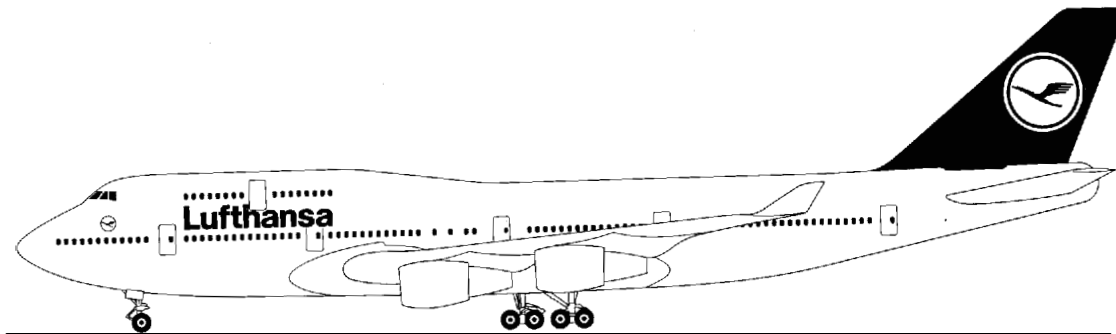# Lufthansa Technical Training

Training Manual
B 747-400

ATA 27-32
STALL WARNING SY-STEM
ATA Spec. 104 Level III

Book No:

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ATA 27-32 STALL WARNING SYSTEM

STALL WARNING SYSTEM

INTRODUCTION

General

The stall warning system consists of two separate (left and right) stall warning computers. The function of the computers is to calculate when the airplane is nearing a stall condition and provide a warning through two separately operated stick shakers mounted on each control column. Two computer cards (left card A5 for the captain and right A10 for the first officer) are mounted in the modularized avionics and warning electronics assembly (MAWEA). This assembly is located on the right side of the forward main equipment center.

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FWD

LEFT STALL WARNING
MANAGEMENT COMPUTER
CARD A5

RIGHT STALL WARNING
MANAGEMENT COMPUTER
CARD A10

CONTROL COLUMN
SHAKER (TYPICAL)

M7952 MODULARIZED AVIONICS AND WARNING
ELECTRONICS ASSEMBLY (MAWEA)

BACK

MA-WEA

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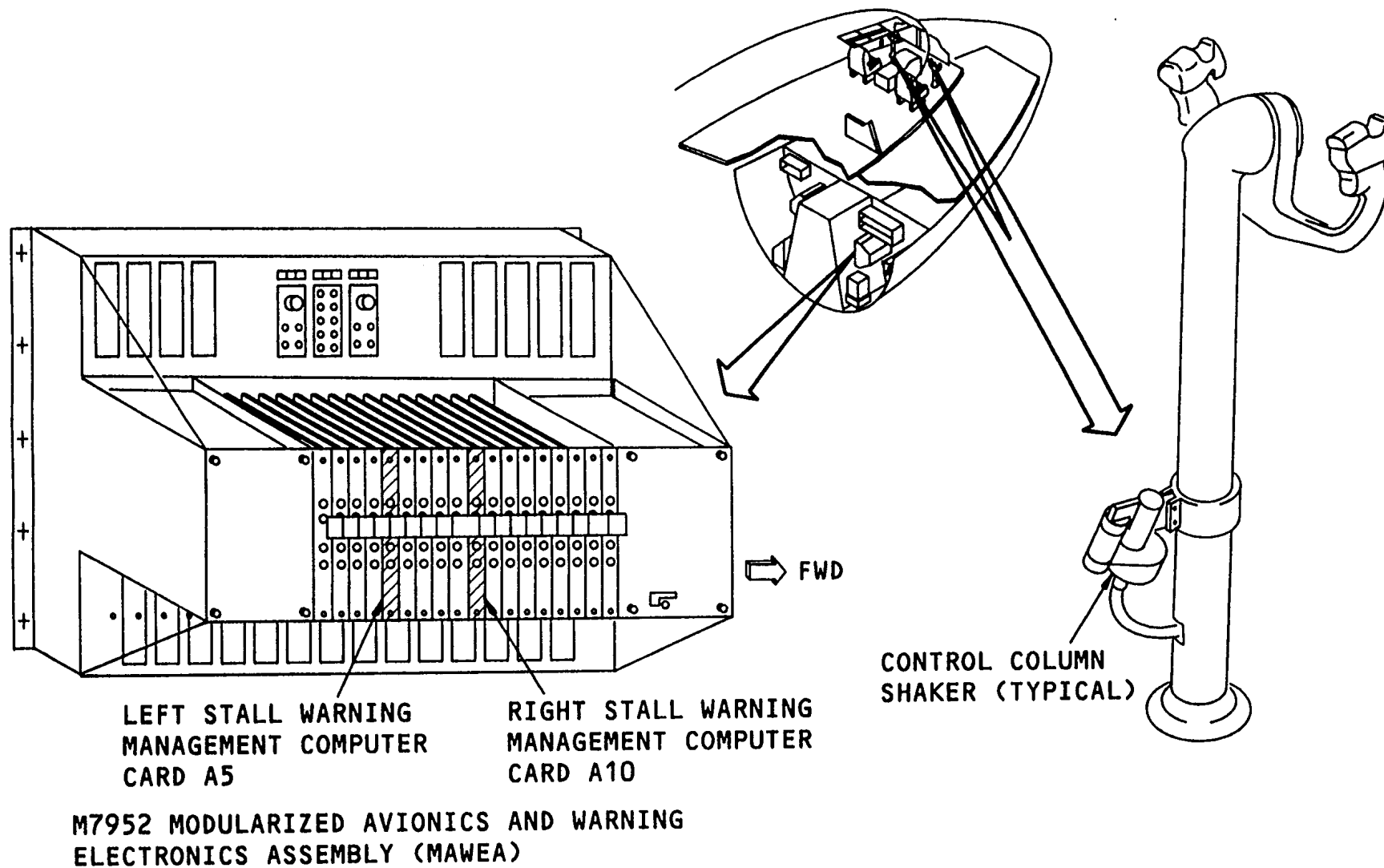**Figure 1   STALL WARNING SYSTEM INTRODUCTION**

STALL WARNING SYSTEM GENERAL OPERATION

Stall Warning Management Computer Inputs

The stall warning management computer (SWMC) cards gather information from many sources to evaluate and determine stall onset. These sources include information derived both directly and indirectly through other units.

