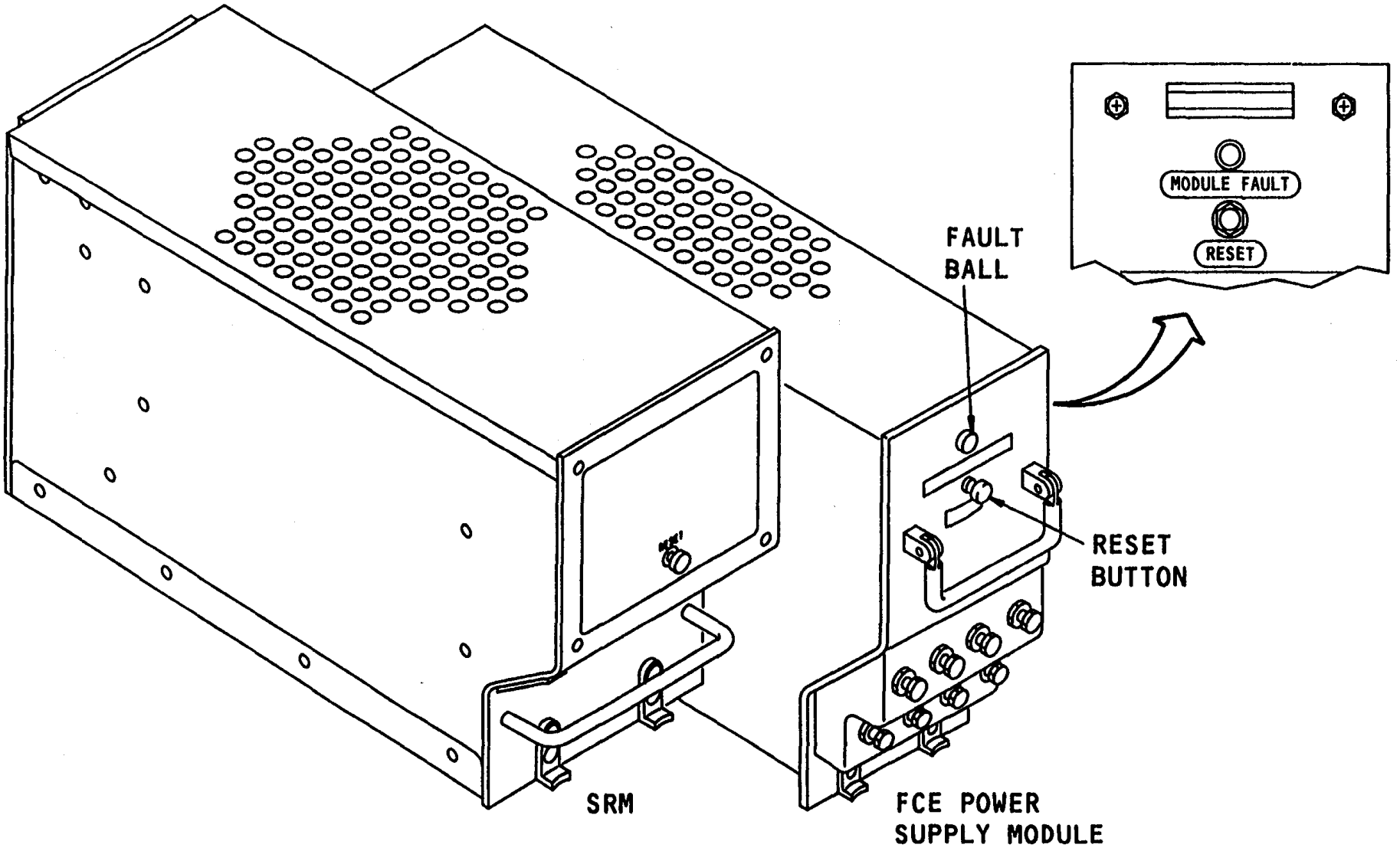


Figure 11 SRM & FCEPSM

FLIGHT CONTROL COMPUTER

General

The flight control computer (FCC) does the automatic stabilizer trim (autotrim) function as well as other functions related to automatic flight control and auto-land.

Operation

The FCC does the autotrim function while the FCC is engaged. The FCC sends an autotrim command to the SRM with a command for the elevator to be out of the neutral position. The FCC also controls the autotrim mode in the SRM.

CAUTION: CAUTION: STATIC SENSITIVE. DO NOT HANDLE BEFORE READING PROCEDURE FOR HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (REF 20-41-02/201). CONTAINS DEVICES THAT CAN BE DAMAGED BY STATIC DISCHARGE.

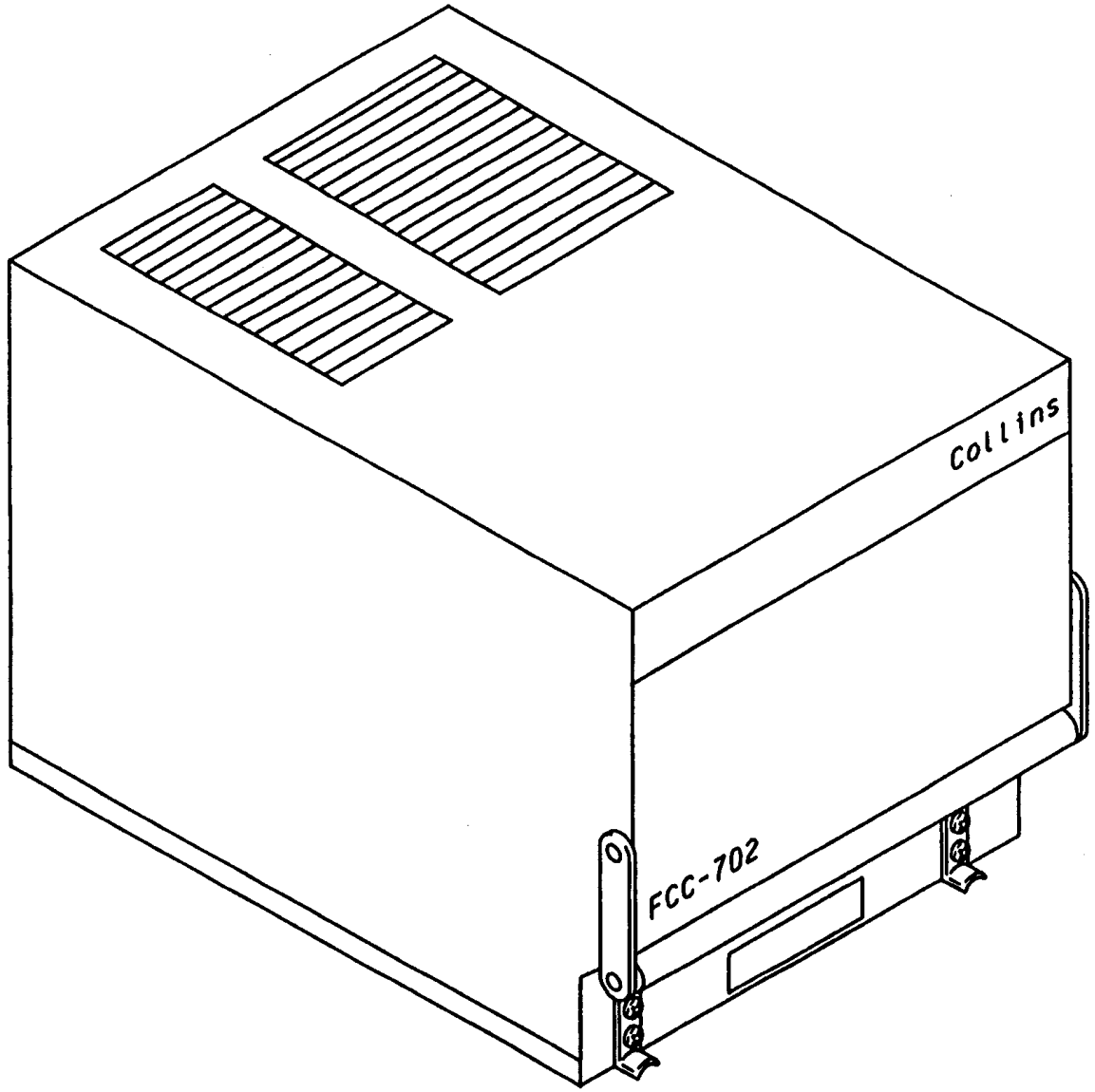


Figure 12 FLIGHT CONTROL COMPUTER

STCM & STABILIZER TRIM LIMIT SWITCHES

The stabilizer trim system components located in section 48 are:

- Stabilizer trim control modules: The stabilizer trim control module (STCM) has five solenoid valves mounted on it. The solenoid valves are interchangeable and line replaceable. Each solenoid valve has two 28v dc coils, applying 28v dc to either coil will cause the valve to open and allow hydraulic fluid to flow. The STCM has a motor operated valve (MOV) mounted on it. The MOV is line replaceable. The MOV has two 28v dc inputs, one causes the valve to open and the other causes the valve to close. When the MOV is open, hydraulic pressure is available-to the STCM.
- Stabilizer trim limit switches: The limit switches open the trim circuit when activated by cams on the stabilizer. This prevents the stabilizer from trimming beyond the limit set for the active stabilizer trim mode.

The nose down trim limit is 0.8 units for:

- Speed trim
- Manual trim with landing gear down or flaps down
- Autotrim with landing gear down or flaps down

The nose down trim limit for alternate electric trim is 0.25 units.

The nose down trim limit is 1.8 units for:

- Manual trim with landing gear up and flaps up
- Autotrim with landing gear up and flaps up

The nose up trim limit is 11.6 units for:

- Speed trim
- Manual trim
- Single rate autotrim

The nose up trim limit for alternate electric trim is 14.75 units.

The nose up trim limit for full rate autotrim is 13.5 units.

