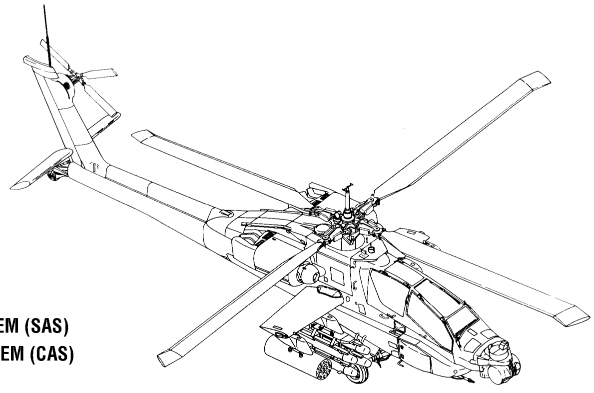
FLIGHT CONTROLS
STUDENT HANDOUT
PART TWO
SPACER PAGE

DASE FEATURES



- STABILITY AUGMENTATION SYSTEM (SAS)
- COMMAND AUGMENTATION SYSTEM (CAS)
- ATTITUDE HOLD
- TURN COORDINATION
- HOVER AUGMENTATION SYSTEM (HAS)
- HEADING HOLD
- BACKUP CONTROL SYSTEM (BUCS)

11-92-21
83-1272

NOTES

A. AH-64A Digital Automatic Stabilization Equipment (DASE) System

1. Purpose

a. The DASE system reduces the pilot work load by providing limited hands-off control of the aircraft.

b. The DASE system provides a fly-by-wire Back Up Control System (BUCS) in the event the primary flight control system becomes jammed or severed.

2. Features and capabilities

a. Stability Augmentation System (SAS)

b. Command Augmentation System (CAS)

c. Attitude Hold

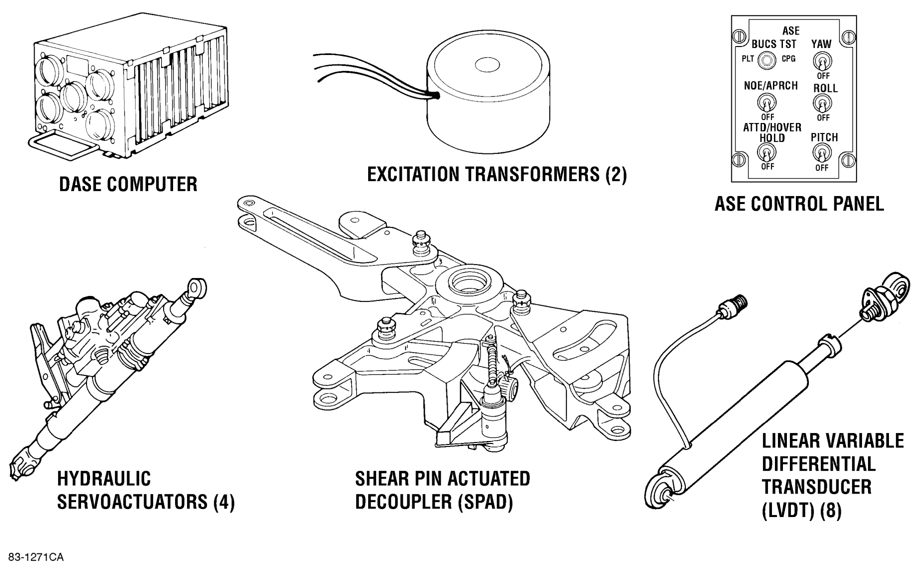
d. Turn Coordination

e. Hover Augmentation System (HAS)

f. Heading Hold

g. Back Up Control System (BUCS) - Helicopters S/N 88-0200 and subsequent

DASE SYSTEM MAJOR COMPONENTS HELICOPTER S/N 88-0199 AND BELOW



NOTES

3. Major components

   a. DASE System - S/N 88-0199 and below

      (1) Digital Automatic Stabilization Equipment (DASE) Computer

      (2) ASE (Automatic Stabilization Equipment) control panel

      (3) Excitation transformers (T1 and T2)

      (4) Position Linear Variable Differential Transducers (LVDTs) (color is black, connector is female)

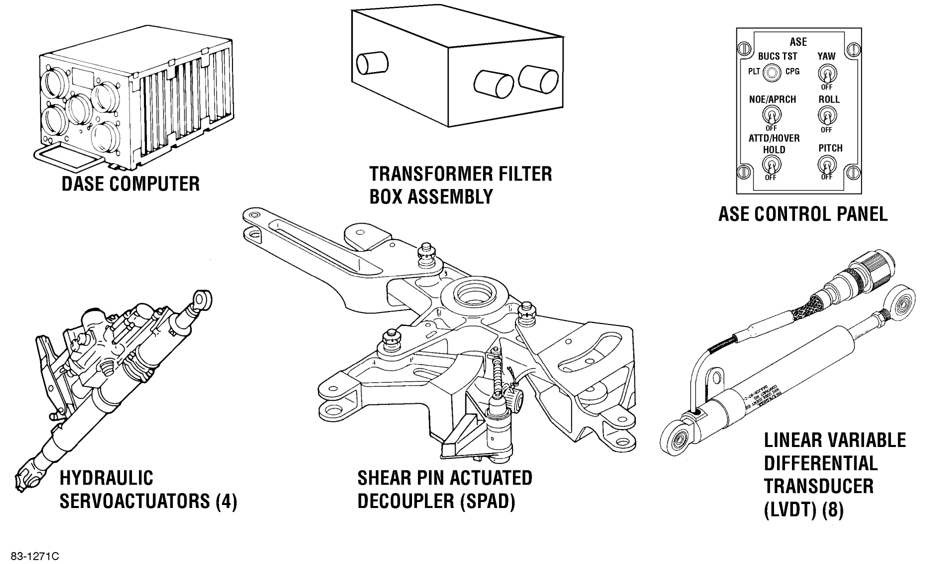
      (5) Shear Pin Activated Decouplers (SPAD) Assemblies, steel pins installed in place of shear pins

      (6) Hydraulic servoactuators

         (a) BUCS plungers deactivated, steel pins installed in place of shear pins

      (7) Controls and indicators (not shown)

DASE SYSTEM MAJOR COMPONENTS
HELICOPTER S/N 88-0200 AND SUBSEQUENT



NOTES

b. DASE System - S/N 88-0200 and subsequent

(1) DASE Computer (must be part number 21 or higher)

(2) ASE control panel

(3) Isolation transformer filter box assembly

(4) Hydraulic servoactuators - part numbers for BUCS-equipped helicopters

(a) Collective and lateral servoactuators - 7-31182001

(b) Longitudinal servoactuator - 7-311820012

(c) Directional servoactuator - 7-311820014

(5) Position Linear Variable Differential Transducer (color is olive drab, the connector is a male connector and has bonding straps).

(6) Shear Pin Actuated Decouplers (SPAD) - part numbers for BUCS-equipped helicopters

(a) Directional SPAD assembly

1) Pilot's - 7-311517067-9

2) CPG's - 7-311516077-7

(b) Lateral SPAD assembly (part of cyclic stick housing)

1) Pilot's - 7-311514075-11

2) CPG's - 7-311515074-11

(c) Longitudinal SPAD assembly

1) Pilot's - 7-311517069-7

2) CPG's - 7-311515074-11

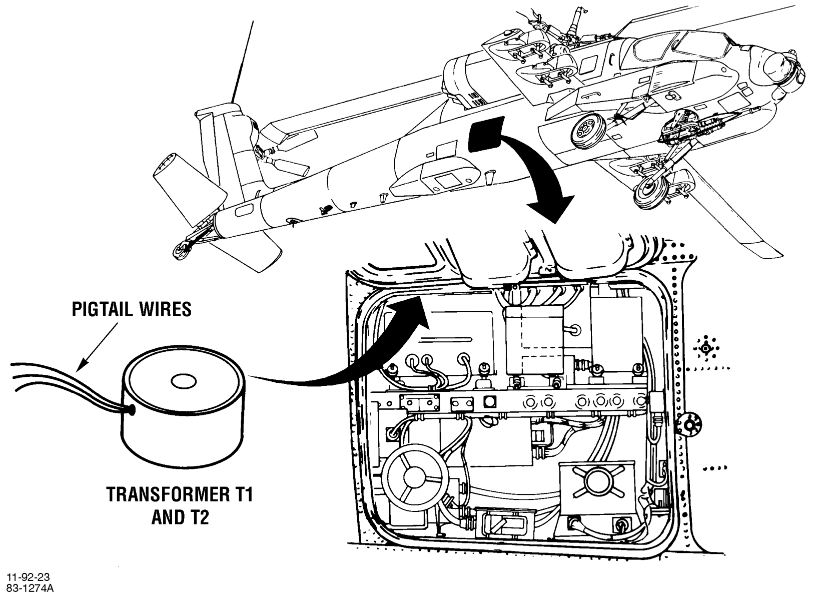
(d) Collective SPAD assembly

1) Pilot's - 7-311512085-11

2) CPG's - 7-311513001-7

(7) Controls and indicators (not shown)

EXCITATION TRANSFORMERS



NOTES

A. Digital Automatic Stabilization Equipment (DASE) component purpose, location, description, and operation

1. Excitation transformers T1 and T2 - (effectivity S/N 88-0199 and below)

a. Transform 115 VAC into 26 VAC for DASE components.

b. Located in the matrix module, aft avionics bay.

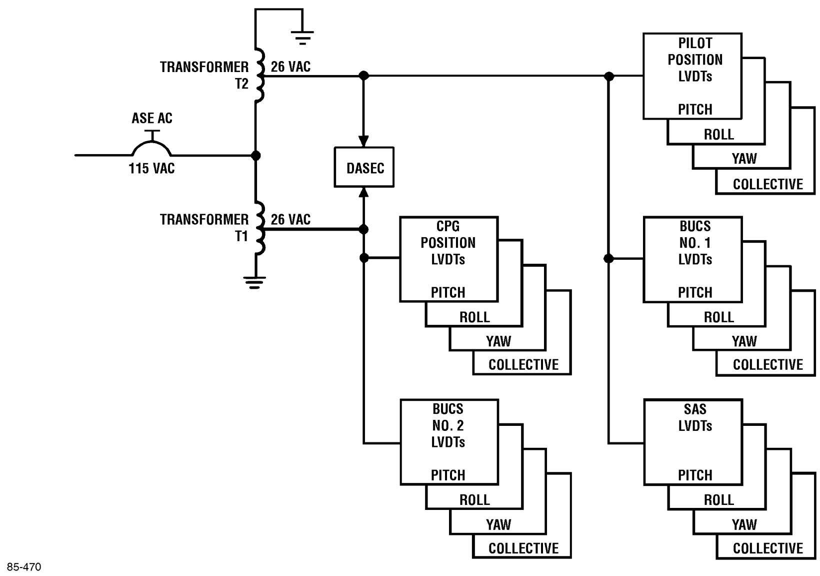
c. The excitation transformers are 1.5 inch diameter circular transformers with three electrical leads extending 12 inches out of the transformer case.

(1) The electrical leads are colored brown, red, and orange respectively.

(2) 115 VAC is applied to the brown and orange leads.

(3) 26 VAC is output on the red and orange leads

EXCITATION TRANSFORMERS SCHEMATIC



NOTES

d. Operation

(1) Transformer T2 is the number 1 transformer and supplies 26 VAC.

(1) DASE computer as a power source

(2) Position LVDTs in the pilot's station

(3) Number 1 (RAM 1) BUCS LVDT on each hydraulic servoactuator

(4) SAS LVDT on each hydraulic servoactuator

(2) Transformer T1 is the number 2 transformer and supplies 26 VAC.

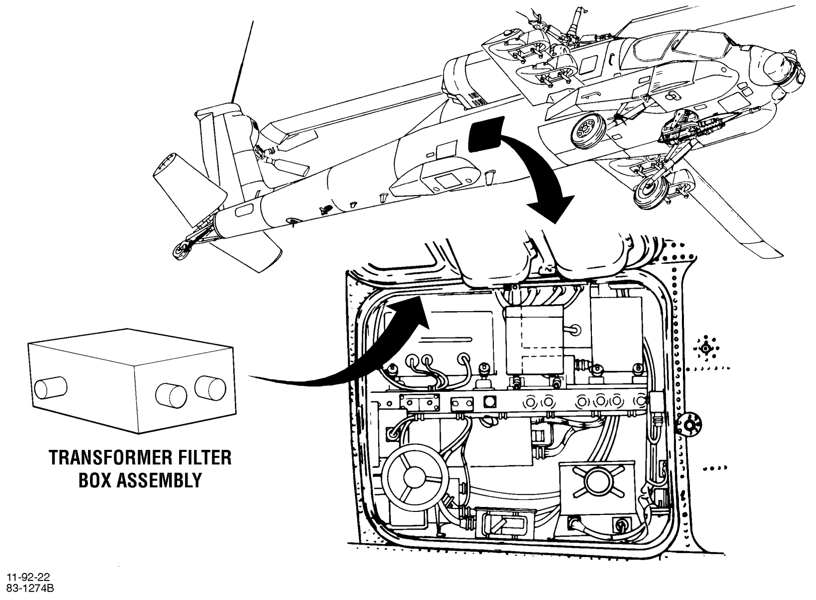
(a) DASE computer as a power source

(b) Position LVDTs in the CPG's station

(c) Number 2 BUCS (RAM 2) LVDT on each servoactuator

(3) Both transformers supply 26 VAC reference voltage to the Stabilator Control System.

ISOLATION TRANSFORMER FILTER BOX ASSEMBLY LOCATION



NOTES

2. Isolation transformer filter box assembly - (effectivity S/N 88-0200 and subsequent)

   a. To transform 115 VAC into 26 VAC for DASE and BUCS components.

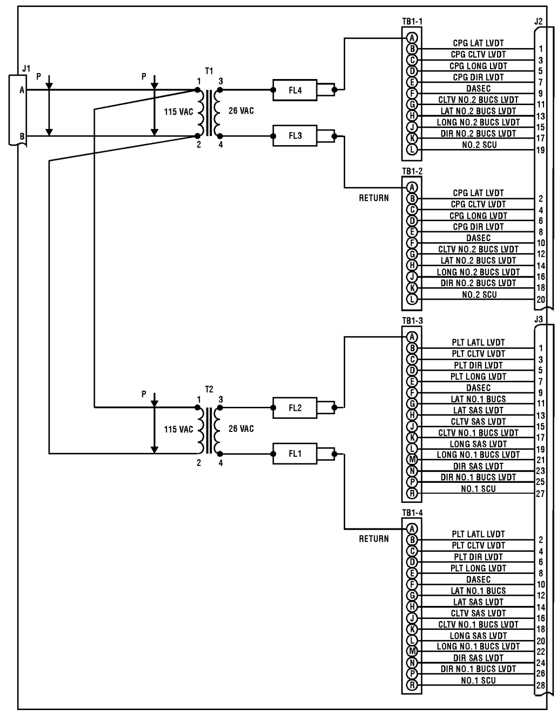
   b. Located in the aft avionics bay (top aft portion).

   c. Description

      (1) The Isolation Transformer Filter Box Assembly is a Line Replaceable Unit (LRU) that houses two step-down transformers. Each transformer has 2 filters to provide Electromagnetic Interference (EMI) hardening.

      (2) The LRU has three electrical connectors mounted on the unit.

ISOLATION TRANSFORMER FILTER BOX ASSEMBLY SCHEMATIC



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NOTES

d. Operation

(1) The filter box assembly is supplied 115 VAC from the No.1 AC bus (phase B) power via connector J1.

(2) The single phase input is paralleled to transformers T1 and T2.

(a) T1 output is 26 VAC, 400 hz. The output is protected from electromagnetic interference by filters FL4 and FL3.

1) The output of FL4 supplies terminal board one-one (TB1-1).

2) The output of FL3 supplies terminal board one-two (TB1-2).

3) TB1-1 and TB1-2 provide power to connector J2.

a) Pins 1 and 2 - CPG lateral LVDT

b) Pins 3 and 4 - CPG collective LVDT

c) Pins 5 and 6 - CPG longitudinal LVDT

d) Pins 7 and 8 - CPG directional LVDT

e) Pins 9 and 10 - DASE computer (DASEC)

f) Pins 11 and 12 - No. 2 BUCS LVDT on the collective servoactuator

g) Pins 13 and 14 - No. 2 BUCS LVDT on the lateral servoactuator

h) Pins 15 and 16 - No. 2 BUCS LVDT on the longitudinal servoactuator

i) Pins 17 and 18 - No. 2 BUCS LVDT on the directional servoactuator

j) Pins 19 and 20 - No. 2 Stabilator Control Unit (SCU)

(b) T2 output is 26 VAC, 400 hz. The output is protected from electromagnetic interference by filters FL1 and FL2.

1) The output of FL2 supplies TB1-3.

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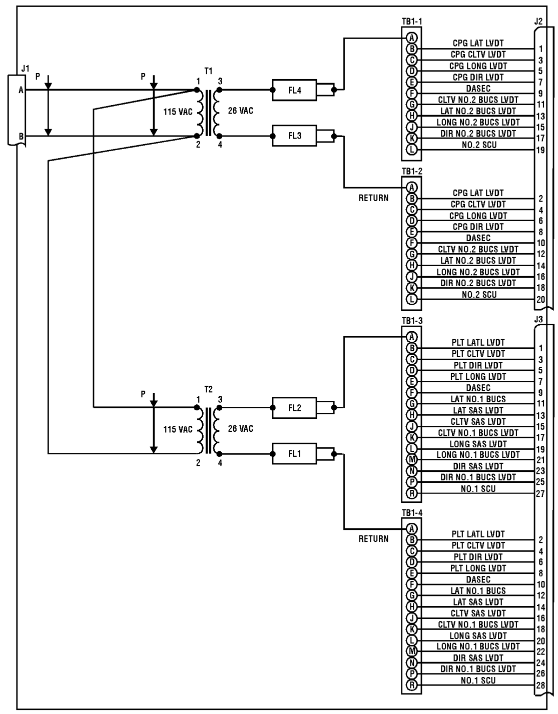
ISOLATION TRANSFORMER FILTER BOX ASSEMBLY SCHEMATIC



89-11-12

NOTES

2) The output of FL1 supplies TB1-4.

3) TB1-3 and TB1-4 provide power to connector J3.

a) Pins 1 and 2 - Pilot lateral LVDT

b) Pins 3 and 4 - Pilot collective LVDT

c) Pins 5 and 6 - Pilot directional LVDT

d) Pins 7 and 8 - Pilot longitudinal LVDT

e) Pins 9 and 10 - DASE Computer (DASEC)

f) Pins 11 and 12 - No. 1 BUCS LVDT on lateral servoactuator

g) Pins 13 and 14 - SAS LVDT on lateral servoactuator

h) Pins 15 and 16 - SAS LVDT on collective servoactuator

i) Pins 17 and 18 - No. 1 BUCS LVDT on collective servoactuator

j) Pins 19 and 20 - SAS LVDT on longitudinal servoactuator

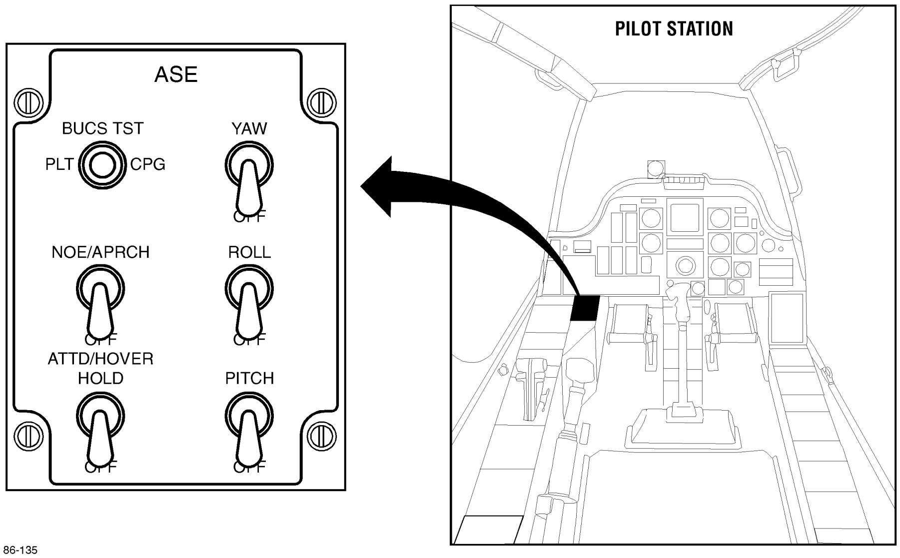
k) Pins 21 and 22 - No. 1 BUCS LVDT on longitudinal servoactuator

l) Pins 23 and 24 - SAS LVDT on directional servoactuator

m) Pins 25 and 26 - No. 1 BUCS LVDT on directional servoactuator

n) Pins 27 and 28 - No. 1 Stabilator Control Unit.

ASE CONTROL PANEL



NOTES

3. Automatic Stabilization Equipment (ASE) control panel

a. Purpose

(1) Automatic Stabilization Equipment (ASE) Control Panel controls DASE functions.

(2) Applicable to all AH-64A Helicopters.

(3) To test the Back Up Control System (BUCS) (S/N 88-0200 and subsequent).

b. The ASE Control Panel is mounted on the top, inboard portion of the pilot's left console.

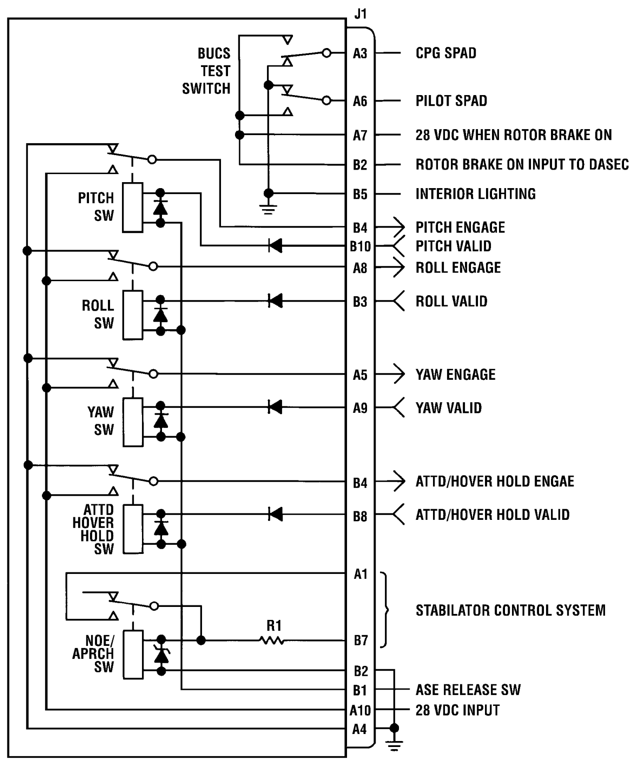
c. Description

(1) The ASE control panel contains five switches for the control and testing of the DASE system and one NOE/APRCH switch for the Stabilator Control System.

(2) The YAW, PITCH, ROLL, and ATTD/HOVER HOLD ENGAGE switches are 2-position, spring-loaded-off toggle switches that are magnetically latched in the on (engage) position.

(3) The BUCS TST switch is a single-pole, double-throw, spring-loaded off switch used for testing pilot and CPG BUCS components.

ASE CONTROL PANEL SCHEMATIC



85-472

NOTES

d. Operation

(1) Yaw engage switch

(a) 28 VDC from the ASE DC circuit breaker is supplied to the open contacts of the yaw engage switch.

(b) When the yaw engage switch is placed to the YAW position, the contacts close and apply 28 VDC to the DASE Computer (DASEC) via pin A5 of J1.

(c) The DASEC performs a built-in test, and if the yaw portion of the DASEC checks good, a yaw valid signal is sent back to the ASE panel through A9 of J1.

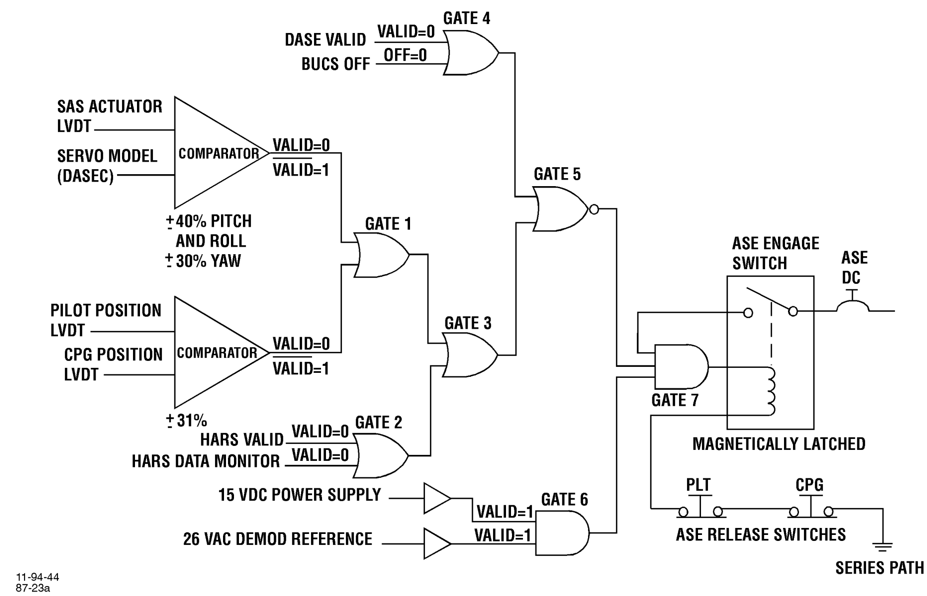
(d) The signal energizes a solenoid that holds the spring-loaded off switch in the engage position.

1) Electrical ground for the solenoid is available through pin B1 of J1 and the ASE release switches on both cyclic sticks.

2) If either crew member presses the ASE release switch, the ground for all switches is removed and all switches return to the spring-loaded off position.

(2) The ATTD/HOVER HOLD switch is a magnetically latched switch. For the switch to latch in the engaged position, the FORCE TRIM switch and at least one ASE (PITCH, ROLL, OR YAW) switch must be engaged.

ASE ENGAGE LOGIC



NOTES

(3) When AC and DC electrical power is applied to the helicopter, the DASEC performs the following tests.

(a) Compares the position of the SAS actuator on the servoactuators to a model reference inside the DASEC. If the difference is less than plus or minus 40 percent in pitch and roll, or 30 percent in yaw, the comparator applies a logic 0 to gate one.

(b) Compares the position of the pilot's and CPG's position LVDTs. If the difference is less than 31 percent, the comparator applies a logic 0 to gate one. When both comparators apply a logic 0 to gate one, the output of gate one is a logic 0.

(c) Monitors the Heading Attitude Reference Set (HARS). If the HARS is valid, and HARS DATA MONITOR is valid, the output of gate 2 is a logic 0.

(d) The outputs of gates one and two are applied to gate three. With two logic 0 inputs, the output of gate three is a logic 0, and is applied to gate five.

(e) Gate four monitors the DASE VALID and BUCS off circuits. If the DASE is valid, and the BUCS is off, the output of gate four is a logic 0, and is applied to gate five.

(f) With a logic 0 applied to gate five from gates three and four, the output of gate five is a logic 0, which is inverted to a logic 1 and is applied to gate seven.

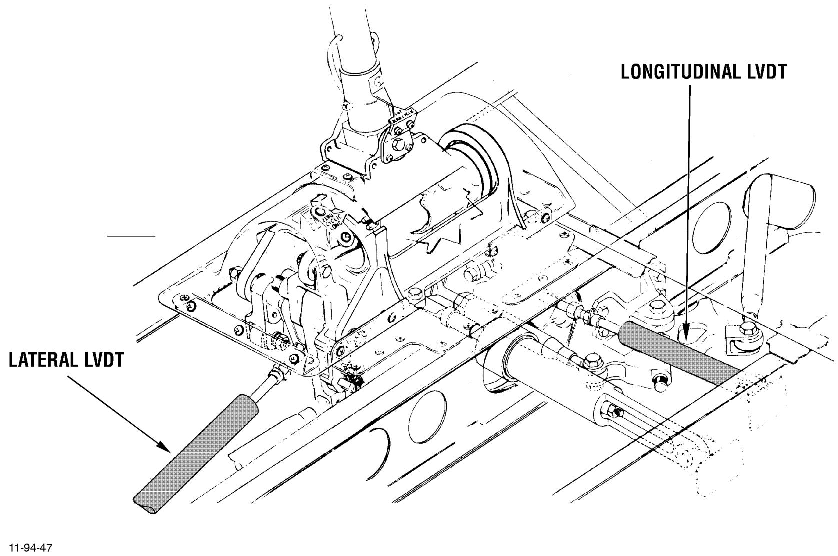
(g) Gate six monitors the 15 VDC power supply (DASEC) output and the 26 VAC demodulator reference. If both are valid, the output of gate six is a logic 1, and is applied to gate seven.

(h) When the ASE engage switch is placed in the engage position, a logic 1 is applied to gate seven.

(i) With a logic 1 from gate five, gate six, and the ASE engage switch is applied to gate 7, the output of gate seven is a logic 1 and is applied to the solenoid of the engage switch to hold the switch in the engaged position.

(j) The ASE RELEASE switches are located on both cyclic control sticks. If either switch is activated, the ground circuit is removed from the holding coils, and all ASE switches will return to the disengage position.

CYCLIC LONGITUDINAL AND LATERAL LVDTs



NOTES

4. Position Linear Variable Differential Transducer (LVDT) Helicopter SN 83-2355 through 88-0199

   a. Develops a signal that is proportional to the position of the flight controls.

   b. The LVDTs on all AH-64A helicopters are located under the floor panels in both the crew stations and are attached to

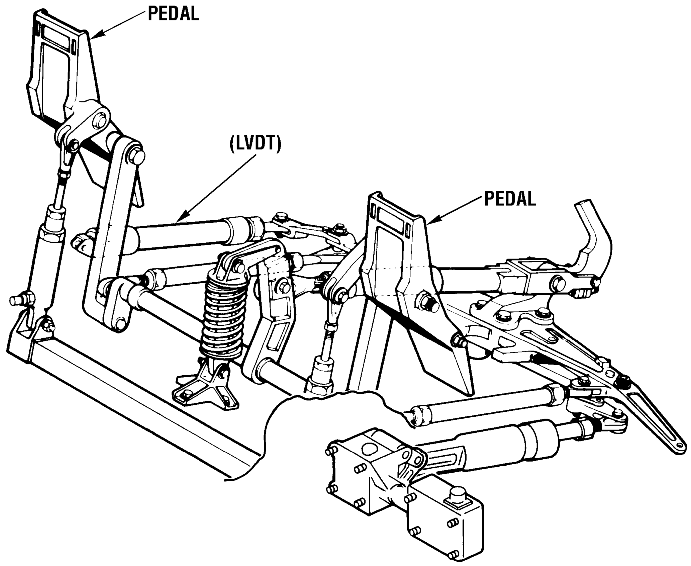
      (a) Cyclic control stick for pitch and roll. (Fore and aft, left and right cyclic movement).

WARNING

BUCS AND NON BUCS LVDT'S ARE DIFFERENT

The LVDTs for BUCS-equipped helicopters are different from the LVDTs for helicopters with the BUCS deactivated. Extreme care must be exercised to ensure the LVDTs are not interchanged or mixed.

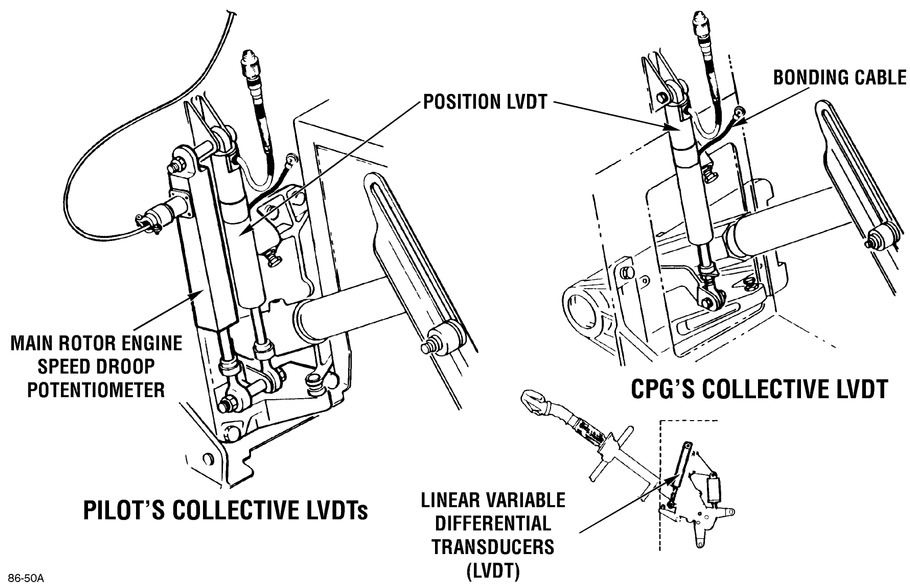
DIRECTIONAL CONTROL PEDALS LVDT



NOTES

(b) Directional control pedals (yaw)

COLLECTIVE LINEAR VARIABLE DIFFERENTIAL TRANSDUCERS (LVDT)
(A/C S/N 88-0200 AND SUBSEQUENT)

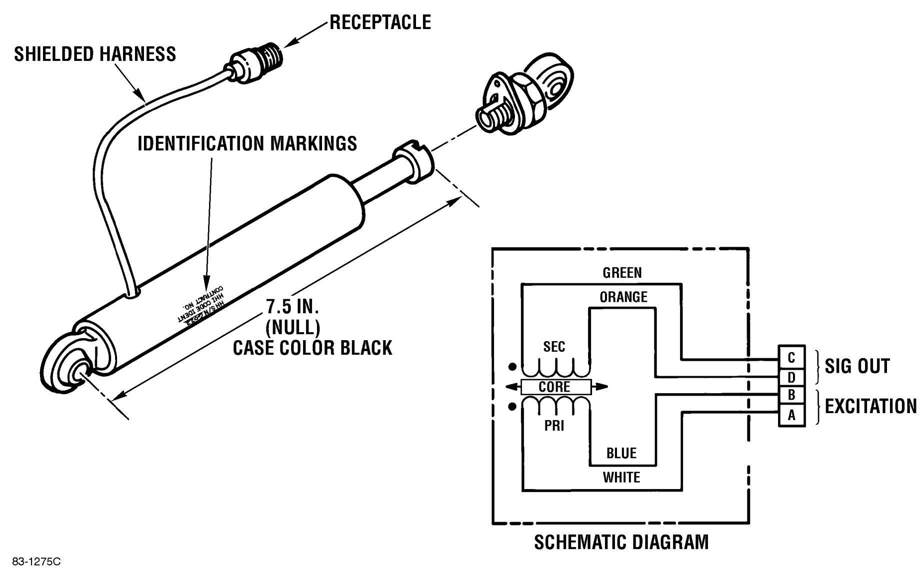


NOTES

(c) Collective control sticks for vertical control.