Input sources include:

- Proximity switch electronic unit (PSEU) information: gear position
- Flap control units (FCU) information: flap position
- Master monitor cards information: gear and flap, position from PSEU and FCUs, the cards control power-up BITE
- Spoiler position information: spoiler deployment
- Inertial reference units (IRU) information: pitch acceleration
- Air data computer (ADC) information: angle of attack, speed/mach
- CMC test: BITE test initiated by use of the CDU

Stall Warning Management Computer outputs

The SWMCs directly control the operation of the control column stick shakers. They provide information to the electronic interface units (EIUs), flight management computers (FMC) and central maintenance computers (CMC) via the EIUs. The SWMC also supplies information to the ground proximity warning computer (GPWC).
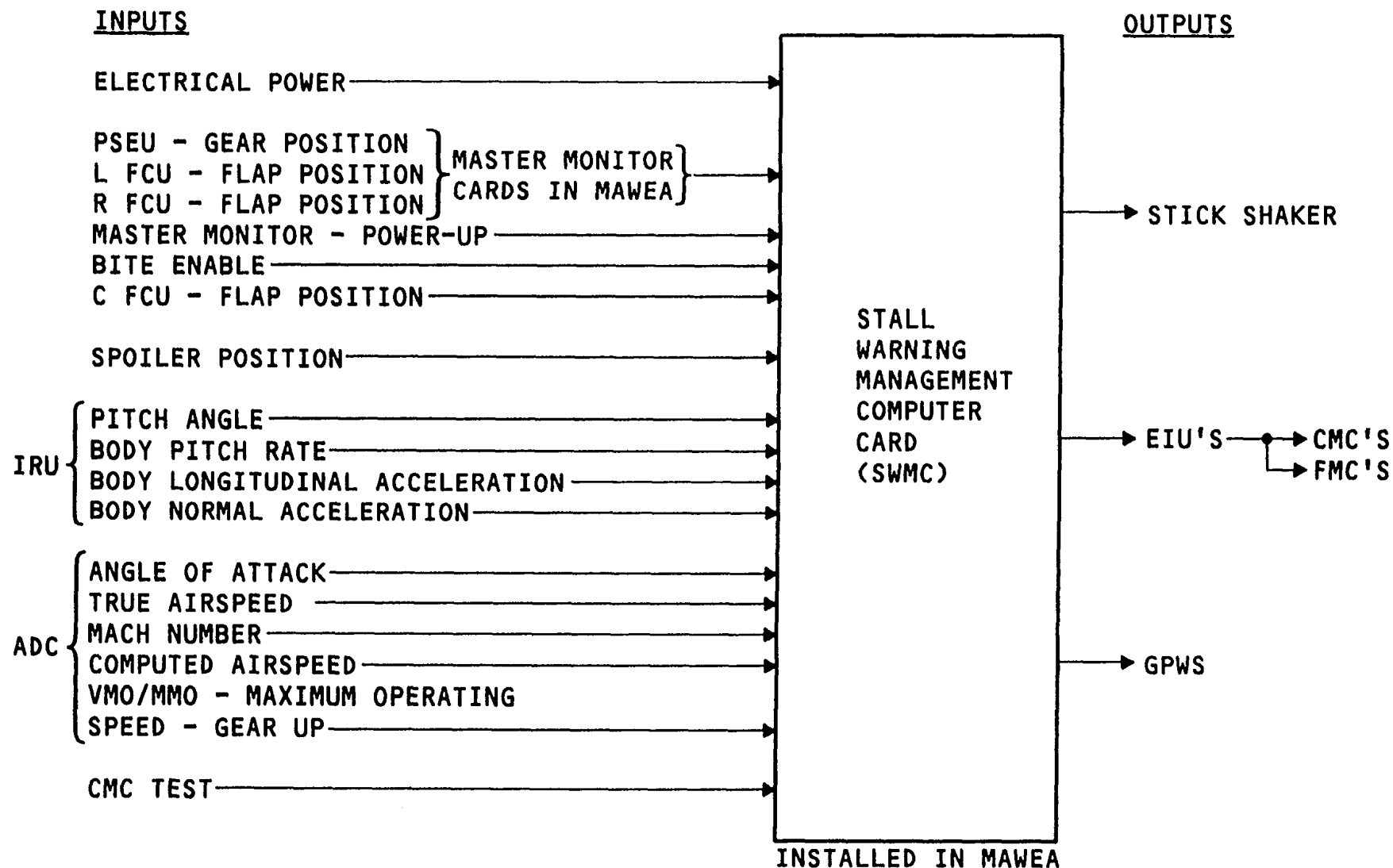
INPUTS

ELECTRICAL POWER ─────────────►

PSEU - GEAR POSITION ┐
L FCU - FLAP POSITION ├ MASTER MONITOR ┐
R FCU - FLAP POSITION ┘ CARDS IN MAWEA ┘ ──►
MASTER MONITOR - POWER-UP ─────►
BITE ENABLE ──────────────────►
C FCU - FLAP POSITION ─────────►

SPOILER POSITION ─────────────►

IRU ┌ PITCH ANGLE ─────────────►
    │ BODY PITCH RATE ──────────►
    │ BODY LONGITUDINAL ACCELERATION ►
    └ BODY NORMAL ACCELERATION ─►

ADC ┌ ANGLE OF ATTACK ──────────►
    │ TRUE AIRSPEED ────────────►
    │ MACH NUMBER ──────────────►
    │ COMPUTED AIRSPEED ────────►
    │ VMO/MMO - MAXIMUM OPERATING ►
    └ SPEED - GEAR UP ──────────►

CMC TEST ─────────────────────►

STALL WARNING MANAGEMENT COMPUTER CARD (SWMC)

INSTALLED IN MAWEA

OUTPUTS

──► STICK SHAKER

──► EIU'S ──•──► CMC'S
            └─► FMC'S

──► GPWS

Figure 2   STALL WARNING SYSTEM GENERAL OPERATION

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CONTROL COLUMN SHAKERS

Each control column, captain's and first officer's, has its own control column shaker motor assembly consisting of an electric motor and eccentric unit. When the motor is energized, the column shakes to warn the pilots of an impending stall condition. Normally, both motors operate, since each stall warning computer provides a signal to both column shakers simultaneously.