STABILIZER TRIM TABLE

Units		Degree
0.0		+3.0
0.25	NOSE DOWN	+2.75
0.8	LIMIT	+2.2
1.8	SWITCHES	+1.2
5.0		-2.0
7.0		-4.0
9.0		-6.0
11.6	NOSE UP	-8.6
13.5	LIMIT	-10.5
14.75	SWITCHES	-11.75
15.0		-12.0

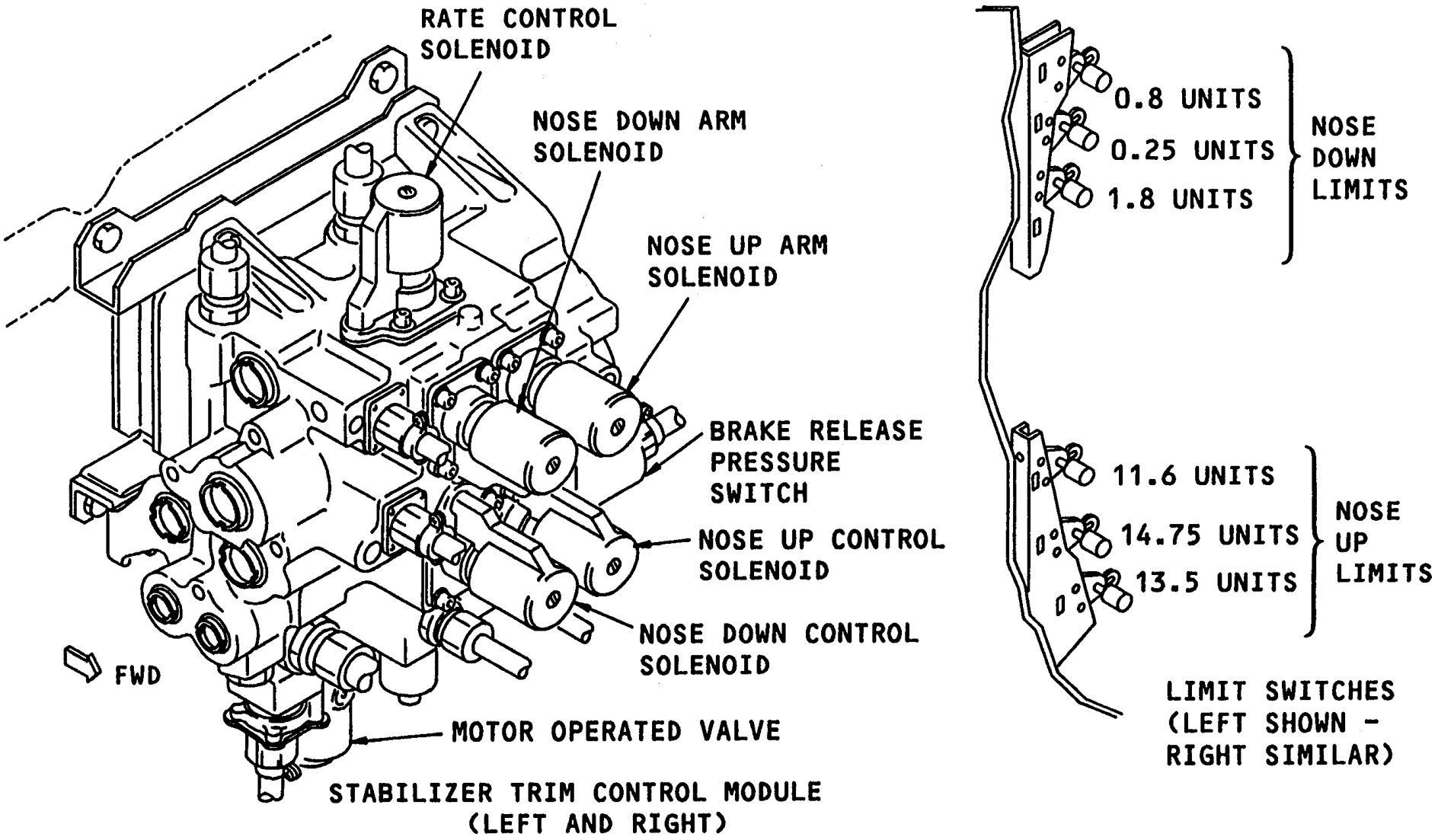


Figure 13 STCM & STABILIZER TRIM LIMIT SWITCHES

SWITCHES AND INDICATORS

Manual stab Trim Switches

The captain's and first officer's manual stab trim switches receive 28v dc. The switches connect this 28v dc to the STCM solenoid valves for nose up or nose down trim, when the switches are used during the manual trim mode.

Stab Cutout Switches

The stab trim cutout switches receive 28v dc. The switches connect the 28v dc to open the MOV when the switches are in the ON position, or close the MOV when the switches are in the CUTOUT position. The switches are guarded to the AUTO position. The switches also provide a ground signal to the L or R SRM, so the SRM knows the position of the switch.

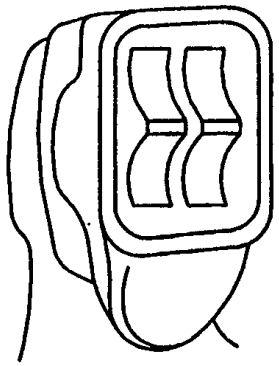
Alternate Electric Stab Trim Switches

The alternate electric stab trim switches receive 28v dc. The switches connect this 28v dc to the appropriate STCM solenoid valves, when the switches are in the APL NOSE UP or APL NOSE DOWN

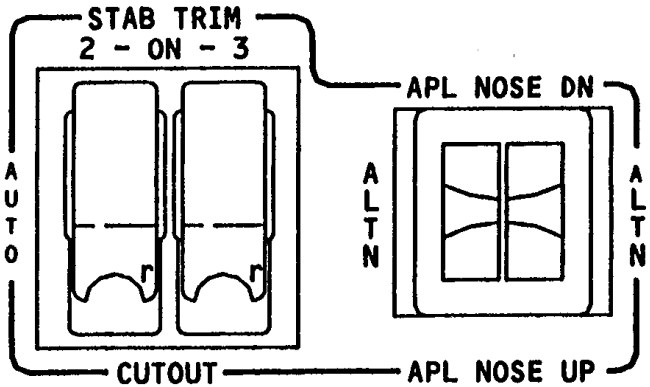
position. The switch position also goes to the SRMs.

Stab Trim Indicators

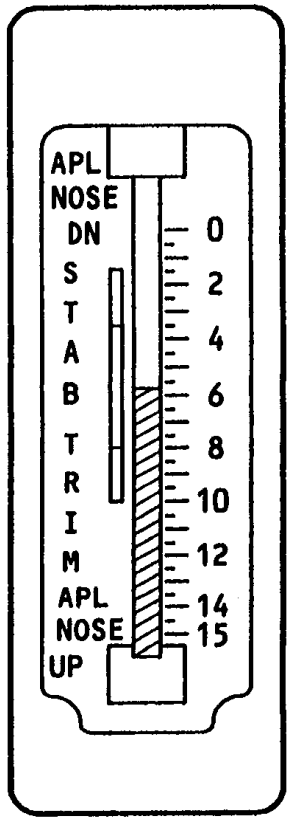
The captain's and first officer's stabilizer trim indicators are synchro receivers. They display the stabilizer position in units of trim.



CAPT AND F/O
MANUAL STAB
TRIM SWITCHES



STAB TRIM CUTOUT AND
ALTERNATE ELECTRIC
STAB TRIM SWITCHES



CAPT AND F/O
STABILIZER
POSITION
INDICATOR

Figure 14 SWITCHES AND INDICATORS

THIS PAGE INTENTIONALLY LEFT BLANK

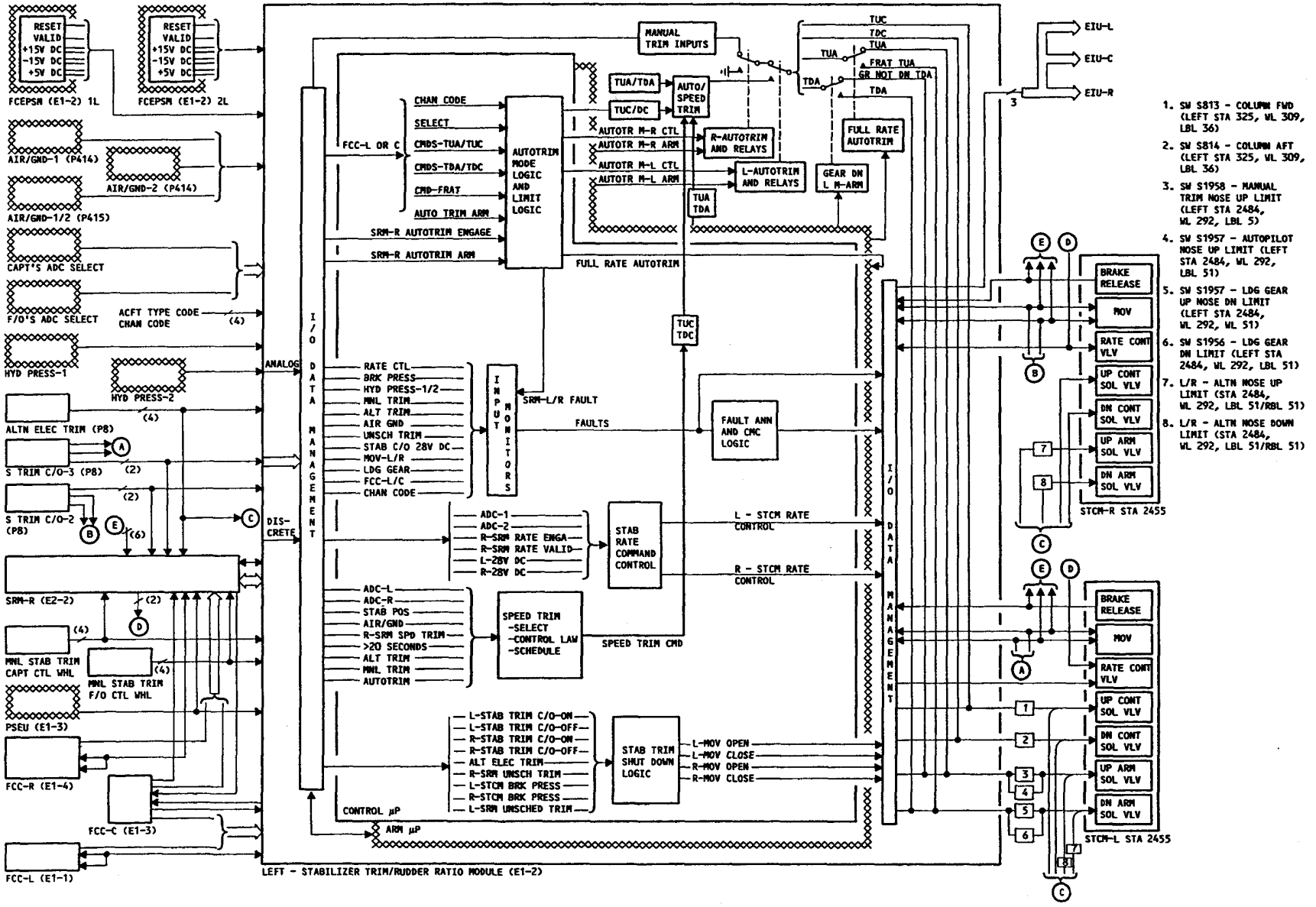


Figure 15 SCHEMATIC DIAGRAM

OPERATIONAL MODES

Power-Up

Power-up occurs when power is applied. If power is applied on the ground and no autopilot is in command, then the SRM is disengaged. If power is applied in the air and no autopilot is in command, the speed trim mode starts. If power is applied and an autopilot is in command, then the auto trim mode starts.