POSITION LINEAR VARIABLE DIFFERENTIAL TRANSDUCER (LVDT)

S/N 880199 AND BELOW



NOTES

5. Position Linear Variable Differential Transducer (LVDT) S/N 88-0199 & below

a. Description (helicopters with BUCS deactivated on helicopters S/N 83-2355 through 88-0199)

(1) The position LVDTs are black in color and have no electromagnetic interference (EMI) protection.

(2) The connector is a female receptacle.

(3) Each LVDT consists of

(a) A primary coil

(b) A movable core

(c) A secondary coil

(4) The null length (least amount of voltage output) is 7.5 inches.

(5) The maximum length for maximum output is plus or minus one inch from null.

b. Operation (Helicopters with BUCS deactivated helicopters S/N 83-2355 through 88-0199)

(1) The primary coils of the LVDTs in the CPG's station are excited by 26 VAC from transformer T1 and the primary coils of the LVDTs in the pilot's station are excited by 26 VAC from transformer T2.

(2) The movable core of each LVDT is connected to the respective flight controls and can be adjusted for null voltage output.

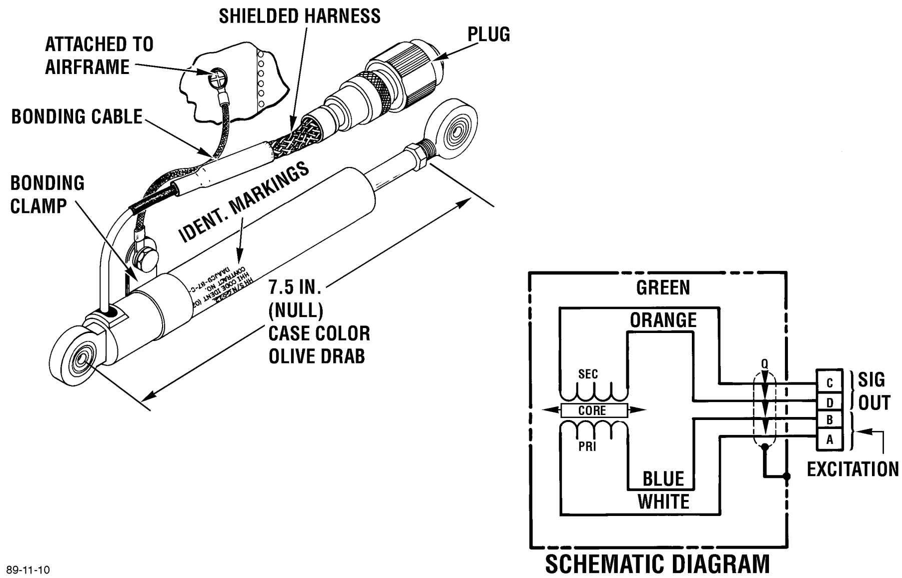
(3) As the flight controls are moved, the core position changes and causes the signal induced into the secondary coil to change.

(4) The gradient of the LVDT is 11 VAC (plus or minus 3%) per inch of movement. The output of the secondary coil is representative of flight control position.

(5) The signal from the pitch, roll, and yaw position LVDTs in helicopters with the BUCS deactivated is used for CAS operations only.

(6) The signal from the collective position LVDTs in helicopters with the BUCS deactivated is not used.

POSITION LINEAR VARIABLE DIFFERENTIAL TRANSDUCER (LVDT) S/N 88-0200 AND SUBSEQUENT



NOTES

6. Position Linear Variable Differential Transducer (LVDT) helicopter S/N 88-0200 and subsequent

a. Description LVDTs for BUCS activated helicopters (S/N 88-0200 AND subsequent)

(1) The position LVDTs are painted olive drab.

(2) Each LVDT has a bonding clamp that is attached to the airframe with a bonding cable.

(a) Shielded harness

(b) Plug (male pins) electrical connector

(c) Internal shielding

(3) Each LVDT consists of

(a) A primary coil

(b) A movable core

(c) A secondary coil

b. The null length (least amount of voltage output) is 7.5 inches.

c. The maximum length for maximum output is plus or minus one inch from null.

d. Operation

(1) Operation of the LVDTs for BUCS activated and BUCS deactivated configurations is identical except for the EMI hardening.

e. The signal from the PITCH, ROLL, AND YAW SPAD LVDTs in helicopters with the BUCS activated is used for

(1) CAS operation

(2) Flight control severance monitoring.

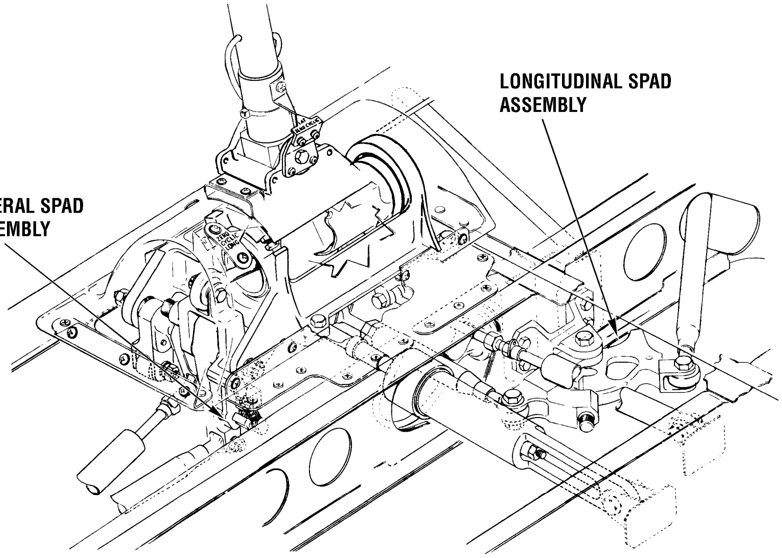
(3) Control of the helicopter if BUCS operation is initiated in the respective axis.

f. The signal from the COLLECTIVE SPAD LVDTs is used for

(1) Flight control severance monitoring.

(2) Control of the helicopter if BUCS is initiated in the vertical axis.

CYCLIC SPAD ASSEMBLIES



NOTES

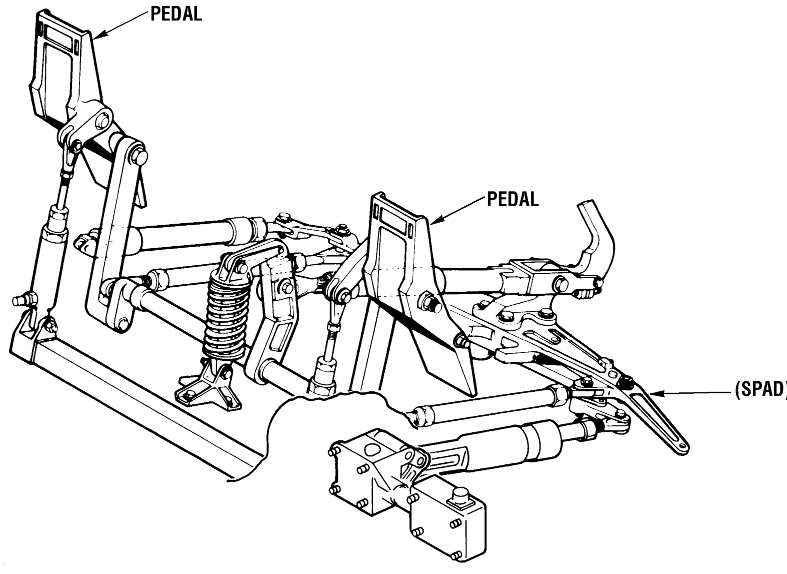
WARNING

BUCS AND NON BUCS SPAD ASSEMBLIES ARE DIFFERENT

The SPAD assemblies in helicopter S/N 83-2355 through S/N 88-0199 have the shear pins replaced by steel pins and function as bellcranks only. Extreme care must be exercised to ensure the SPADs are not mixed or interchanged between BUCS-equipped helicopters (S/N 88-0200 and subsequent) and helicopters with the BUCS deactivated.

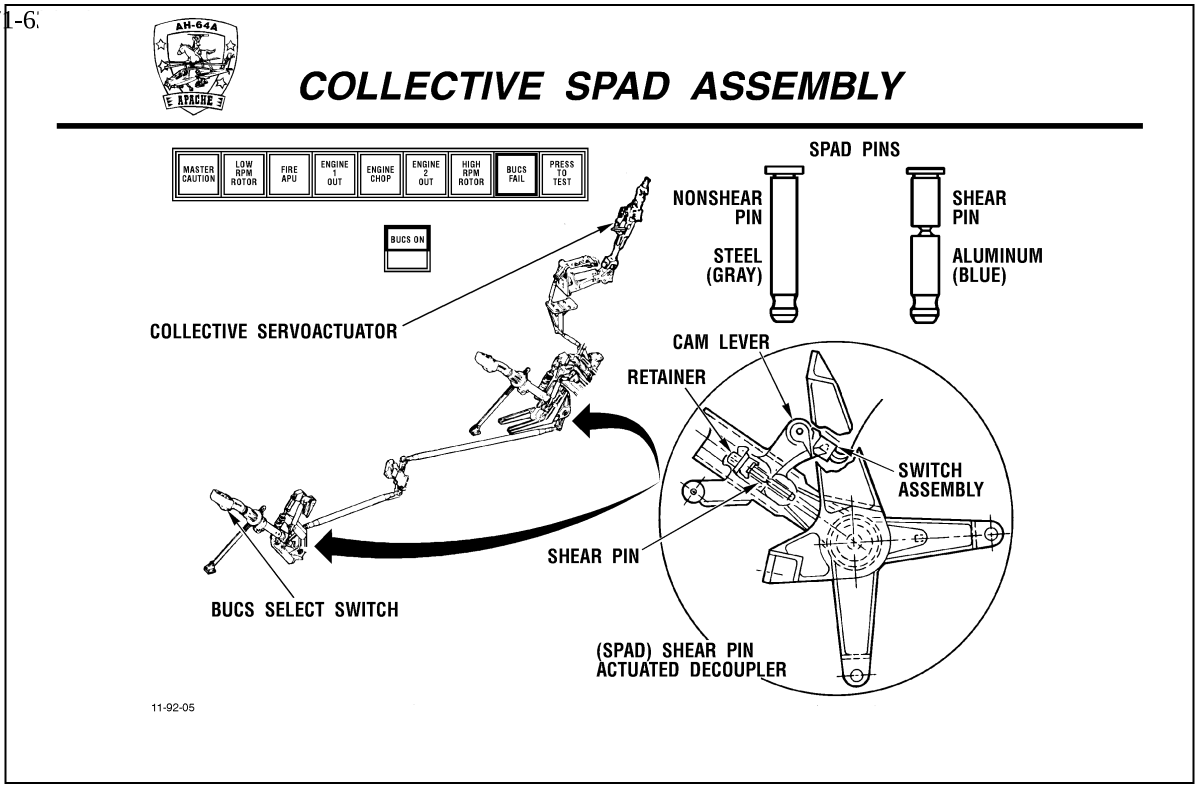
7. The longitudinal (pitch) and lateral (roll) SPADs are located under the floor in both crew stations. They are mechanically attached to the cyclic control sticks.

YAW SPAD ASSEMBLY



NOTES

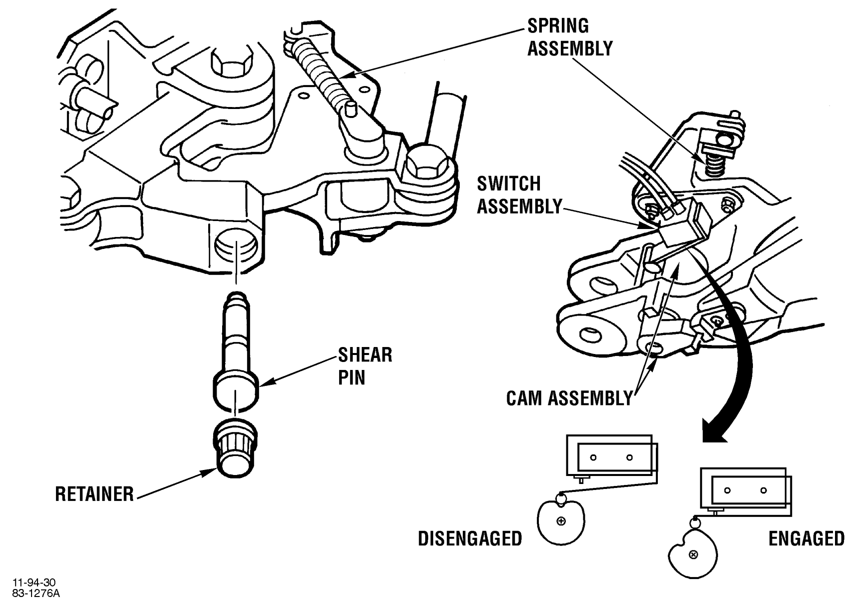
8. The yaw SPAD assemblies are located under the floor in both crew stations. They are mechanically attached to the directional control pedals.


AH-64A
APACHE
COLLECTIVE SPAD ASSEMBLY
MASTER CAUTION
LOW RPM ROTOR
FIRE APU
ENGINE 1 OUT
ENGINE CHOP
ENGINE 2 OUT
HIGH RPM ROTOR
BUCS FAIL
PRESS TO TEST
BUCS ON
SPAD PINS
NONSHEAR PIN
STEEL (GRAY)
SHEAR PIN
ALUMINUM (BLUE)
COLLECTIVE SERVOACTUATOR
CAM LEVER
RETAINER
SWITCH ASSEMBLY
SHEAR PIN
BUCS SELECT SWITCH
(SPAD) SHEAR PIN ACTUATED DECOUPLER
11-92-05

NOTES

9. One collective SPAD is mounted on the base of each collective control stick.

TYPICAL SPAD ASSEMBLY



NOTES

10. Typical spad assembly

a. Purpose

(1) Disconnects the cyclic control stick, the collective control stick, or the directional control pedals from the mechanical flight controls if the respective control becomes jammed.

(2) Enable BUCS when a SPAD pin is sheared.

b. Each SPAD assembly consists of

(1) A shear pin to hold the assembly together; thereby, providing a shear point in case of a flight control jam.

(2) Retainer to hold the shear pin in place.

(3) Switch assembly consisting of two microswitches, which are used to test and engage the BUCS.

(4) Cam assembly to engage the switch assembly.

(5) Spring assembly to hold the cam assembly in the engaged position.

c. Operation

(1) If a flight control becomes jammed, the respective SPAD shear pin must be broken to free the flight controls and activate the BUCS. The force required to activate the respective SPAD is

(a) Pilot's pitch SPAD 30 to 52 pounds

(b) CPG's pitch SPAD 35 to 80 pounds

(c) Pilot's roll SPAD 18 to 32 pounds

(d) CPG's roll SPAD 22 to 38 pounds

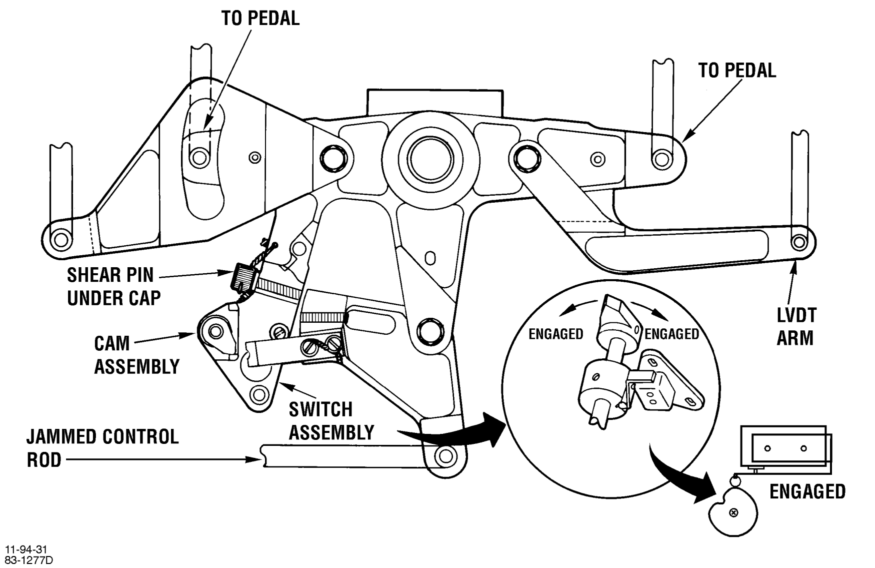
(e) Pilot's yaw SPAD 54 to 103 pounds

(f) CPG's yaw SPAD 65 to 120 pounds

(g) Pilot's coll SPAD 27 to 56 pounds

(h) CPG's coll SPAD 32 to 66 pounds

SPAD (SHEAR PIN BROKEN)



NOTES

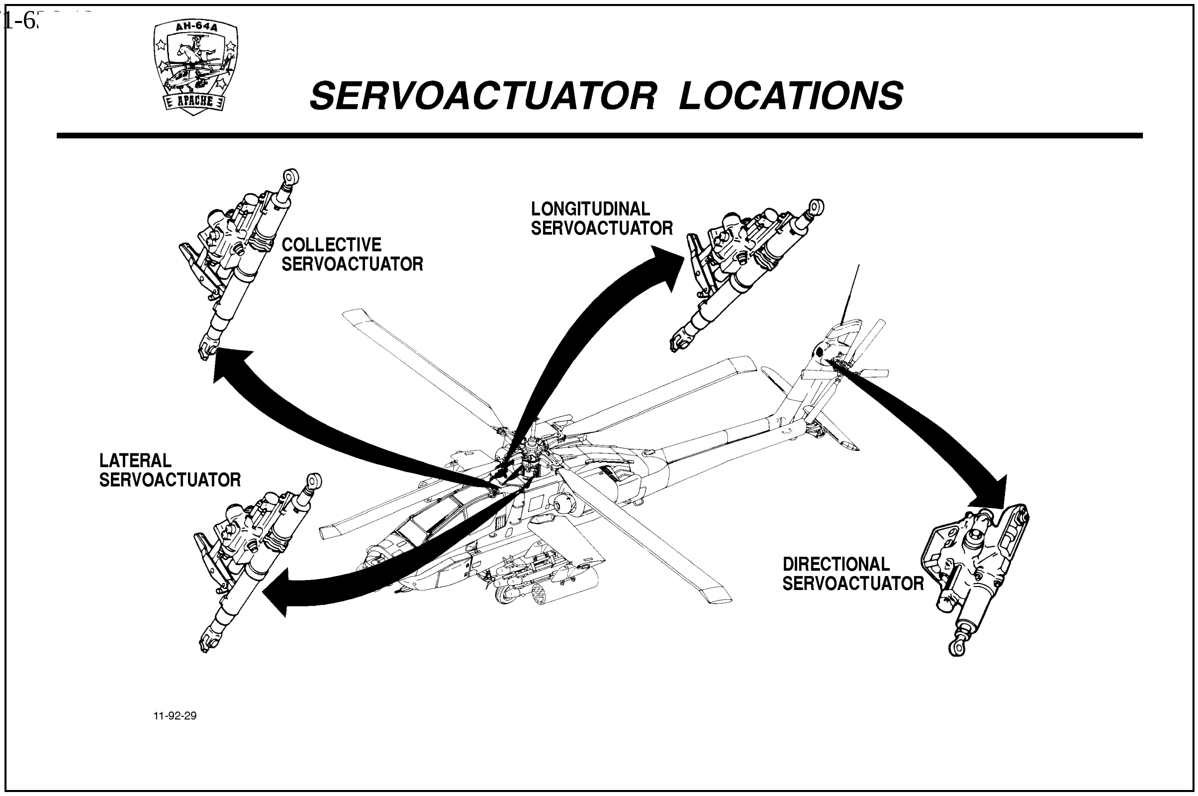
(2) If a control rod becomes jammed, force applied from either crewmember will cause the respective SPAD shear pin to break in the respective crewstation SPAD.

(3) Breaking the shear pin will cause the cam assembly on the SPAD to rotate. The cam assembly will engage the switch assembly, causing both microswitches to close.

(4) When both microswitches close, the necessary logic is provided to the DASEC to engage the Back Up Control System (BUCS).

(5) Breaking the shear pin will also free the flight controls (cyclic control stick, collective control stick, or directional control pedals) and allow free movement of the flight control and respective LVDT to control the helicopter.

(6) The SPAD assemblies are monitored by the FD/LS. A single microswitch failure in one or more axes will cause a FD/LS message to flash. A failure of a single microswitch in one or more axes will not cause the BUCS FAIL light to illuminate.


AH-64A
APACHE
SERVOACTUATOR LOCATIONS
COLLECTIVE
SERVOACTUATOR
LONGITUDINAL
SERVOACTUATOR
LATERAL
SERVOACTUATOR
DIRECTIONAL
SERVOACTUATOR
11-92-29

NOTES

11. Hydraulic servoactuators

a. The hydraulic servoactuators are used to control the pitch of the main and tail rotor blades as directed by pilot/CPG cyclic stick and yaw pedals or DASE flight control signals.

b. Location

(1) The pitch, roll, and collective servos are located in the forward main transmission area.

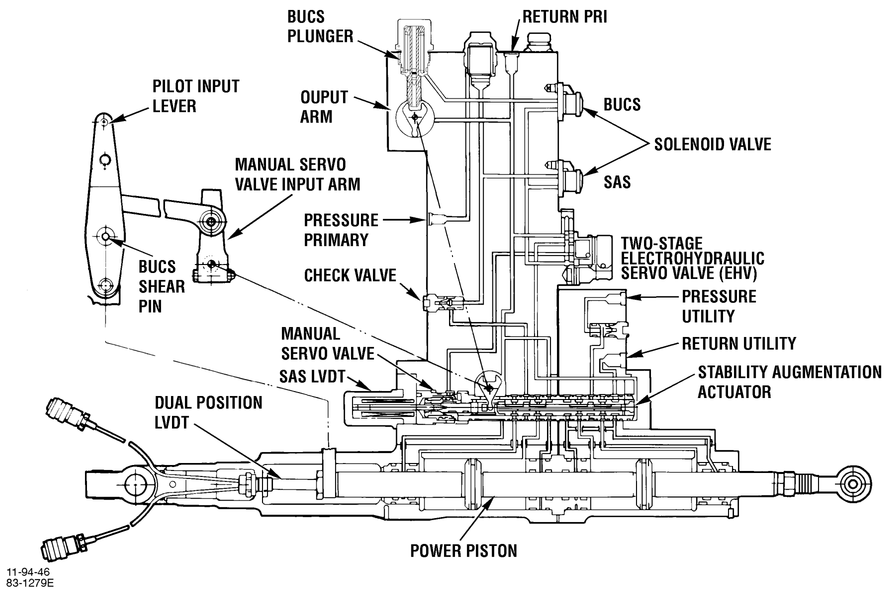
(2) The yaw servoactuator is located on the tail rotor gearbox.

WARNING

BUCS AND NON BUCS SERVOACTUATORS ARE DIFFERENT

The servoactuators on helicopters S/N 83-2355 through 88-0199 have the BUCS plunger removed and a steel pin installed in place of the BUCS shear pin. Extreme caution must be exercised to ensure the servoactuators are not mixed or interchanged between BUCS-equipped helicopters (S/N 88-0200 and subsequent) and helicopters with the BUCS deactivated.

HYDRAULIC SERVOACTUATOR SCHEMATIC



NOTES

c. The hydraulic servoactuators consist of

(1) Power piston

(2) Dual position LVDT (No. 1 and No. 2 BUCS LVDT)

(3) SAS LVDT

(4) Manual servo valve

(5) Manual servo valve input arm

(6) Pilot input lever

(7) BUCS shear pin

(8) Check valve

(9) Primary hydraulic pressure port

(10) Output arm

(11) BUCS plunger (Plunger removed S/N 88-0199 and below)

(12) Primary hydraulic return port

(13) BUCS solenoid valve

(14) SAS solenoid

(15) Two-stage electrohydraulic valve

(16) Utility hydraulic pressure port

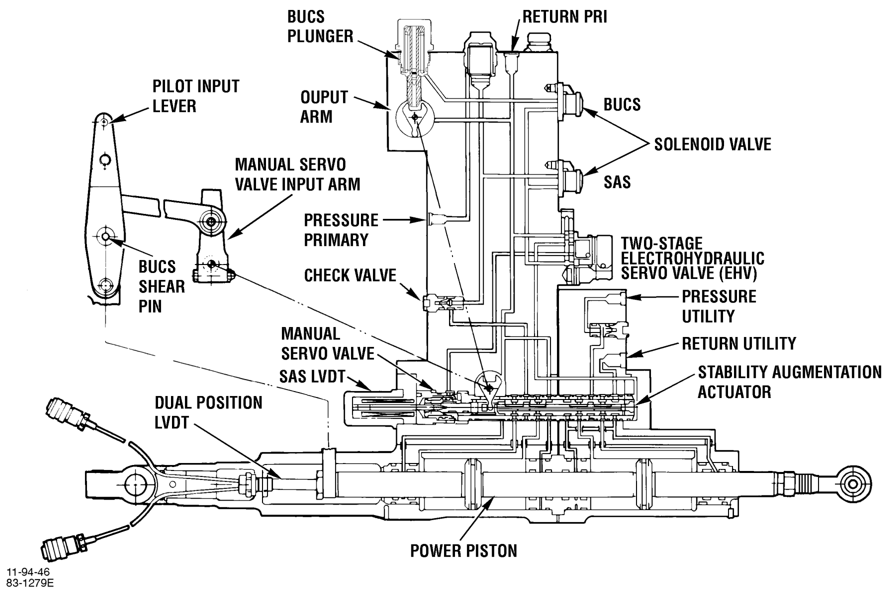
(17) Utility hydraulic return port

(18) Stability augmentation actuator

d. Operation

(1) Manual operation

HYDRAULIC SERVOACTUATOR SCHEMATIC



NOTES

(a) A manual control (pilot) input will move the manual servo valve input arm, which will displace the manual servo valve from the stability augmentation (SAS) actuator neutral position. Displacement of the manual servo valve from the SAS actuator will open hydraulic ports to direct pressure to extend or retract the power piston. Movement of the power piston will increase or decrease the pitch of the rotor blades to cause the helicopter to change attitude as directed by the pilot.

(b) As the power piston moves, mechanical linkage will feed the movement back to the pilot input lever. The pilot input lever will pivot around the pilot input point, causing the manual servo valve input arm to reposition the manual servo valve to realign with the SAS actuator.

(c) When the manual servo valve is aligned with the SAS actuator, the hydraulic ports are closed and fluid is trapped to hold the power piston in that position until the pilot makes another flight control input.

(2) ASE operation

(a) When ASE is engaged, the SAS solenoid valve is energized open. The open SAS valve will port hydraulic fluid under pressure to the two-stage electro-hydraulic valve (EHV).

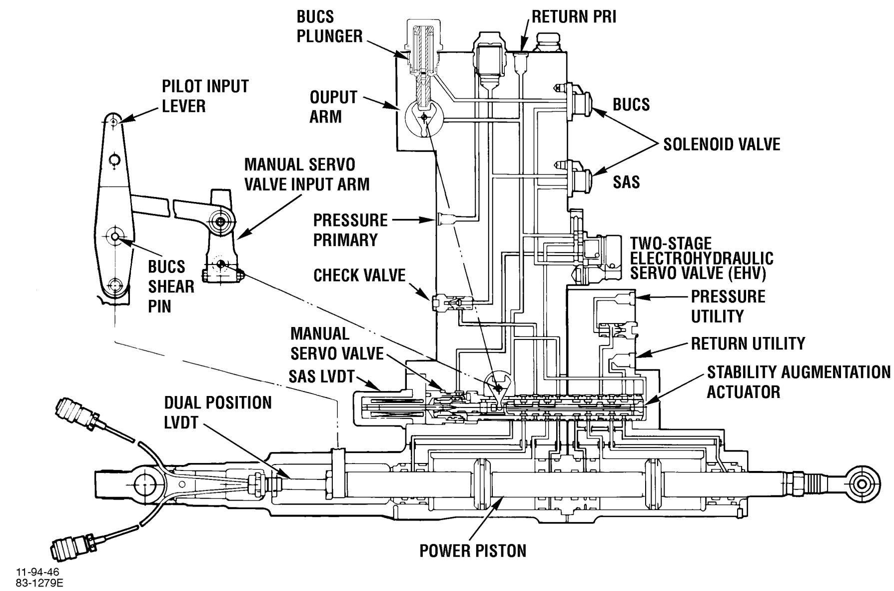
(b) The EHV is a flapper valve that is controlled by an electrical signal from the DASEC. When the EHV valve is in the center (neutral) position, hydraulic pressure is equal on both sides of the SAS actuator. The SAS actuator can not be moved as long as pressure is equal on both sides.

(c) When the helicopter deviates from the reference attitude, a rate signal is developed by the HARS and applied to the DASEC. The DASEC develops a command signal and applies it to the EHV. The flapper valve inside the EHV will be forced to move, causing hydraulic pressure to move the SAS actuator.

(d) Movement of the SAS actuator will

1) Open ports to allow hydraulic pressure to extend or retract the power piston.

HYDRAULIC SERVOACTUATOR SCHEMATIC



NOTES

2) Cause the SAS LVDT to provide a feedback signal to the DASEC where it is summed with the command signal (called Servo Model 1 signal). The feedback signal will always be of opposite polarity to the command signal and is used to prevent over corrections and to aid the washout of the command signal.

3) When the command signal is washed out, the EHV flapper valve will return to the neutral position. This will equalize pressure on the SAS actuator and cause the actuator movement to stop.

(e) As the power piston moves, mechanical feedback is applied to the pilot input lever, causing the lever to pivot around the pilot input point. The mechanical feedback moves the manual servo valve to realign with the new SAS actuator position. When the SAS actuator and the manual servo valve are aligned, the hydraulic ports are closed and power piston movement stops.

(f) As the helicopter is returning to attitude, the rate signal developed by the HARS will be of opposite polarity to the original rate signal. The rate signal will be applied to the EHV to cause the SAS actuator to move back toward the neutral position.

(g) When the SAS actuator moves, it displaces from the manual servo valve and opens hydraulic ports to the power piston.

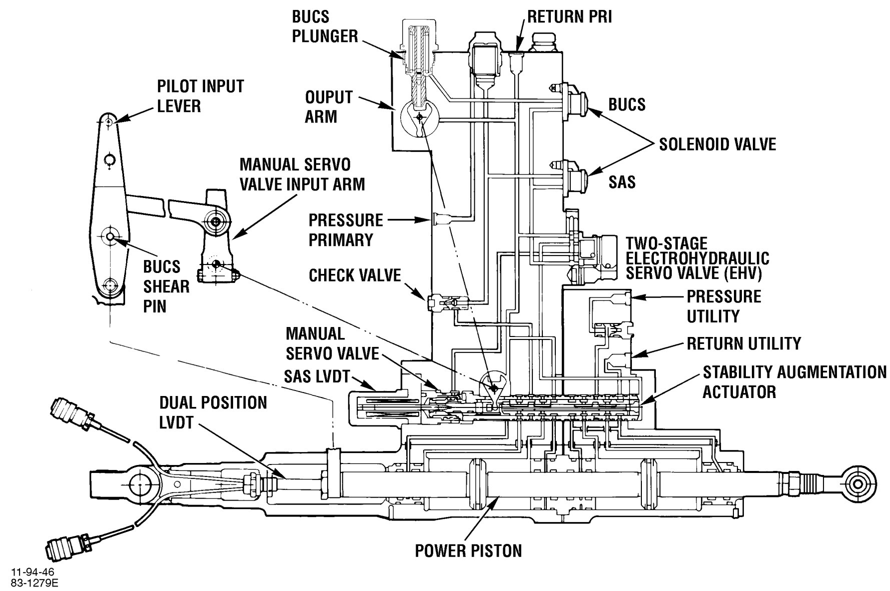
(h) The power piston moves back toward its original position. As the power piston moves, the mechanical feedback moves the manual servo valve input arm, which moves the manual servo valve back to align with the SAS actuator.

(i) When the manual servo valve is aligned with the SAS actuator, the hydraulic ports are again closed and power piston movement stops.

(3) Back Up Control System (BUCS) operation

(a) When the BUCS is engaged, electrical power is applied to the SAS and the BUCS solenoid valves. Both valves are energized open.

HYDRAULIC SERVOACTUATOR SCHEMATIC



NOTES

(b) Hydraulic pressure is applied through the SAS valve and the BUCS valve to the BUCS plunger. The BUCS plunger is forced out to engage the output arm, locking out manual control inputs. With manual control inputs locked out, the EHV becomes the only source of flight control for the helicopter.