The shaker assemblies are attached to the control columns by two mounting bolts and are powered through an electrical connector.
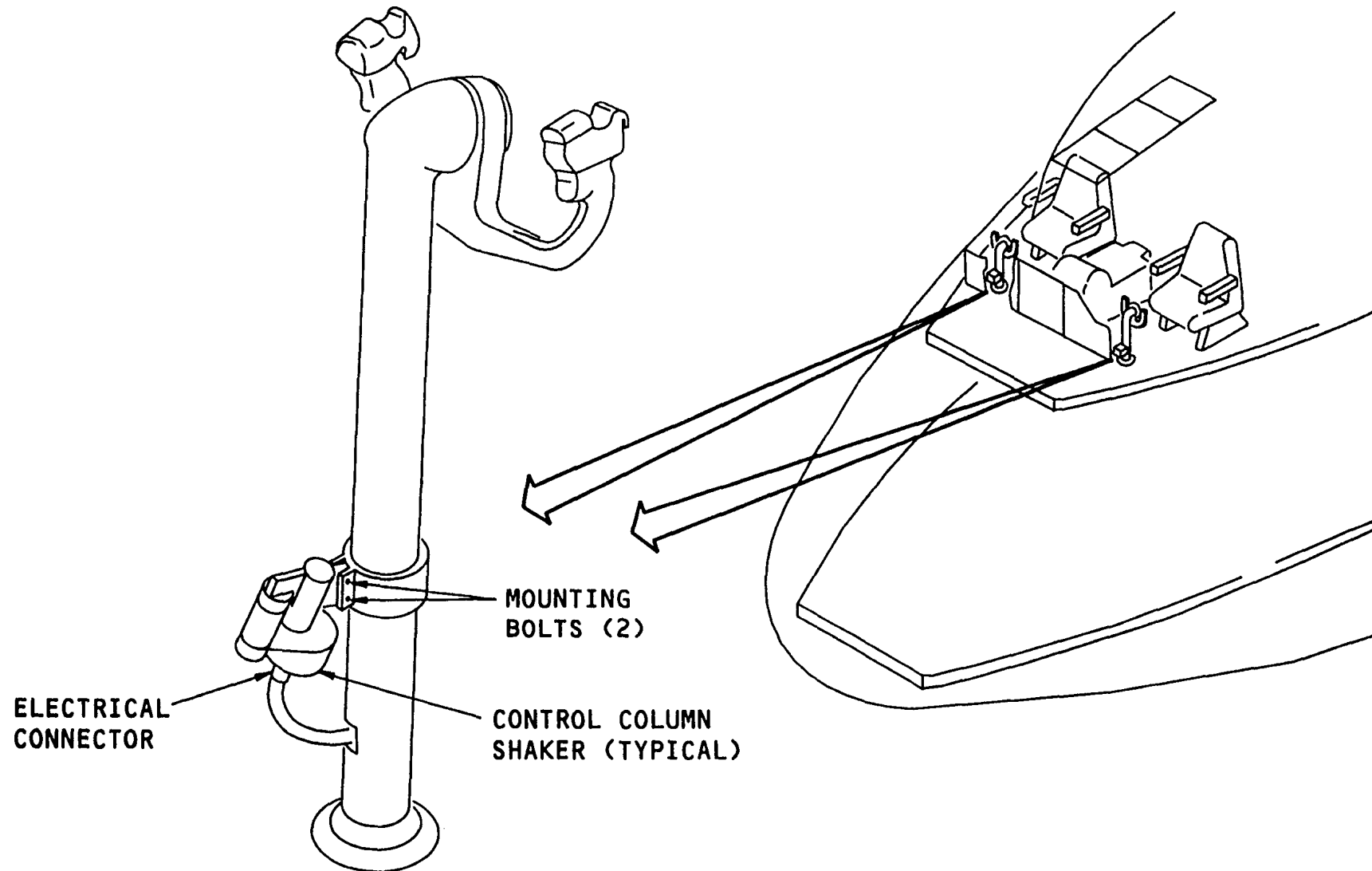
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MOUNTING
BOLTS (2)

ELECTRICAL
CONNECTOR

CONTROL COLUMN
SHAKER (TYPICAL)

Figure 3   CONTROL COLUMN SHAKERS

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SWMC INPUTS

Power Supply A and B

Both stall warning management computer (SWMC) cards receive power from each of the two modularized avionics warning electronics assemblies (MAWEA) power supply units. The SWMC cards are designed to operate with no loss of capability when powered from either or both power supply units.

Master Monitor Cards

The master monitor (MM) cards A and B each receive landing gear information from the PSEU. Each master monitor card also receives flap position information from a flap control unit. The left FCU supplies M M card A and the right FCU card supplies M M card B. In the event of a FCU failure of either left or right FCU, the center FCU is connected for dispatch redundancy directly through internal MAWEA card interface circuitry to SWMC cards, bypassing the master monitor cards.

Power-Up BITE Enable

The master monitor cards in the MAWEA card file will provide the power-up BITE initialization enable for the stall warning management computer cards whenever three power-up conditions exist. These are:

- Ground mode
- All gears are down and locked
- When computer airspeed input has no computed data (NCD); meaning no airspeed.

Upon power up, the master monitor card conducts internal (within the MM card only) housekeeping task operations for a period not to exceed two seconds. If, at the end of this period, the initialization enable is not active, no further BITE tests shall be conducted and the master monitor card will commence normal monitoring operations. If the initialization enable is active, a full BITE shall be conducted. Full BITE testing shall check all onboard circuitry to the extent the BITE is implemented, including the exercising of all output drivers and input receivers.

Test results will be reported on the output bus and sent to the central maintenance computer via the EIUs.

The stick shaker motor will only operate during an actual stall warning or upon initiating the BITE originated from manual CMC inputs.

IRS Source Select of IRU Data

The captain's and first officer's IRS source select switches will determine which IRU will supply data to the SWMC.

ADC Source Select

Both flight crew member's individual ADC sources select switches selects air data computer data inputs for the SWMC. The data supplied includes:

- Angle of attack
- True airspeed
- Mach number
- Computed airspeed
- Altitude
- VMO plus MMO discretes for maximum operation speed for gear up

Spoiler Position

The SWMCs use spoiler position inputs from the auto flight control system, (AFCS). The spoiler position is used by the SWMC only for computing Vmin for display on the pilots flight director EICAS display.