Disengaged

The SRM is disengaged when no other stabilizer trim mode is required. If an autopilot is in command, then the auto trim mode is entered. If manual trim is commanded, then the manual trim mode is entered. If the airplane goes into the air with no autopilot in command, 20 seconds later the speed mode starts.

Speed Trim

The speed trim mode starts when in the air and no other stabilizer trim mode is used. If an autopilot is placed in

command, then the autotrim mode starts. If manual trim is commanded, then the manual trim mode starts.

Auto Trim

The auto trim mode starts when any autopilot is in command. If manual trim is used and only a single autopilot channel is in command, it will disconnect and allow the manual trim mode. If manual trim is used with the autopilot multichannel, the autotrim mode remains engaged. If the autopilot is disconnected, the speed trim mode starts if the airplane is in the air or the SRM is disengaged if the airplane is on the ground.

Manual Trim

The manual trim mode is entered whenever manual trim is used, except when the autopilot is multichannel. When manual trim is no longer commanded, the speed trim mode starts# if the airplane is in the air, or the SRM is disengaged if the airplane is on the ground.

Alternate Trim

The alternate trim mode starts whenever alternate trim is used. The alternate trim mode is independent of all other stabilizer trim modes.

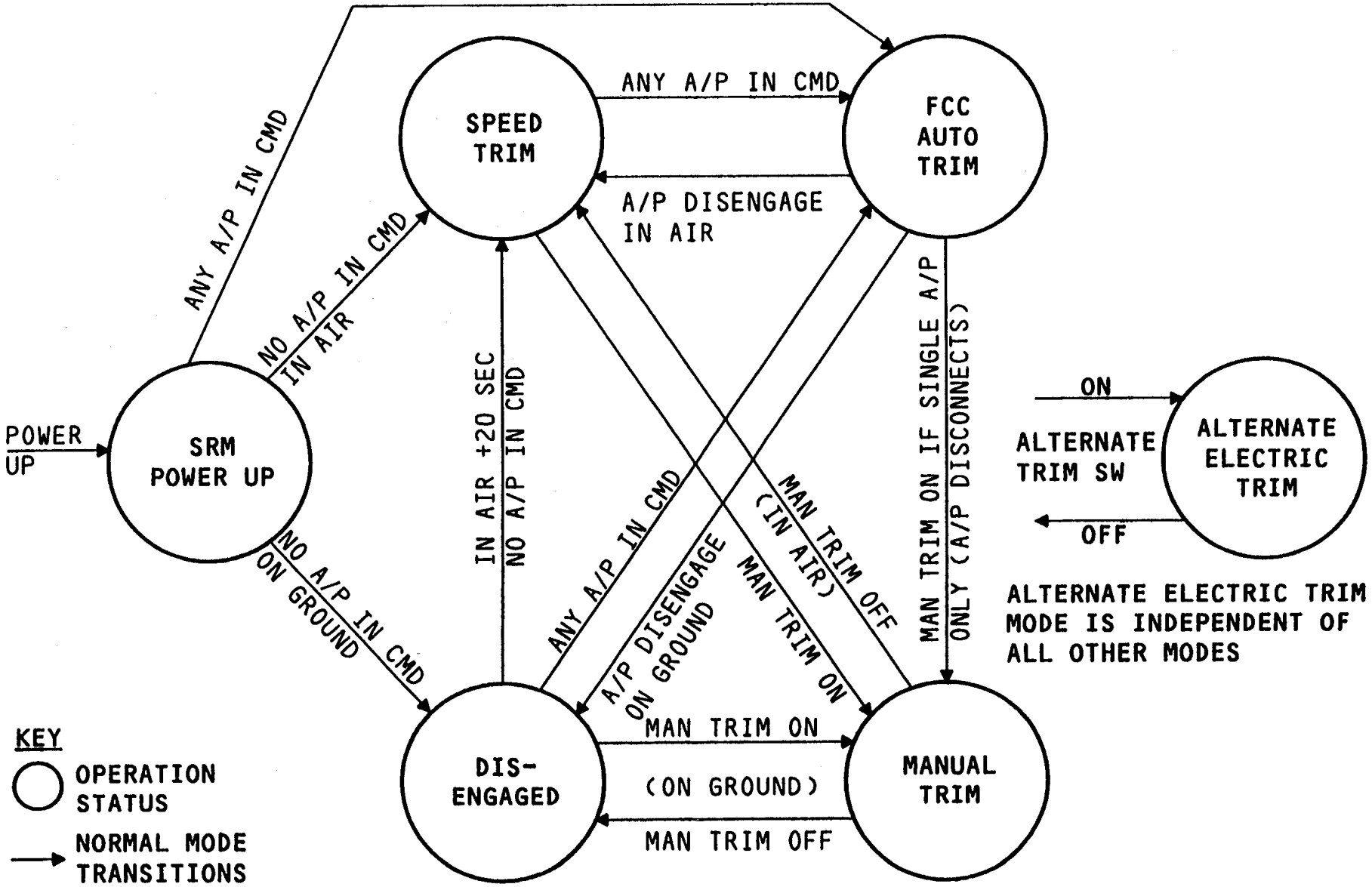


Figure 16 OPERATIONAL MODES

MANUAL STABILIZER TRIM

General

The flight crew's manual stabilizer trim switches are used for manual trim. An arm signal and a control signal in the same direction are necessary for the trim functions. The manual trim signal goes to both SRMs. This causes both STCMs to trim (full-rate trim).

Trim Transfer

The trim transfer relay selects manual or automatic trim. Automatic trim can be either FCC automatic trim or speed trim.

FCC autotrim mode requires autotrim engage and arm logic from the FCCs. Speed trim mode is determined by speed mode logic. When a valid command for manual trim is detected by the monitor logic, two results occur. First, the autotrim valid signal to the FCCs is set to zero. If there is a single autopilot channel engaged, the loss of the autotrim valid signal causes the autopilot to disconnect and the trim transfer relay relaxes, allowing manual trim to occur.

Trim Limit Selection

The nose up arm and nose down arm signals go through the limit switches in the relaxed condition. There is a different nose up limit for full-rate autotrim mode. The full-rate autotrim mode is a special case of autotrim where both SRMs are used. The nose down limit changes when landing gear is up, flaps are up and not in speed trim.

Column Cutout

The column cutout switches stop trim when the control column is moved opposite to the direction of trim.

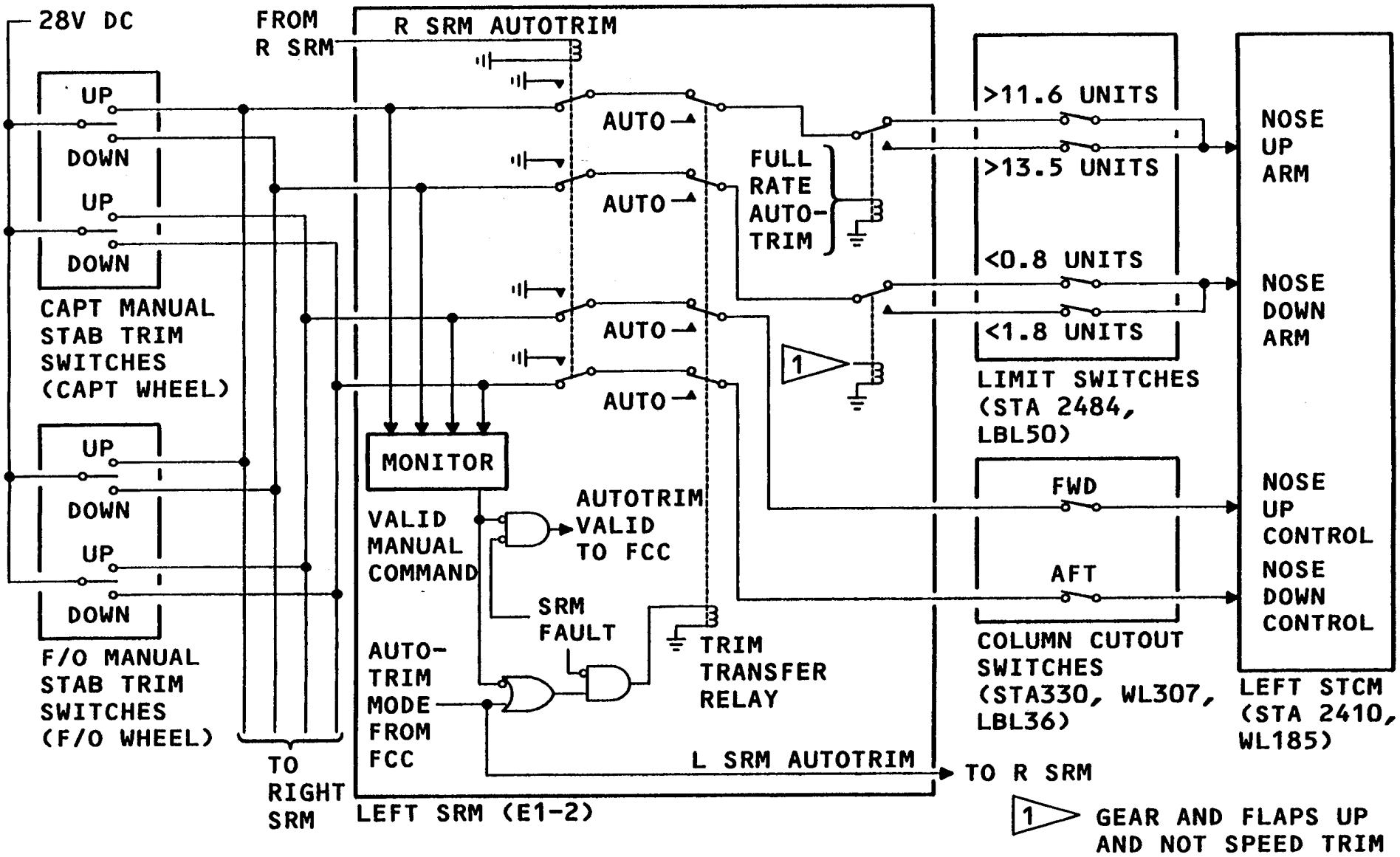


Figure 17 MANUAL STABILIZER TRIM

FCC AUTOTRIM

General

The three flight control computers have this interface with the two SRMs:

- Left FCC to left SRM
- Right FCC to right SRM
- Center FCC to both left and right SRM

Interface

The analog discrete inputs from the FCCs to the SRMs are an ARM signal when the FCC is engaged and selects the SRM to be used for autotrim. The analog output to the FCCs from the SRMs is the autotrim valid signal. The digital input from the FCCs to the SRMs are autotrim commands (up and down, arm and control), full rate autotrim logic and autotrim engage.