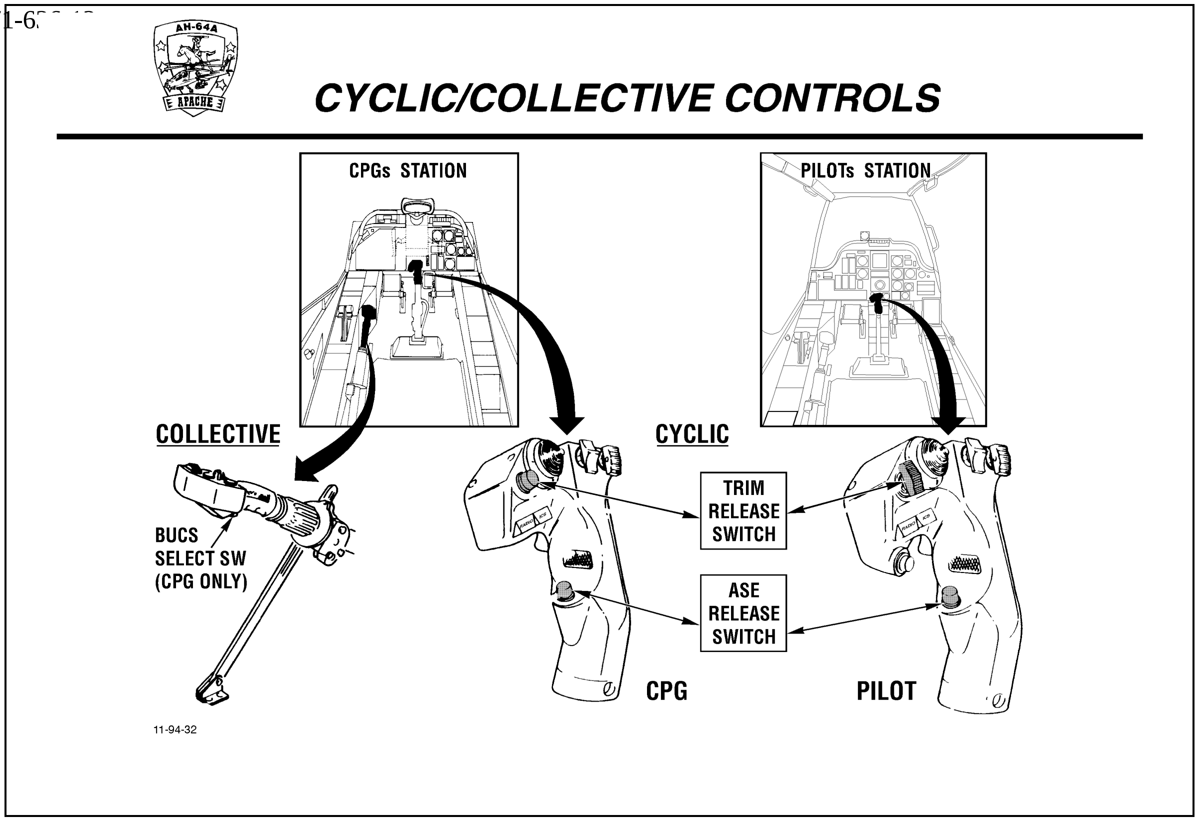
(c) When the pilot moves the cyclic control stick in the roll axis, a signal is developed by the roll LVDT that is proportional to the position of the flight controls. The signal is applied to the DASEC where it is computed into a command signal for the EHV.

(d) The EHV flapper will displace from the neutral position and cause the SAS actuator to move, which will open the hydraulic ports to the power piston.

(e) The power piston will extend or retract as directed by the EHV flapper valve. As the power piston moves, it will shear the BUCS shear pin if the flight control linkage is jammed, separating the servo from the flight control linkage.

(f) As long as the cyclic is displaced, hydraulic pressure will cause the power piston to move. As the power piston moves, the dual position (BUCS 1 and BUCS 2) LVDT develops a signal that is in opposition to the roll command signal developed by the DASEC from the roll LVDT. This gives the SAS actuator 100% flight control authority during BUCS operation.

(g) The dual position (BUCS 1 and BUCS 2) LVDT signal is sent to the DASEC where it is algebraically summed with the roll command (roll LVDT) signal. When the two signals are equal, they cancel each other out and the EHV valve returns to the neutral position and equalizes pressure on the stability augmentation actuator. SAS actuator movement will stop and remain in that position until the pilot makes another flight control input.


AH-64A
APACHE
CYCLIC/COLLECTIVE CONTROLS
CPGs STATION
PILOTs STATION
COLLECTIVE
CYCLIC
BUCS
SELECT SW
(CPG ONLY)
TRIM
RELEASE
SWITCH
ASE
RELEASE
SWITCH
CPG
PILOT
11-94-32

NOTES

12. Controls and Indicators

a. ASE release switches

(1) To provide one-switch disengagement of the DASE system.

(2) One ASE release switch is located on each cyclic control stick.

(3) The ASE release switches are momentary-contact, button-type switches, spring-loaded to the release (on) position.

(4) Operation

(a) When released (on position), the ASE release switches are connected in series and provide the grounding circuit to magnetically latch the pitch, roll, yaw, and ATTD/HOVER HOLD switches in the engaged position.

(b) When either ASE release switch is pressed, the circuit is opened and all ASE switches move simultaneously to the spring-loaded OFF position.

b. BUCS select switch

(1) The BUCS select switch is used to

(a) Transfer control for BUCS operation from the pilot's position LVDT to the CPG's LVDT after BUCS has been engaged.

(b) Test the CPG's BUCS components prior to engaging the rotors.

(c) Initiate BUCS under specific circumstances only.

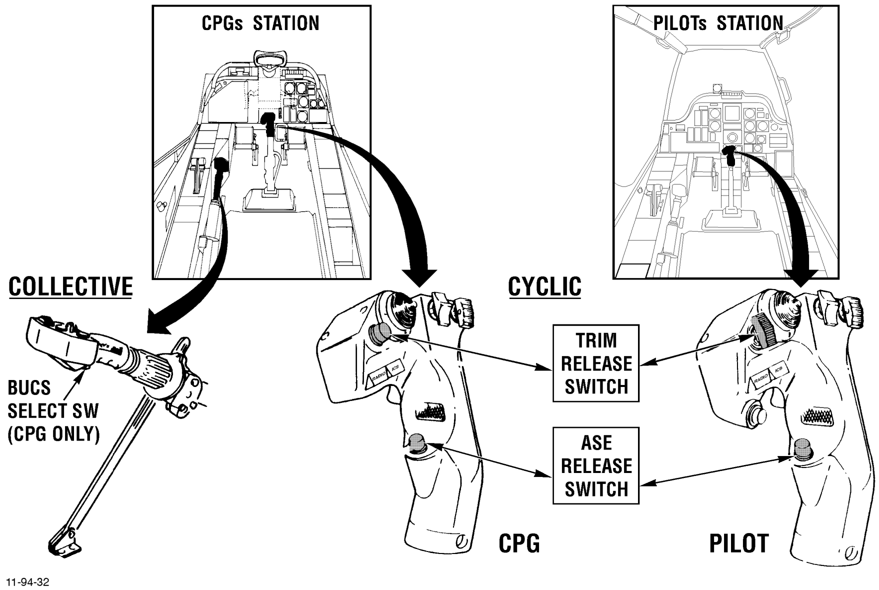
(2) The BUCS select switch is located on the CPG's collective control stick.

(3) The BUCS select switch is a hermetically sealed, single-throw, momentary-contact trigger-switch, with a guard over the trigger.

(4) Operation

(a) If the BUCS has been activated, pressing the BUCS select switch will transfer BUCS control from the pilot's position LVDT to the CPG's position LVDT.

CYCLIC/COLLECTIVE CONTROLS



NOTES

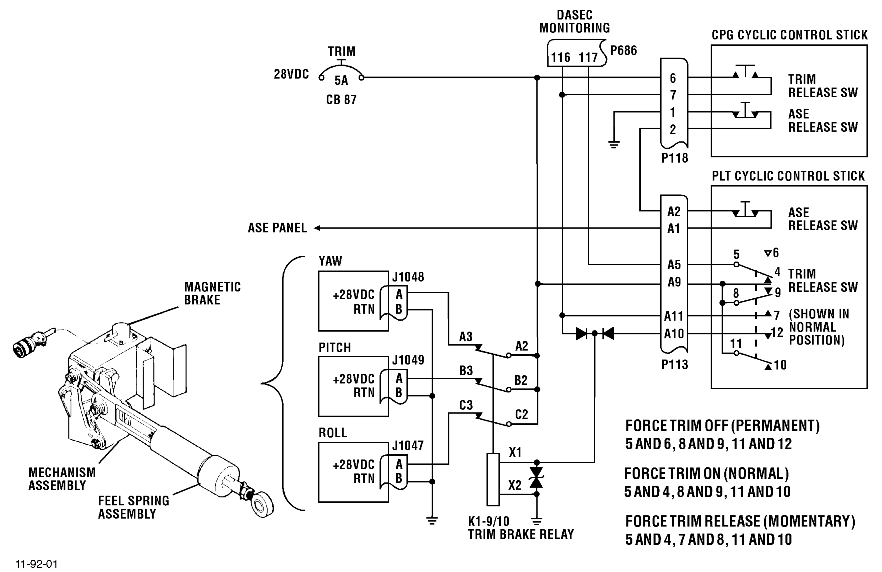
(b) The BUCS select switch is also used to test the CPG's BUCS when the helicopter is on the ground and the rotor brake is on. Test operation will be discussed under the BUCS portion of this lesson.

(c) The BUCS select switch can be used to activate the BUCS under the following conditions only

1) If a mistrack between a CPG position LVDT and a No. 2 BUCS LVDT occurs, automatic engagement of BUCS in that axis will be inhibited by software in the DASEC.

2) This can be overridden by activating the BUCS select switch. Under the above conditions, pressing the BUCS select switch will activate the BUCS in the axis that has the mistrack.

TRIM RELEASE SYSTEM



NOTES

c. Trim release system

(1) The trim release system (also called "force trim") holds the cyclic control stick and the directional control pedals in a neutral position selected by the pilot or CPG to allow limited hands-off flying.

(2) The trim release system consists of two trim switches and three magnetic brakes.

(a) One trim release switch is located on each cyclic stick grip.

(b) One magnetic brake is attached to each of the pitch, roll, and yaw flight controls under the pilot's station floor.

(3) Trim release switches

(a) The pilot's trim switch is a three-position, thumb-actuated switch that is marked OFF, ON, and RELEASE.

1) The OFF position is a permanent position and turns off the trim system.

2) The ON position is a permanent position and engages the trim position.

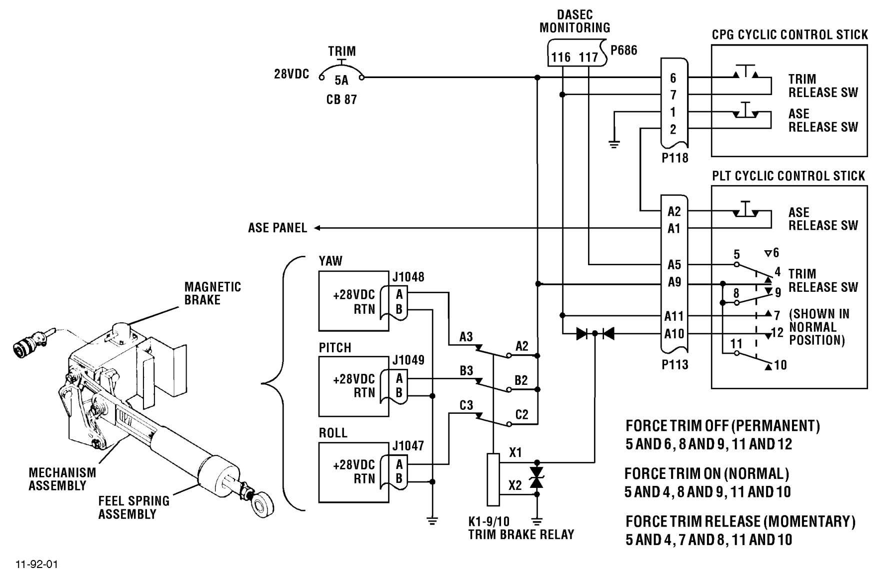
3) The RELEASE position is a momentary-contact position, spring-loaded to the ON position. This position is used to release the magnetic brakes during maneuvering of the helicopter by a crew member, or to establish a new neutral flight control position. The DASE uses the attitude at the time of trim engagement or momentary release as the reference attitude for DASE operations.

(b) The CPG's trim release switch is a two-position, momentary contact button-type switch, spring-loaded to the engage position.

1) When the switch is released, the trim system is engaged.

2) When the switch is pressed, the magnetic brakes are released. This allows the CPG to establish a new stick position.

TRIM RELEASE SYSTEM



NOTES

(c) Operation

1) The trim release system must be engaged for the DASE system to be fully operational. If the trim release system is not on, the ATTD/HOVER HOLD switch can not be latched in the engage position.

2) Operation with trim release off

a) When the pilot's trim release switch is in the OFF position, contacts 5/6, 8/9, and 11/12 close. Contacts 11/12 complete a circuit from the TRIM circuit breaker to the coil of the trim brake relay (K1-9/10).

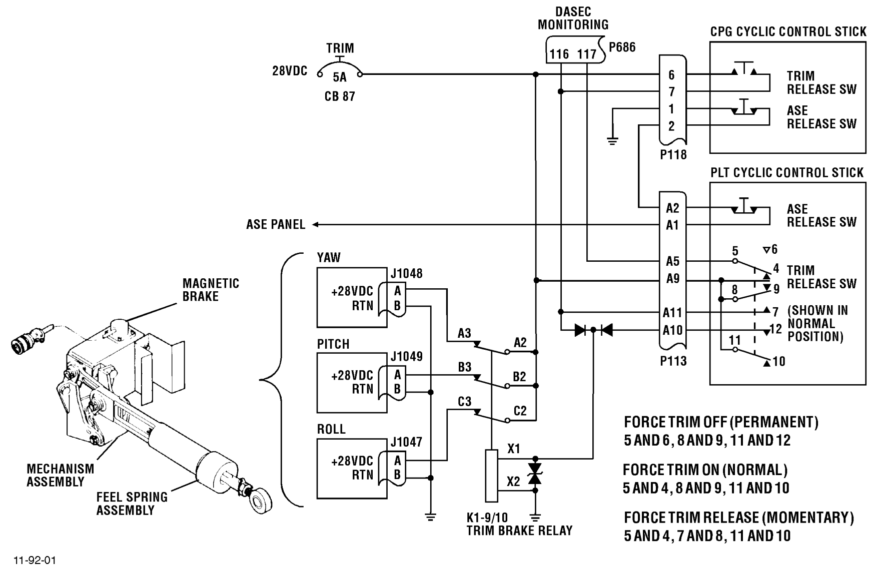
b) Contacts 8/9 and 5/6 are both open circuits. Contacts 5/6 remove 28 VDC from the DASEC when the trim system is off. Without this input, the ATTD/HOVER HOLD switch will not engage.

c) When K1-9/10 energizes, contacts of the relay open and remove power from the magnetic brakes. The brakes are deenergized (released). With the brakes released, the cyclic control sticks and the directional control pedals are free to move in any direction their moment of inertia may direct. Constant hands-on guidance is required by the pilot to hold the stick in a stable position.

3) Trim release on

a) When the pilot's trim release switch is placed to the ON position, contacts 11/12 and 7/8 are opened, and contacts 4/5 are closed. With 11/12 open, 28 VDC is removed from the coil of the trim relay and the relay deenergizes. Contacts A2/A3, B2/B3, and C2/C3 close and apply 28 VDC to each magnetic brake to engage the trim system.

TRIM RELEASE SYSTEM



NOTES

b) Contacts 4/5 of the pilot's trim switch apply 28 VDC to P686 - 117 of the DASEC. This allows the ATTD/HOVER HOLD switch to latch in the engaged position when engaged by the pilot.

c) With the brakes engaged, the yaw pedals and cyclic control stick are held in the position selected by the pilot.

d) If the pilot or CPG moves the controls when the brakes are engaged, the feel spring assembly is compressed. When the controls are released, the feel spring assembly will return the controls to the original position without pilot intervention.

4) Trim released

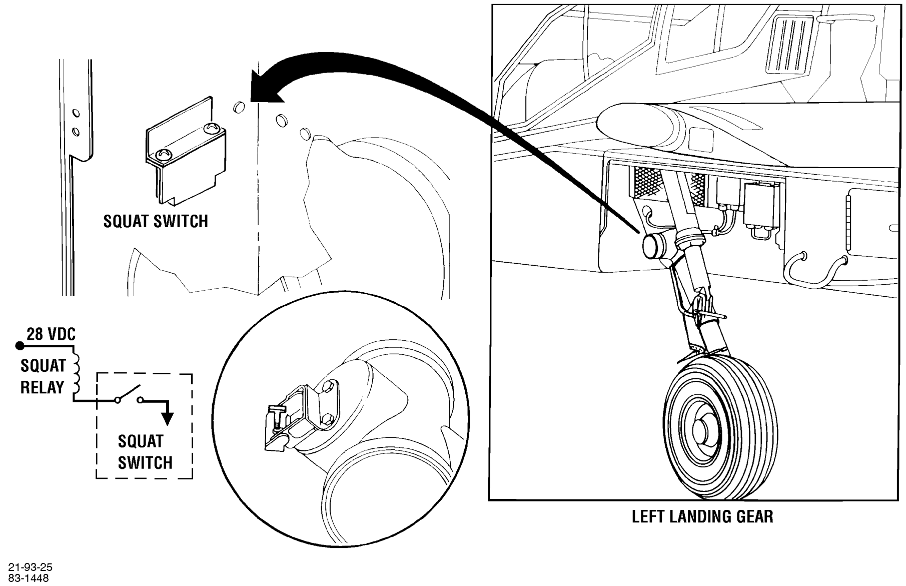
a) When either crew member selects the momentary RELEASE position, 28 VDC is applied to the coil of relay K1-9/10 and to pin 116 of the DASEC connector.

b) When relay K1-9/10 energizes, power is removed from the magnetic brakes. With the brakes released, a flight control input by either crew member will cause the mechanism assembly and the feel spring assembly to move as a unit. The feel spring assembly does not compress and the controls are free to be positioned as desired by the crew.

c) When the release position is selected, contacts 5/4, 7/8, and 11/10 are closed. The input to pin 116 of the DASEC causes the DASEC to go into synchronization and prevents the DASE system from opposing pilot or CPG inputs.

d) When the desired cyclic or pedal position is reached, the trim release switch is allowed to return to the spring-loaded ON position. This establishes a new reference for DASE operations and deenergizes the trim relay to engage the trim system.

SQUAT SWITCH



NOTES

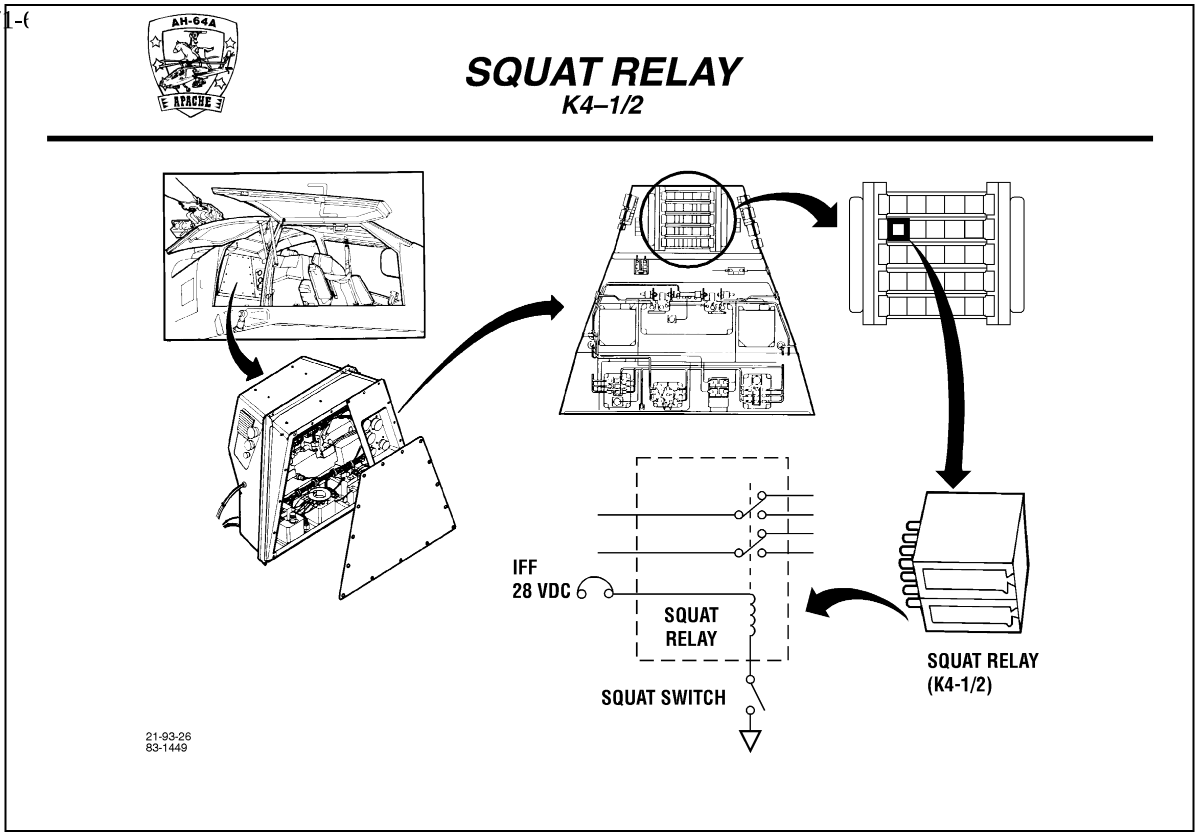
d. Squat switch

(1) Controls the operation of the squat relay.

(2) The squat switch is located on top of the left main landing gear.

(3) The squat switch is a solid-state proximity switch.

(4) When the aircraft is on the ground, the switch is open and the ground is removed from the return side of the squat relay coil.


AH-64A
APACHE
SQUAT RELAY
K4–1/2
IFF
28 VDC
SQUAT
RELAY
SQUAT SWITCH
SQUAT RELAY
(K4-1/2)
21-93-26
83-1449

NOTES

e. Squat relay

(1) The squat relay disables the Yaw Command Augmentation System (CAS) when the aircraft is on the ground, and enables the BUCS test and the DASE FD/LS test when the aircraft is on the ground.

(2) Located in the electrical power distribution center.

(3) A small (1 inch X 1 inch) lightweight (1.4 ounces) solid state Line Replaceable Unit.

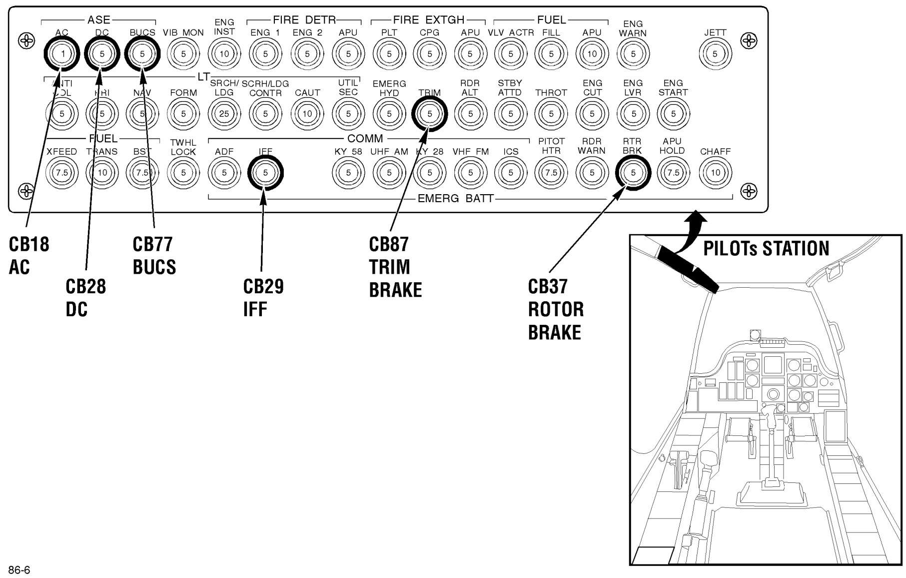
(4) Operation

(a) The coil is powered by 28 VDC from the emergency bus via the IFF circuit breaker.

(b) When the aircraft is on the ground, the squat switch maintains an open circuit in the ground path of the coil of the relay, and the relay is deenergized. When deenergized, a set of closed contacts connects 28 VDC into the DASE computer (DASEC). This signal disables yaw CAS and enables the DASE FD/LS test and the BUCS self-test.

(c) When the aircraft is airborne, the squat switch provides the ground for the relay and the relay is energized. When energized, a set of closed contact connects a ground into the DASEC to disable the DASE FD/LS test and BUCS self-test, and enables yaw CAS.

DASE CIRCUIT BREAKERS



NOTES

f. Circuit breakers

(1) Provide circuit protection for the DASE electrical system.

(2) The DASE circuit breakers are located on the pilot's center overhead circuit breaker panel.

(3) Description and operation

(a) ASE AC, 1 amp, supplies 115 VAC from the No. 1 AC bus to transformers T1, T2, and DASE Computer.

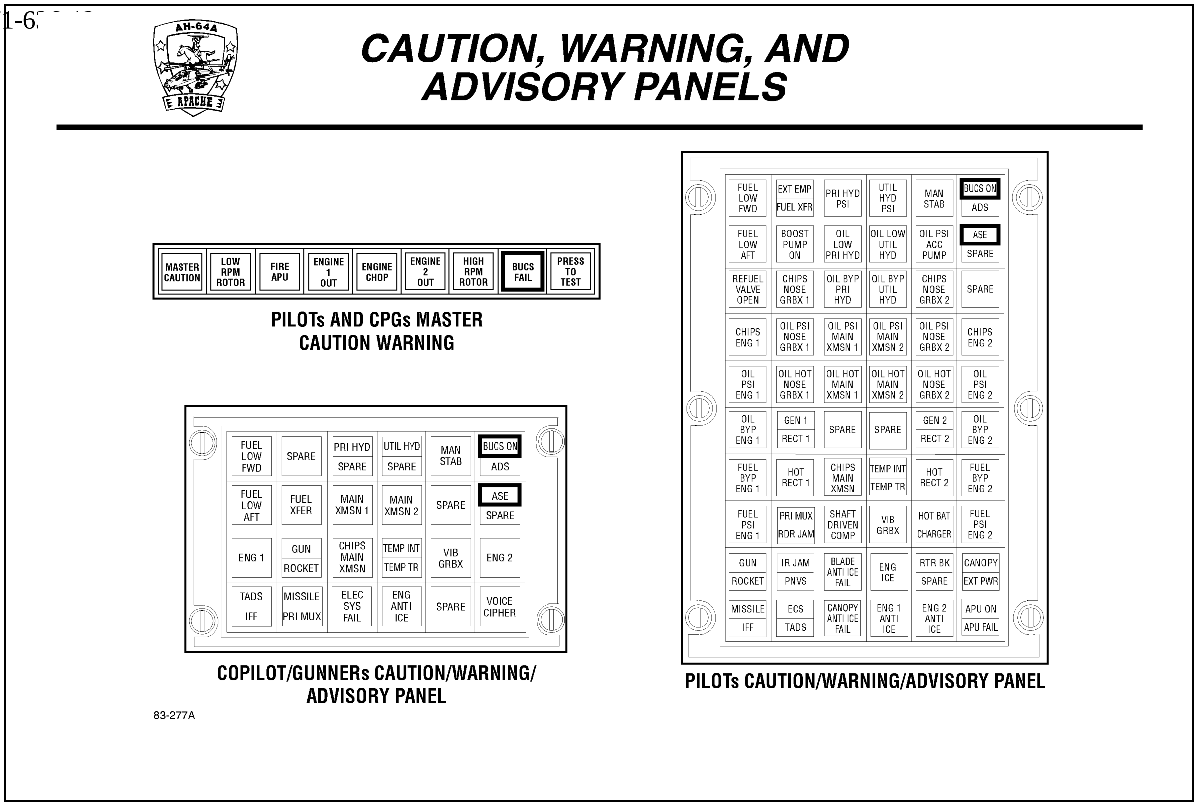
(b) ASE DC, 5 amp, supplies 28 VDC from the No. 3 DC bus to the DASEC.

(c) ASE BUCS, 5 amp, supplies 28 VDC from the DC emergency bus to the DASEC and to the BUCS components.

(d) COMM IFF, 5 amp, supplies 28 VDC from the emergency bus to the squat switch and squat relay.

(e) TRIM, 5 amp, supplies 28 VDC from the emergency bus to the trim system.

(f) RTR BRK, 5 amp, supplies 28 VDC from the emergency bus to rotor brake.


AH-64A
APACHE
CAUTION, WARNING, AND
ADVISORY PANELS
MASTER CAUTION
LOW RPM ROTOR
FIRE APU
ENGINE 1 OUT
ENGINE CHOP
ENGINE 2 OUT
HIGH RPM ROTOR
BUCS FAIL
PRESS TO TEST
PILOTs AND CPGs MASTER
CAUTION WARNING
FUEL LOW FWD
SPARE
PRI HYD / SPARE
UTIL HYD / SPARE
MAN STAB
BUCS ON / ADS
FUEL LOW AFT
FUEL XFER
MAIN XMSN 1
MAIN XMSN 2
SPARE
ASE / SPARE
ENG 1
GUN / ROCKET
CHIPS MAIN XMSN
TEMP INT / TEMP TR
VIB GRBX
ENG 2
TADS / IFF
MISSILE / PRI MUX
ELEC SYS FAIL
ENG ANTI ICE
SPARE
VOICE CIPHER
COPILOT/GUNNERs CAUTION/WARNING/
ADVISORY PANEL
FUEL LOW FWD
EXT EMP / FUEL XFR
PRI HYD PSI
UTIL HYD PSI
MAN STAB
BUCS ON / ADS
FUEL LOW AFT
BOOST PUMP ON
OIL LOW PRI HYD
OIL LOW UTIL HYD
OIL PSI ACC PUMP
ASE / SPARE
REFUEL VALVE OPEN
CHIPS NOSE GRBX 1
OIL BYP PRI HYD
OIL BYP UTIL HYD
CHIPS NOSE GRBX 2
SPARE
CHIPS ENG 1
OIL PSI NOSE GRBX 1
OIL PSI MAIN XMSN 1
OIL PSI MAIN XMSN 2
OIL PSI NOSE GRBX 2
CHIPS ENG 2
OIL PSI ENG 1
OIL HOT NOSE GRBX 1
OIL HOT MAIN XMSN 1
OIL HOT MAIN XMSN 2
OIL HOT NOSE GRBX 2
OIL PSI ENG 2
OIL BYP ENG 1
GEN 1 / RECT 1
SPARE
SPARE
GEN 2 / RECT 2
OIL BYP ENG 2
FUEL BYP ENG 1
HOT RECT 1
CHIPS MAIN XMSN
TEMP INT / TEMP TR
HOT RECT 2
FUEL BYP ENG 2
FUEL PSI ENG 1
PRI MUX / RDR JAM
SHAFT DRIVEN COMP
VIB GRBX
HOT BAT / CHARGER
FUEL PSI ENG 2
GUN / ROCKET
IR JAM / PNVS
BLADE ANTI ICE FAIL
ENG ICE
RTR BK / SPARE
CANOPY / EXT PWR
MISSILE / IFF
ECS / TADS
CANOPY ANTI ICE FAIL
ENG 1 ANTI ICE
ENG 2 ANTI ICE
APU ON / APU FAIL
PILOTs CAUTION/WARNING/ADVISORY PANEL
83-277A

NOTES

g. Caution, warning, and advisory panels

(1) Provides visual indications to the crew members of the status of the ASE and BUCS.

(2) Location

(a) The ASE caution light and the BUCS ON advisory light are located on the Caution/Warning/Advisory panels in both crew stations.

(b) The BUCS FAIL warning light is located on the Master Caution panel in both crew stations.

(3) Description

(a) The ASE caution light and the BUCS ON advisory light are amber when illuminated.

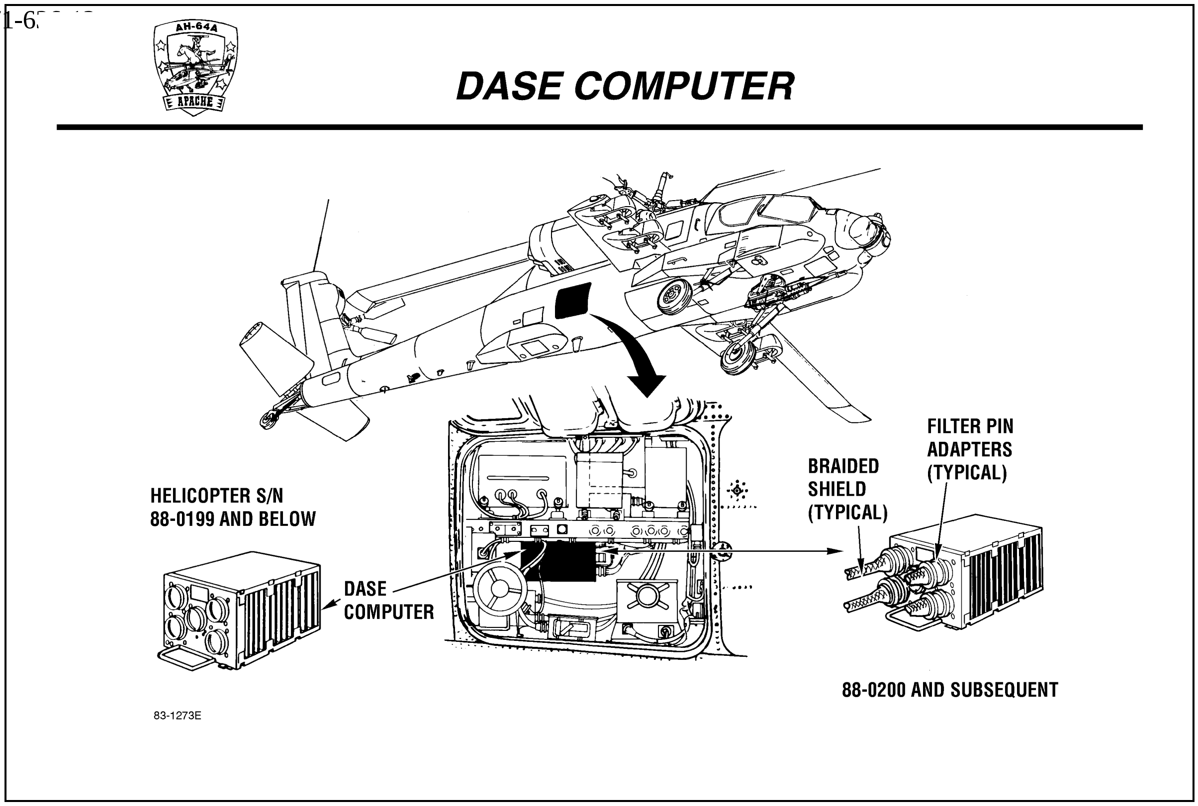
(b) The BUCS FAIL light is red when illuminated.