CMC Test

CMC tests of the SWMCs are initiated by use of the control display units (CDUs). This test is accomplished on the ground via the CMC confidence tests menu. The same test can be initiated from the test panel on the MAWEA.
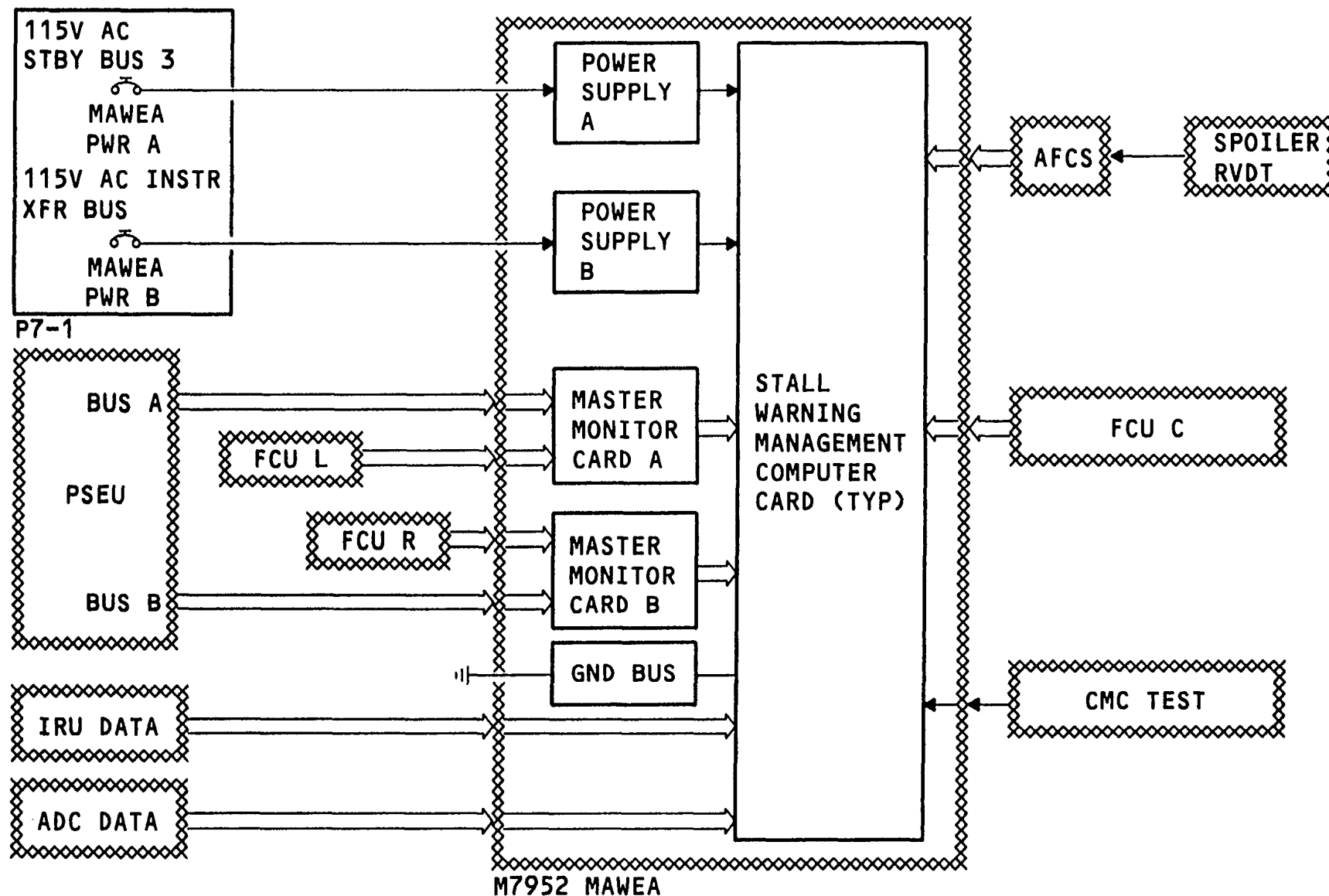
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Figure 4   SWMC INPUTS

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SWMC OPERATION AND OUTPUTS

Stall Warning

The stall warning calculations utilize leading and trailing edge flap position to determine a maximum angle of attack (alpha max value) for stick shaker operation. This alpha max value will be modified by mach and computed airspeed as well as nose landing gear and speedbrake position to determine an upper limit for the airplane angle of attack trip point. If this upper limit is exceeded by the incoming angle of attack (IAOA) as modified and corrected by pitch rate and airspeed, the stall warning management computer shall activate the stick shaker enable circuits. A ground within the circuits will operate the control column shakers. Each SWMC will operate both control column shakers.

Bite Operation

The stick shaker will also operate when the CDU or MAWEA test panel are used to initiate a confidence test. The stick shaker will not operate during the master monitor card power-up BITE test.

ARINC 429 Output

In addition to generating the alpha-max value for stick shaker operation, the SWMC computes two types of parameters for ARINC 429 outputs. They are:

- Pitch limit parameters: SWMC calculation of pitch limit parameters are used to indicate the maneuver margins available for the airplane to recover from windshear condition without encountering stick shaker warnings. This information is transmitted to the ground proximity warning computer.

  The same information will also be transmitted first to the EFIS/EICAS interface units (EIUs) and then on to flight management computers (FMCs) for display of the pitch limit indicator (PLI) symbol on the primary flight displays (PFDs). (PLIs and PFDs not shown.)
- Speed Tape Parameters: the SWMC also generates various speed tape parameters such as Vmo and Vss (stick shaker speed). This information is transmitted to the FMCs via the EIUs.

CMCs

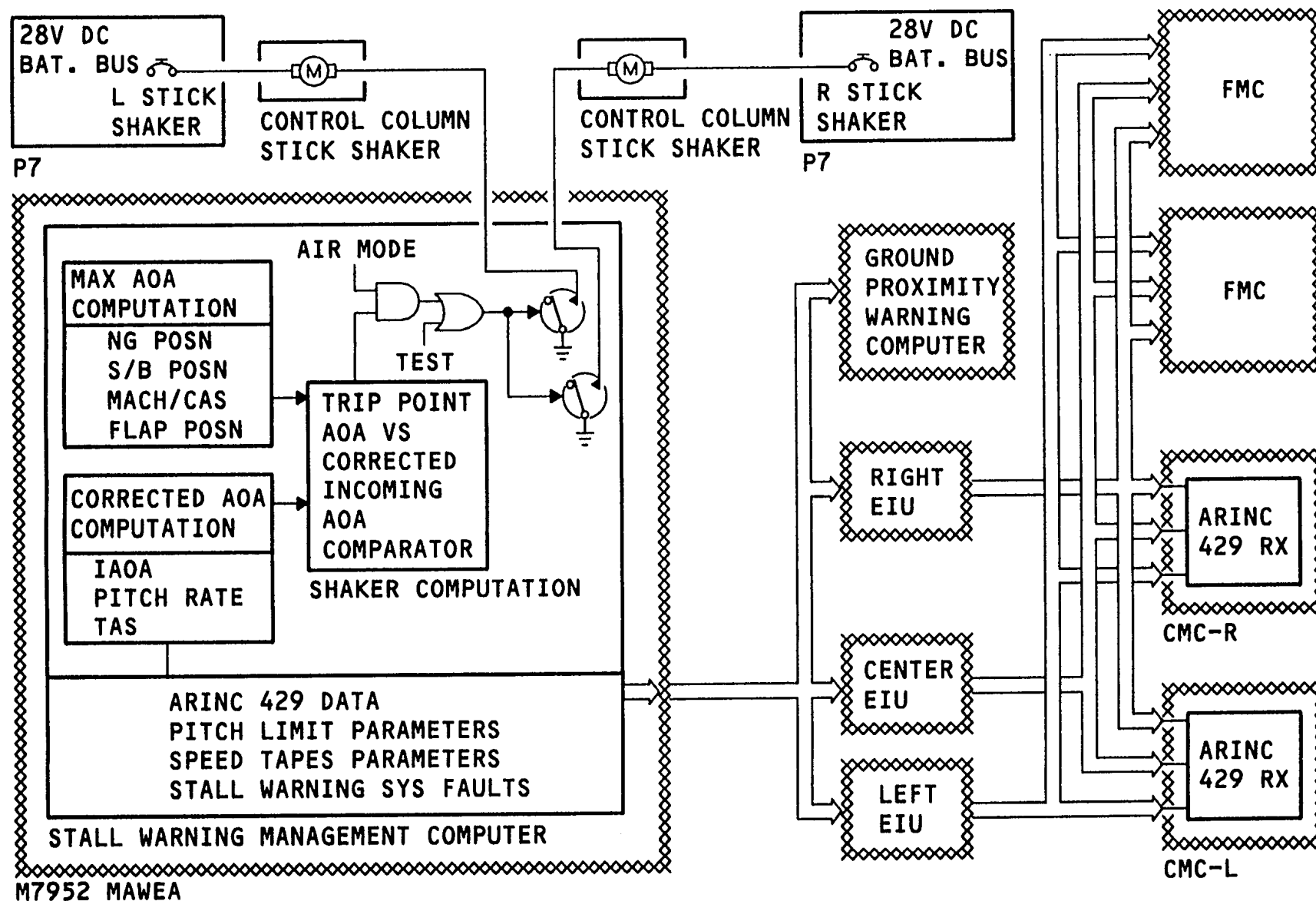All ARINC 429 bus data is also distributed to both central maintenance computers for fault monitoring.