The FCC selection logic receives autotrim arm and engage status from the FCCs. When both signals are received from a common FCC this logic sets the autotrim mode output to one. This signal is used by the trim transfer logic to control the trim transfer relay.

The full rate autotrim logic removes the 3.5 second delay from the autotrim command output during LAND 2 when two channels are available for stabilizer trim.

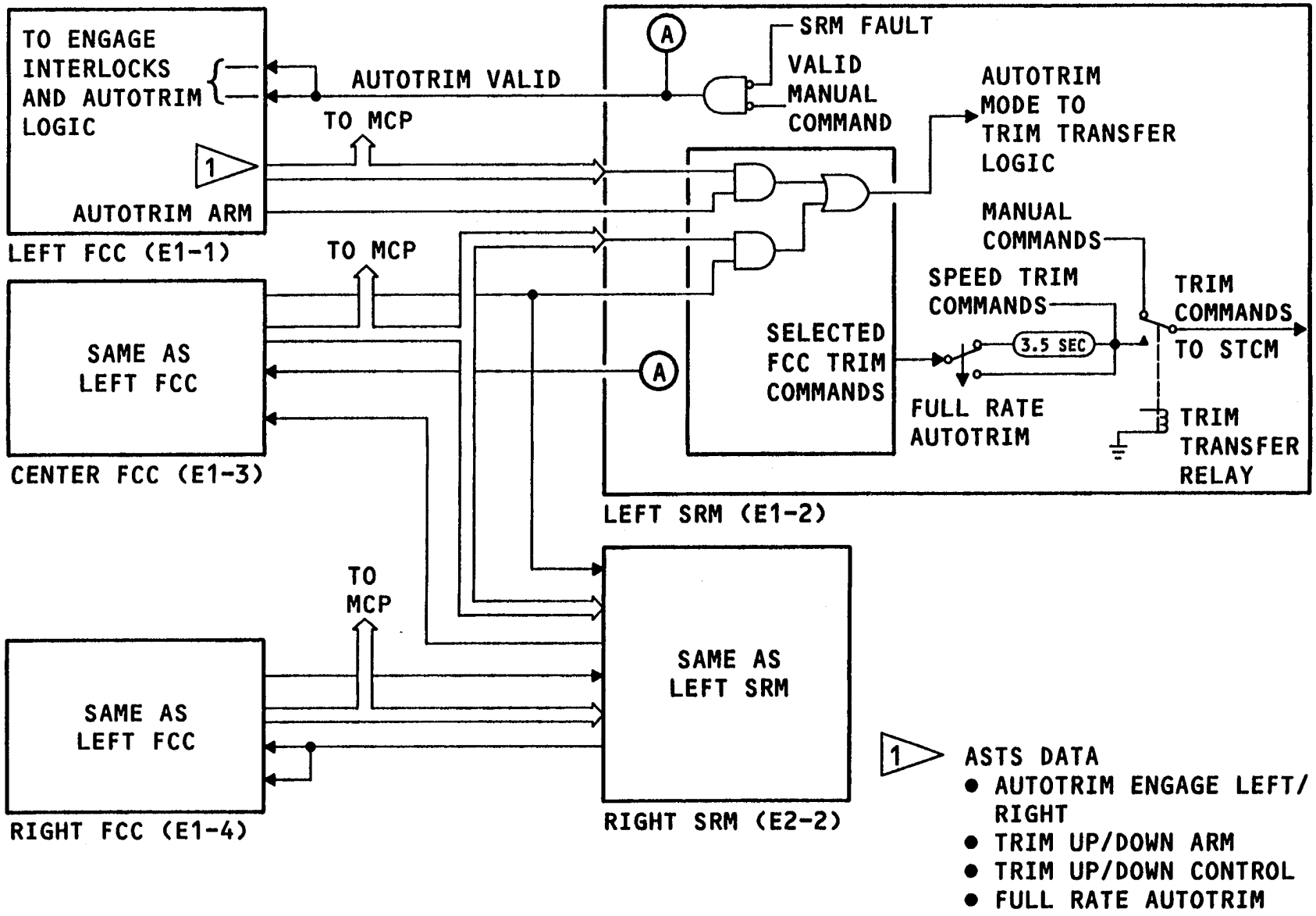


Figure 18 FCC AUTOTRIM

FCC AUTOTRIM LOGIC AND CONTROL

General

The purpose of FCC autotrim is to keep the airplane in trim while the autopilot is engaged. This will make sure that disengagement of the autopilot will not cause a pitch change or out of trim condition (except during LAND 2 approach when this condition is wanted).

The automatic trim logic in each FCC gives the trim commands and arm, engage and full rate autotrim logic to the SRM(s). In addition, the logic for stabilizer trim bias is included.

Stabilizer Trim Commands

The trim commands are caused by an elevator servo command. When the elevator is commanded out of the neutral position, the FCC produces a trim command. The trim commands are prevented during the rollout mode.

SRM Autotrim Engage

The autotrim engage logic to the SRM is controlled by the SRM/FCC select logic.

The initial selection of the trim path is the result of the first autopilot channel to be engaged. An autosequence may occur after this initial selection.

Stabilizer Trim Bias

A bias is added to the stabilizer trim command during LAND 2 conditions only. This bias gives a pitch-up condition if the autopilot disconnects at low altitude. The bias is enabled at 120 feet radio altitude if both SRMs are valid. The bias is enabled at 190 feet if only one SRM is valid. The bias is cancelled at go-around.

Full Rate Autotrim

Full rate autotrim occurs during LAND 2 conditions only This is provided below 120 feet radio altitude and only if both SRMs are valid. The full rate autotrim mode removes the 3.5 second time delay for autotrim commands in the SRM and provides the autotrim engagement of both SRMs.

Trim Fault Monitor

The trim fault monitor compares stabilizer movement to the autotrim command. If the stabilizer moves without a command or opposite to the command, UNSCHEDULED TRIM logic is true. If there is a command and the stabilizer does not move, this is called DEAD TRIM.

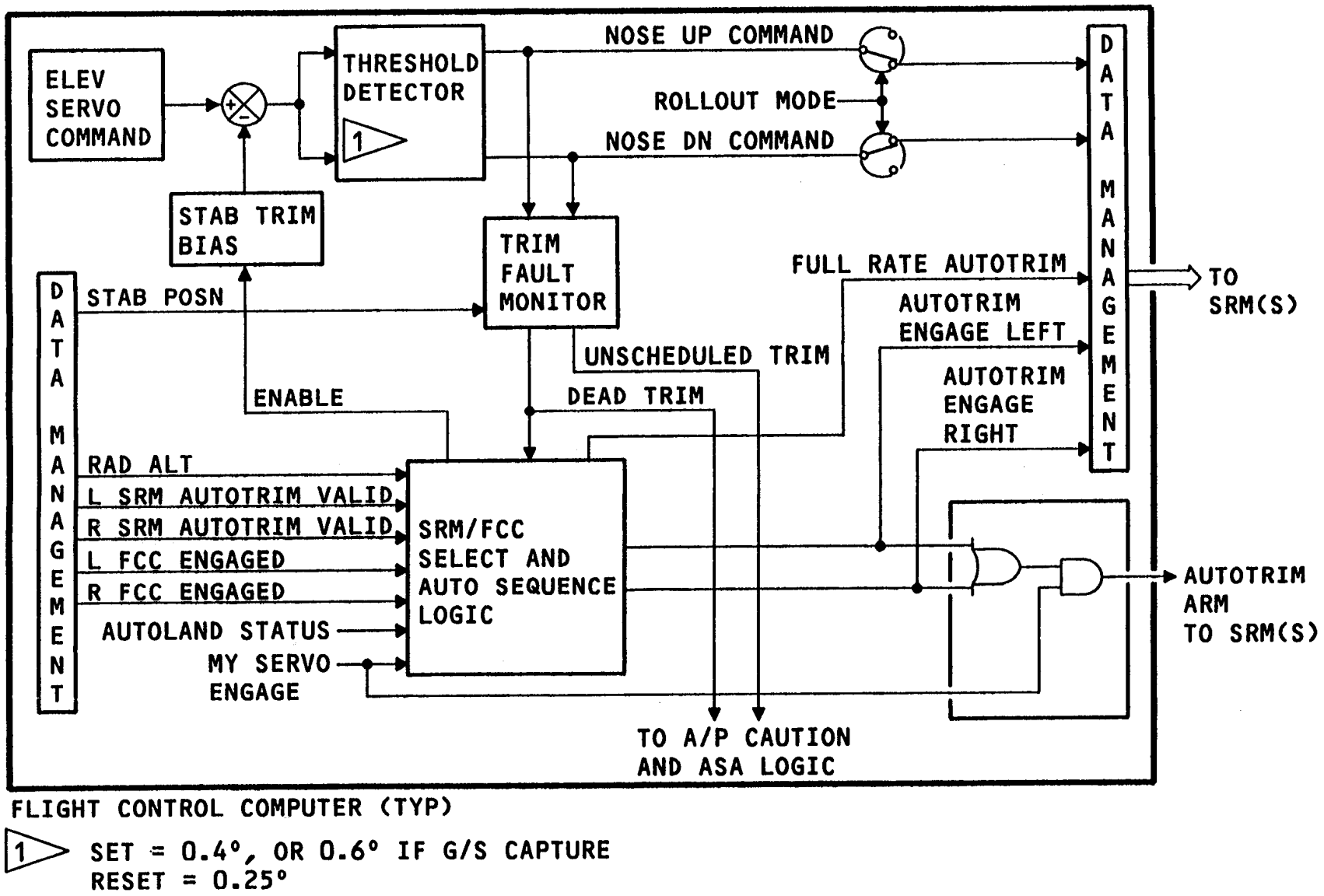


Figure 19 AUTOTRIM LOGIC AND CONTROL

FCC AUTOTRIM FAILURE SUMMARY

The FCC supplies responses and flight deck effects to stabilizer trim failure conditions. These are:

- A/P disconnect
- A/P caution
- No LAND 3
- No AUTOLAND
- Autosequence

The response and/or flight deck effect is related to the A/P engage status.