(4) Operation

(a) The ASE light, when illuminated, indicates that one or more axis have failed or is turned off.

(b) The BUCS ON light, when illuminated, indicates that the BUCS is engaged.

(c) The BUCS FAIL light, when illuminated, indicates that one or more of the Back-Up Control System circuits or components have failed.


AH-64A
APACHE
DASE COMPUTER
HELICOPTER S/N
88-0199 AND BELOW
DASE
COMPUTER
BRAIDED
SHIELD
(TYPICAL)
FILTER PIN
ADAPTERS
(TYPICAL)
88-0200 AND SUBSEQUENT
83-1273E

NOTES

A. Digital Automatic Stabilization Equipment Computer (DASEC)

1. The DASEC receives and transmits flight reference signals for the control and stability of the helicopter.

2. The DASEC is mounted in the aft avionics bay.

3. Description

a. The DASEC is a lightweight (12 pounds), solid-state, line replaceable unit containing replaceable integrated circuit boards.

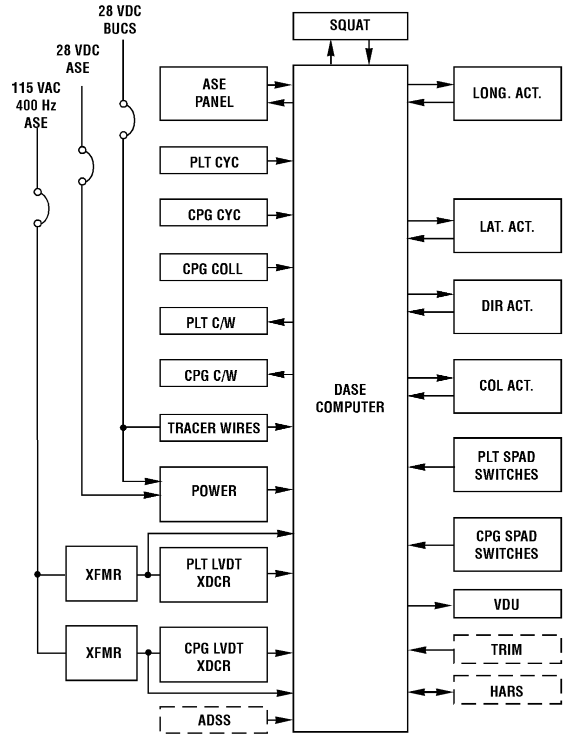
b. The DASEC has five connectors on the front panel.

(1) Four connectors are used for aircraft interface and DASE operations.

(2) On helicopters S/N 88-0200 and subsequent, FILTER PIN ADAPTERS are installed in line with the four connectors for EMI hardening.

(3) The fifth connector is used during AVIM level of maintenance to test the DASEC, utilizing the Automatic Test Equipment (ATE) van.

DASE BLOCK DIAGRAM



83-278B

NOTES

4. DASE computer operation

a. Flight control input signals to the DASEC are

(1) 28 VDC BUCS power to engage and operate the emergency Back-Up Control System, and to monitor for wire severance through tracer wires.

(2) 28 VDC ASE power to operate the DASE Computer.

(3) 115 VAC ASE power to the step-down transformers to provide 26 VAC for DASEC and LVDT operation.

(4) Pilot's and CPG's cyclic control stick for ASE disengagement.

(5) BUCS select switch on the CPG's collective stick, to transfer control from the pilot station to the CPG station when the BUCS has been activated and to enable BUCS under specific circumstances.

(6) Pilot's and CPG's SPAD switches to activate the BUCS when the flight controls are jammed.

(7) Pilot's and CPG's SPAD LVDT's provide control position information during ASE and BUCS operation.

(8) SAS LVDT for SAS actuator position during ASE and BUCS operation.

(9) BUCS LVDT's for servoactuator power piston position during ASE and BUCS operation.

b. Output and return signals of the DASE system are

(1) ASE control panel control signals to engage the PITCH, ROLL, YAW, and ATTD/HOVER HOLD switches, and to test the BUCS.

(2) Squat switch for disabling yaw Command Augmentation when the helicopter is on the ground.

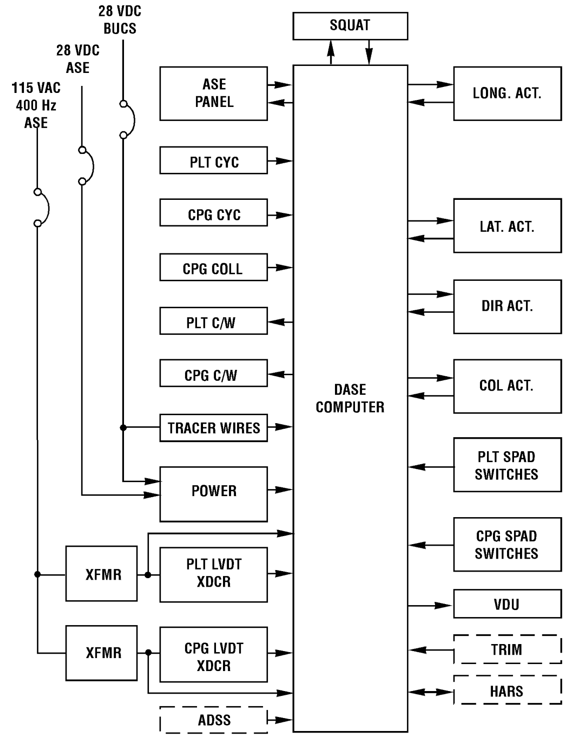
(3) Hydraulic servoactuators (pitch, roll, yaw, and collective)

(4) Output signal to the Video Display Unit (VDU) for rate of turn display.

(5) Pilot's and CPG's caution and warning signals for BUCS ON, ASE, and BUCS FAIL warning lights.

071-

DASE BLOCK DIAGRAM



83-278B

NOTES

c. The systems that interface with the DASE system are

(1) Air Data Subsystem (ADSS) providing airspeed and sideslip information.

(2) Heading Attitude and Reference Set (HARS)

(3) Force trim system for Attitude/Hover Hold operations.

(4) The Dase Computer controls the DASE electrical system. The DASE electrical system will be discussed in detail in system operation of this lesson.

DASE FLIGHT CONTROL INTERFACE SIGNALS I

SIGNAL	QTY	CHARACTERISTICS	CONNECTOR
SQUAT RELAY	1	• 1 WIRE INPUT • AIRBORNE = GND • GROUND = 28 VDC	J2 PIN 118
DASE POWER	1	• 1 WIRE INPUT • 28 VDC	J3 PIN 121
ADS SIDE SLIP	1	• 2 WIRE INPUT • 400 MVDC/DEGREE • ±25° MAX RANGE	J1 PINS 75/76
A/S FAIL	1	• 2 WIRE INPUT • VALID = 5 VDC • NOT VALID = 0 VDC	J2 PINS 32/33
ADP VALID	1	• 2 WIRE INPUT • VALID = 5 VDC • NOT VALID = 0 VDC	J2 PINS 28/29
HARS RATE VALID	1	• 2 WIRE INPUT • VALID = 5 VDC • NOT VALID = 0 VDC	J3 PINS 27/28
MODE ENGAGE SWITCH SIGNALS	4	• 1 WIRE INPUT • ON = 28 VDC • OFF = GND	J1 PINS PITCH 116 ROLL 117 YAW 118 ATTD/HOVER HOLD 119
BUCS SPAD SIGNALS (PILOT)	8	• 1 WIRE INPUT • SPAD BROKEN = 28 VDC • SPAD NOT BROKEN = GND	J1 NO. 1 SW NO. 2 SW PITCH 115 122 ROLL 123 124 YAW 125 126 COLL 127 128
CPG BUCS SELECT SWITCH	1	• 1 WIRE INPUT • OFF = GND • ON = 28 VDC	J2 PIN 113
BUCS SPAD SIGNALS (CPG)	8	• 1 WIRE INPUT • SPAD BROKEN = 28 VDC • SPAD NOT BROKEN = GND	J2 NO. 1 SW NO. 2 SW PITCH 115 122 ROLL 123 124 YAW 125 126 COLL 127 128

11-91-03

NOTES

d. DASE flight controls interface signals

(1) The squat relay signal is a 1-wire input through connector J2, pin 118.

(2) DASE Power signal 28 VDC DASE power is a 1-wire input through connector J3, pin 121.

(3) Air data sideslip is a 2-wire input through connector J1, pins 75 and 76. The output of the ADS is 400 mVDC per degree of sideslip.

(4) The A/S fail signal is a 2-wire input through connector J2, pins 32 and 33. If the airspeed is valid, the input will be 5 VDC.

(5) The Air Data Processor (ADP) Valid signal is a 2-wire input through connector J2, pins 28 and 29. If the Air Data Processor is valid, the signal will be 5 VDC.

(6) The HARS rate valid signal is a 2-wire input through connector J3, pins 27 and 28. If the HARS rate is valid, the input will be 5 VDC.

(7) Each of the four mode engage switches provides a 1-wire input through connector J1 when the switch is placed in the engage position.

(a)	Pitch	Pin 116
(b)	Roll	Pin 117
(c)	Yaw	Pin 118
(d)	ATT/HOVER HOLD	Pin 119

(8) The two microswitches on each SPAD in the pilot's station supply a 1-wire input to the DASEC through connector J1. If the SPAD shear pin is not broken (normal operation), the input will be a ground potential. If the SPAD shear pin has been sheared (flight control jam), the input will be 28 VDC. The inputs and the respective connector pins are

(a)	AXIS	No. 1 Switch	No. 2 Switch
(b)	Pitch	Pin 115	Pin 122
(c)	Roll	Pin 123	Pin 124
(d)	Yaw	Pin 125	Pin 126
(e)	Coll	Pin 127	Pin 128

DASE FLIGHT CONTROL INTERFACE SIGNALS I

SIGNAL	QTY	CHARACTERISTICS	CONNECTOR
SQUAT RELAY	1	• 1 WIRE INPUT • AIRBORNE = GND • GROUND = 28 VDC	J2 PIN 118
DASE POWER	1	• 1 WIRE INPUT • 28 VDC	J3 PIN 121
ADS SIDE SLIP	1	• 2 WIRE INPUT • 400 MVDC/DEGREE • ±25° MAX RANGE	J1 PINS 75/76
A/S FAIL	1	• 2 WIRE INPUT • VALID = 5 VDC • NOT VALID = 0 VDC	J2 PINS 32/33
ADP VALID	1	• 2 WIRE INPUT • VALID = 5 VDC • NOT VALID = 0 VDC	J2 PINS 28/29
HARS RATE VALID	1	• 2 WIRE INPUT • VALID = 5 VDC • NOT VALID = 0 VDC	J3 PINS 27/28
MODE ENGAGE SWITCH SIGNALS	4	• 1 WIRE INPUT • ON = 28 VDC • OFF = GND	J1 PINS PITCH 116 ROLL 117 YAW 118 ATTD/HOVER HOLD 119
BUCS SPAD SIGNALS (PILOT)	8	• 1 WIRE INPUT • SPAD BROKEN = 28 VDC • SPAD NOT BROKEN = GND	J1 NO. 1 SW NO. 2 SW PITCH 115 122 ROLL 123 124 YAW 125 126 COLL 127 128
CPG BUCS SELECT SWITCH	1	• 1 WIRE INPUT • OFF = GND • ON = 28 VDC	J2 PIN 113
BUCS SPAD SIGNALS (CPG)	8	• 1 WIRE INPUT • SPAD BROKEN = 28 VDC • SPAD NOT BROKEN = GND	J2 NO. 1 SW NO. 2 SW PITCH 115 122 ROLL 123 124 YAW 125 126 COLL 127 128

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NOTES

(9) The input from the CPG's BUCS select switch is through connector J2, pin 113. The input is normally a ground potential. If the switch is activated, the input will be 28 VDC.

(10) The two microswitches on each SPAD in the CPG's station supply a 1-wire input through connector J2. The respective pins are

(a)	AXIS	No. 1 Switch	No. 2 Switch
(b)	Pitch	Pin 115	Pin 122
(c)	Roll	Pin 123	Pin 124
(d)	Yaw	Pin 125	Pin 126
(e)	Coll	Pin 127	Pin 128

DASE FLIGHT CONTROL INTERFACE SIGNALS II

SIGNAL	QTY	CHARACTERISTICS	CONNECTOR
LONGITUDINAL AIRSPEED	1	• 2 WIRE INPUT • 40 MV/KT • -50 TO + 250 KTS	J1 PINS 73/74
BUCS SOLENOID ENGAGE HI	4	• 1 WIRE OUTPUT • BUCS ENGAGED>18VDC • BUCS NOT ENGAGED≤6VDC	J4 PINS PITCH 102 ROLL 104 YAW 106 COLLECTIVE 108
BUCS SOLENOID ENGAGE LO	4	• 1 WIRE OUTPUT • BUCS ENGAGED = GND • BUCS NOT ENGAGED = OPEN	J4 PINS PITCH 101 ROLL 103 YAW 105 COLLECTIVE 107
ROTOR BRAKE	1	• ON = 28 VDC • OFF = 0 VDC	J2 PIN 114
BUCS TRACER WIRE — POSITION LVDT'S	4	• 1 WIRE INPUT • VALID = 28 VDC • NOT VALID = OPEN	J2 PINS PITCH 52 ROLL 51 YAW 53 COLLECTIVE 54
BUCS TRACER WIRE — NO. 2 BUCS LVDT'S	4	• 1 WIRE INPUT • VALID = 28 VDC • NOT VALID = OPEN	J2 PIN PITCH 59 ROLL 60 YAW 61 COLLECTIVE 62
SCAS ACTUATOR SOLENOID VALVES	4	• 1 WIRE OUTPUT • ON = >18 VDC • OFF = ≤6 VDC	J4 PINS PITCH 109 ROLL 110 YAW 111 COLLECTIVE 112
FORCE TRIM OFF	1	• 1 WIRE INPUT • ON = 28 VDC • OFF = OPEN	J2 PIN 117
FORCE TRIM RELEASE	1	• 1 WIRE INPUT • ON = 28 VDC • OFF = OPEN	J2 PIN 116

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NOTES

(11) Longitudinal airspeed is a 2-wire input through connector J1, pins 73 and 74. The input is 40 mVDC per knot of airspeed from 0 to 250 knots.

(12) The DASEC supplies outputs to energize the BUCS solenoid valves when the BUCS engage logic determines that BUCS is required. When BUCS is not required, the "HI" output is less than 6 VDC and the "LO" is an open circuit. When BUCS is needed, the "HI" output will be greater than 18 VDC (normally 28 VDC), and the "LO" becomes a complete circuit to ground. The outputs are through connector J4.

(a)	AXIS	BUCS Solenoid HI	BUCS Solenoid LO
(b)	Pitch	Pin 102	Pin 101
(c)	Roll	Pin 104	Pin 103
(d)	Yaw	Pin 106	Pin 105
(e)	Coll	Pin 108	Pin 107

(13) The input from the rotor brake is through J2, pin 114. The input is 28 VDC when the rotor brake is on.

(14) Each of the LVDTs and SPADs in the CPG's station has tracer wires to monitor the integrity of the wiring from the crew station to the DASEC. The inputs are through connector J2.

(a)	Pitch	Pin 52
(b)	Roll	Pin 51
(c)	Yaw	Pin 53
(d)	Coll	Pin 54

(15) The No. 2 BUCS LVDT wiring is monitored by tracer wires. The inputs are through connector J2.

(a)	Pitch	Pin 59
(b)	Roll	Pin 60
(c)	Yaw	Pin 61
(d)	Coll	Pin 62

DASE FLIGHT CONTROL INTERFACE SIGNALS II

SIGNAL	QTY	CHARACTERISTICS	CONNECTOR	
LONGITUDINAL AIRSPEED	1	• 2 WIRE INPUT • 40 MV/KT • -50 TO + 250 KTS	J1	PINS 73/74
BUCS SOLENOID ENGAGE HI	4	• 1 WIRE OUTPUT • BUCS ENGAGED>18VDC • BUCS NOT ENGAGED≤6VDC	J4 PITCH ROLL YAW COLLECTIVE	PINS 102 104 106 108
BUCS SOLENOID ENGAGE LO	4	• 1 WIRE OUTPUT • BUCS ENGAGED = GND • BUCS NOT ENGAGED = OPEN	J4 PITCH ROLL YAW COLLECTIVE	PINS 101 103 105 107
ROTOR BRAKE	1	• ON = 28 VDC • OFF = 0 VDC	J2	PIN 114
BUCS TRACER WIRE — POSITION LVDT'S	4	• 1 WIRE INPUT • VALID = 28 VDC • NOT VALID = OPEN	J2 PITCH ROLL YAW COLLECTIVE	PINS 52 51 53 54
BUCS TRACER WIRE — NO. 2 BUCS LVDT'S	4	• 1 WIRE INPUT • VALID = 28 VDC • NOT VALID = OPEN	J2 PITCH ROLL YAW COLLECTIVE	PIN 59 60 61 62
SCAS ACTUATOR SOLENOID VALVES	4	• 1 WIRE OUTPUT • ON = >18 VDC • OFF = ≤6 VDC	J4 PITCH ROLL YAW COLLECTIVE	PINS 109 110 111 112
FORCE TRIM OFF	1	• 1 WIRE INPUT • ON = 28 VDC • OFF = OPEN	J2	PIN 117
FORCE TRIM RELEASE	1	• 1 WIRE INPUT • ON = 28 VDC • OFF = OPEN	J2	PIN 116

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NOTES

(16) The DASEC supplies a 1-wire output signal through J4 to energize the SCAS solenoid valve.

(a) Pitch Pin 109

(b) Roll Pin 110

(c) Yaw Pin 111

(d) Coll Pin 112

(17) When the force trim switch is placed to ON, 28 VDC is supplied to the DASEC through J2, pin 117. When either force trim release switch is momentarily held in the release position, 28 VDC is supplied to the DASEC through J2, pin 116.

DASE FLIGHT CONTROL INTERFACE SIGNALS III

SIGNAL	QTY	CHARACTERISTICS	CONNECTOR
SCAS ACTUATOR EHV SIGNAL	4	• 2 WIRE OUTPUT • ± 4 madc MAX CURRENT	J1 SHIELDS PINS PITCH 51 49/50 ROLL 54 52/53 YAW 57 55/56 COLLECTIVE 61 59/60
DASE ENGAGE SWITCH MAGNETIC HOLDING COILS	4	• 1 WIRE OUTPUT • ON = >18 VDC • OFF ≤6 VDC	J4 PINS PITCH 119 ROLL 120 YAW 121 ATTD/HOVER HOLD 122
BUCS TEST PILOT POSITION	1	• 1 WIRE INPUT • TEST = 28 VDC • NOT IN TEST = GND	J1 PIN 121
BUCS TEST CPG POSITION	1	• 1 WIRE INPUT • TEST = 28 VDC • NOT IN TEST = GND	J2 PIN 121
CAUTION/WARNING PANEL	3	• 1 WIRE OUTPUT • NO FAIL = GND • FAIL = OPEN	J4 PINS BUCS ON 114 BUCS FAIL 115 ASE FAIL 116
SHIELD GROUND	1	• 1 WIRE SHIELD GROUND	J1 PIN 111
26 VAC REF NO. 1	1	• 2 WIRE INPUT • 26 VAC	J1 PINS 68/69
26 VAC REF NO. 2	1	• 2 WIRE INPUT • 26 VAC	J2 PINS 55/56
BUCS 1 POWER	1	• 1 WIRE INPUT • 28 VDC	J3 PIN 66
	1	• 1 WIRE INPUT • 28 VDC	J3 PIN 68

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NOTES

(18) The DASEC provides command signals to the EHV on all four servoactuators through J1.

(a) Pitch Pins 49/50

(b) Roll Pins 52/53

(c) Yaw Pins 55/56

(d) Coll Pins 59/60

(19) When an ASE switch is placed in the engage position, the DASEC will provide an output to magnetically latch the switch if that axis is valid. The outputs are through connector J4.

(a) Pitch Pin 119

(b) Roll Pin 120

(c) Yaw Pin 121

(d) ATTD/Hover Hold Pin 122

(20) Inputs from the BUCS test switch are

(a) Pilot position J1 Pin 121

(b) CPG position J2 Pin 121

(21) The DASEC provides outputs for the caution/warning/advisory system through connector J4.

(a) BUCS ON - S/N 88-0200 and subsequent Pin 114

(b) BUCS FAIL - S/N 88-0200 and subsequent Pin 115

(c) ASE FAIL Pin 116

(22) Connector J1, pin 111, provides a shield ground.

(23) Transformer T1 supplies a 2-wire input through connector J1, pins 68/69, for S/N 83-2355 through S/N 88-0199. On S/N 88-0200 and subsequent, this input is supplied by the Isolation Transformer Filter Assembly.

(24) Transformer T2 supplies a 2-wire input through connector J1, pins 55/56, for S/N 83-2355 through 88-0199. On S/N 88-0200 and subsequent, this input is supplied by the Isolation Transformer Filter Assembly.

DASE FLIGHT CONTROL INTERFACE SIGNALS III

SIGNAL	QTY	CHARACTERISTICS	CONNECTOR
SCAS ACTUATOR EHV SIGNAL	4	• 2 WIRE OUTPUT • ± 4 madc MAX CURRENT	J1 / SHIELDS / PINS PITCH 51 49/50 ROLL 54 52/53 YAW 57 55/56 COLLECTIVE 61 59/60
DASE ENGAGE SWITCH MAGNETIC HOLDING COILS	4	• 1 WIRE OUTPUT • ON = >18 VDC • OFF ≤6 VDC	J4 / PINS PITCH 119 ROLL 120 YAW 121 ATTD/HOVER HOLD 122
BUCS TEST PILOT POSITION	1	• 1 WIRE INPUT • TEST = 28 VDC • NOT IN TEST = GND	J1 PIN 121
BUCS TEST CPG POSITION	1	• 1 WIRE INPUT • TEST = 28 VDC • NOT IN TEST = GND	J2 PIN 121
CAUTION/WARNING PANEL	3	• 1 WIRE OUTPUT • NO FAIL = GND • FAIL = OPEN	J4 / PINS BUCS ON 114 BUCS FAIL 115 ASE FAIL 116
SHIELD GROUND	1	• 1 WIRE SHIELD GROUND	J1 PIN 111
26 VAC REF NO. 1	1	• 2 WIRE INPUT • 26 VAC	J1 PINS 68/69
26 VAC REF NO. 2	1	• 2 WIRE INPUT • 26 VAC	J2 PINS 55/56
BUCS 1 POWER	1	• 1 WIRE INPUT • 28 VDC	J3 PIN 66
	1	• 1 WIRE INPUT • 28 VDC	J3 PIN 68

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NOTES

(25) 28 VDC is supplied to the DASEC via connector J3, pin 66 (No. 1 BUCS Power) and pin 68 (No. 2 BUCS Power) on helicopters S/N 88-0200 and subsequent.

DASE FLIGHT CONTROL INTERFACE SIGNALS IV

SIGNAL	QTY	CHARACTERISTICS	CONNECTOR
TURN RATE	1	• 2 WIRE OUTPUT	J1 PINS 82/83
PILOT STICK POSITION LVDT	4	• 2 WIRE INPUT • ± 1 IN. MAX TRAVEL • 11 VRMS/IN. AT 400 HZ	J1 PINS PITCH 8/15 ROLL 9/10 YAW 17/18 COLLECTIVE 20/21
CPG STICK POSITION LVDT	4	• 2 WIRE INPUT • ± 1 IN. MAX TRAVEL • 11 VRMS/IN. AT 400 HZ	J2 PINS PITCH 26/27 ROLL 36/37 YAW 40/41 COLLECTIVE 38/39
SERVOACTUATOR NO. 1 BUCS LVDT	4	• 2 WIRE INPUT • MAX TRAVEL MAIN ROTOR ACTUATORS ± 1.75 IN. • MAX TRAVEL TAIL ROTOR ACTUATOR ± 0.88 IN. • NULL = 50 MV MAX • 2.8 VRMS/IN. AT 400 HZ	J1 PINS PITCH 36/37 ROLL 39/40 YAW 42/43 COLLECTIVE 45/46
SERVOACTUATOR NO. 2 BUCS LVDT	4	• 2 WIRE INPUT • MAX TRAVEL MAIN ROTOR ACTUATORS ± 1.75 IN. • MAX TRAVEL TAIL ROTOR ACTUATOR ± 0.88 IN. • 2.8 VRMS/IN. AT 400 HZ	J2 PINS PITCH 42/43 ROLL 44/45 YAW 46/47 COLLECTIVE 57/58
SCAS ACTUATOR POSITION LVDTs	4	• 2 WIRE INPUT • 0.088 • NULL = 50 MV MAX • 45 VRMS AT 400 HZ	J1 PINS PITCH 23/24 ROLL 25/26 YAW 27/28 COLLECTIVE 29/30

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NOTES

(26) The turn rate signal output to the VDU is through connector J1, pins 82/83.

(27) Inputs from the position LVDTs in the pilot's station are through J1.

(a) Pitch Pins 8/15

(b) Roll Pins 9/10

(c) Yaw Pins 17/18

(d) Coll Pins 20/21

(28) Inputs from the position LVDTs in the CPG's station are through connector J2.

(a) Pitch Pins 26/27

(b) Roll Pins 36/37

(c) Yaw Pins 40/41

(d) Coll Pins 38/39

(29) A 2-wire input from servoactuator No. 1 BUCS LVDT is supplied to the DASEC through connector J1.

(a) Pitch Pins 36/37

(b) Roll Pins 39/40

(c) Yaw Pins 42/43

(d) Coll Pins 45/46

(30) A 2-wire input from servoactuator No. 2 BUCS LVDTs is supplied to the DASEC through connector J2.

(a) Pitch Pins 42/43

(b) Roll Pins 44/45

(c) Yaw Pins 46/47

(d) Coll Pins 57/58

DASE FLIGHT CONTROL INTERFACE SIGNALS IV

SIGNAL	QTY	CHARACTERISTICS	CONNECTOR
TURN RATE	1	• 2 WIRE OUTPUT	J1 PINS 82/83
PILOT STICK POSITION LVDT	4	• 2 WIRE INPUT • ± 1 IN. MAX TRAVEL • 11 VRMS/IN. AT 400 HZ	J1 PINS PITCH 8/15 ROLL 9/10 YAW 17/18 COLLECTIVE 20/21
CPG STICK POSITION LVDT	4	• 2 WIRE INPUT • ± 1 IN. MAX TRAVEL • 11 VRMS/IN. AT 400 HZ	J2 PINS PITCH 26/27 ROLL 36/37 YAW 40/41 COLLECTIVE 38/39
SERVOACTUATOR NO. 1 BUCS LVDT	4	• 2 WIRE INPUT • MAX TRAVEL MAIN ROTOR ACTUATORS ± 1.75 IN. • MAX TRAVEL TAIL ROTOR ACTUATOR ± 0.88 IN. • NULL = 50 MV MAX • 2.8 VRMS/IN. AT 400 HZ	J1 PINS PITCH 36/37 ROLL 39/40 YAW 42/43 COLLECTIVE 45/46
SERVOACTUATOR NO. 2 BUCS LVDT	4	• 2 WIRE INPUT • MAX TRAVEL MAIN ROTOR ACTUATORS ± 1.75 IN. • MAX TRAVEL TAIL ROTOR ACTUATOR ± 0.88 IN. • 2.8 VRMS/IN. AT 400 HZ	J2 PINS PITCH 42/43 ROLL 44/45 YAW 46/47 COLLECTIVE 57/58
SCAS ACTUATOR POSITION LVDTs	4	• 2 WIRE INPUT • 0.088 • NULL = 50 MV MAX • 45 VRMS AT 400 HZ	J1 PINS PITCH 23/24 ROLL 25/26 YAW 27/28 COLLECTIVE 29/30

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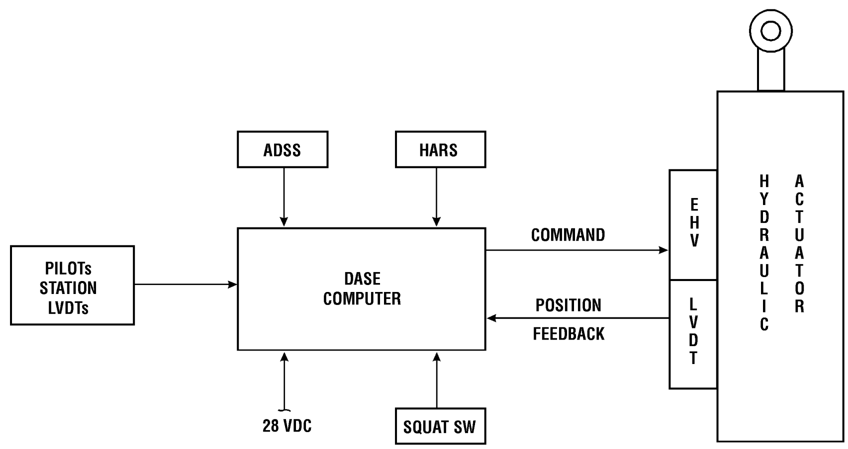
NOTES

(31) Each Servoactuator SCAS LVDT supplies an input to the DASEC through connector J1.

(a)	Pitch	Pins 23/24
(b)	Roll	Pins 25/26
(c)	Yaw	Pins 27/28
(d)	Coll	Pins 29/30

SAS/CAS FUNCTION



83-280A

NOTES

A. DASE System Operation

1. Stability Augmentation System (SAS)

a. The Stability Augmentation System (SAS) provides the damping of the airframe in the pitch, roll, and yaw axes caused by external disturbances (i.e., air turbulence, weapons delivery, etc). For explanation purposes, THE PITCH (longitudinal) AXIS WILL BE DISCUSSED.

b. With the pitch axis engaged, the DASEC monitors the HARS and the ADSS.

c. When a deviation from attitude occurs, the HARS provides a signal to the DASEC that corresponds to the direction and rate of the deviation.

d. The DASEC computes a command signal and applies it to the EHV on the longitudinal hydraulic actuator.

e. The EHV will cause the hydraulic actuator to correct for the pitch change within the limits of its authority.

f. The command signals are washed out in time to provide a centered SAS actuator for long-term inputs such as a climb, descent, or turn.

g. As the SAS actuator moves in response to the command signal, the SAS LVDT provides a position feedback signal to the DASEC. This signal is used to

(1) Aid the command signal washout time.

(2) Prevent oscillations from occurring due to overcorrection by the SAS.

(3) Monitor SAS actuator position and movement.

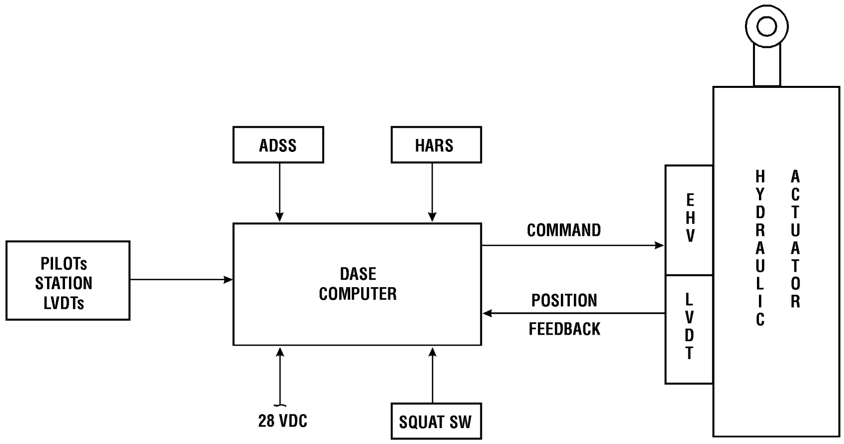
2. Command Augmentation System (CAS)

a. CAS is a function of helicopter movement commanded by the pilot and is defined as an increase of response to flight control movement while not affecting the stability of the SAS.

b. The DASEC monitors the pilot's position LVDTs for CAS functions as follows

(1) The controls are moved by the pilot or CPG via mechanical linkages to the servoactuators and cause the helicopter to respond to the pilot or CPG input. There is a very slight delay in time between the

SAS/CAS FUNCTION



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NOTES

mechanical control inputs in the crewstations and the actual movement of the servoactuator pilot input lever. This is because of the time it takes to close all the necessary mechanical tolerances in the rod end bearings, bellcrank pivot points in the SPADs, push pull tubes, and the bellcranks before the mechanical movement reaches the servoactuator.

(2) At the same time, movement of the flight controls in the crewstations causes the SPAD LVDT's to develop signals proportional to the direction and amount of flight control movement.

(3) Because the LVDT's are connected directly to the SPADs, the delay time in moving the LVDT's due to mechanical tolerances is minor when compared to the mechanical linkages from the crewstation controls to the servoactuators.

(4) Once the LVDT is moved, the signal is developed and present at the DASE immediately (electron current flows at the speed of light).

(5) The DASEC uses the signal from the PILOT'S LVDTs to compute a command signal proportional to the flight control movement. The computation is instantaneous.