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Figure 5   SWMC OPERATION AND OUTPUTS

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STALL WARNING SYSTEM POWER SUPPLY

Power Supply

Power for the MAWEA power supply comes from two sources on the P7 panel. 115 volts ac standby bus 3 supplies MAWEA power A CB and 115 volts ac instrument Xfer bus supplies power for MAWEA power B CB. The power supply units in the MAWEA provide three dc voltages to the card Ales; +12 volts, and +5 volts. Maintenance verification of power supply voltage outputs is provided with the power supply test jacks on the MAWEA monitor panel. A red LED power supply light comes on when there is a loss of any one or more of the three outputs for each supply source.

Card Operation

The stall warning management computer cards will operate on either or both power sources.

Stick Shaker Operation

Power to operate the stick shaker motors is provided through separate CBs on the P7 panel. The left stick shaker CB is located on the left side of the P7 panel. The right stick shaker CB is in a similar position on the right side of the P7 panel. Power for the CBs comes from the 28 volts dc battery bus. The ground to operate the stick shaker motors is made through their respective SWMC cards by the stick shaker enable circuit. The MAWEA card ground bus is rated for all ground current requirements.
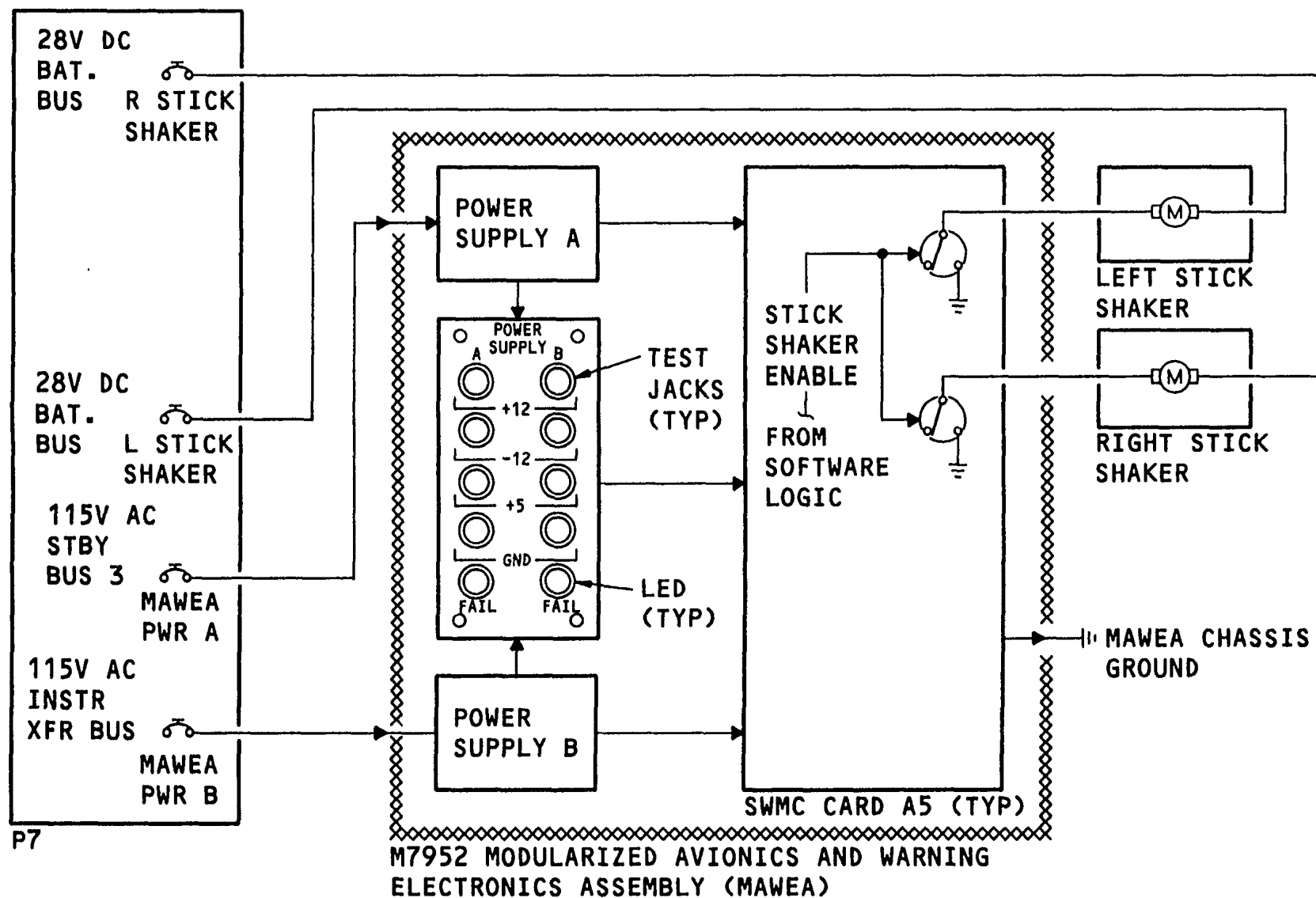
Figure 6   STALL WARNING SYSTEM POWER SUPPLY

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SWMC MAINTENANCE PRACTICES

Maintenance Practices

The stall warning management computer cards are installed in position A5 for the left stick shaker and A10 for the right system. The card positions are numbered from left to right when facing the MAWEA panel.

Replacement Precautions

The individual universal logic cards (ULC) are static sensitive, as their labels indicate. Prior to removal, the electrostatic grounding wrist strap must be connected utilizing the ground Jack provided on the MAWEA chassis.