A/P ENGAGE STATUS	FAILURE TYPE	AUTOTRIM RESPONSE	FCC FLIGHT DECK EFFECT
NONE ENGAGED	SRM AUTOTRIM VALID FAIL 3	———	A/P FAILS TO ENGAGE A/P DISCONNECT
SINGLE CHANNEL ENGAGED C FCC/L SRM	• DEAD TRIM • FCC UNSCHED TRIM • SRM AUTOTRIM VALID FAIL (L SRM ONLY)	• AUTOSEQUENCE TO R SRM 1 ——— • REMOVE SRM FROM AUTOTRIM	• NONE 2 • A/P CAUTION • NONE 2
SINGLE CHANNEL ENGAGED C FCC/R SRM OR R FCC/R SRM OR L FCC/L SRM	• DEAD TRIM • FCC UNSCHED TRIM • SRM AUTOTRIM VALID FAIL 3	• REMOVE SRM FROM AUTOTRIM ——— • REMOVE SRM FROM AUTOTRIM	• A/P CAUTION • A/P CAUTION • A/P DISCONNECT AND NO LAND 3 ANNUNCIATION
MULTICHANNEL ENGAGED	• DEAD TRIM (FIRST FAIL - ONE AUTOTRIM PATH REMAINS) • DEAD TRIM (SECOND FAIL - NO AUTOTRIM PATH REMAINS) • FCC UNSCHED TRIM (ONE FCC DETECTED) • FCC UNSCHED TRIM (TWO OR MORE FCC'S DETECT)	• AUTOSEQUENCE 1 • REMOVE SRM FROM AUTOTRIM ——— ———	• NONE 2 • NO AUTOLAND ANNUNCIATION AND A/P CAUTION • NONE 2 • NO AUTOLAND ANNUNCIATION AND A/P CAUTION

1 IF SEQUENCE TO INVALID SRM, ANNUNCIATE NO AUTOLAND

2 ANNUNCIATE NO LAND 3 AFTER TOUCHDOWN, NO A/P ENGAGE, AND < 40 KTS, FOR MAINT ACTION

3 BOTH INPUTS ARE LOGIC LOW DUE TO SRM FAIL, MANUAL TRIM OR AUTOTRIM VALID INTERFACE OPEN

Figure 20 FCC AUTOTRIM FAILURE SUMMARY

FCC/SRM AUTOSEQUENCE LOGIC

General

The FCC selects the FCC/SRM trim path. The initial selection of the trim path is related to the channel which is engaged first.

Transfer of the trim path (autosequence) is made only if dead trim occurs. One autosequence may take place before reset.

The sequence is reset with complete disconnect of the autopilot system.

Operation

The autosequence logic is shown in the illustration. The direction of the arrow shows the FCC/SRM from/to condition.

As an example, the left FCC is engaged first in a triple channel engaged condition, the left FCC uses the left SRM. If dead trim is detected, the autotrim function will autosequence to the right FCC and the right SRM.

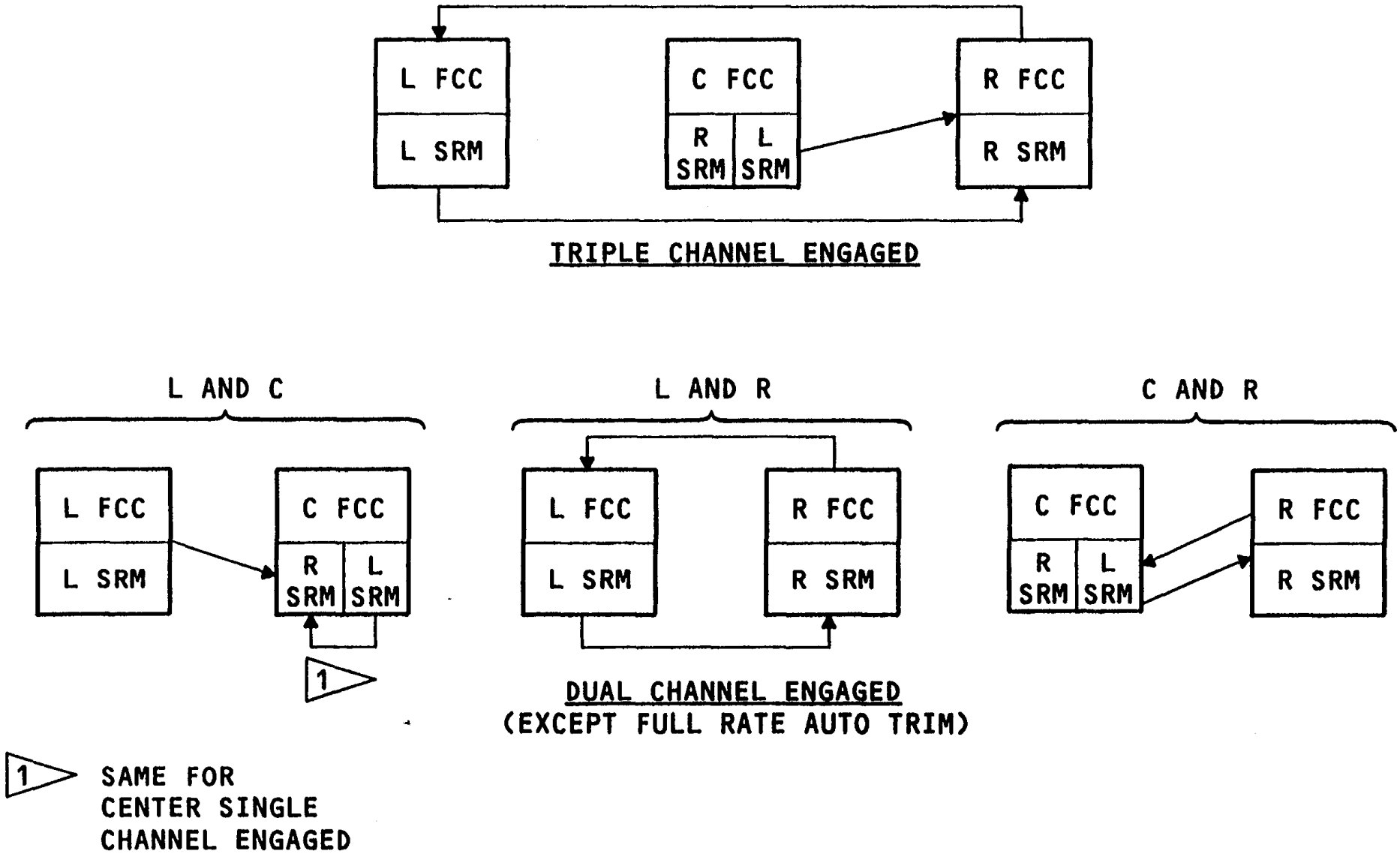


Figure 21 FCC/SRM AUTOSEQUENCE LOGIC

SPEED TRIM LOGIC AND CONTROL

General

The purpose of the speed trim function is to reduce the response of the airplane to airspeed changes. The speed trim control senses an airspeed change and moves the stabilizer. This trims the airplane nose up for an increase in airspeed and nose down for a decrease in airspeed.

Speed trim logic controls the speed trim command. It also selects the SRM to do the speed trim function. It also selects the source of ADC data. Speed trim is done by one SRM at a time.

Air Data Monitor/Select

The left SRM uses the captain's selected ADC as primary data and the first officer's selected ADC as secondary data. The right SRM is opposite. The secondary data will be used only if the other SRM is not valid. If the other SRM is valid, the speed trim engage will change to the other SRM when primary air data is lost.

The two ADC signals are also compared. A difference of 10 knots will set air data to be not valid. This is called a comparison fault.

Speed Trim Select

Speed trim select logic requires that the air data be valid. It also requires no fault in other sensors used for control logic. These sensors are:

- Stabilizer position - Air/ground

The control loop (command compared to stabilizer movement) is monitored to make sure the STCM works properly.

A random selection at power-up is included in the speed trim select logic. This allows equal opportunity for speed trim selection by both SRMs.

Speed Trim Engage

Speed trim select is used with the following to engage the control law:

- In air for 20 seconds
- Not manual trim
- Not alternate trim
- Left SRM not in FCC autotrim
- Right SRM not in FCC autotrim

The control law is synchronized to the stabilizer position that exists when the engage logic goes valid.