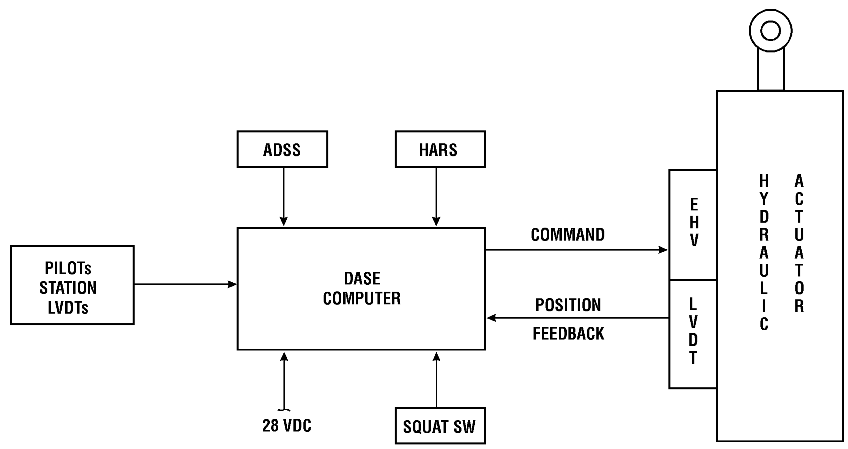
(6) The command signal is processed and applied to the EHV before the mechanical linkages to the servoactuators are able to move the pilot input lever. The command signal applied to the EHV is washed out in time. Washout of a signal is the intentional, controlled, decrease of a signal to obtain a desired transition. In this case the EHV is commanded to open, and then the command signal is "washed out", or reduced, over a short period of time to enable the mechanical linkage to resume control, once the EHV has started the power piston moving.

(7) While the command signal is being applied to the EHV, the EHV will direct hydraulic fluid to displace the SAS actuator from the manual servo valve, which is controlled by the mechanical linkage pilot input lever.

(8) When the manual servo valve and the SAS actuator are not in the neutral position with respect to each other, in this case because of SAS actuator displacement, hydraulic pressure is directed to move the power piston in a direction to aid the helicopter in answering the pilot's command.

(9) The mechanical input to the servoactuator pilot input lever is moving at this time, moving the manual servo valve in relation to the SAS actuator, but the SAS actuator will remain in control until the EHV signal from the DASEC is entirely washed out, or until the servoactuator reaches its commanded position.

SAS/CAS FUNCTION



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NOTES

(10) As the power piston continues to move MECHANICAL FEEDBACK from the power piston will position the manual servo valve to a neutral position with respect to the stability augmentation actuator. ELECTRICAL FEEDBACK is also developed in the form of a signal proportional to the piston movement from the BUCS 1 and BUCS 2 LVDTs and is are sent to the DASEC. The DASEC algebraically sums the BUCS 1 LVDT signal with the position LVDT signal from the pilot's station.

(11) When the No. 1 BUCS LVDT and the pilot's position LVDT signals ARE EQUAL, the resultant command signal will be ZERO. The EHV will return to its neutral position. When the EHV is in the neutral position, hydraulic pressure is equalized on both sides of the SAS actuator, causing SAS actuator movement to stop.

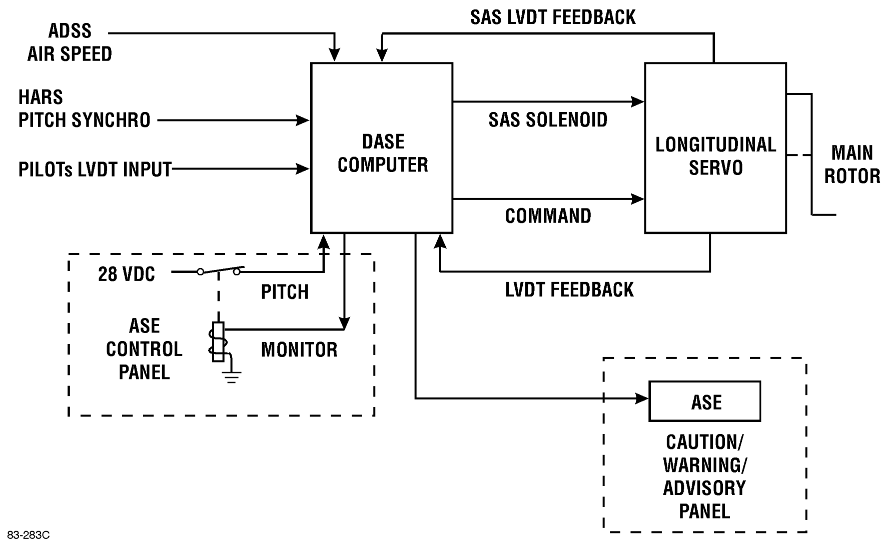
(12) When the SAS actuator AND the manual servo valve are in their neutral position, the hydraulic ports to the power piston close and stop power piston movement. The power piston will stay in the new position until the pilot makes another manual flight control movement and/or a CAS or SAS signal is applied to the EHV.

c. The squat switch input disables the yaw CAS when the aircraft is on the ground to prevent over controlling during taxi operations. The SAS is not disabled on the ground and will continue to provide rate damping.

3. Stability Command Augmentation System (SCAS)

a. The SCAS mode is a combination of the SAS and CAS modes. The SCAS provides long- and short-term stability while the aircraft is stabilized or maneuvering. SCAS operation for the pitch, roll, and yaw axes is identical except for authorities, gains, and washout times. The pitch axis will be discussed in detail, and the roll and yaw axes will be discussed insofar as differences exist between them and the pitch axis.

PITCH SCAS



NOTES

4. Pitch SCAS

a. Pitch SCAS controls the helicopter about the lateral axis as a function of rate, attitude, airspeed, and cyclic stick position.

b. When the Pitch ASE switch is placed in the engage position, the DASEC will magnetically latch the switch and engage pitch SCAS. When pitch SCAS is engaged, the DASEC

(1) Energizes the longitudinal servoactuator SAS (SCAS) solenoid valve, allowing hydraulic pressure to the two-stage electro-hydraulic valve (EHV).

(2) Monitors the pitch position LVDTs and the HARS pitch output.

c. Command Augmentation System (CAS) operation

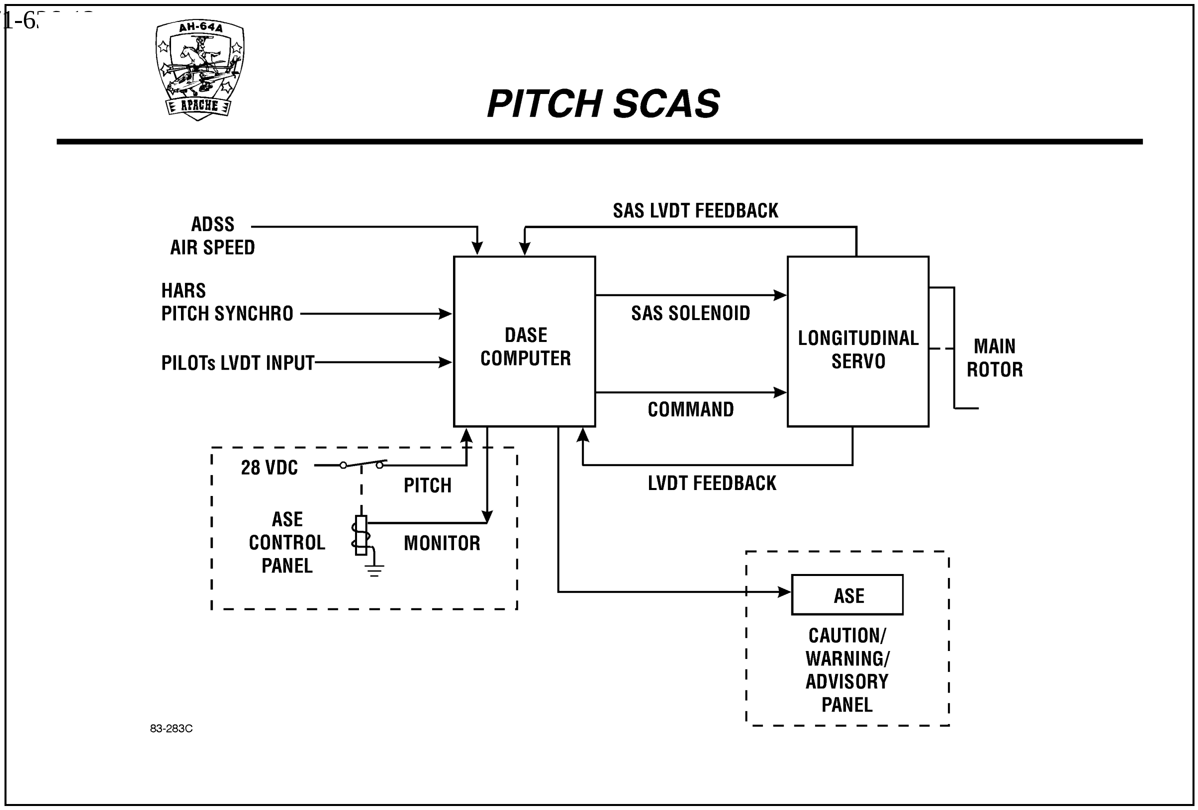
(1) When the cyclic stick is moved in the pitch axis the mechanical movement of the cyclic pitch position LVDT in the pilot's station develops a signal proportional to the amount of cyclic stick movement.

(2) The pitch position LVDT signal is applied to the DASEC, where it is computed into a command signal that is washed out in time. Before the command signal is washed out, it is applied to the EHV, causing the stability augmentation actuator to move in a direction that aids the pilot's commands. As the stability augmentation actuator moves, it will cause the power piston to move.

(3) The mechanical linkage will "catch up" and begin to move the manual servo valve in relation to the stability augmentation actuator.

(4) As the power piston continues to move, the mechanical feedback will also position the manual servo valve to realign with the SAS actuator in its new position. When the manual servo valve and the SAS actuator are aligned in their relative neutral position, the hydraulic ports are closed off and power piston movement stops. The power piston is held in that position until the pilot makes another flight control input.

(5) During CAS operation, the SAS will correct for short-term deviations.


PITCH SCAS
ADSS
AIR SPEED
SAS LVDT FEEDBACK
HARS
PITCH SYNCHRO
PILOTs LVDT INPUT
DASE
COMPUTER
SAS SOLENOID
COMMAND
LONGITUDINAL
SERVO
MAIN
ROTOR
28 VDC
PITCH
ASE
CONTROL
PANEL
MONITOR
LVDT FEEDBACK
ASE
CAUTION/
WARNING/
ADVISORY
PANEL
83-283C

NOTES

5. Stability augmentation operation

   a. When an outside force causes a deviation in the helicopter attitude, the HARS senses the change and provides a signal to the DASEC that is proportional to the rate and direction of change.

   b. The DASEC provides a command signal to the EHV on the servoactuator. The EHV ports hydraulic pressure to the stability augmentation actuator. The stability augmentation actuator is displaced from the manual servo valve, which causes the power piston to move in a direction to correct the deviation.

      (1) As the power piston moves, the mechanical feedback acting on the servo input arm forces the manual servo valve to realign with the stability augmentation actuator.

      (2) This closes the hydraulic ports to the power piston and power piston movement stops.

   c. As the stability augmentation actuator moves in response to the command signal, the SAS LVDT develops a signal that is proportional to the amount of SAS actuator movement and applies it to the DASEC.

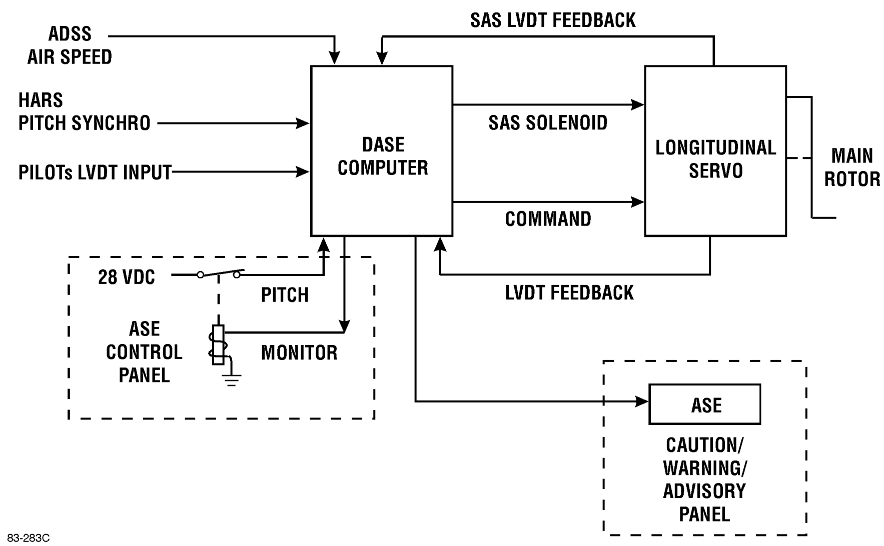
      (1) The DASEC algebraically sums the command signal with the SAS LVDT signal.

      (2) When the stability augmentation actuator has moved as far as the command signal has directed, the SAS LVDT signal will be equal and opposite to the command signal and the resultant signal to the EHV will be zero.

   d. As the helicopter responds to the flight control movement caused by the command signal, the HARS will develop a rate signal that is proportional to the rate and direction of movement. The rate signal is applied to the DASEC where a command signal is computed and applied to the EHV on the servoactuator. The EHV will cause the servoactuator to move back toward the position the servo was in before the disturbance occurred.

6. SCAS signals have 10 percent of flight control authority in the pitch axis for aft movement, and 20 percent authority for forward movement.

PITCH SCAS



NOTES

7. Pitch CAS is gain-programmed above 80 knots to decrease control sensitivity.

8. The DASEC will automatically disengage the pitch engage switch on the ASE control panel if

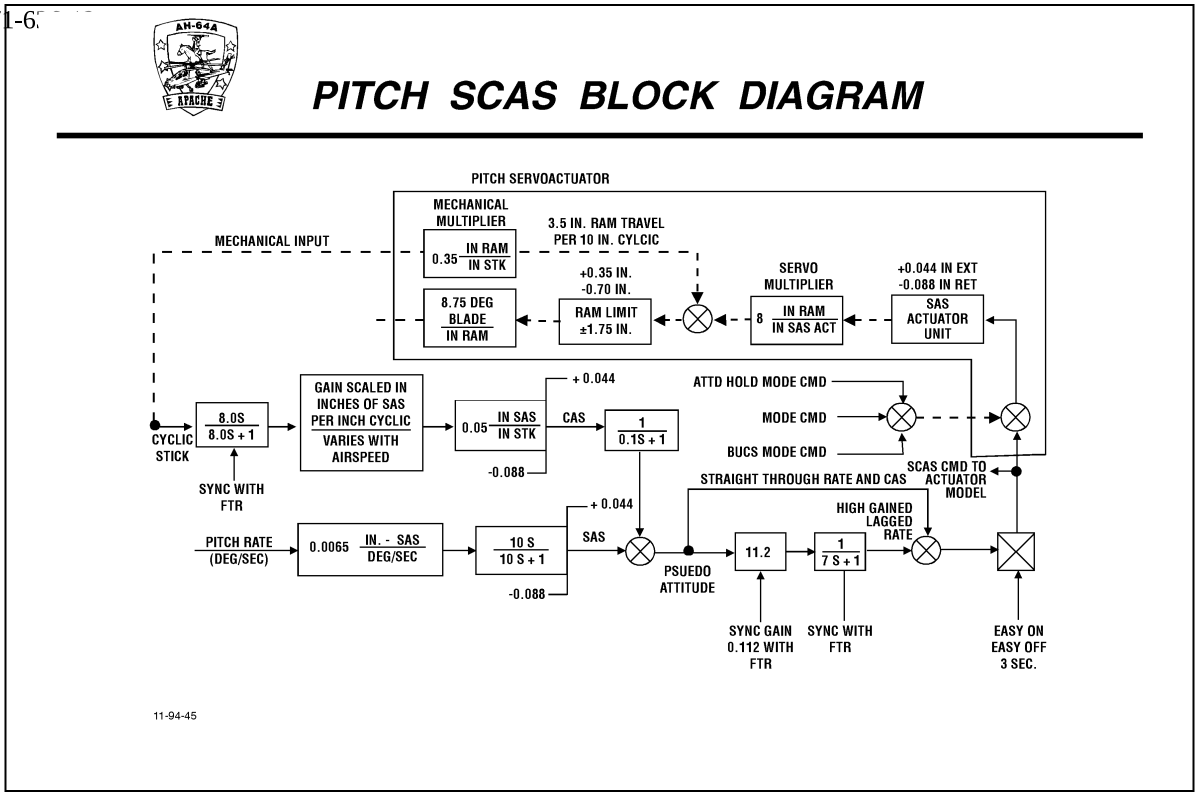
   a. The HARS malfunctions.

   b. The SAS LVDT signal does not match the DASEC servo model.

   c. A mistrack between the pilot's and CPG's position LVDTs occurs.

   d. A mistrack between the No. 1 BUCS LVDT and the pilot's position LVDT occurs.

   e. A mistrack between the No. 1 BUCS LVDT and the No. 2 BUCS LVDT occurs.


AH-64A
APACHE
PITCH SCAS BLOCK DIAGRAM
PITCH SERVOACTUATOR
MECHANICAL MULTIPLIER
0.35 IN RAM / IN STK
3.5 IN. RAM TRAVEL PER 10 IN. CYLCIC
MECHANICAL INPUT
+0.35 IN. -0.70 IN.
SERVO MULTIPLIER
+0.044 IN EXT -0.088 IN RET
8.75 DEG BLADE / IN RAM
RAM LIMIT ±1.75 IN.
8 IN RAM / IN SAS ACT
SAS ACTUATOR UNIT
+ 0.044
ATTD HOLD MODE CMD
GAIN SCALED IN INCHES OF SAS PER INCH CYCLIC
VARIES WITH AIRSPEED
8.0S / 8.0S + 1
0.05 IN SAS / IN STK
CAS
1 / 0.1S + 1
MODE CMD
CYCLIC STICK
BUCS MODE CMD
-0.088
SYNC WITH FTR
STRAIGHT THROUGH RATE AND CAS
SCAS CMD TO ACTUATOR MODEL
+ 0.044
HIGH GAINED LAGGED RATE
PITCH RATE (DEG/SEC)
0.0065 IN. - SAS / DEG/SEC
10 S / 10 S + 1
SAS
11.2
1 / 7 S + 1
PSUEDO ATTITUDE
-0.088
SYNC GAIN 0.112 WITH FTR
SYNC WITH FTR
EASY ON EASY OFF 3 SEC.
11-94-45

NOTES

9. Stability augmentation operation

   a. When an outside force acts upon the helicopter in the lateral axis, the HARS senses the deviation and supplies a rate signal to the DASEC. The pitch rate signal is scaled in inches of SAS actuator movement per degree per second (in-SAS/deg-sec).

   b. The rate signal is applied to a washout to provide a centered (SAS) actuator for long-term pitch inputs.

   c. The rate signal is then summed with the CAS signal, which is phased to override rate and provide rapid responses to manual flight control commands from the crew stations.

10. Command augmentation operation

    a. The CAS signal is generated by the pilot's LVDT located at the base of the cyclic control stick. This signal is washed out with time to provide zero offset for trimmed cyclic positions, which allows the SAS actuator to operate around the center position.

    b. The CAS gain is scaled in inches of SAS actuator movement per inch of cyclic and will vary with airspeed. Gain programming of the CAS is utilized when less aircraft response per cyclic motion is desired at higher airspeeds.

    c. The CAS signal is then lagged to generate the desired aircraft response when summed with the rate signal.

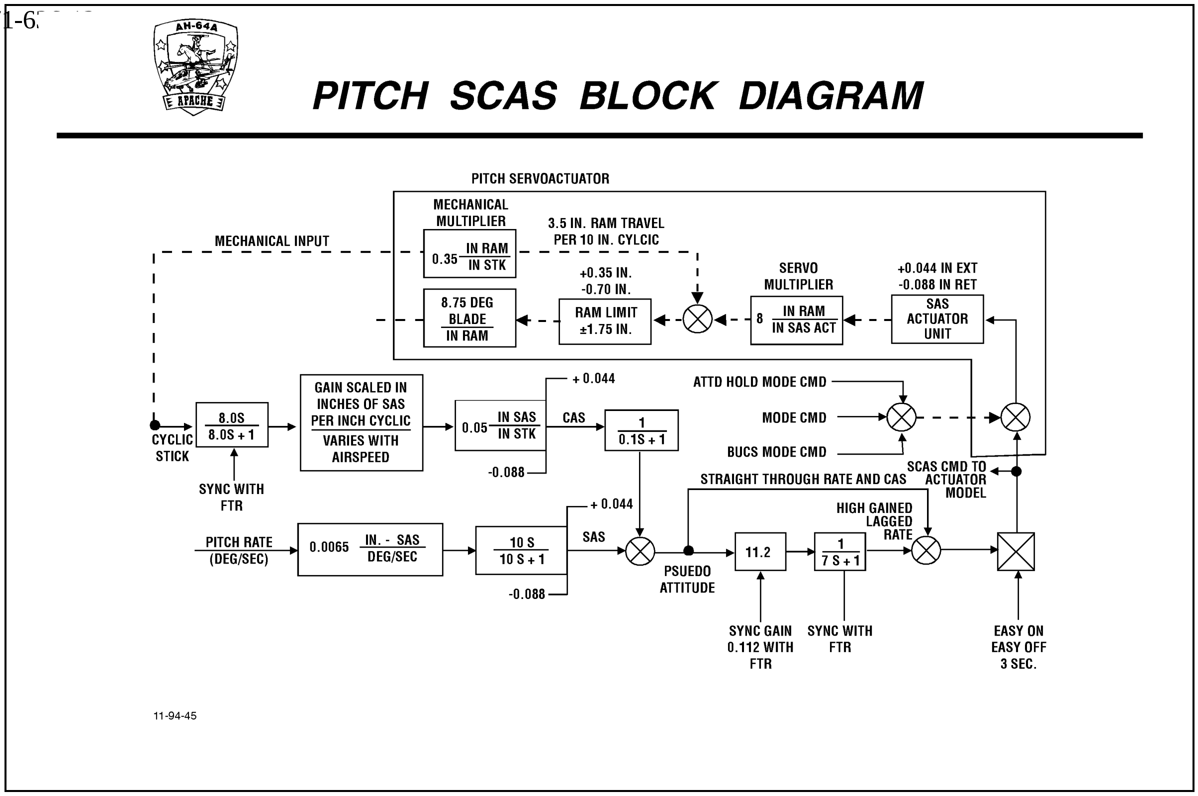
11. Stability command augmentation operation

    a. The summed rate and CAS signal is applied to a high gain lagged rate path which generates a pseudo attitude to return to after a deviation.

    b. The lagged rate and CAS is summed with straight-through rate and CAS to provide SCAS.

    c. The SCAS command is then applied to the EHV which drives the SAS actuator.

    d. The SCAS command is also applied to a servo mathematical model of the actuator position which is compared to the feedback signal from the SAS LVDT on the servo. This comparison is for SAS actuator monitoring and will be discussed later in this lesson.


AH-64A
APACHE
PITCH SCAS BLOCK DIAGRAM
PITCH SERVOACTUATOR
MECHANICAL MULTIPLIER
3.5 IN. RAM TRAVEL PER 10 IN. CYLCIC
MECHANICAL INPUT
0.35 IN RAM / IN STK
+0.35 IN. -0.70 IN.
SERVO MULTIPLIER
+0.044 IN EXT -0.088 IN RET
8.75 DEG BLADE / IN RAM
RAM LIMIT ±1.75 IN.
8 IN RAM / IN SAS ACT
SAS ACTUATOR UNIT
GAIN SCALED IN INCHES OF SAS PER INCH CYCLIC VARIES WITH AIRSPEED
+ 0.044
ATTD HOLD MODE CMD
8.0S / 8.0S + 1
0.05 IN SAS / IN STK
CAS
1 / 0.1S + 1
MODE CMD
CYCLIC STICK
BUCS MODE CMD
-0.088
SYNC WITH FTR
STRAIGHT THROUGH RATE AND CAS
SCAS CMD TO ACTUATOR MODEL
+ 0.044
HIGH GAINED LAGGED RATE
PITCH RATE (DEG/SEC)
0.0065 IN. - SAS / DEG/SEC
10 S / 10 S + 1
SAS
11.2
1 / 7 S + 1
PSUEDO ATTITUDE
-0.088
SYNC GAIN 0.112 WITH FTR
SYNC WITH FTR
EASY ON EASY OFF 3 SEC.
11-94-45

NOTES

12. Pitch SCAS servoactuator

a. SAS actuator travel of +0.044 inches generates a 10 percent motion of total servoactuator (power piston) travel which is +0.035 inches.

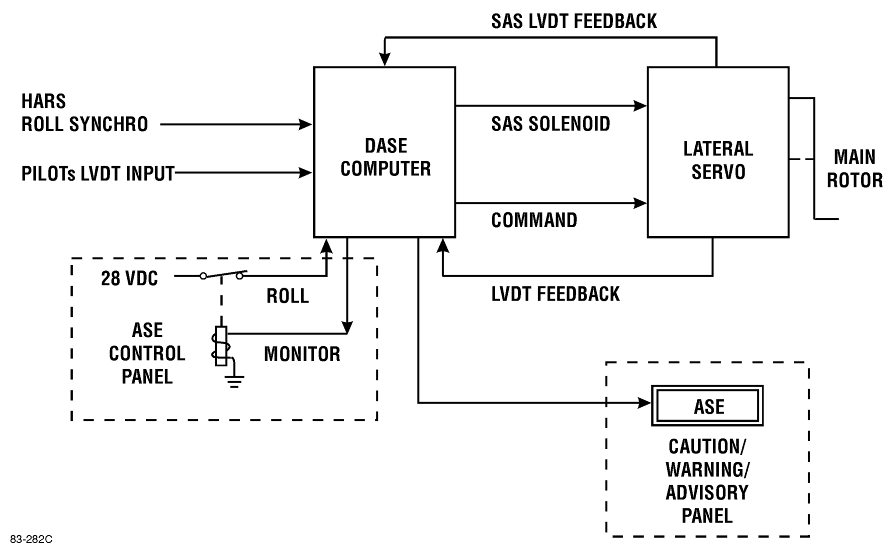
b. SAS actuator travel of -0.088 inches generates a -20 percent motion of servoactuator travel which is -0.070 inches.

c. A mechanical servo gain (servo multiplier) of 8 is required to obtain the proper authority.

d. A mechanical summing of pilot control motion and SAS actuator motion provides total servoactuator movement.

e. The mechanical linkage multiplier is scaled in inches of servoactuator movement per inch of input and is used to provide total actuator movement for total control motion, that is, 3.5 inches of servo movement per 10 inches of pitch cyclic movement.

ROLL SCAS



NOTES

13. Roll SCAS

a. Roll SCAS controls the helicopter about the longitudinal axis as a function of rate, attitude, and lateral stick position through the lateral servoactuator.

b. When the roll ASE switch on the ASE control panel is placed in the engage position, the DASEC will magnetically latch the switch in the engage position and engage the roll axis ASE. When the roll SCAS is engaged, the DASEC

(1) Energizes the lateral servo SAS solenoid, allowing hydraulic pressure to the two-stage EHV.

(2) Monitors the roll position LVDTs and the HARS for inputs.

c. SCAS signals have 10 percent of flight control authority in the roll axis.

d. The DASEC will disengage roll SCAS if

(1) The HARS malfunctions.

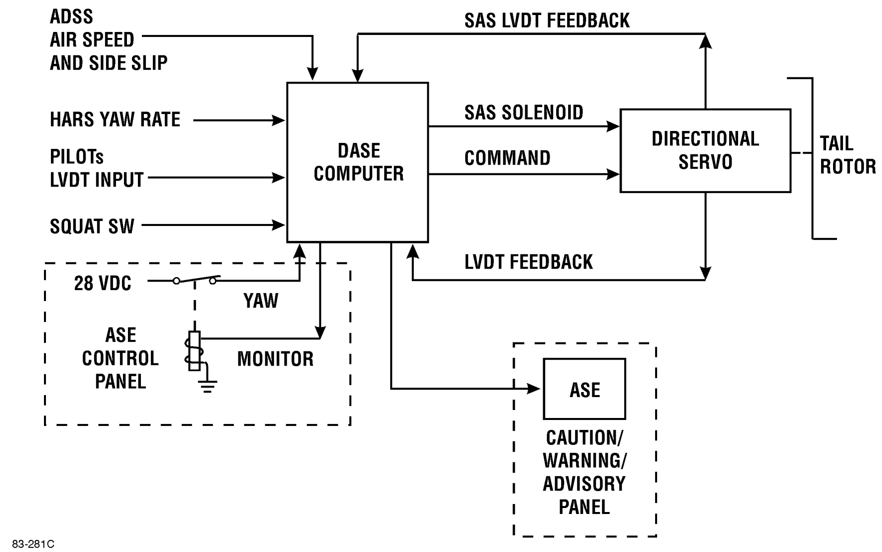
(2) The SAS LVDT signal does not match the DASEC servo model.

(3) A mistrack occurs between the pilot's and CPG's position LVDTs.

(4) A mistrack occurs between the pilot's position LVDT and the No. 1 BUCS LVDT.

(5) A mistrack between the No. 1 BUCS LVDT and the No. 2 BUCS LVDTs occurs.

YAW SCAS



NOTES

14. Yaw SCAS

a. Yaw SCAS controls the helicopter about the vertical axis as a function of rate, attitude, and directional control pedal position. When the yaw ASE switch is placed in the engage position, the DASEC will latch the switch and engage yaw SCAS. With the yaw SCAS engaged

(1) The DASEC energizes the directional servo SAS (SCAS) solenoid valve, allowing hydraulic pressure to the two-stage EHV.

(2) The DASEC monitors the HARS, the yaw position LVDTs, and the ADSS.

b. Yaw CAS is gain-programmed down above 50 knots to prevent over corrections.

c. SCAS signals have 10 percent of flight control authority in the yaw axis.

d. The DASEC will disengage yaw SCAS if

(1) The ADS and/or HARS malfunctions.

(2) The SAS LVDT signal does not match the servo model.

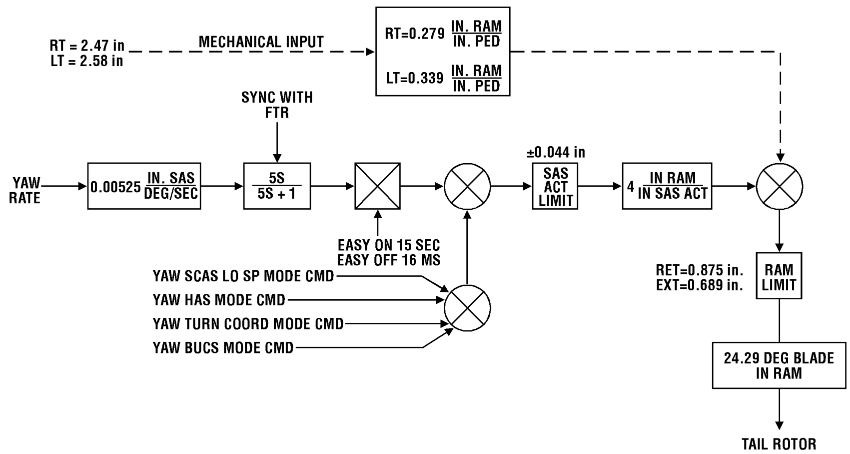
(3) A mistrack occurs between the pilot's and CPG's position LVDTs.

(4) A mistrack between the No. 1 BUCS LVDT and the No. 2 BUCS LVDT occurs.

(5) A mistrack between the No. 1 BUCS LVDT and the pilot's position LVDT occurs.

e. Yaw CAS is automatically switched out on the ground as a function of the squat relay input. Stability augmentation (SAS) is not switched out on the ground, and will operate normally if engaged.

YAW SCAS GROUND MODE BLOCK DIAGRAM



87-28

NOTES

f. Yaw SCAS ground mode operation

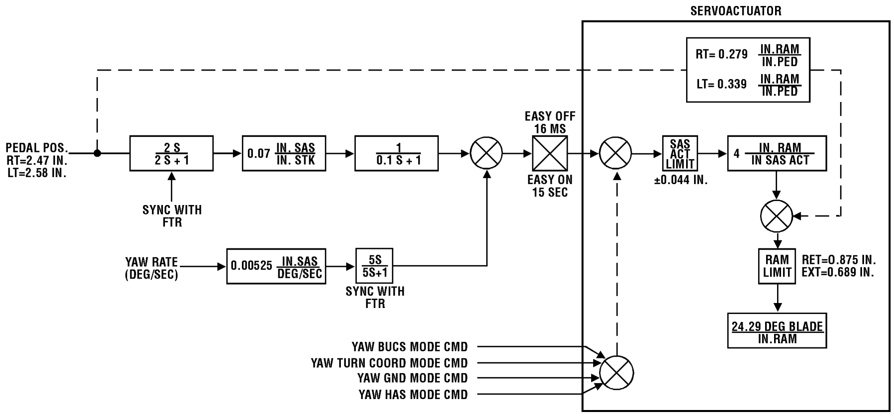
(1) Rate damping

(a) Yaw rate is provided by the HARS and is scaled in inches of SAS actuator displacement per degree per second of yaw rate (in SAS/deg/sec).

(b) The rate signal is applied to a washout to remove steady-state yaw rate signals during continuous pedal turns.

(c) The rate signal is applied to an easy on/off timed ramp, then to the actuator.