Monitor Panel Stall Warning Test Jacks

Two test jacks (left and right SWMC systems) are provided for testing the stick shaker circuit and motors from the MAWEA location. By installing a jumper connection from either of these test Jack points to the ground jack on the MAWEA chassis, the stall warning

shaker motor will operate if the SWMC system card and interfaces are good. At the same time a STALL WARN SYS status message will show on the EICAS display.

The same test can be initiated from the flight deck by selecting the stall warning system GROUND TESTS from the CMC menu on the CDU.

A failed test will inhibit the stick shaker.

These tests must be performed with the airplane in the ground mode, with angle of attack and calculated airspeed from the air data computer showing no computed data (NCD).
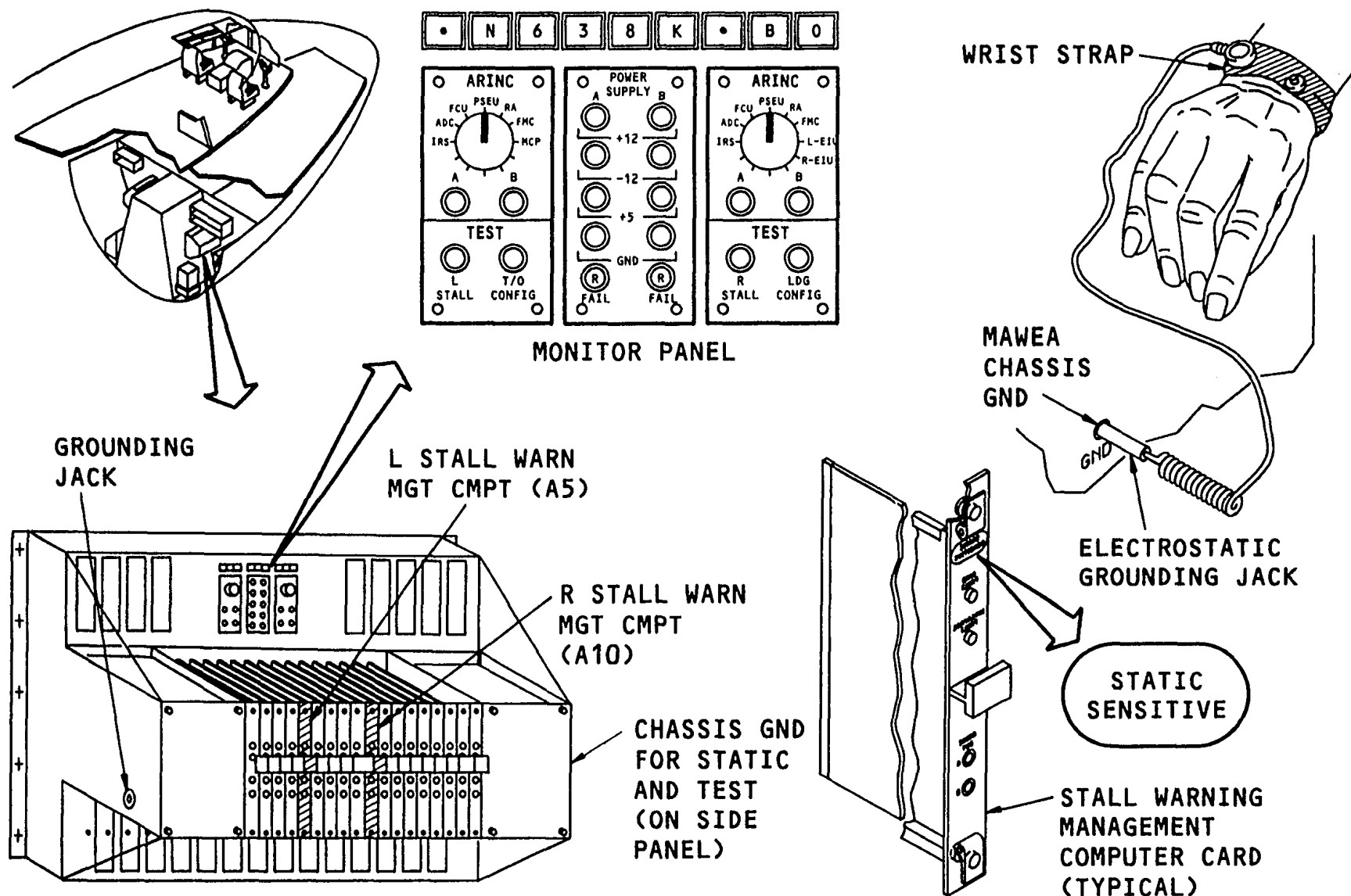
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MONITOR PANEL

GROUNDING JACK

L STALL WARN MGT CMPT (A5)

R STALL WARN MGT CMPT (A10)

CHASSIS GND FOR STATIC AND TEST (ON SIDE PANEL)

WRIST STRAP

MAWEA CHASSIS GND

ELECTROSTATIC GROUNDING JACK

STATIC SENSITIVE

STALL WARNING MANAGEMENT COMPUTER CARD (TYPICAL)

Figure 7   SWMC MAINTENANCE PRACTICES

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UNIVERSAL LOGIC CARD

Configuration Definition

The universal logic card (ULC) is a multipurpose card used for stall warning management computer needs. Other uses for the card include crew alerting, master monitoring, and configuration warning. Sixteen program pins (not shown) are used to define the complete identity or usage of the card. The states of these program pins are established entirely within the MAWEA backplane pin connector assembly and are not made available for changes outside of the MAWEA.

LED Card Indications

There are two LED indicator lights on the cards used for fault isolation. The red LED indicates a card fault and the yellow LED indicates an interface fault. The red card fault LED will illuminate if the board is not functioning properly for 5 to 7 seconds. Interface faults are input ARINC information coming into the card or input or output analog discretes which are not correct or complete for 5 to 7 seconds. Both lights will come on when the respective left and right stall warning test jack on the MAWEA monitor panel (not shown) is connected to the MAWEA ground (not shown). The stick shaker will operate at the same time and a stall warning fault indication will display on the EICAS (not shown).

ULC Card Test Jacks

The ARINC out test jacks on the card permit the monitoring of ARINC out data being supplied to the EIUs for the FMCs and CMCs as well as the ground proximity warning computer.