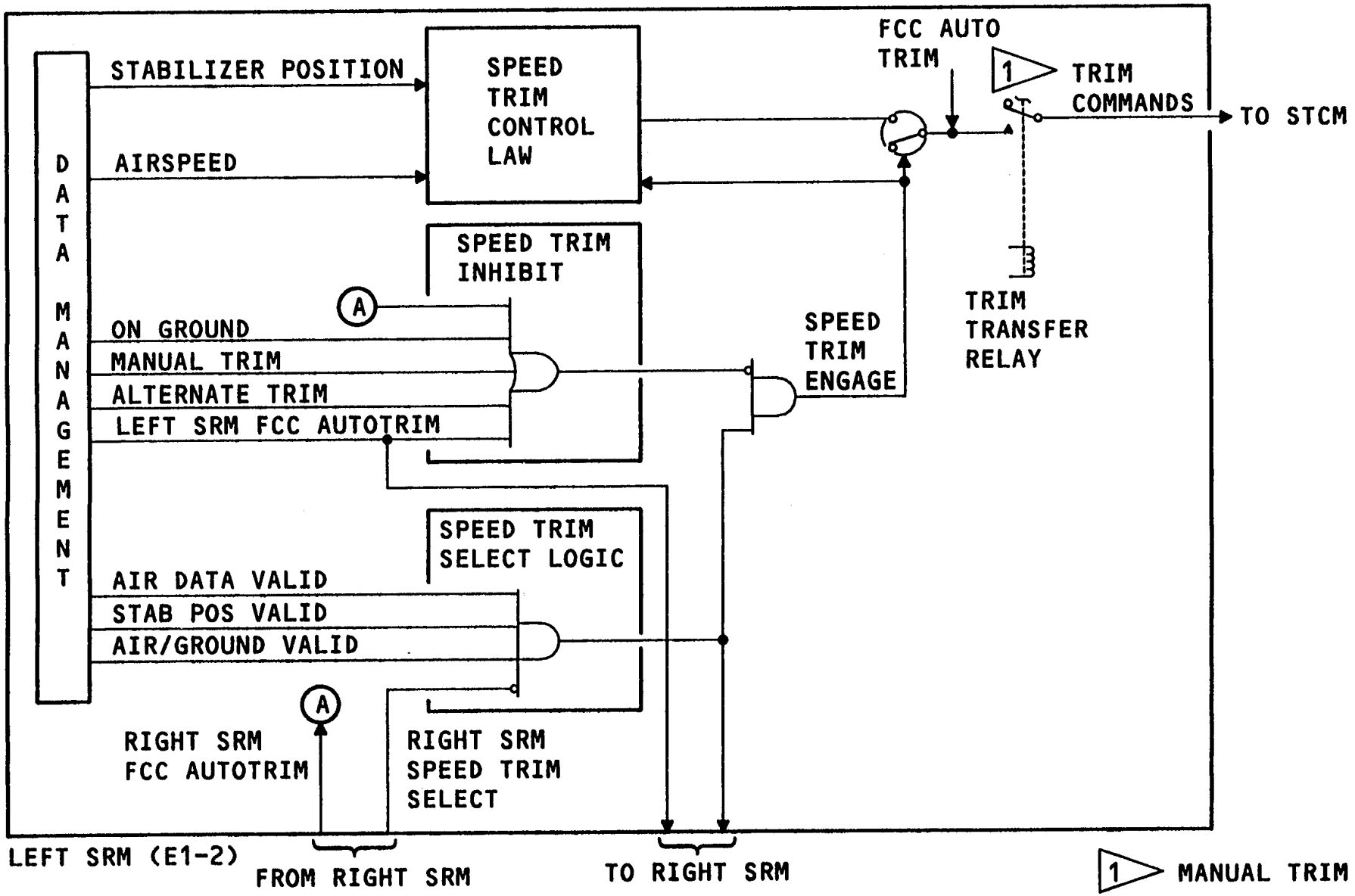


Figure 22 SPEED TRIM LOGIC AND CONTROL

SPEED TRIM CONTROL LAW

When not engaged in speed trim, the control law synchronizes to the present stabilizer position. After speed trim engage, the control law commands the STCM to move the stabilizer related to a change in airspeed.

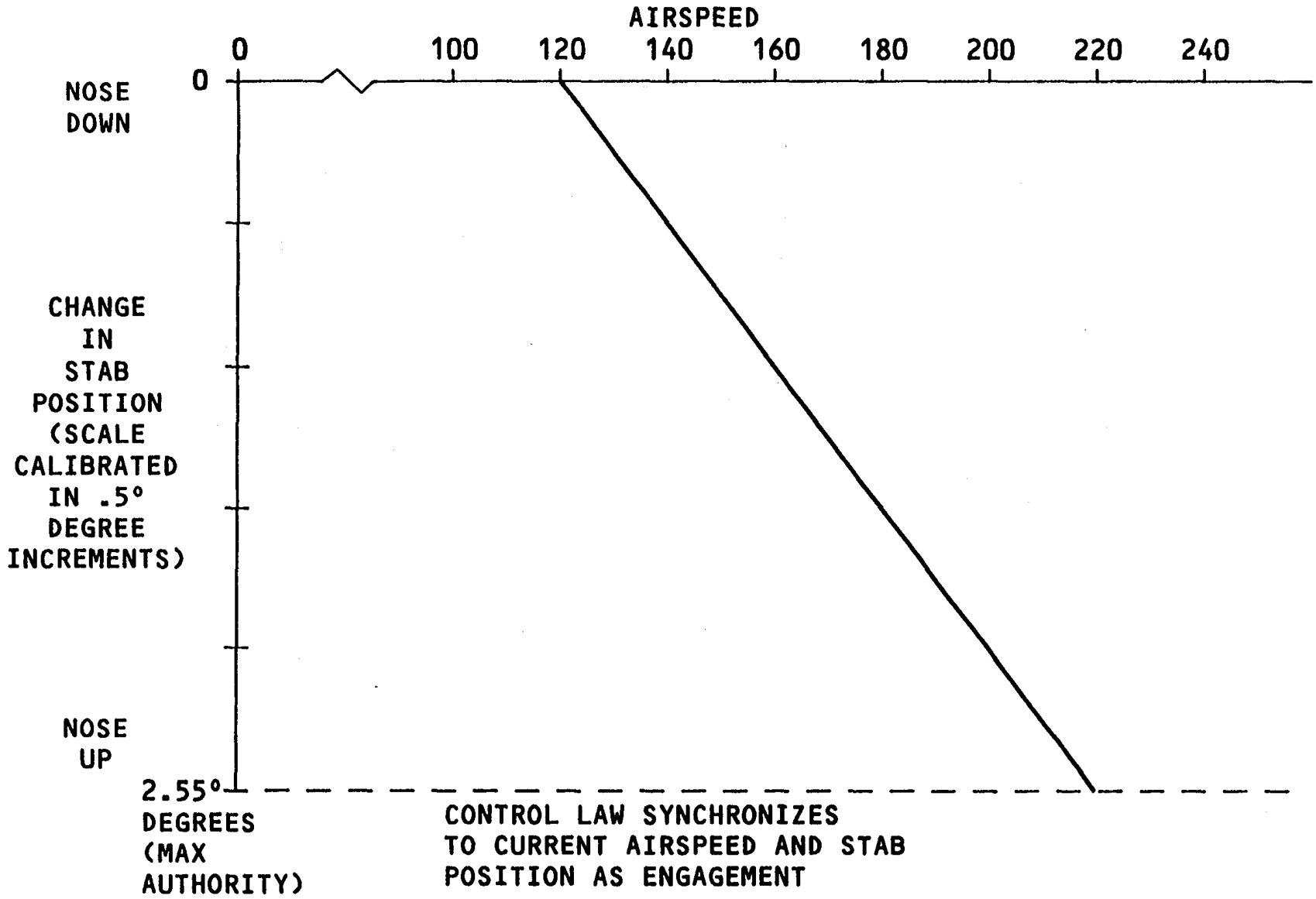


Figure 23 SPEED TRIM CONTROL LAW

STCM CONTROL

The STCM control signals are:

- Motor operated valve open and close
- Rate control
- Arm up and down
- Control up and down

The MOV control signal operates a shutoff valve in the STCM to shutdown the STCM in case of unscheduled trim movement.

The rate control signal controls a solenoid in the STCM. This solenoid controls the rate of hydraulic flow, and in turn the rate of stabilizer movement. This control is based on airspeed.

The arm and control signals operate solenoid valves in the STCM, which move arm and control spool valves. The spool valves control the-direction of hydraulic flow to the hydraulic motor. Arm and control movement in the same direction is necessary to cause brake release pressure and hydraulic motor operation,

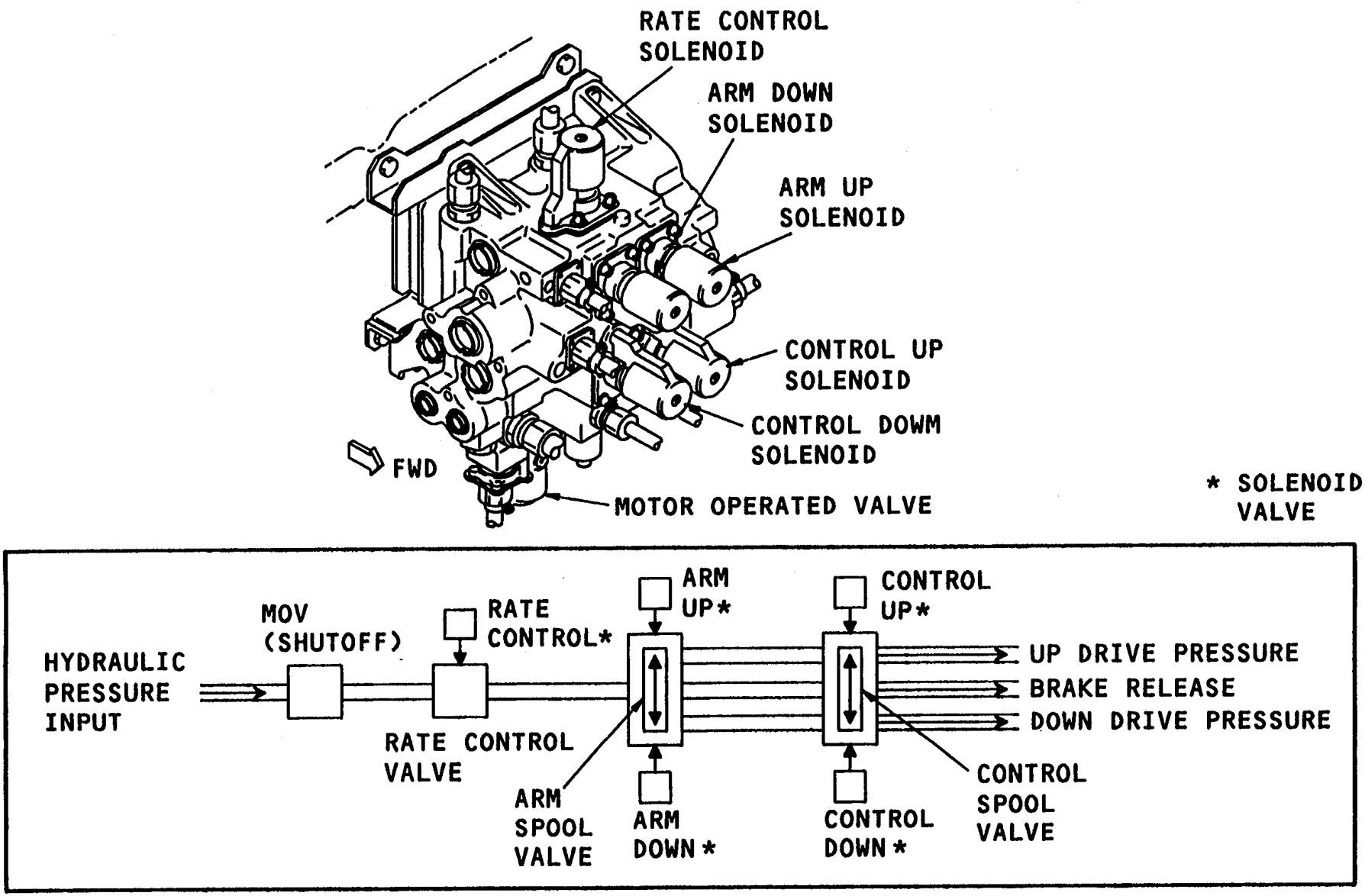


Figure 24 STCM CONTROL

STABILIZER SHUTDOWN LOGIC

General

Each STCM has a motor-operated valve (MOV) used to shut off hydraulic pressure to the STCM. This valve is controlled by the cutout switches on the control stand or by the SRM if the cutout switch is in the AUTO position. The automatic shutdown occurs with detection of unscheduled trim by the unscheduled trim monitor in the SRM.