YAW SCAS LOW SPEED MODE BLOCK DIAGRAM



87-29

NOTES

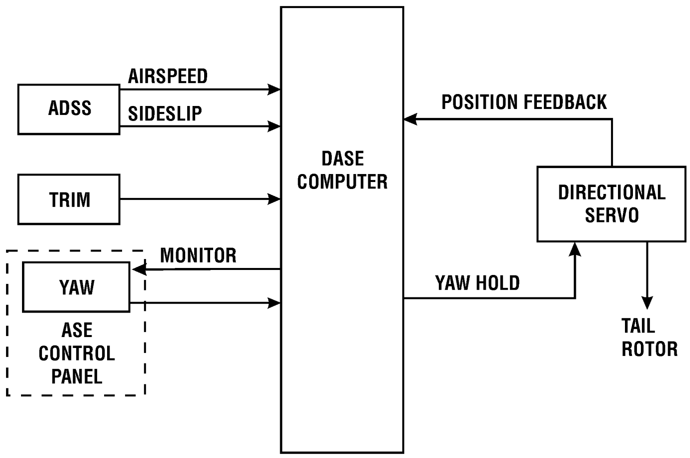
g. Yaw low-speed mode

(1) The low-speed mode provides pedal CAS for hover and low-speed maneuvering purposes. Above 60 knots, the CAS is removed and the Turn Coordination Mode becomes active.

(2) Rate damping for low-speed operation is identical to that of the ground mode.

(3) The pedal CAS is summed with the rate damping in the same manner as pitch SCAS and will not be repeated.

TURN COORDINATION



83-285C

NOTES

h. Turn coordination

(1) Automatic turn coordination is provided through yaw SCAS as a function of sideslip and airspeed data from the Air Data Subsystem when the yaw SCAS is engaged, force trim is on, and airspeed is above 60 knots.

(2) Sideslip from the ADSS is used for the primary turn coordination command.

(3) Sideslip from the ADSS is compared to a reference sideslip that is obtained at the moment of mode engagement. Any difference between the reference sideslip and the actual helicopter sideslip will generate a command to bring the helicopter back to the reference attitude.

(4) Yaw rate damping tends to oppose a turn which will generate adverse yaw. To compensate for this tendency, a computed turn rate is generated using roll bank angle and airspeed to oppose the rate damping signal and decrease its effect on adverse yaw.

(5) Placing the force trim switch to the momentary RELEASE position will cause turn coordination to synchronize.

(6) The turn coordination function will disengage when

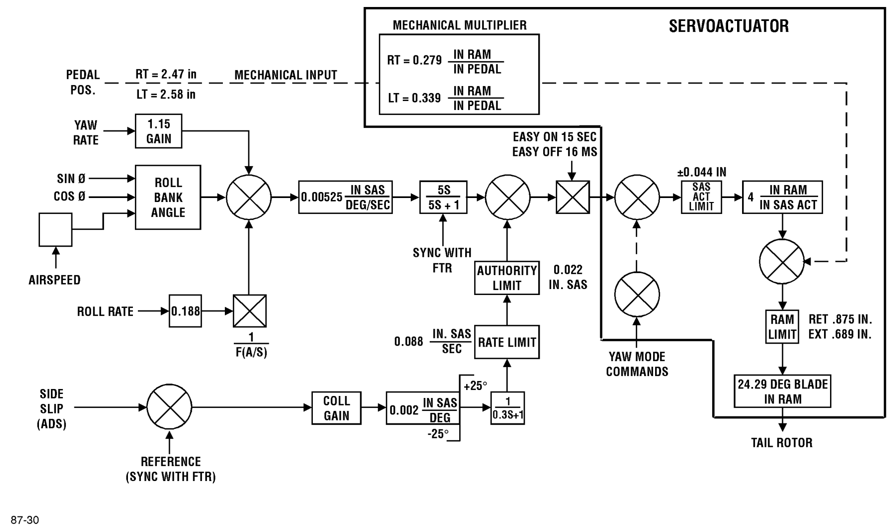
(a) Yaw ASE switch is disengaged.

(b) TRIM release switch is in the off position.

(c) Airspeed is below 50 knots.

(7) Yaw CAS is removed when turn coordination is operating.

TURN COORDINATION BLOCK DIAGRAM



NOTES

i. Yaw rate damping for turn coordination is identical to that used for the ground and low-speed modes.

(1) Sideslip from the ADS is used for the primary turn coordination command.

(2) Sideslip from the ADS is compared to a reference which is the sideslip of the helicopter at the time of mode engagement or force trim release.

(3) Any difference between the reference sideslip and the helicopter sideslip will generate a command to bring the helicopter to the reference sideslip.

(4) The sideslip command is scaled in inches of SAS displacement per degree of sideslip (in/SAS/deg).

(5) The sideslip command is applied to a lag for filtering and then summed with a combined rate signal before becoming the actuator command.

j. Combined rate

(1) Yaw rate damping tends to oppose a turn which will generate adverse yaw.

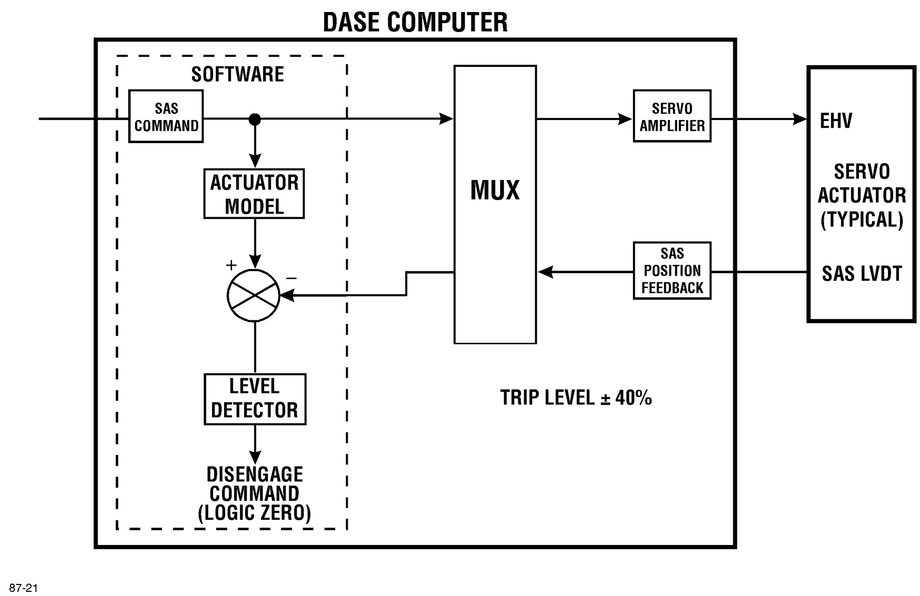
(2) Therefore, a computed turn rate is generated using roll bank angle and airspeed to oppose the rate damping signal and decrease its effect on adverse yaw.

(3) A roll rate signal is also applied to the summing of computed turn rate and yaw rate to provide quickening for rapid turns.

(4) The roll rate signal is multiplied by airspeed to linearly increase its gain between 50 and 150 knots to compensate for increased yaw at higher airspeeds with rapid turns.

(5) The combined rate signal is combined with the sideslip command for coordinated turns.

SAS ACTUATOR MONITOR



NOTES

A. SAS Actuator Monitoring

1. The SAS command generated by the DASEC is applied to the EHV on the servoactuator and to a mathematical model of the actuator inside the DASEC.

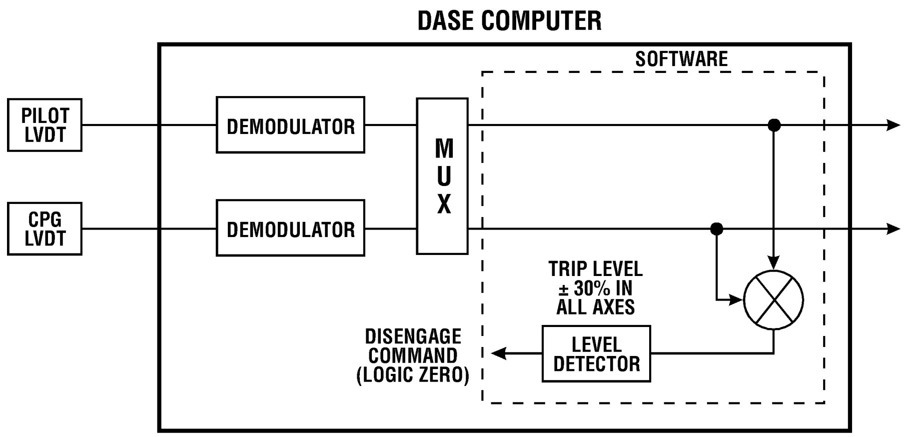
2. As the displacement of the EHV causes the SAS actuator to extend or retract, the SAS actuator LVDT develops a signal that is proportional to actuator movement.

3. The SAS LVDT feedback signal and the output of the actuator model are compared to verify actuator response to the SAS command.

4. Should the modeled command and the actuator position differ by plus or minus 40%, the DASEC will command a disengagement of that axis by disengaging the SAS solenoid and the yaw engage switch on the ASE control panel.

5. This action will illuminate the ASE caution light to advise the crew of a yaw axis disengagement.

POSITION LVDT MONITOR



87-22

NOTES

B. Position LVDT Monitoring

1. As the crew moves the flight controls during CAS operations, the LVDTs in both crew stations develop a signal that is proportional to the amount of movement.

2. The signal from the LVDTs is demodulated and applied to a level detector inside the DASEC.

3. If the difference between the pilot's and CPG's flight control position reaches plus or minus 30%, the DASEC will command the respective axis to disengage.

ATTD/HOVER HOLD SWITCH MODES

- **HOVER AUGMENTATION SYSTEM (HAS)**
  BELOW 15 KNOTS GS OR 50 KIAS
- **HEADING HOLD**
  BELOW 50 KIAS
- **ATTITUDE HOLD**
  ABOVE 60 KIAS

87-32

NOTES

A. Attitude/hover hold mode engagement (applicable to all AH-64A Helicopters)

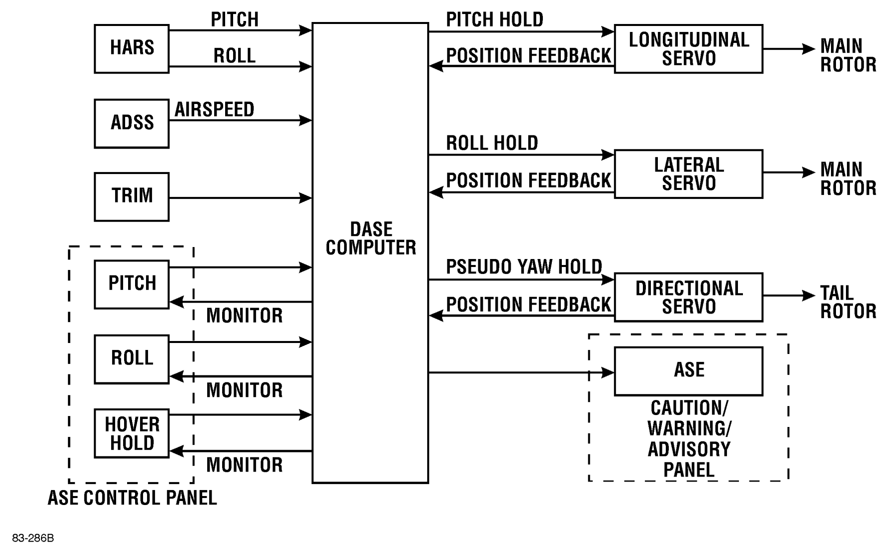
1. When the ATTD/HOVER HOLD switch is placed in the engage position, the DASEC provides additional capabilities (modes) to the DASE system. The modes that are controlled by the ATTD/HOVER HOLD switch are

a. Hover Augmentation (below 15 knots ground speed or 50 knots indicated airspeed)

b. Heading Hold (below 50 knots indicated airspeed)

c. Attitude Hold (above 60 knots indicated airspeed)

HOVER AUGMENTATION



NOTES

2. Hover Augmentation System (HAS)

   a. A limited authority hover augmentation mode is provided through pitch and roll SCAS, using body axis velocities from the HARS. The hover augmentation mode provides reduced crew workload by maintaining desired position and attitude during hover and low-speed operations.

   b. The HAS is engaged by the ATTD/HOVER HOLD switch on the ASE control if the

      (1) Pitch or roll ASE switches are engaged.

      (2) TRIM System is on.

      (3) Airspeed from the ADSS is below 50 knots.

      (4) Ground speed is below 15 knots.

   c. The HAS mode uses lateral and longitudinal linear velocities, compensated by the doppler, to maintain position accuracy.

   d. The hover augmentation mode will hold the helicopter in a 12-foot radius circle for 20 seconds in a 5-to 10-knot wind, without exceeding plus or minus 0.25 inch of cyclic and plus or minus 1 inch of directional control. Slow ascent or descent from 200 feet above ground level and pedal turns can be executed while maintaining the above position accuracies.

   e. Command augmentation is retained when the mode is engaged.

   f. Mode disengagement will occur when the

      (1) ATTD/HOVER HOLD switch is placed in the OFF position by the pilot.

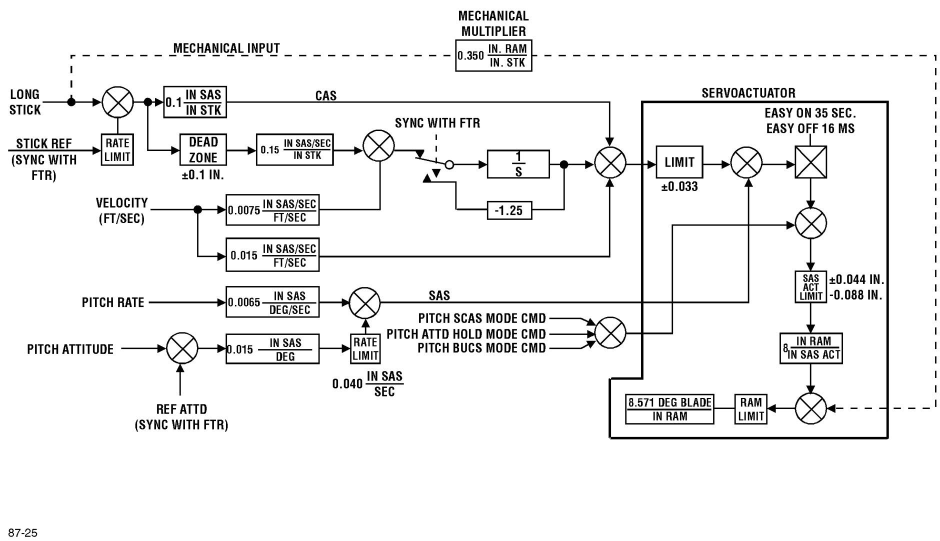
      (2) TRIM switch is placed in the OFF position.

      (3) Pitch and Roll ASE switches are off.

      (4) Airspeed exceeds 50 knots or ground speed exceeds 15 knots.

   g. Placing the TRIM switch to the RELEASE position will cause the mode to synchronize.

PITCH HOVER AUGMENTATION SYSTEM BLOCK DIAGRAM



NOTES

3. Hover augmentation mode

   a. Rate damping for pitch HAS is identical to the rate damping for pitch SCAS except for the elimination of the rate damping washout.

   b. Pitch attitude is the actual helicopter attitude obtained from the HARS.

      (1) The actual attitude is compared to a reference attitude that is obtained at the moment of mode engagement or force trim release. The difference between these two attitudes generates a command that is rate-limited.

      (2) The attitude command is scaled in inches of SAS actuator displacement per degree of attitude change (in SAS/deg).

      (3) The rate limiter is set up in inches of SAS actuator per second (in SAS/sec).

      (4) The pitch attitude command signal is summed with the pitch rate and CAS signals to provide hover augmentation.

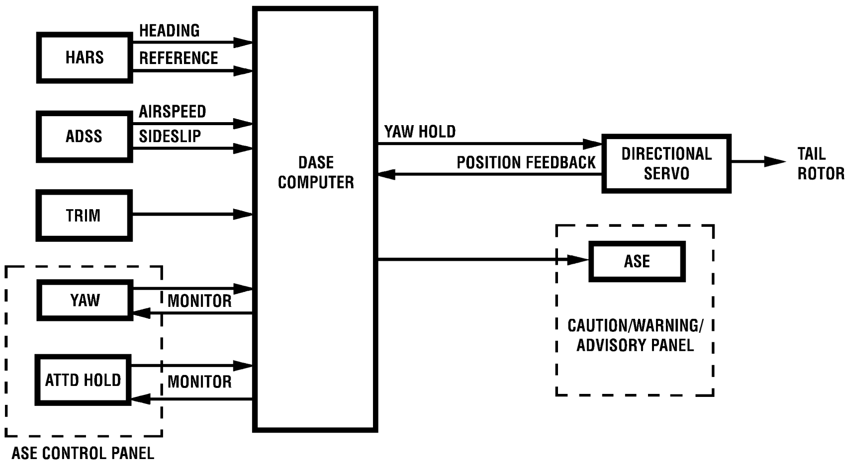
   c. Velocity paths

      (1) Doppler-compensated longitudinal velocity is received from the HARS and is used for translational damping.

      (2) The longitudinal velocity is summed with attitude and angular velocity.

      (3) The velocity paths are scaled in inches of SAS actuator displacement per second per foot per second (in SAS/sec/ft/sec).

HEADING HOLD



83-287A

NOTES

4. Heading hold

   a. The heading hold mode reduces crew workload by maintaining the desired heading.

   b. The heading hold mode is engaged by the ATTD/HOVER HOLD switch on the ASE control panel if

      (1) Yaw ASE is engaged.

      (2) Force trim system is engaged.

      (3) Airspeed from the ADSS is below 50 knots.

   c. When engaged, heading reference from the HARS is used to maintain helicopter heading.

   d. The Heading hold mode will maintain a 1- degree heading in a 5- to 10-knot wind from any azimuth, and will hold the heading with less than 0.25 inch of directional control movement.

   e. Mode disengagement will occur when the

      (1) ATTD/HOVER HOLD switch is placed to the OFF position.

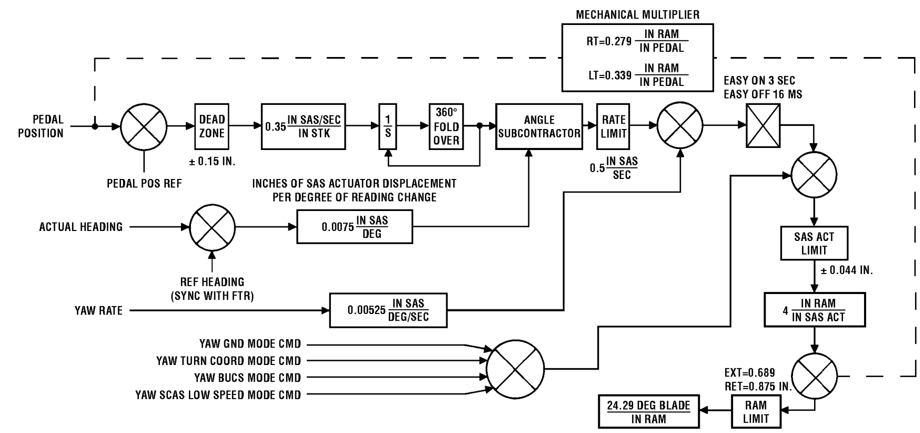
      (2) Force trim system is not engaged.

      (3) Yaw ASE switch is in the OFF position

      (4) Airspeed exceeds 50 knots.

   f. Placing the force trim switch to the momentary RELEASE position or displacing the pedals by more than 0.24 inches will cause the mode to go into synchronization.

HEADING HOLD MODE BLOCK DIAGRAM



87-26

NOTES

5. Heading hold operation

a. Rate damping for heading hold is identical to that used for yaw low-speed ground and turn coordination modes. Review as necessary.

b. Heading command

(1) Aircraft heading is received from the HARS.

(2) Actual heading is compared to a reference heading obtained at the time of mode engagement or force trim release.

(3) The difference between the actual and reference headings becomes the heading command.

(4) The heading command is scaled in inches of SAS actuator displacement per degree of heading change (in SAS/deg).

(5) The heading command is applied to the angle subtractor which permits greater than 360 degrees of heading change without discontinuity.

(6) After being applied to the angle subtractor, the heading command is rate-limited and added to the yaw rate to become the actuator command.

c. Command Augmentation (CAS)

(1) Yaw CAS in the heading mode is used to provide the pilot with the ability to make small heading changes without requiring re-trimming of control forces.

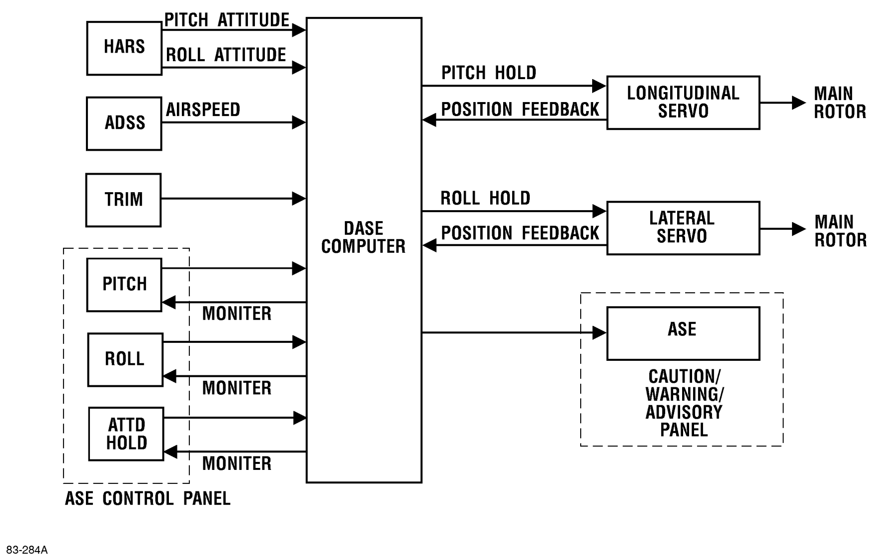
(2) The yaw command augmentation signal is compared with a reference CAS obtained at the time of engagement or force trim release. The difference between the two signals becomes the CAS command signal.

(3) This command signal is applied to a dead zone to eliminate nuisance heading changes for pedal displacements which are not control movements.

(4) The SCAS is scaled and applied to an integrator which subtracts from heading. Therefore, commanded heading changes will not be opposed by heading commands, but will cancel each other to produce a new reference heading.

(5) A 360-degree fold-over for CAS signals is used to follow the 360-degree heading changes from the angle subtractor so no discontinuities will exist.

ATTITUDE HOLD



NOTES

6. Attitude hold

a. Attitude hold mode reduces crew workload by maintaining the desired pitch and roll attitude when airspeed is above 60 knots.

b. The attitude hold mode is engaged by the ATTD/HOVER HOLD switch if the

(1) Pitch and roll ASE switches are engaged.

(2) Trim release system is on.

(3) Airspeed from the ADSS is above 60 knots.

c. When engaged, actual pitch and roll attitude from the HARS is utilized to maintain position accuracy.

d. Attitude hold allows hands-off operation when no more than 50 percent of the pitch and roll SCAS actuator authority is required for control.

e. The CAS is removed when the attitude hold mode is engaged.

f. The attitude hold mode will disengage when the

(1) ATTD/HOVER HOLD switch is in the OFF position.

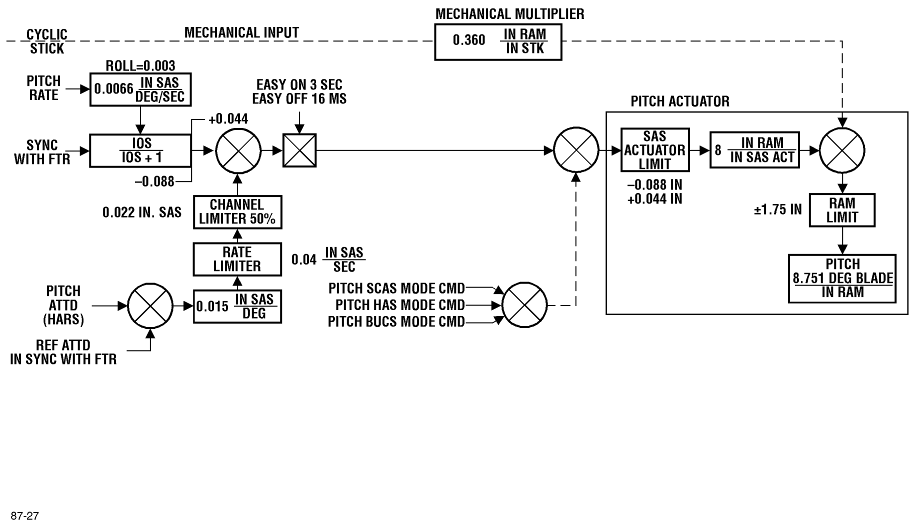
(2) TRIM switch is placed in the OFF position (The ATTD/HOVER HOLD switch automatically returns to off).

(3) Pitch or roll ASE control switch is in the OFF position

(4) Airspeed goes below 50 knots.

g. Placing the TRIM switch to the momentary release position will cause the mode to synchronize.

PITCH ATTITUDE HOLD



NOTES

7. Rate damping for attitude hold

   a. Rate damping is provided for stability augmentation in the Attitude Hold Mode by the HARS.

   b. Pitch rate is scaled in inches of SAS actuator per degree per second (in-SAS/deg-sec).

   c. The rate signal is applied to a washout to provide a centered SAS actuator for long-term pitch rate inputs.

   d. The rate signal is then summed with the attitude command signal.

8. Attitude command

   a. The pitch attitude command path utilizes actual aircraft attitude obtained from the HARS.

   b. The actual attitude is compared to a reference attitude and the difference between the two attitudes generates a command signal which is rate-limited.

   c. The attitude command which is applied to the rate limiter is scaled in inches of SAS actuator displacement per degree of aircraft attitude change (in-SAS/deg).

   d. The rate limiter is set up in inches of SAS actuator movement per second (in-SAS/sec).

   e. The limited attitude signal is applied to a channel limiter which permits 50 percent of the SAS actuator to be utilized for attitude deviations, allowing the remaining 50 percent for rate damping.

   f. The summation of attitude and rate is applied to the SAS actuator through an easy ON/OFF.

   g. Momentary release of the force trim will re-synchronize the rate path and establish a new reference attitude upon release.

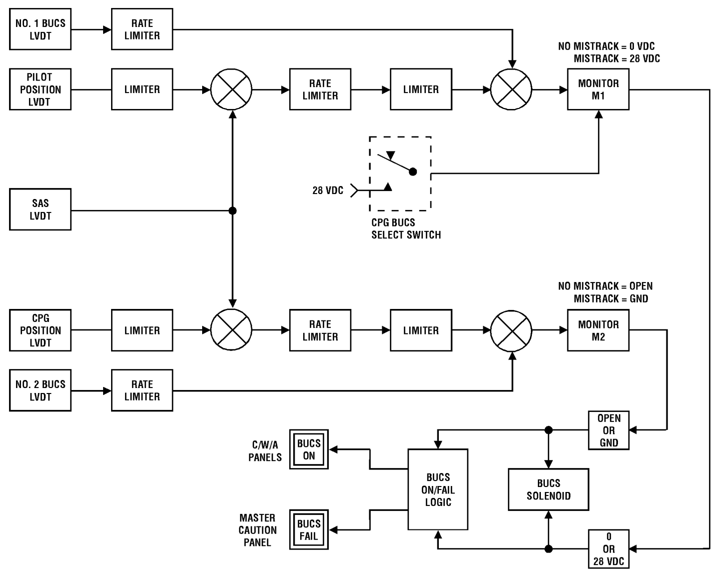
   h. Operation of the servoactuator in the Attitude Hold Mode is identical to operation in the SCAS Mode.

      (1) Actuator travel of +0.044 inches generates a +10 percent motion of the total RAM authority (0.35 inches).

      (2) Actuator travel of -0.088 inches generates a -20 percent motion of total RAM authority (0.070 inches).

      (3) A mechanical servo gain (servo multiplier) of 8 is required to obtain the proper authority.

BUCS SEVERANCE ENGAGE LOGIC



87-16

NOTES

A. Back Up Control System (BUCS) Operation

1. The BUCS is activated on helicopters S/N 88-0200 and subsequent (BUCS equipped). A non-redundant, emergency fly-by-wire Back Up Control System (BUCS) is provided to control the main and tail rotor actuators electrically as a function of stick position transducers on the pilot's and CPG's controls. The mode will engage automatically in the case of a flight severance, or in the case of a flight control jam, will engage when either crewmember breaks a SPAD.

2. Severance engage logic

a. The BUCS will engage automatically for two crew station position LVDT-to-BUCS 1 and BUCS 2 LVDT mistracks, or manually, when a single CPG position LVDT-to-BUCS 2 LVDT mistrack occurs and the CPG activates the BUCS Select Switch on the collective stick.

b. The DASEC monitors and compares the No. 1 BUCS (RAM 1) LVDT to the sum of the pilot's position LVDT and the SAS LVDT. The DASEC also monitors and compares the No. 2 BUCS (RAM 2) LVDT to the sum of the CPG's position LVDT and the SAS LVDT.

(1) When no malfunction is present, the output of monitor M1 is 0.00 VDC, and monitor M2 maintains an open circuit.

(2) If a mistrack in excess of the SCAS authority plus 7% (22.5% for the pitch axis; 17.5% in all other axes) occurs, the output of M1 will be 28 VDC, and M2 will close to provide an electrical ground.

c. The output of M1 and the ground of M2 will initiate BUCS operation by energizing the BUCS solenoid valve within 1 second of the mistrack occurrence. When the solenoid valve is energized, the BUCS ON advisory light on both Caution/Warning/Advisory panels will illuminate.

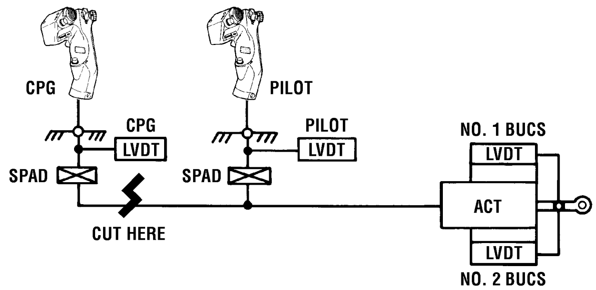
d. If a mistrack between a pilot's position LVDT and the No. 1 BUCS LVDT occurs, with no corresponding mistrack between the CPG's LVDT and the No. 2 BUCS LVDT within 10 seconds, the BUCS FAIL light will illuminate and automatic engagement of the BUCS in that axis will be inhibited.

e. If a mistrack between the CPG's LVDT and the No. 2 BUCS LVDT occurs with no corresponding mistrack between the pilot's position LVDT and the No. 1 BUCS LVDT, the BUCS FAIL light will illuminate and automatic engagement of that axis will be inhibited.

f. If a failure listed in paragraph (e) above should occur, and then a subsequent severance (after 10 seconds) occurs that requires the use of the BUCS in that axis, the BUCS must be engaged manually by activating the BUCS select switch on the CPG's collective control stick.

g. When the BUCS is initiated due to a severance, an easy on circuit provides a 1-second engagement

SEVERED CONTROL SITUATION 1



- CPG CONTROL FREE TO MOVE TO MECHANICAL STOP. **BUCS FAIL LIGHT** WILL BE ILLUMINATED.
- PILOT RETAINS NORMAL PRIMARY MECHANICAL CONTROL.
- BUCS ENGAGEMENT NOT AUTHORIZED. NO MISTRACK BETWEEN PILOT LVDT AND NO.1 BUCS LVDT. MISTRACK BETWEEN CPG LVDT AND NO. 2 BUCS LVDT NECESSARY BUT NOT SUFFICIENT FOR ENGAGEMENT.
- CPG CAN ENGAGE BUCS BY ACTUATING BUCS SELECT SWITCH ON HIS COLLECTIVE STICK. CPG WILL FLY USING BUCS. CANNOT BE TRANSFERRED BACK TO PILOT.

87-56

NOTES

3. With a severance between the pilot's station and the CPG's station

   a. CPG control free to move to mechanical stop.

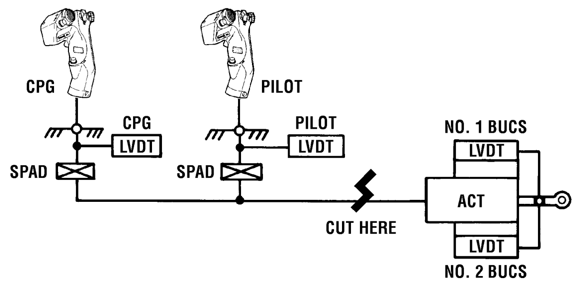
   b. Mistrack between the CPG's position LVDT and the No. 2 BUCS LVDT will cause the BUCS FAIL light to illuminate.

   c. Pilot retains normal flight control.

   d. BUCS initiation in case of a severance requires a mistrack between CPG and No. 2 BUCS LVDTs and a mistrack between the pilot and No. 1 BUCS LVDTs.

   e. CPG can engage BUCS by actuating the BUCS Select Switch.

SEVERED CONTROL SITUATION 2



- **BOTH PILOT AND CPG CONTROLS FREE TO MOVE TO MECHANICAL STOP.**
- **BUCS ENGAGEMENT AUTHORIZED AS SOON AS PILOT LVDT AND NO. 1 BUCS LVDT AND CPG LVDT AND NO. 2 BUCS LVDT MISTRACK SIMULTANEOUSLY. EITHER PILOT OR CPG CAN CONTROL ACFT. PILOT LVDT COMMANDS ACTUATOR.**
- **ONE SECOND EASY ON TO ACHIEVE 100 PERCENT CONTROL.**
- **ENGAGEMENT LOCKS MECHANICAL INPUT TO ACTUATOR. INERTIAL MOTIONS OF CONTROL CANNOT INPUT TO ACTUATOR.**

87-55

NOTES

4. With a severance between the pilot and the servoactuator

   a. Both pilot and CPG controls free to move.

   b. BUCS will come on automatically as soon as pilot's LVDT and No. 1 BUCS LVDT, and CPG LVDT and No. 2 BUCS LVDT mistrack simultaneously.