CMC

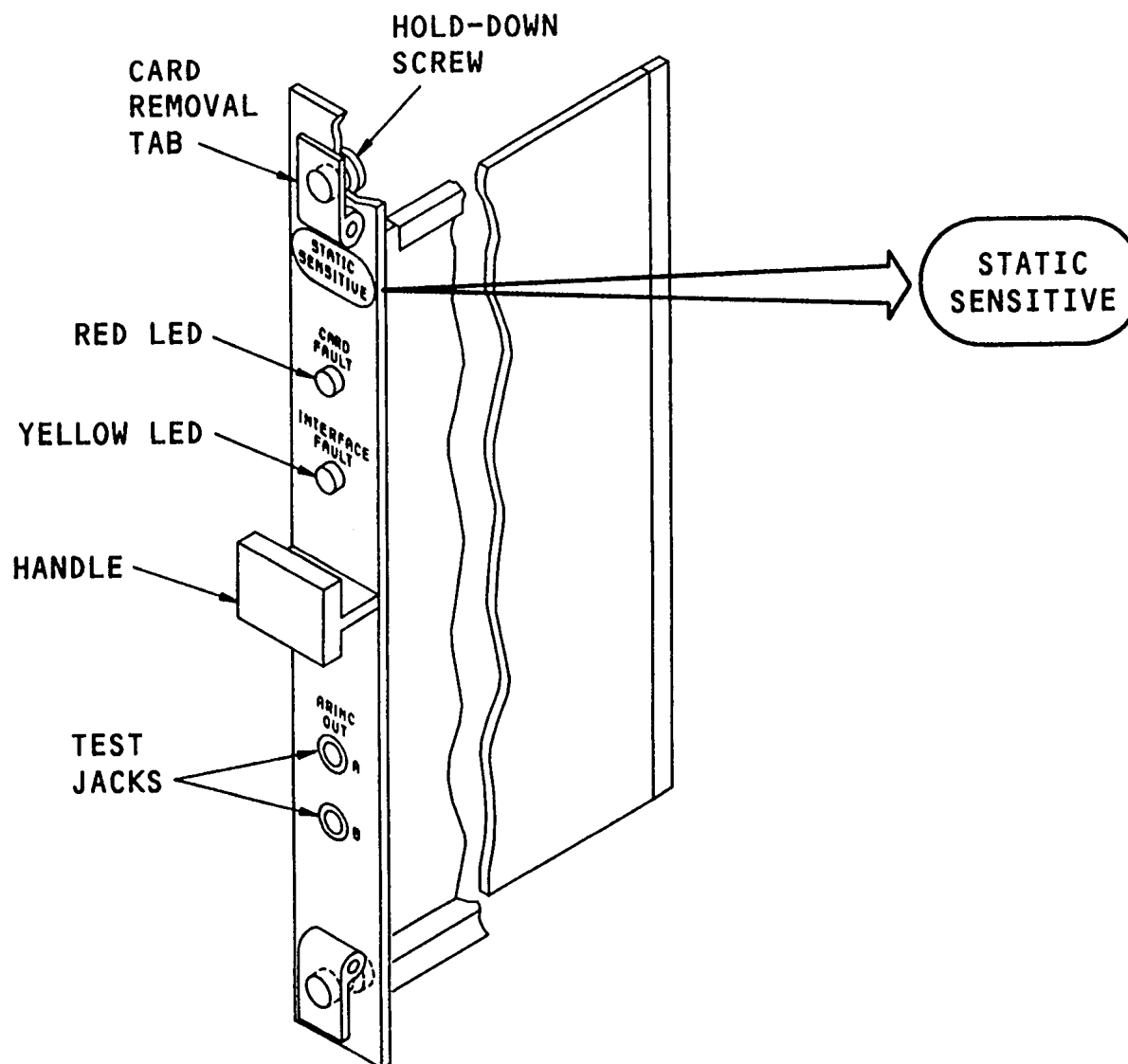Stall warning card failures are reported as ATA chapter 31-51 CMC messages.

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Figure 8   UNIVERSAL LOGIC CARD

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STALL WARNINGS SYSTEM GROUND TESTS - 1

This is an operational test of the STALL WARNING SYSTEM. The CMC is used to do a ground test of the Stall Warning System. The control column shakers will energized during the test.
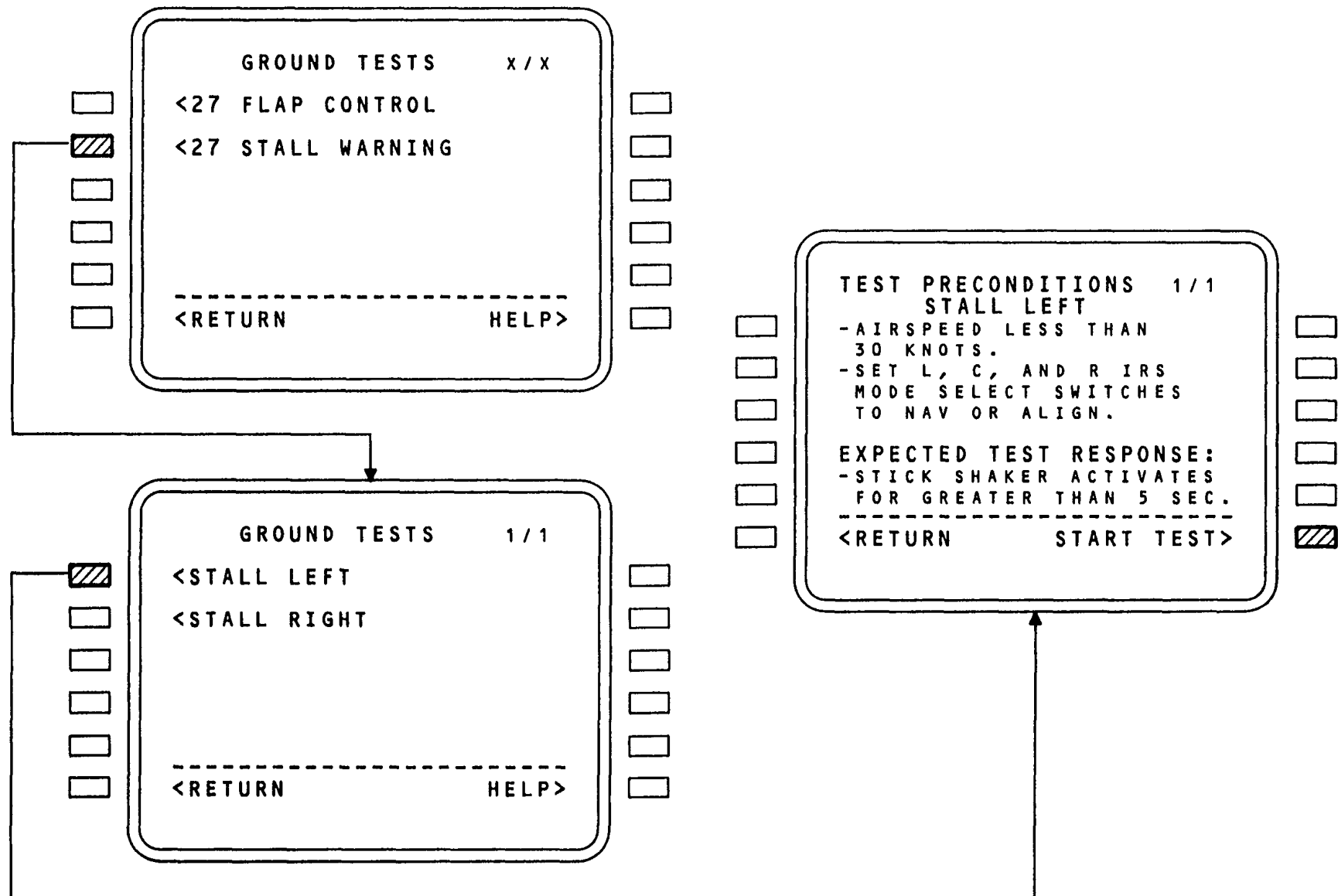
Test Initiation

From a control display unit (CDU) select the following:

- CMC
- GROUND TESTS
- 27 STALL WARNING
- STALL LEFT

Precondition Page

Upon STALL WARNING test initiation a precondition page will appear with action items to be completed before continuing with the test. After all preconditions have been met, depress the START TEST line select key (LSK).