Unscheduled Trim Monitor

The unscheduled trim monitor is enabled in all trim modes. An unscheduled trim condition exists if the stabilizer moves without a trim command in the same direction.

Autoshutdown/Auto On Logic

A STCM will receive an automatic shutdown command when both of these conditions are true:

- Either SRM detects unscheduled trim
- Brake release for that STCM

This will not happen during alternate trim.

The auto shutdown command is on for ten seconds. The command is inhibited if the STCM is being commanded ON by the stab trim cutout switch.

A ten second open command occurs five seconds after the cutout switch changes from CUTOUT or ON to AUTO. It also occurs at power-up with the switch in AUTO.

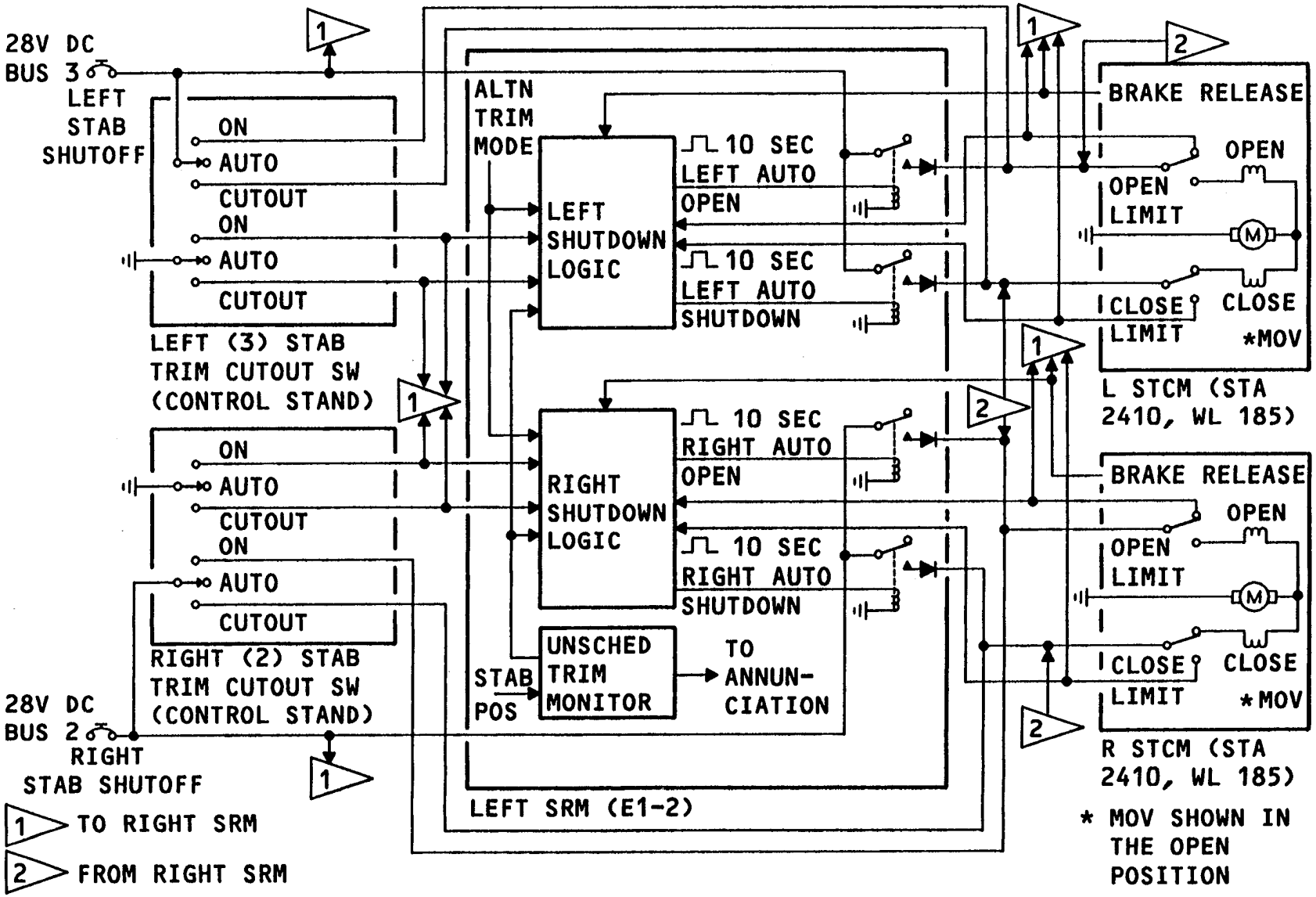


Figure 25 STABILIZER SHUTDOWN LOGIC

STABILIZER RATE CONTROL

General

The SRM controls the rate of trim through the STCM. Computed airspeed is used for this control function. The rate control function is done by one SRM at a time.

Air Data Monitor/Select

The method source selection for stabilizer rate control is the same as for the speed mode.

Stabilizer Rate Engage Logic

At power-up, a random selection is made for the SRM to do the rate control function. This selection is the same as for the speed mode.

Stabilizer Rate Control

The trim rate can be selected from two values. The rate control relays will be de-energized and high rate will be selected until the computed airspeed is 230 knots. Above this value, the relays will be energized and low rate

will be selected. Low-rate trim will operate until the airspeed goes below 220 knots.

Dual channel full rate trim at .5 degrees/second occurs when airspeed is below 220 knots during:

- Manual trim
- Alternate trim
- Full rate autotrim (LAND 2) <1201

Single channel half rate trim at .25 degrees/second occurs when airspeed is below 220 knots during:

- Manual trim
- Alternate trim
- Autotrim

Dual channel full rate trim at .2 degrees/second occurs when airspeed is above 230 knots during:

- Manual trim
- Alternate trim

Single channel half rate trim at .1 degrees/second occurs when airspeed is above 230 knots during:

- Manual trim
- Alternate Trim
- Autotrim

NOTE: WHEN THE AIRPLANE IS INCREASING SPEED THE TRIM RATE CHANGEOVER SPEED IS 230 KNOTS. WHEN THE AIRPLANE IS DECREASING SPEED THE TRIM RATE CHANGEOVER SPEED IS 220 KNOTS.

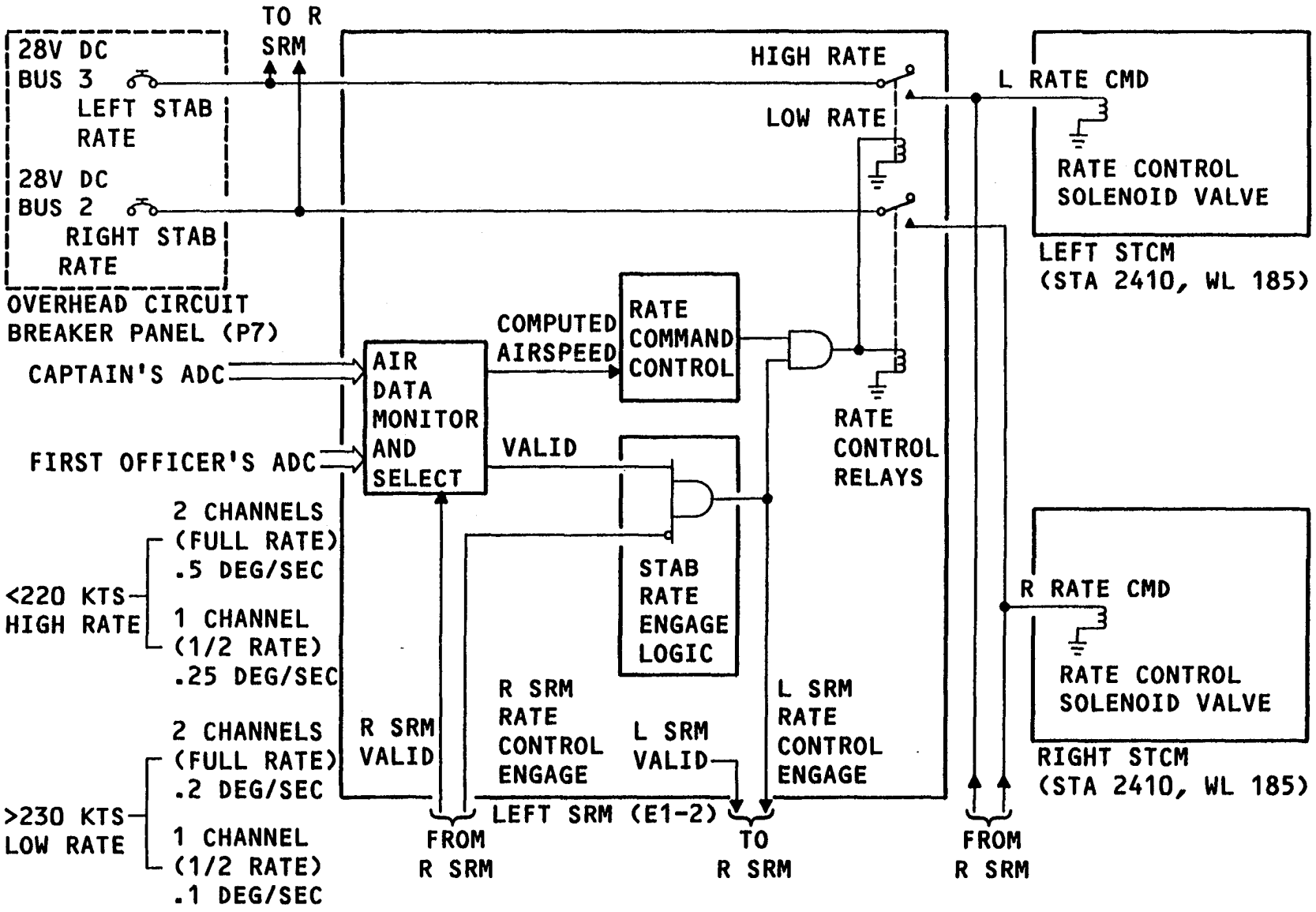


Figure 26 STABILIZER RATE CONTROL

FCC AUTOTRIM GROUND TEST

General

The automatic stabilizer trim test (STAB TRIM) is one of the tests in the autopilot flight director ground tests menu.

Ground Test

During this ground test, the autopilot channels will be engaged separately and the ability of the FCC to do the autostabilizer trim function will be monitored. All inputs necessary for this function will also be monitored.