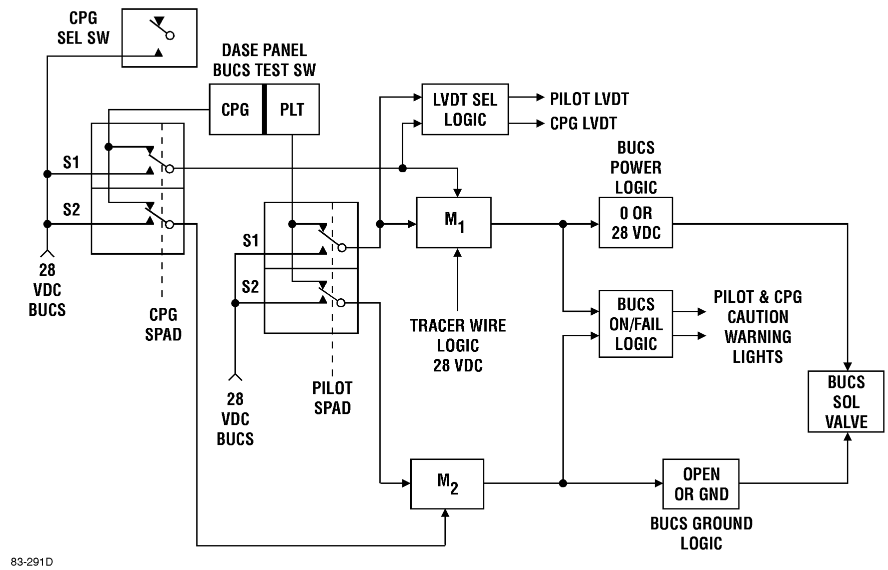
   c. Either crew member can control the helicopter.

   d. Pilot's LVDT commands actuator.

   e. One second easy on to achieve 100 percent control.

   f. Engagement locks mechanical input to actuator. Inertial motions of control cannot input to actuator.

JAM ENGAGE LOGIC



NOTES

5. Jam engage logic

a. BUCS engagement due to a flight control jam requires

(1) that BOTH microswitches in a SPAD assembly activate.

- OR -

(2) 1 SPAD microswitch activates, followed by a mistrack of 17.5% between the control stick LVDT and the respective BUCS in the servoactuator in all axis except pitch which is 22.5%.

b. If the mechanical flight controls become jammed, the pilot or CPG must apply enough force to break the shear pin in the SPAD assembly. When the SPAD shear pin is broken, the respective cockpit controls are freed and BOTH microswitches in the SPAD assembly will close. Breaking the SPAD shear pin in EITHER crew station will cause the BUCS to engage.

c. The closed BUCS microswitches will connect 28 VDC to the input of monitors M1 and M2 in the DASE Computer.

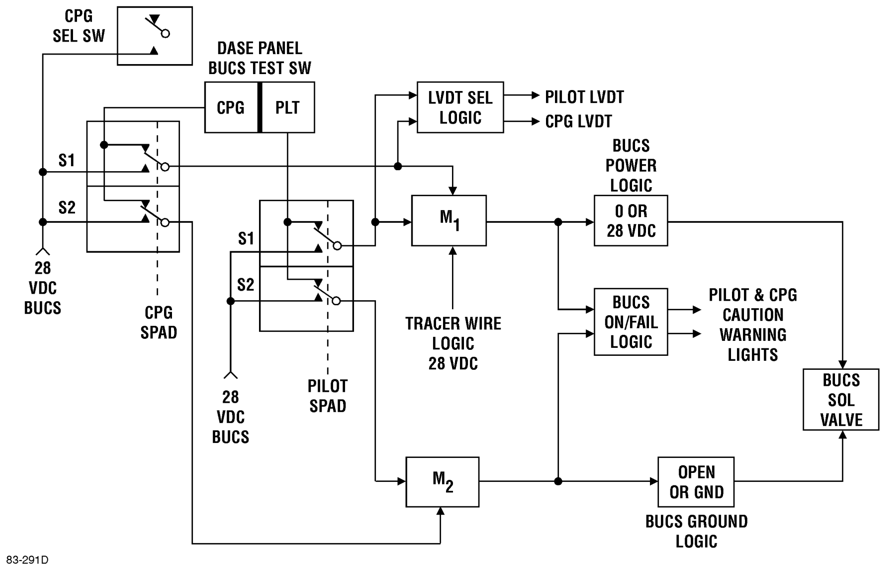
(1) Monitor M1 output will switch from 0.0 VDC to 28 VDC.

(2) Monitor M2 output will switch from an open circuit to ground (0.0 VDC).

d. The BUCS ON/FAIL logic will illuminate the BUCS ON advisory light. If only one microswitch activates, the monitor circuits will provide the BUCS ON/FAIL logic circuit with a combination of signals that will illuminate the BUCS FAIL advisory light.

e. The BUCS power and ground logic will energize the BUCS and SAS solenoid valves open, locking out manual control inputs and BUCS is now engaged. If only one microswitch activates, the BUCS power and ground logic circuits will provide the BUCS solenoid valve with a combination of signals that will prevent the valve from opening until a mistrack of 17.5% between the control stick LVDT and the respective BUCS in the servoactuator (pitch axis mistrack is 22.5%). Once the mistrack has occurred, the BUCS power and ground logic will then energize the BUCS and SAS solenoid valves open to engage BUCS.

JAM ENGAGE LOGIC



NOTES

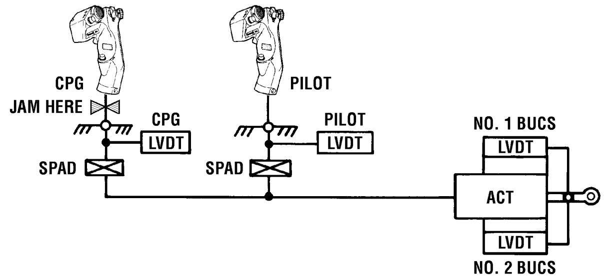
f. The DASEC now controls the helicopter by the control position signal from the crew station LVDT that has the broken SPAD shear pin.

(1) If the BUCS activated SPAD is in the pilot crewstation, BUCS control can be transferred to the CPG station by actuating the BUCS select switch on the CPG collective stick. ONCE CONTROL HAS BEEN TRANSFERRED FROM THE PILOT TO THE CPG, IT CAN NOT BE TRANSFERRED BACK TO THE PILOT.

(2) If the SPAD in the CPG station is sheared, BUCS will engage and control will be from the CPG station. In order for the pilot to control the helicopter, the respective SPAD in the pilot station must be broken.

g. An easy-on feature of the DASEC allows a maximum of 3 seconds for full BUCS control when a SPAD shearpin is broken due to a flight control jam.

JAMMED CONTROL SITUATION 1



- CPG CONTROL LOCKED. CPG CANNOT SHEAR PIN IN HIS SPAD.
- PILOT CAN SHEAR PIN IN HIS SPAD.
- SPAD SWITCH ASSEMBLY ACTIVATION ENGAGES BUCS.
- PILOT LVDT WILL COMMAND.

87-60

NOTES

6. In case of a jam at the base of the CPG's cyclic

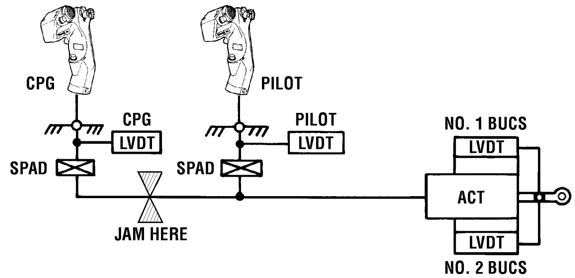
    a. CPG control locked. CPG cannot break his SPAD shear pin.

    b. Pilot can shear pin in his SPAD.

    c. SPAD switch assembly activation engages BUCS.

    d. Pilot LVDT will command the actuator.

JAMMED CONTROL SITUATION 2



- FORCE ON EITHER CONTROL WILL DECOUPLE THE RESPECTIVE SPAD.
- BUCS ENGAGEMENT AUTHORIZED BY DECOUPLED SPAD.
- LVDT IN STATION WITH DECOUPLED SPAD WILL COMMAND.
- IF BUCS INITIATED BY CPG, PILOT CAN TRANSFER CONTROL BY DECOUPLING SPAD.
- IF BUCS INITIATED BY PILOT, CPG CAN TRANSFER CONTROL BY DECOUPLING SPAD AND ACTIVATING BUCS SELECT SWITCH.
- THREE SECOND EASY-ON TO ACHIEVE 100 PERCENT AUTHORITY.

87-59A

NOTES

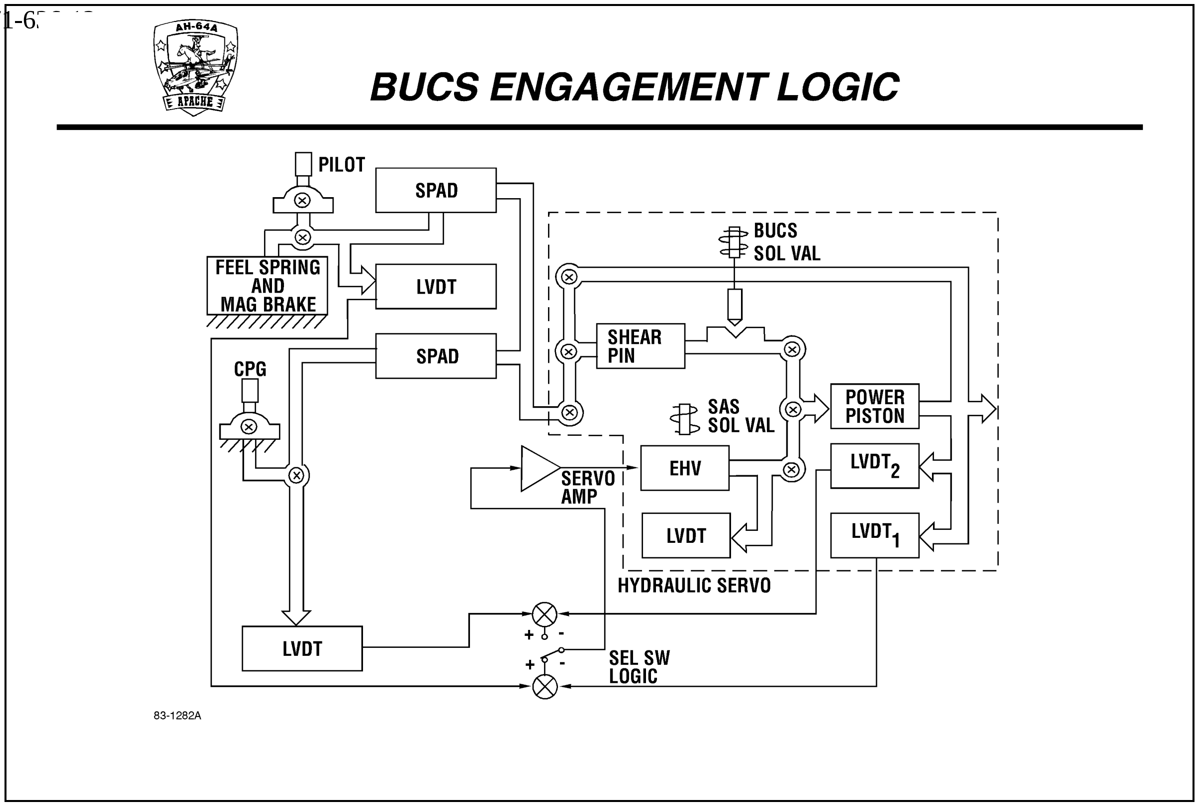
7. In case of a jam between the crew stations

   a. Force on the CPG or Pilot control will shear the pin on the respective SPAD and engage BUCS.

   b. Pilot LVDT will command if pilot SPAD sheared. Control can be transferred to the CPG station by breaking the CPG's SPAD and activating the CPG's BUCS select switch.

   c. CPG LVDT will command if CPG SPAD sheared. Control can be transferred to pilot's station by breaking the pilot's SPAD.

   d. 3-second easy-on to achieve 100 percent authority.


AH-64A
APACHE
BUCS ENGAGEMENT LOGIC
PILOT
SPAD
FEEL SPRING
AND
MAG BRAKE
LVDT
SPAD
CPG
BUCS
SOL VAL
SHEAR
PIN
SAS
SOL VAL
POWER
PISTON
SERVO
AMP
EHV
LVDT2
LVDT
LVDT1
HYDRAULIC SERVO
LVDT
SEL SW
LOGIC
83-1282A

NOTES

B. With BUCS engaged in any axis, ASE (SCAS) for that axis is disengaged and the DASEC controls 100% authority of the hydraulic servoactuator. With the BUCS engaged

1. The DASEC will apply electrical power to the SAS and BUCS solenoid valves on the respective servoactuator. Both valves will be energized open.

2. Hydraulic pressure is applied through the SAS and BUCS solenoid valves to the BUCS plunger. The plunger is forced to engage the output arm, locking out manual control for the affected axis.

3. With the manual control input locked, the electrohydraulic servovalve (EHV) becomes the only source of control in the axis that BUCS engaged in.

4. When the pilot or CPG moves the controls, a signal is developed by the position LVDT in the crew station and applied to the EHV via the DASEC.

5. The EHV, as directed by the DASEC, will apply hydraulic pressure to the power piston to extend or retract the piston.

6. As the power piston moves, the BUCS LVDT develops a signal that is in opposition to the position LVDT signal.

7. The BUCS LVDT signal is sent to the DASEC, where it is compared to the position LVDT signal. When the power piston has moved as much as required by the DASEC, the BUCS LVDT signal will be equal to and of opposite polarity to the position LVDT. The resultant signal to the EHV will be zero and the EHV will return to the neutral position and equalize hydraulic pressure on the power piston.

8. The power piston will be hydraulically locked in this position until the pilot moves the controls again, causing an imbalance between the position LVDT and the BUCS LVDT.

9. BUCS control may be switched from the pilot's LVDT to the CPG's LVDT by pressing the BUCS select switch on the CPG's collective control stick. Once the BUCS select switch is pressed, control can not be transferred back to the pilot's station.

BUCS ACTIVATION

I. OPERATIONAL QUESTIONS AND CONCERNS

II. MAINTENANCE ISSUES

11-94-36

NOTES

C. The following will be discussed

1. Operational questions and concerns

2. Maintenance issues concerning the BUCS and ECP 904.

BUCS ACTIVATION II

1. OPERATIONAL QUESTIONS AND CONCERNS

   1.1 <u>INADVERTENT BUCS ENGAGEMENT: BROKEN SHEAR PINS</u>

   - THIS IS HIGHLY UNLIKELY, BUT NOT IMPOSSIBLE. THE CONSEQUENCES OF SUCH AN EVENT WILL BE SAFE AIRCRAFT OPERATION ON THE BUCS.

   - PILOT INADVERTENTLY BREAKS SHEAR PIN RESULTING IN BUCS ENGAGEMENT.
     - PILOT FLIES AIRCRAFT ON BUCS.
     - COPILOT GAINS CONTROL BY BREAKING SHEAR PINS AND ACTIVATING CPG BUCS SELECT SWITCH.

   - COPILOT INADVERTENTLY BREAKS SHEAR PIN RESULTING IN BUCS ENGAGEMENT.
     - COPILOT FLIES AIRCRAFT ON BUCS.
     - PILOT MAY REGAIN CONTROL BY BREAKING SHEAR PIN.

11-94-37

NOTES

D. Operational questions and concerns

1. Inadvertent BUCS engagement: broken shear pins

a. Highly unlikely, but not impossible.

b. Consequence of such an event will be safe aircraft operation utilizing BUCS.

c. If pilot inadvertently breaks a shear pin (or pins) resulting in BUCS engagement.

(1) the pilot can fly the helicopter safely under BUCS operation.

(2) If the CPG has to fly the helicopter, CPG must break SPAD and activate BUCS select switch.

d. CPG inadvertently breaks a shear pin (or pins), resulting in BUCS engagement.

(1) CPG flies aircraft utilizing BUCS.

(2) Pilot may regain control by breaking shear pin.

BUCS ACTIVATION III

1. OPERATIONAL QUESTIONS AND CONCERNS (CONT.)

   1.2 INADVERTENT BUCS ENGAGEMENT: SHEAR PINS NOT BROKEN

   - SYSTEM WAS DESIGNED TO MAKE THE POSSIBILITY OF THIS EVENT EXTREMELY REMOTE.
   - HOWEVER, THERE ARE UNLIKELY FAILURES THAT COULD OCCUR, SUCH AS A DUAL FAILURE OF THE SPAD MICROSWITCH ASSEMBLY.
   - IN THE UNLIKELY EVENT THAT THIS SHOULD OCCUR, THE PILOT WILL BREAK SHEAR PIN AND CONTROL AIRCRAFT VIA BUCS.
   - COPILOT GAINS CONTROL BY BREAKING SHEAR PINS AND ACTIVATING CPG BUCS SELECT SWITCH.
   - THE MANDATORY BUCS PREFLIGHT SELF-TEST AND DASE GROUND FD/LS TESTS WILL DETECT SUCH FAILURES, INCLUDING ELECTRICAL FAILURES OF THE SPAD ASSEMBLIES, AND TURN ON THE BUCS FAIL LAMP.

11-94-38

NOTES

2. Inadvertent BUCS engagement: shear pins not broken.

   a. System designed to make possibility of this event extremely remote.

   b. However there are unlikely failures that could occur, such a dual failure of the SPAD microswitch assembly, or a failure in the wire harness.

   c. In the unlikely event that this should occur, the pilot will break shear pin and control aircraft via BUCs.

   d. CPG gains control by breaking shear pin and activating BUCS Select Switch.

   e. The mandatory BUCS preflight self-test and DASE ground FD/LS test will detect such failures, including electrical failures of the SPAD assemblies, and turn on the BUCS fail lamp.

BUCS ACTIVATION IV

1. OPERATIONAL QUESTIONS AND CONCERNS (CONT.)
   1.3 ELECTROMAGNETIC INTERFERENCE (EMI) HARDENING
   - MUST MAINTAIN PROPER CONFIGURATION OF BUCS-HARDENED LRUs FOR EFFECTIVE EMI PROTECTION OF BUCS-EQUIPPED AIRCRAFT.
     - DASH 21 DASE
     - BONDED PRIMARY ACTUATORS (DECAL DENOTES BUCS ACTUATORS)
     - CREWSTATION LVDTS (CONNECTORS CHANGED, COLOR CHANGED)
     - LVDT EXCITATION TRANSFORMER ASSEMBLY
     - FILTER PIN ADAPTERS
     - EMI GASKETS AND SEALS
   - INCOMPLETE INSTALLATION OF ALL EMI-HARDENED LRUs WILL INCREASE LIKELIHOOD OF NUISANCE BUCS FAIL INDICATIONS IN STRONG ELECTROMAGNETIC FIELDS.
   - FAILURES OR DEGRADATION OF HARDENED BUCS LRUs, SUCH AS INDIVIDUAL FILTER PINS, WILL NOT PRODUCE HAZARDOUS CONDITIONS. HOWEVER, NUISANCE ILLUMINATION OF BUCS FAIL LAMP MAY OCCUR IN SEVERE EMI ENVIRONMENTS.

11-94-39

NOTES

3. Electromagnetic Interference (EMI) hardening

   a. Must maintain proper configuration of BUCS hardened LRUs for effective EMI protection.

   b. Incomplete installation of all EMI hardened LRUs will increase the likelihood of nuisance BUCS fail indications in strong electromagnetic fields.

   c. Failures or degradation of hardened BUCS LRUs, such as individual filter pins, will not produce hazardous conditions. However, nuisance illumination of the BUCS fail lamp may occur in severe EMI environments.

BUCS ACTIVATION V

1. OPERATIONAL QUESTIONS AND CONCERNS (CONT.)

   1.4 BUCS PERFORMANCE IF ENGAGED
   - BUCS HANDLING QUALITIES IDENTICAL TO MECHANICALLY CONTROLLED AIRCRAFT WITH DASE DISENGAGED.

   1.5 BUCS SELF-TEST AND GROUND FD/LS TEST
   - BUCS SELF-TEST PERFORMED PRIOR TO EVERY FLIGHT. VERIFIES INTEGRITY OF BUCS SYSTEM.
   - DASE 02 GROUND FD/LS FOR MAINTENANCE VERIFIES INTEGRITY OF THE DASE/BUCS SYSTEM.

11-94-40

NOTES

4. BUCS performance if engaged - BUCS handling qualities identical to mechanically controlled aircraft with DASE disengaged.

BUCS ACTIVATION VI

1. OPERATIONAL QUESTIONS AND CONCERNS (CONT.)

1.6 BUCS FAIL LAMP MASTER WARNING LAMP

- NON-BUCS AIRCRAFT NORMALLY OPERATE WITH THE BUCS FAIL LAMP ILLUMINATED OR DISARMED (BULBS REMOVED). FOR BUCS-EQUIPPED AIRCRAFT, BUCS FAIL MUST NOW BE TREATED AS A MASTER WARNING LAMP AND NOT NEGLECTED. CREW TRAINING IS ESSENTIAL.
- LAMP ILLUMINATED AS A RESULT OF FAILURES IDENTIFIED BY CONTINUOUS MONITORING TESTS, BUCS SELF-TEST, OR DASE 02 GROUND FD/LS.
- LAND AS SOON AS POSSIBLE.

11-94-41

NOTES

5. BUCS FAIL master caution light

   a. Non-BUCS aircraft normally have BUCS FAIL light illuminated or disarmed.

   b. BUCS equipped aircraft, BUCS lamp must be treated as a master warning light and not be neglected by the crew. Crew training is essential.

   c. Lamp illuminated as a result of failures identified by continuous monitoring tests, BUCS self-test, or DASE FD/LS test.

   d. Crew should land as soon as possible.

BUCS ACTIVATION VII

2. MAINTENANCE CONCERNS

2.1 CAN BUCS AND NON-BUCS EQUIPMENT BE SWAPPED AND CAUSE PROBLEMS?

- YES
  - BUCS AIRCRAFT MUST HAVE BUCS ACTUATORS INSTALLED. IMPROPER
  - INSTALLATION DETECTED BY BUCS SELF-TEST AND DASE 02 GROUND FD/LS.
    - ACTUATORS HAVE LARGER BUCS PLUNGER CAVITY, A DIFFERENT NUMBER, AND WILL HAVE A PLACARD BOLTED ON TO DENOTE BUCS INSTALLATION ONLY.
  - BUCS AIRCRAFT MUST HAVE SHEAR PINS INSTALLED IN THE SPAD ASSEMBLIES.
  - BUCS SELF-TEST AND DASE GROUND FD/LS CANNOT VERIFY STATUS OF THESE
  - PARTS.
  - CONNECTORS ON CREW STATION LVDTs HAVE BEEN CHANGED TO PLUGS VICE
  - RECEPTACLES AND ARE OLIVE DRAB IN COLOR VICE BLACK.

2.2 AIRCRAFT READINESS

- BUCS FAIL LAMP ABORTS MISSION. BUCS FAIL LAMP SHOULD BE EXTINGUISHED TO TURN ROTOR HEAD UNLESS FD/LS CONFIRMS BUCS FAIL LAMP IS ON DUE TO TRACER WIRE FAULT.

11-94-42

NOTES

E. Maintenance issues concerning the BUCS and ECP 904.

1. BUCS and NON-BUCS equipment

a. Extreme caution must be exercised to prevent mixing of BUCS and NON-BUCS components.

BUCS ACTIVATION VIII

2. MAINTENANCE CONCERNS (CONT.)

2.3 SHEAR PIN PROTECTION

- CREWSTATION SHEAR PINS MAY BE BROKEN DURING AIRCRAFT MAINTENANCE, AND WHILE ENTERING AND EXITING THE COCKPITS.

- TO PREVENT DAMAGE TO THE SHEAR PINS, ECP 1131 INSTALLS CONTROL LOCKS THAT PROTECT THE SHEAR PINS WHILE HYDRAULIC POWER IS OFF.

11-94-43

NOTES

2. Shear pin protection

   a. ECP 1131 provides locks to protect shear pins.

BUCS HARDWARE CHANGES TO SERVOACTUATORS
ECP 904RI & 1036RI

- ALL SERVOACTUATOR BUCS PLUNGERS MODIFIED WITH A DICRONITE COATING AND STRONGER SPRINGS WITH RETRACT FORCE OF 115 ± 10 POUNDS.
- ALL SERVOACTUATOR SHEAR PINS INSTALLED.
- SERVOACTUATOR PART NUMBERS
  - COLLECTIVE 7-311820011
  - LATERAL. 7-311820011
  - LONGITUDINAL. 7-311820012
  - DIRECTIONAL 7-311820014
- WARNING PLACARD BOLTED TO BUCS ACTUATORS:

WARNING

THIS ACTUATOR IS EQUIPPED WITH A SHEAR PIN. DO NOT INSTALL IN AIRCRAFT NOT MODIFIED FOR BACKUP CONTROL SYSTEMS. FAILURE TO COMPLY CAN RESULT IN DEATH OR SERIOUS INJURY AND LOSS OF AIRCRAFT.

- GROUNDING CABLES (P/N MS25083-2BC12) INSTALLED ON ALL SERVOACTUATORS.

89-11-20

NOTES

A. Servoactuator actuator changes

1. BUCS plungers modified with a dicronite coating and stronger retract springs.

2. All servoactuator shear pins installed.

3. Grounding cables

4. Warning placard

WARNING

BUCS ACTIVE

THIS ACTUATOR IS EQUIPPED WITH A SHEAR PIN. DO NOT INSTALL IN AIRCRAFT NOT MODIFIED FOR BACKUP CONTROL SYSTEMS. FAILURE TO COMPLY CAN RESULT IN DEATH OR SERIOUS INJURY AND LOSS OF AIRCRAFT.

BUCS HARDWARE
SHEAR PIN ACTUATED DECOUPLER PART NUMBERS

ECP 904R1

- ALL SPAD SHEAR PINS INSTALLED
  - SHEAR PIN P/N 7-211514082
- SPAD ASSEMBLIES PART NUMBER CHANGED TO:
  - DIRECTIONAL SPAD ASSEMBLIES
    - PILOTS 7-311517067-9
    - COPILOTS. 7-311516077-7
  - LONGITUDINAL SPAD ASSEMBLIES
    - PILOTS 7-311517069-7
    - COPILOTS. 7-311516077-5
  - LATERAL SPAD ASSEMBLIES (CYCLIC STICK HOUSING ASSEMBLIES)
    - PILOTS 7-311514075-11
    - COPILOTS. 7-311515074-11
  - COLLECTIVE SPAD ASSEMBLIES (COLLECTIVE STICK SUPPORT ASSEMBLIES)
    - PILOTS 7-311512085-11
    - COPILOTS. 7-311513001-7

89-11-19

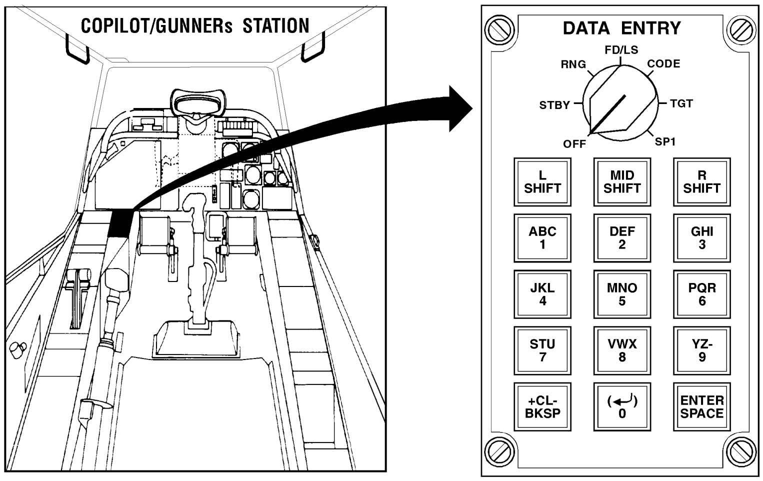
NOTES

5. All shear pins installed.

6. Shear pin actuated decouplers

7. BUCS Test or FD/LS cannot identify non-BUCS SPAD installation.

DATA ENTRY KEYBOARD (DEK)



DATA ENTRY KEYBOARD

27-93-80

NOTES

A. The DASE system tests consist of two types of Built-In Test (BIT) and the Back Up Control System (BUCS) test

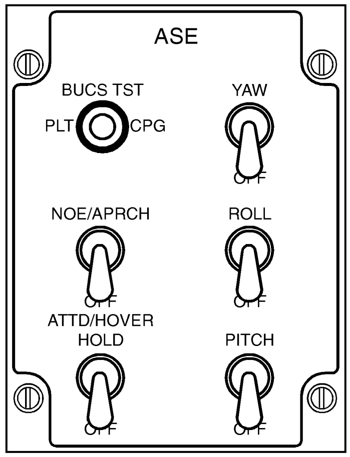
1. Automatic Built-In Test (BIT) - the automatic built-in test monitors all DASE functions and performs the automatic tests associated with DASE functions.

   a. The result of the automatic test is an output to the MUX bus as part of a status word for the FD/LS.

   b. When a DASE function or component fails, the automatic BIT causes disengagement of the ASE switch and illuminates the ASE light on the Caution/Warning/Advisory panels in the crew stations.

2. Initiated Built-In Test (FD/LS) - the FD/LS test is initiated by using the Data Entry keyboard (DEK) in the CPG station. When initiated, FD/LS tests the DASEC and associated Line Replaceable Units (LRU).

BUCS TST



83-294A

NOTES

B. BUCS self-test (Helicopter S/N 88-0200 and subsequent only)

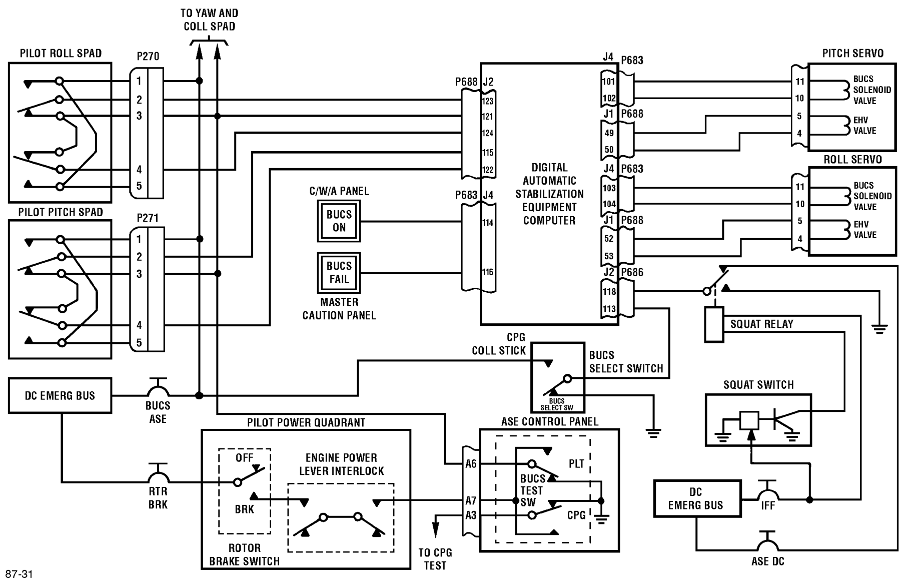
1. The Back-Up Control System can be tested by utilizing the BUCS test switch on the ASE panel in the pilot's station. Prior to initiating the test, the following conditions must be satisfied

a. The helicopter must be on the ground. When the helicopter is on the ground, the squat relay deenergizes and supplies 28 VDC to the DASEC via connector P686, pin 118.

b. The rotor brake switch must be in the BRAKE position and both engine power levers must be in the OFF position in order to arm the BUCS test switch.

c. The flight controls should be centered.

PILOT BUCS TEST



NOTES

C. Pilot BUCS test

1. When the above conditions are met and the BUCS TST switch is placed in the PLT position, 28 VDC is applied to all four SPAD assemblies in the pilot's station.

a. 28 VDC from the BUCS TST switch (PLT position) enters each SPAD assembly through pin 3 of the respective connector and exits pin 2, then enters the DASEC through connector P688 as follows

Pitch	Pin 122
Roll	Pin 121
Yaw	Pin 125 (Not Shown)
Collective	Pin 127 (Not Shown)

b. 28 VDC is also applied to the DASEC through P688, pin 121.

c. The input from each SPAD and the input to pin 121 signals the DASEC to perform the following sequence of events to test the engagement, operation, and disengagement of the Back-Up Control System.

(1) The DASEC issues a maximum command to the EHV with the SAS and BUCS solenoid valves deenergized. The flight controls in the crew station and the servoactuators should not move.

(2) The DASEC energizes the SAS solenoid valve.

(3) The DASEC commands 100% of SAS authority.

(4) The servo actuator moves 100% of SAS authority. Rotor blades change pitch; crew station controls do not move.

(5) The DASEC energizes the BUCS solenoid valve. The opening of the solenoid valves forces the BUCS plungers out to lock out manual flight control inputs. Any input to the EHV will cause the controls in the crew stations to be backdriven.

(6) The DASEC commands one inch of servoactuator movement.

(7) The DASEC checks for one inch of power piston movement.