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```
        GROUND TESTS      X / X

    <27 FLAP CONTROL

    <27 STALL WARNING



    ---------------------------
    <RETURN               HELP>
```

```
        GROUND TESTS      1 / 1

    <STALL LEFT

    <STALL RIGHT



    ---------------------------
    <RETURN               HELP>
```

```
    TEST PRECONDITIONS    1/1
           STALL LEFT
    -AIRSPEED LESS THAN
     30 KNOTS.
    -SET L, C, AND R IRS
     MODE SELECT SWITCHES
     TO NAV OR ALIGN.

    EXPECTED TEST RESPONSE:
    -STICK SHAKER ACTIVATES
     FOR GREATER THAN 5 SEC.
    ---------------------------
    <RETURN          START TEST>
```

Figure 9   STALL WARNINGS SYSTEM GROUND TESTS - 1

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STALL WARNING SYSTEM GROUND TESTS - 2

Test Application

IN PROGRESS will show during the test and the control column shakers should operate for approximately ten seconds.

When IN PROGRESS goes out of view the ground test screen will ask if the control column shakers functioned. Depress the line select key adjacent to <NO or YES> and look for PASS or FAIL. Note the GROUND TEST MSG page for any failure.
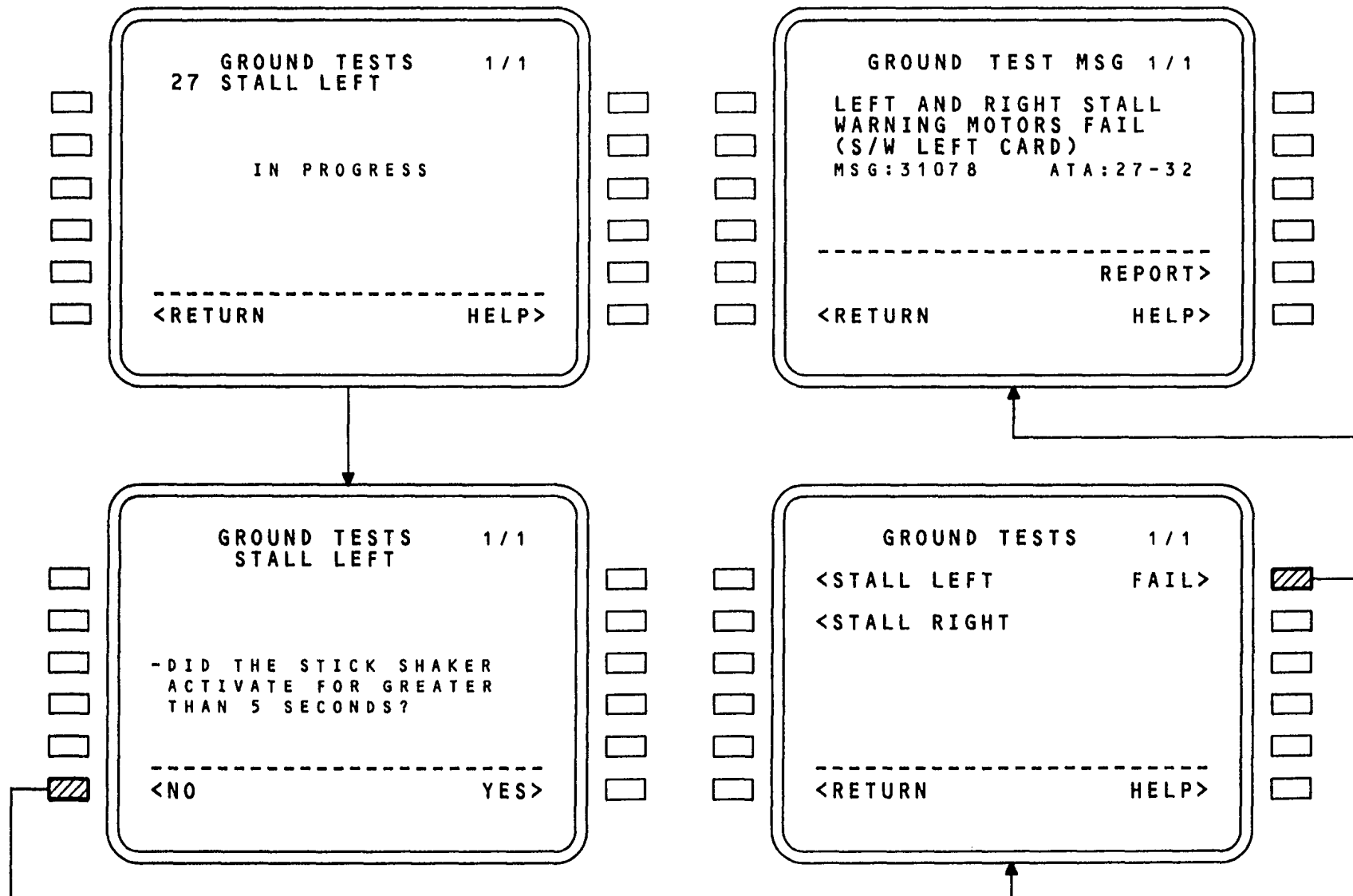
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```
      GROUND TESTS      1/1
   27 STALL LEFT


        IN PROGRESS


   ---------------------------
   <RETURN          HELP>
```

```
      GROUND TEST MSG 1/1

   LEFT AND RIGHT STALL
   WARNING MOTORS FAIL
   (S/W LEFT CARD)
   MSG:31078     ATA:27-32


   ---------------------------
                     REPORT>
   <RETURN          HELP>
```

```
      GROUND TESTS      1/1
        STALL LEFT



   -DID THE STICK SHAKER
   ACTIVATE FOR GREATER
   THAN 5 SECONDS?

   ---------------------------
   <NO               YES>
```

```
      GROUND TESTS      1/1
   <STALL LEFT       FAIL>
   <STALL RIGHT




   ---------------------------
   <RETURN          HELP>
```

Figure 10   STALL WARNING SYSTEM GROUND TESTS - 2

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