WARNING: MAKE SURE THAT PERSONS AND EQUIPMENT ARE CLEAR OF ALL CONTROL SURFACES BEFORE YOU SUPPLY HYDRAULIC POWE R. AILERONS, RUDDERS, ELEVATORS, FLAPS, SPOILERS, LANDING GEAR, AND THRUST REVERSERS CAN MOVE QUICKLY WHEN YOU SUPPLY HYDRAULIC POWER. THIS CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

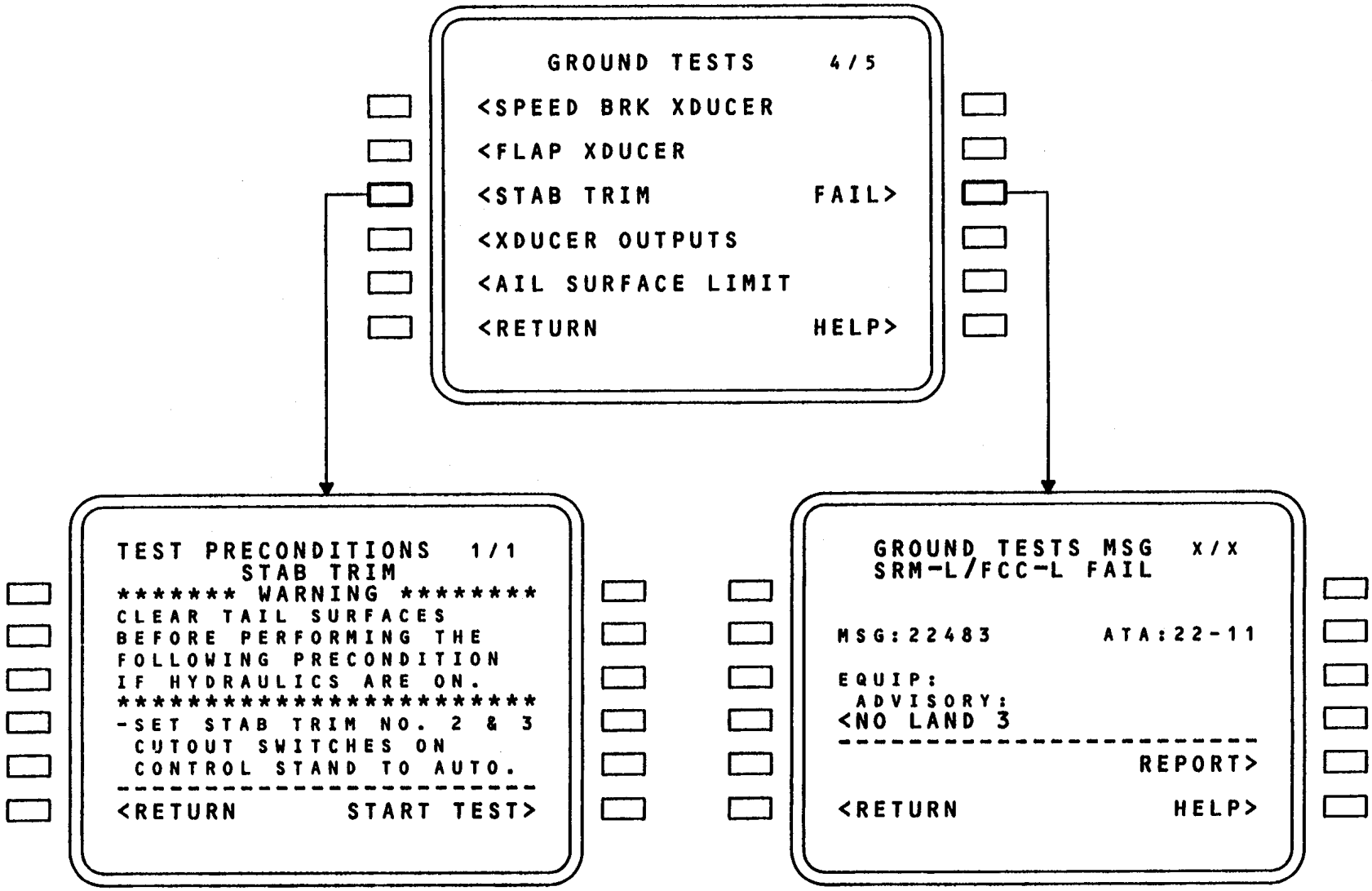


Figure 27 FCC AUTOTRIM GROUND TEST

SRM FLIGHT DECK EFFECTS & CMC MESSAGES

Flight Deck Effect

The EICAS messages for the stabilizer trim system and the meaning of these messages are:

- STAB AUTO TRIM indicates a fault in the autotrim system.
- STAB SPEED TRIM indicates a speed trim fault.
- STAB TRIM indicates that either system 2 or 3 hydraulic power to the stabilizer drive has been lost, this causes stabilizer drive to operate at 1/2 normal speed.
- STAB TRIM UNSCHD indicates uncommanded stabilizer movement.
- STAB AUTO CUTOUT indicates an automatic stabilizer shutdown fault.

CMC Messages

The types of CMC messages for the stabilizer trim system are:

- COMPONENT FAILURE indicates a component fault of the stabilizer trim system during normal operation or during ground test.
- INPUT SENSOR FAILURE indicates a data bus or discrete input fault.
- DISAGREE indicates data from more than one source does not agree.

FLIGHT DECK EFFECTS	TYPE
STAB AUTO TRIM	STATUS
STAB SPEED TRIM	STATUS
STAB TRIM	STATUS
STAB TRIM UNSCHD	STATUS, CAUTION
STAB AUTO CUTOUT	STATUS

CMC MESSAGES (ATA 27) 1

SRM-X FAIL (SRM-X)
SRM-X ~ SRM-X DATA FAIL
SRM-X ~ SRM-X BUS FAIL
SRM-X HYD - Y STAB TRIM ANNUNCIATION SIGNAL ~ SRM-X INTERFACE FAIL
SRM-X UNSCHEDULED TRIM SIGNAL ~ SRM-X INTERFACE FAIL
SRM-X VALID TRIM COMMAND SIGNAL ~ SRM-X INTERFACE FAIL
SRM-X AUTOTRIM ENGAGE - CONT SIGNAL ~ SRM-X INTERFACE FAIL
SRM-X SRM VALID SIGNAL ~ SRM-X INTERFACE FAIL
SRM-X SPEED TRIM ENGAGE SIGNAL ~ SRM-X INTERFACE FAIL
SRM-X STAB RATE CONTROL ENGAGED SIGNAL ~ SRM-X INTERFACE FAIL
ADC-Z ~ SRM-X DATA FAIL
SRM-X FAIL OR ADC-Z ~ SRM-X BUS FAIL
ADC DATA DISAGREE (SRM-X)
FCC-Z ~ SRM-X DATA FAIL
FCC-Z ~ SRM-X BUS FAIL
SRM-X FAIL OR FCC-Z ~ SRM-X BUS FAIL
LANDING GEAR INPUT FAIL (SRM-X)
INVALID OPTION CODE/INCORRECT SRM-X P/N INSTALLED (SRM-X)
STAB TRIM 28 VDC FAIL (SRM-X)

1 X = L (LEFT) OR R (RIGHT)
Y = 1, 2 OR 3
Z = L (LEFT), C (CENTER) OR R (RIGHT)

Figure 28 FLIGHT DECK EFFECTS & CMC MESSAGES - 1

CMC MESSAGES (CONTINUED) 1

HYD-Y PRESSURE DISAGREE (SRM-X)
AIR/GND INPUT - 1 FAIL (SRM-X)
AIR/GND INPUT - 2 FAIL (SRM-X)
AIR/GND INPUT - 1/2 FAIL (SRM-X)
AIR/GND SECOND FAIL (SRM-X)
SRM OPTION PIN FAIL (SRM-X)
SRM-X CHANNEL CODE FAULT (SRM-X)
FCU-Z FLAP SIGNAL ~ SRM-X INTERFACE FAIL
SECOND FCU FLAP INPUT FAIL (SRM-X)
FCU-Z STAB POSITION SIGNAL ~ SRM-X INTERFACE FAIL
ELEC THUMB SWITCH INPUT FAIL (SRM-X)
ALTERNATE ELEC TRIM SWITCH INPUT FAIL (SRM-X)
HYD-Y STAB TRIM ACT BRAKE RELEASE SW FAIL (SRM-X)
HYD-Y STAB TRIM ACT 'SHUTOFF VALVE CLOSE' FAIL (SRM-X)
HYD-Y STAB TRIM ACT 'SHUTOFF VALVE OPEN' FAIL (SRM-X)
STAB-X CUTOUT 28 VDC FAIL (SRM-X)
STAB-X RATE 28 VDC FAIL (SRM-X)

1 X = L (LEFT) OR R (RIGHT)
Y = 1, 2 OR 3
Z = L (LEFT), C (CENTER) OR R (RIGHT)

Figure 29 FLIGHT DECK EFFECTS & CMC MESSAGES - 2

ADC	- AIR DATA COMPUTER
A/P	- AUTOPILOT
ASA	- AUTOLAND STATUS ANNUNCIATOR
ASTS	- AUTOMATIC STABILIZER TRIM SYSTEM
CMC	- CENTRAL MAINTENANCE COMPUTER
CG	- CENTER OF GRAVITY
C/O	- CUTOUT
EICAS	- ENGINE INDICATION & CREW ALERTING SYSTEM
EIU	- EFIS/EICAS INTERFACE UNIT
FCC	- FLIGHT CONTROL COMPUTER
FCE	- FLIGHT CONTROL ELECTRONICS
FCE PSM	- FLIGHT CONTROL ELECTRONICS POWER SUPPLY MODULE
FRAT	- FULL RATE AUTOTRIM
HYD	- HYDRAULIC
IND	- INDICATION
LRU	- LINE REPLACEABLE UNIT
MCP	- MODE CONTROL PANEL
MCU	- MODULAR CONCEPT UNIT
MOV	- MOTOR OPERATED VALVE
ND	- NOSE DOWN
NU	- NOSE UP
PSM	- POWER SUPPLY MODULE
RVDT	- ROTARY VARIABLE DIFFERENTIAL TRANSFORMER
SRM	- STABILIZER TRIM/RUDDER RATIO MODULE
STAB	- STABILIZER
STCM	- STABILIZER TRIM CONTROL MODULE
TDA	- TRIM DOWN ARM
TDC	- TRIM DOWN COMMAND
TUA	- TRIM UP ARM
TUC	- TRIM UP COMMAND
TYP	- TYPICAL

Figure 30 ABBREVIATIONS/ACRONYM LIST

TABLE OF CONTENTS

TABLE OF FIGURES