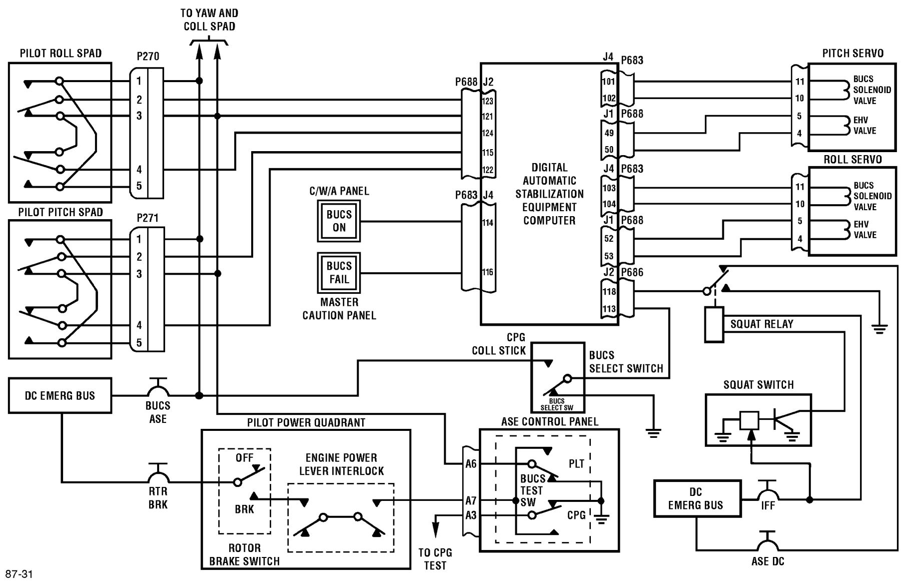
(8) The crew station controls are backdriven a corresponding amount.

(9) The DASEC deenergizes the SAS solenoid valves.

(10) The DASEC deenergizes the BUCS solenoid valves.

(11) The DASEC energizes the SAS solenoid valves.

PILOT BUCS TEST



NOTES

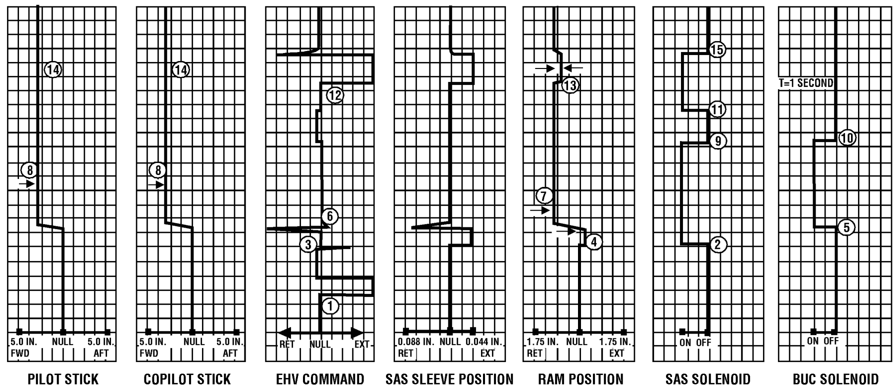
(12) The DASEC issues a maximum EHV command.

(13) The DASEC checks for 10% SAS authority RAM movement.

(14) The DASEC determines that the BUCS solenoid valves have deenergized by verifying that there is no stick movement.

(15) The DASEC deenergizes the SAS solenoid valves.

BUCS TEST SEQUENCE



SEQUENCE OF EVENTS

1. DASEC ISSUES MAXIMUM EHV CMD WITH SAS AND BUS SOLENOIDS OFF AND VERIFIES THAT THE STICKS AND RAMS DO NOT MOVE
2. DASEC ENERGIZES SAS SOLENOID
3. DASEC COMMANDS 100% OF SAS AUTHORITY
4. RAM MOVES 100% OF SAS AUTHORITY
5. DASEC ENGAGES BUCS SOLENOID
6. DASEC COMMANDS ONE INCH (29%) OF RAM MOVEMENT
7. DASEC CHECKS FOR ONE INCH RAM MOVEMENT
8. STICKS TRAVEL THE CORRESPONDING CONTROL MOVEMENT
9. DASEC DEENERGIZES SAS SOLENOID
10. DASEC DEENERGIZES BUCS SOLENOID
11. DASEC ENEGERGIZES SAS SOLENOID
12. DASEC ISSUES MAXIMUM ENV COMMAND
13. DASEC CHECKS FOR 10% SAS AUTHORITY RAM MOVEMENT
14. DASEC DETERMINES THAT THE BUCS SOLENOID HAS DISENGAGED BY VERIFYING THAT THERE IS NO STICK MOVEMENT
15. DASEC DEENERGIZES SAS SOLENOID

87-18B

NOTES

D. BUCS test sequence

1. The DASEC issues a maximum command to the EHV with the SAS and BUCS solenoid valves deenergized. The flight controls in the crew station and the RAMs should not move.

2. The DASEC energizes the SAS solenoid valve.

3. The DASEC commands 100 percent of SAS authority.

4. The RAM moves 100 percent of SAS authority. Rotor blades change pitch; crew station controls do not move.

    a. Full scale RAM travel = 40 divisions on the chart (0.35 inches of RAM movement).

    b. SAS authority = 10 percent of full scale (4 divisions).

5. The DASEC energizes the BUCS solenoid valve. The opening of the solenoid valve forces the BUCS plunger out to lock out manual flight control inputs. Any input to the EHV will cause the controls in the crew stations to be backdriven.

6. The DASEC commands one inch of RAM movement.

    a. The DASEC checks for one inch of RAM movement.

    b. 1.0 inch of RAM equals 11.4 divisions (3.5 inches of RAM equals 40 divisions on the chart)

7. The crew station flight controls move a corresponding amount (1.0 inch of RAM equals approximately 2.86 inches of stick movement).

8. The DASEC deenergizes the SAS solenoid valves.

9. The DASEC deenergizes the BUCS solenoid valve.

10. The DASEC energizes the SAS solenoid valve.

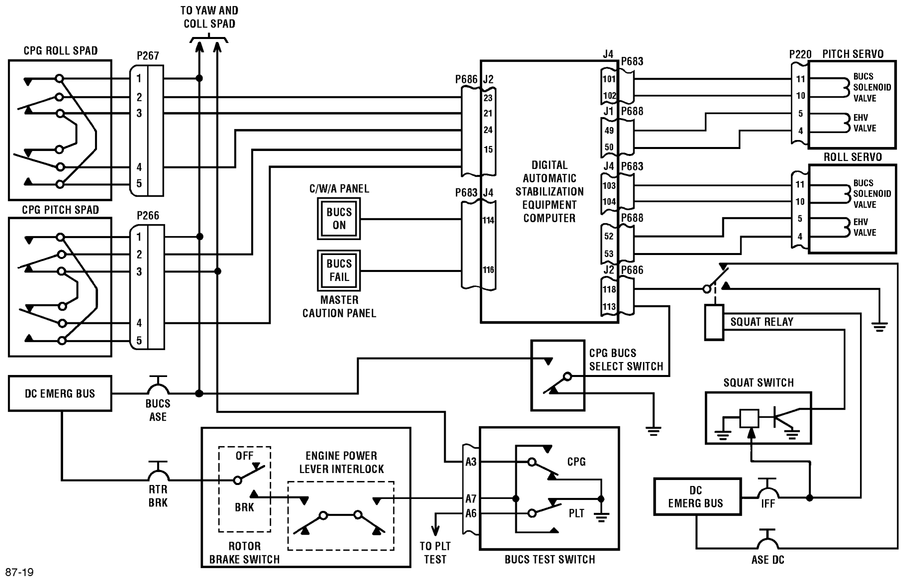
11. The DASEC issues a maximum EHV command.

12. The DASE computer checks for 10 percent SAS authority RAM movement.

13. The DASEC determines that the BUCS solenoid has disengaged by verifying that there is no stick movement.

14. The DASEC deenergizes the SAS solenoid valve.

CPG BUCS TEST



NOTES

E. CPG BUCS test

1. When the CPG position of the BUCS TST switch is selected, the signal is routed through the SPAD assemblies in the CPG's station to the DASEC via connector P686. 28 VDC is also applied to the DASEC via pin 121 from the BUCS TST switch. The same sequence of events will take place as occurred in the PLT position.

   a. The SAS actuator will be exercised as indicated by small movements of the rotor blades.

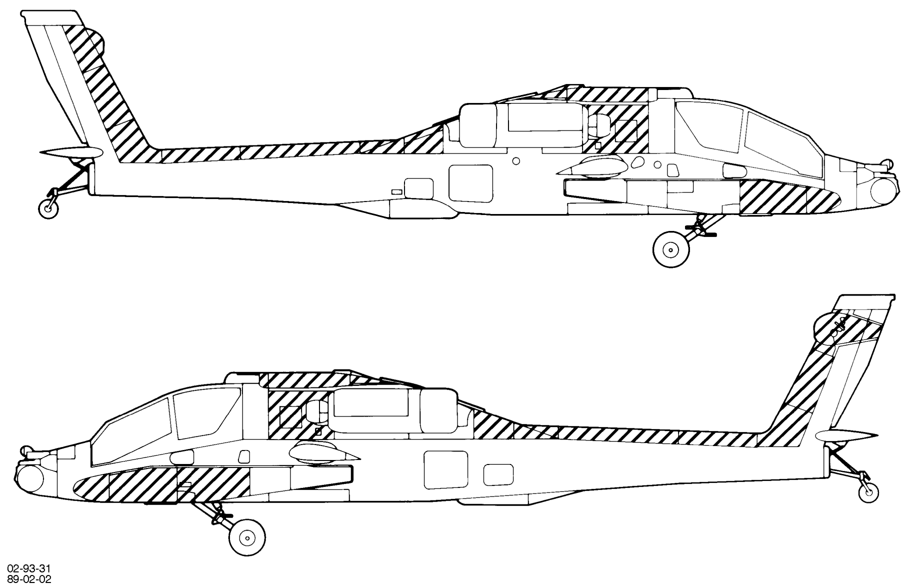
   b. The BUCS will be activated, the BUCS ON light will illuminate, and the crew station controls will be backdriven.

2. The final step of the BUCS test is to activate the CPG BUCS select switch on the collective control stick to check for a mistrack between the CPG position LVDTs and the No. 2 BUCS LVDTs.

   a. If a mistrack DOES NOT EXIST, the BUCS FAIL light on the Master Caution Panel will illuminate to indicate a good test.

   b. If a mistrack of 2.5% or more does exist, the BUCS FAIL light will not illuminate and the BUCS ON light will illuminate to indicate a malfunction.

AH-64A FAIRINGS WITH CONDUCTIVE PAINT A/C S/N 88-0200 AND SUBS.



NOTES

F. Electromagnetic Interference (EMI) hardening

1. Must maintain proper configuration of BUCS - hardened components for effective EMI protection

   a. DASH 21 or higher DASEC

   b. Bonded servoactuators

   c. Crew station LVDTs

   d. LVDT Excitation Transformer Assembly

   e. Filter Pin Adapters

   f. EMI Seals, tape and gaskets

2. Failures or degradation of EMI - hardened BUCS components will not produce hazardous conditions. Illumination of the BUCS FAIL lamp may occur in severe EMI environments.

3. Modified "Kevlar" fairings

   a. Specific "Kevlar" components are coated on their inner sides with a conductive shield material (silver paint), which provides an airframe ground path for Electro-magnetic Interference (EMI). This helps to protect the DASE Computer's electrical signals during operation of the Back Up Control System (BUCS).

   b. Provide an EMI conductive surface from the aircraft skin to the conductive "Kevlar" fairings and to certain aluminum panels and doors, conductive seals and/or silver/aluminum tape is installed on their mating surfaces. Thus an EMI boundary is established for the BUCS system.

CONDUCTIVE COATINGS

Black silver oxide is a natural phenomenon with silver pigment conductive paint. Since the silver oxide is highly conductive, it is still functional and removal is not necessary.

Contaminants on or near edges such as fuel, oils, and dirt must be cleaned to prevent coating of gaskets, tape and loosening of adhesives.

Cracks or peeling of conductive coatings must be repaired by cleaning and re-coating of the damaged area. A cut or scratch less than 6 inches in length and less than 0.01 inch in width is permissible (use standard repair procedures).

01-90-42

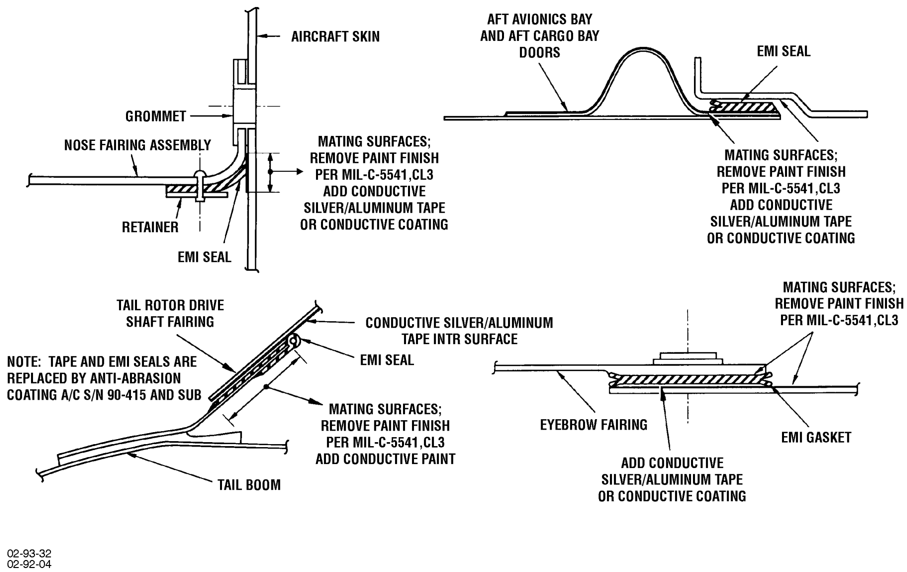
NOTES

4. Black silver oxide is a natural phenomenon with silver pigment conductive paint. Since the silver oxide is highly conductive, it is still functional and removal is not necessary.

   a. Contaminants on or near edges such as fuel, oils, and dirt must be cleaned to prevent coating of gaskets, tape, and loosening of adhesives.

   b. Cracks or peeling of conductive coating must be repaired by cleaning and recoating of the damaged area. A cut or scratch less than 6 inches in length and less than 0.01 inch in width is permissible (Use standard repair procedures).

EMI CONDUCTIVE SEALS



NOTES

5. Four basic EMI seal designs

a. A "single lip" EMI seal, retained by a metal retainer, mates with the silver/aluminum tape in these applied areas.

(1) L60 and R60, FAB Nose Fairing Assemblies. Seal is on the fairing, and tape on the aircraft skin.

(2) L90 and R90, FAB access doors. Seal is on the airframe (except where latches contact), and the tape is on the doors.

(3) T250L and T250R, T290L and T290R; Aft Equipment Bay doors. Seals on the left doors, and tape on the right doors.

b. An EMI seal with a "double lip" is bonded to the aluminum door surface and mates with the tape on the aircraft skin in these applications

(1) L295, Aft Cargo Stowage Door

(2) R295, Aft Avionics Bay Door

c. A "rolled" EMI seal is bonded to the airframe flange along the tailboom and mates with the tape on the following fairings

(1) R410, Number four tail rotor driveshaft fairing

(2) R475, Number five tail rotor driveshaft fairing

d. An EMI seal with two "double lips" is bonded to the aluminum panel surface and forms a gasket against the silver/aluminum tape on these fairings

(1) L40, "Eyebrow" Electronic equipment cover

(2) R40, "Eyebrow" Electronic equipment cover

e. Several other fairings use silver/aluminum tape on both mating surfaces without the need for any of the seals

(1) L540, Tail Rotor Transmission fairing

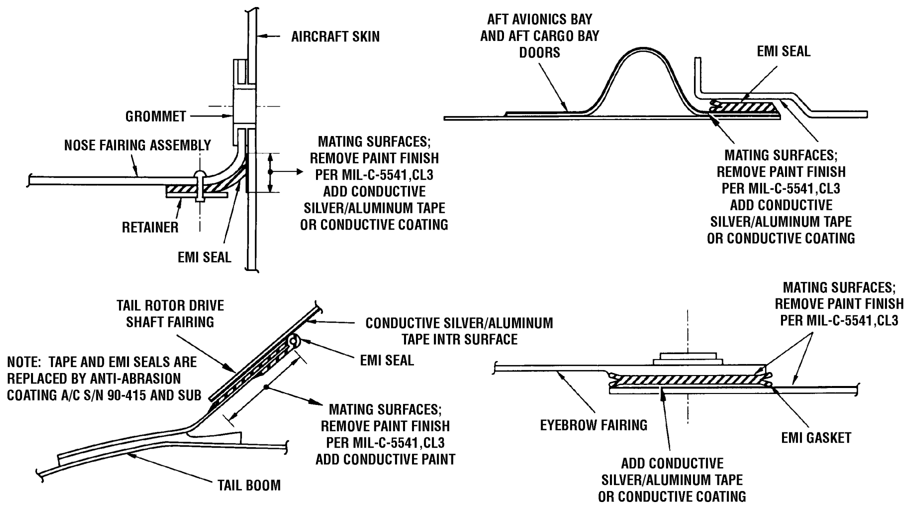
(2) L510, Vertical Stabilizer fairing

(3) L530, Vertical Stabilizer leading edge fairing

(4) L200 and R200, Main Rotor Transmission access panels

(5) T355, Forward Tail Rotor Driveshaft fairing

EMI CONDUCTIVE SEALS



02-93-32
02-92-04

NOTES

(6) L140 and L175, Ammunition Feed Mechanism fairings

(7) R325, GSE access door

(8) L325 "Catwalk" access door

EMI TAPE

The aluminum tape used as the faying surface for EMI gaskets must be bubble free and with minimum wrinkles, not to exceed two cross bands in a six inch section.

The paint overspray of aluminum tape must not cover the joining surface for the gasket or opposite tape surfaces in such installations. In no case shall spray exceed 50% of tape width.

Torn tape around fasteners is allowable if the gap is limited to one side of the fastener and not wider than 0.25 inches.

01-94-70
01-90-41

NOTES

6. EMI Tape

a. The aluminum tape used as the faying surface for EMI gaskets must be bubble free and with minimum wrinkles, not to exceed two cross bands in a six inch section.

b. The paint over spray of aluminum tape must not cover the joining surface for the gasket or opposite tape surfaces in such installations. In no case shall spray exceed 50% of tape width.

c. Torn tape around fasteners is allowable if the gap is limited to one side of the fastener and not wider than 0.25 inches.

EMI TAPE (Continued)

Torn tape that has adequate conductive adhesive may be reattached if the resulting gap is less than 0.25 inches.

Contaminants on tape shall be removed with a soft cloth and isopropyl alcohol taking care not to loosen adhesive or damage coating on the tape.

Black residue on tape caused by either aluminum flaking (abrasion) or silver oxide will not degrade shields if less than 20% of periphery.

Aluminum oxide (white residue) must be removed and tape refinished or replaced as appropriate.

01-94-71

NOTES

d. Torn tape that has adequate conductive adhesive may be re-attached if the resulting gap is less than 0.25 inches.

e. Contaminants on tape shall be removed with a soft cloth and isopropyl alcohol taking care not to loosen adhesive or damage coating on the tape.

f. Black residue on tape caused by either aluminum flaking (abrasion) or silver oxide will not degrade shields if less than 20% of periphery.

g. Aluminum oxide (white residue) must be removed and tape refinished or replaced as appropriate.

EMI GASKETS

Adhesive used for EMI gasket attachment must not exceed 0.010 inches in thickness as conductivity degrades with thickness.

Gaps between gasket and faying surfaces are not allowed on forward and AFT avionics bays. Other components such as the drive shaft covers, vertical stabilizer fairings and intermediate gearbox fairings may have gaps not longer than six inches nor more than 0.050 inches between surfaces.

Torn gaskets may be reinstalled if adhesive will maintain the gasket in position and the spaces across torn area (Butt joint) does not exceed 0.030 inches.

01-90-43

NOTES

7. EMI Gasket

a. Adhesive used for EMI gasket attachment must not exceed 0.010 inches in thickness as conductivity degrades with thickness.

b. Gaps between gasket and faying surfaces are not allowed on forward and AFT avionics bays. Other components such as the drive shaft covers, vertical stabilizer fairings and intermediate gearbox fairings may have gaps not longer than six inches nor more than 0.050 inches between surfaces.

c. Torn gaskets may be reinstalled if adhesive will maintain the gasket in position and the spaces across torn area (butt joint) does not exceed 0.030 inches.

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Gaps between gasket and faying surfaces are not allowed on forward and AFT avionics bays. Other components such as the drive shaft covers, vertical stabilizer fairings and intermediate gearbox fairings may have gaps not longer than six inches nor more than 0.050 inches between surfaces.

Torn gaskets may be reinstalled if adhesive will maintain the gasket in position and the spaces across torn area (Butt joint) does not exceed 0.030 inches.

01-90-43

NOTES

WARNING

CONTROL MOVEMENT

Maintenance personnel must be warned verbally prior to moving the collective, cyclic sticks or directional pedals. Any control activated can result in sudden blade movement that can sever or crush fingers or hands.

CAUTION

HYDRAULIC POWER

If controls bind, check problem prior to continuing procedure. Failure to clear controls of binding may result in sheared pins in the control axis.

WARNING

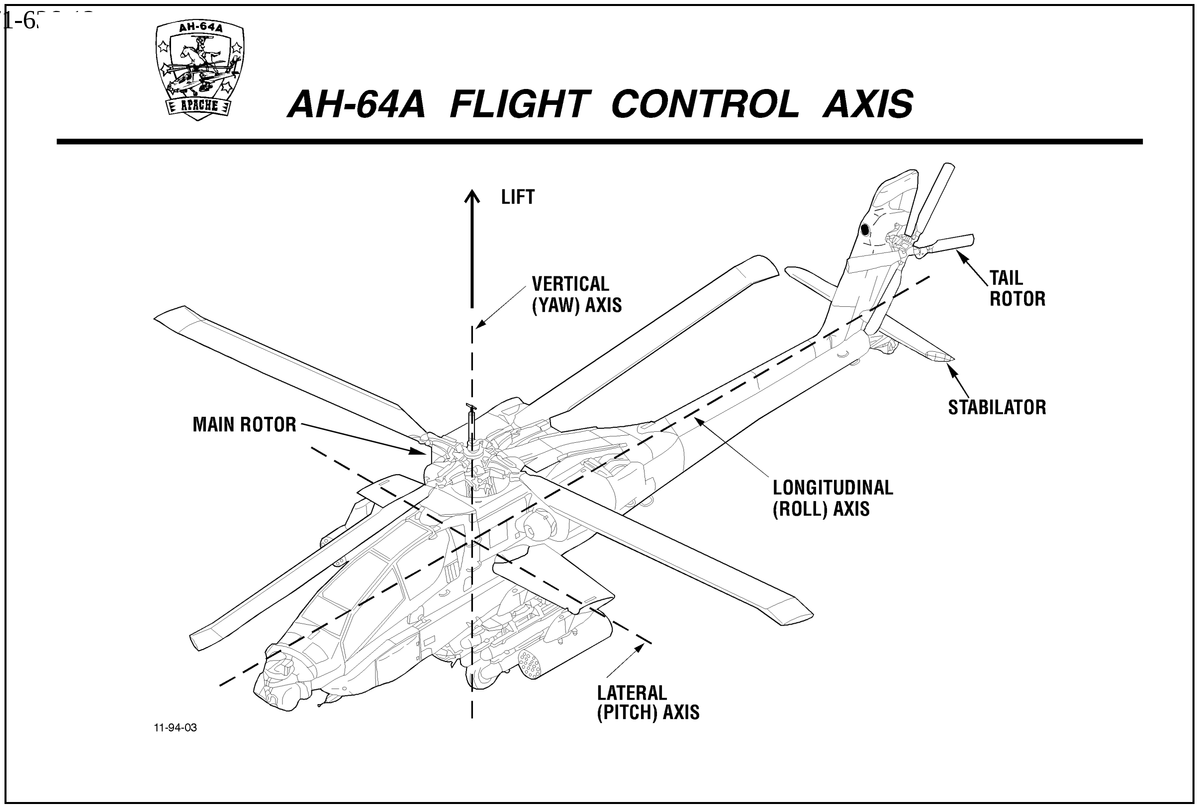
SERVOCYLINDER ROD END ADJUSTMENT

To provide enough thread engagement to maintain safe flight, the distance between center of the rod end and end of the servocylinder piston must not exceed 3.06 inches.

CAUTION

SERVOCYLINDER ROD END ADJUSTMENT

Top prevent breakdown of cylinder piston rigs, rotation of piston is limited to 90 DEGREES during rigging and installation. Adjustments are made by turning rod end, not piston.


AH-64A
APACHE
AH-64A FLIGHT CONTROL AXIS
LIFT
VERTICAL
(YAW) AXIS
TAIL
ROTOR
STABILATOR
MAIN ROTOR
LONGITUDINAL
(ROLL) AXIS
LATERAL
(PITCH) AXIS
11-94-03

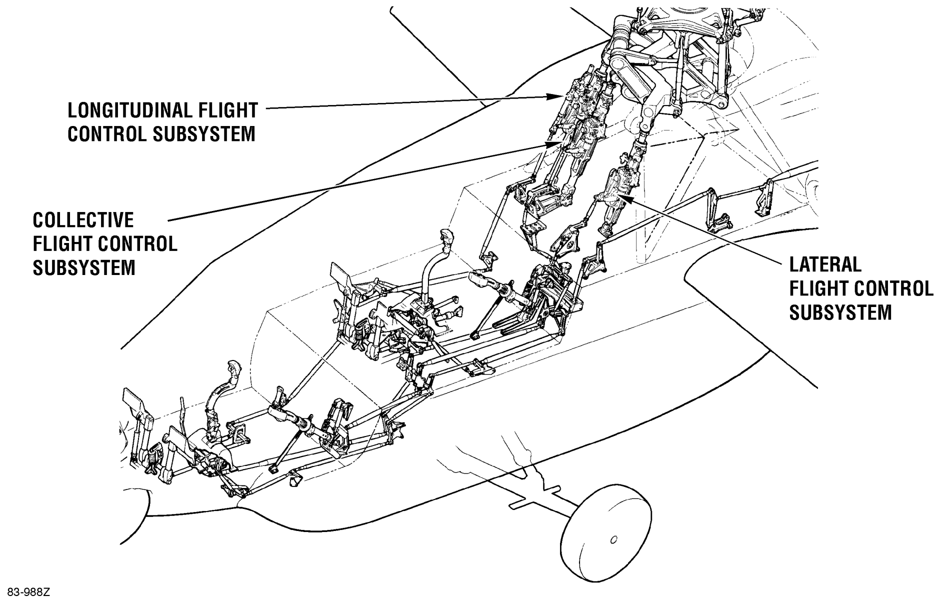
NOTES

A. Rigging the mechanical flight controls

1. Rigging of the flight control system is required to ensure proper flight controllability of the helicopter pitch, roll, and yaw axis, with regard to the pilot's and CPG's control sticks and pedals input.

2. We will now discuss the rigging procedures for the AH-64A Mechanical Flight Controls. We will identify the tools and procedures necessary to ensure that the lateral, longitudinal, collective, and directional flight controls are properly adjusted.

FLIGHT CONTROL RIGGING (1)



NOTES

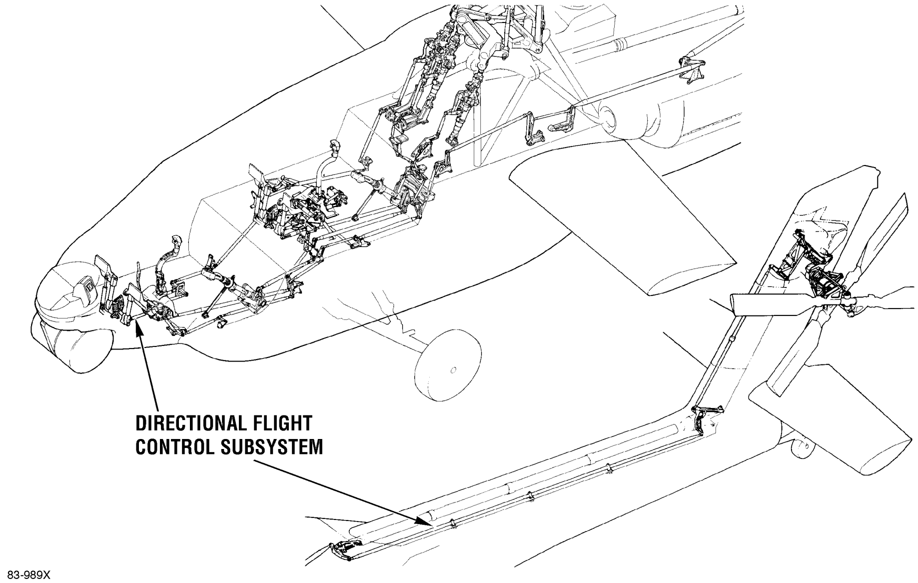
B. There are four flight control subsystems that require mechanical rigging

1. Collective flight control subsystem

2. Longitudinal flight control subsystem

3. Lateral flight control subsystem

FLIGHT CONTROL RIGGING (2)



NOTES

4. Directional flight control subsystem

C. Areas to be rigged within the four major subsystems of the flight controls are

1. Mechanical controls located between the pilot's and CPG's stations.

2. Mechanical controls located between the pilot's station and the servoactuators.

3. The pilot's and CPG's cyclic, collective, and directional pedal stops.

4. The upper flight control system (collective, longitudinal, lateral, and directional).

D. Flight control rigging general precautions

1. To prevent damage to the flight control system components, do not force the controls if binding or roughness occurs.

2. When installing or removing rig pins, ensure that the rig pins are loose in the hole. This is called a "drop fit". If drop fit on a rig pin does not exist, this indicates that the system is preloaded. Determine the adjustable rod end affecting that rig pin hole you are working with and adjust until the preload no longer exists.

3. When using the flight control rigging kit, ensure that, upon completion of a specific rigging task/step, all items in the kit are accounted for. This requires a complete inventory before and after use.

WARNING

CONTROL MOVEMENT

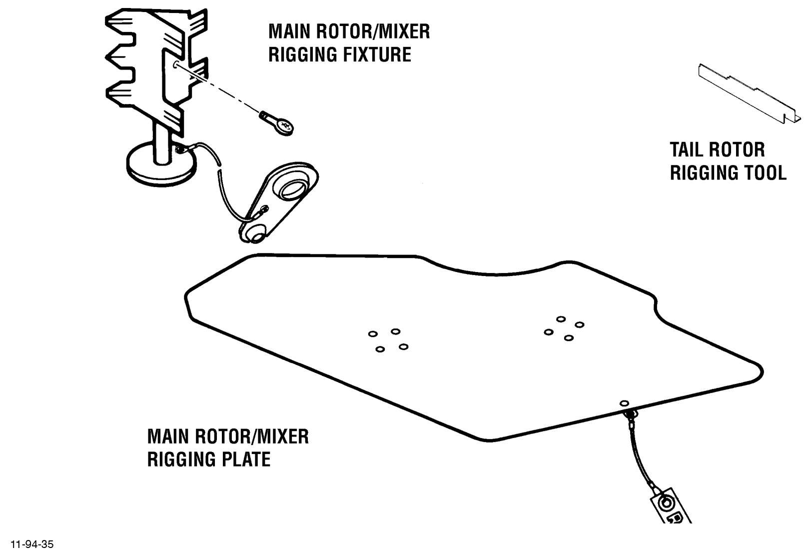
Maintenance personnel must be warned verbally prior to moving the collective, cyclic sticks or directional pedals. Any control activated can result in sudden blade movement that can sever or crush fingers or hands.

CAUTION

HYDRAULIC POWER

If controls bind, check problem prior to continuing procedure. Failure to clear controls of binding may result in sheared pins in the control axis

RIGGING KIT (1)



NOTES

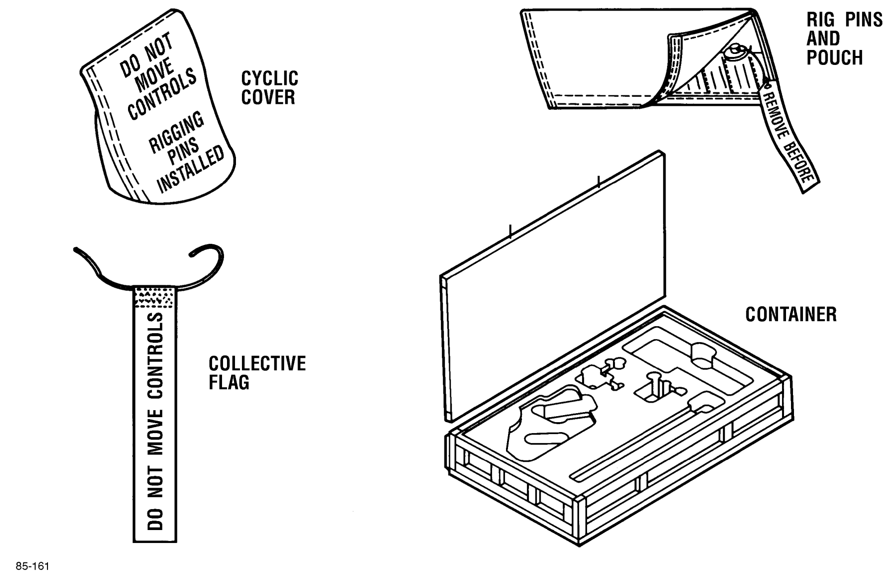
A. The flight control system rigging kit consists of

1. Main rotor/mixer, rigging fixture

2. Main rotor/mixer, rigging plate

3. Tail rotor rigging tool

RIGGING KIT (2)



NOTES

4. Control rigging pin set

5. Collective stick flag assembly (2)

6. Cyclic stick cover assembly (2)

7. Container and pouches

WARNING

CONTROL MOVEMENT

Maintenance personnel must be warned verbally prior to moving the collective, cyclic sticks or directional pedals. Any control activated can result in sudden blade movement that can sever or crush fingers or hands.

CAUTION

HYDRAULIC POWER

If controls bind, check problem prior to continuing procedure. Failure to clear controls of binding may result in sheared pins in the control axis.

MECHANICAL FLIGHT CONTROL RIGGING

Rigging of the Mechanical Flight Controls Is Required in the Following Areas:

A. Mechanical Controls Between the Pilot and Co–Pilot Gunner Stations.

B. Mechanical Controls Between the Pilot Station and the Flight Control Servo Actuators.

C. Mechanical Controls to be Rigged Include:

1. Longitudinal Control System
2. Lateral Control System
3. Collective Control System
4. Directional Control System

85-612

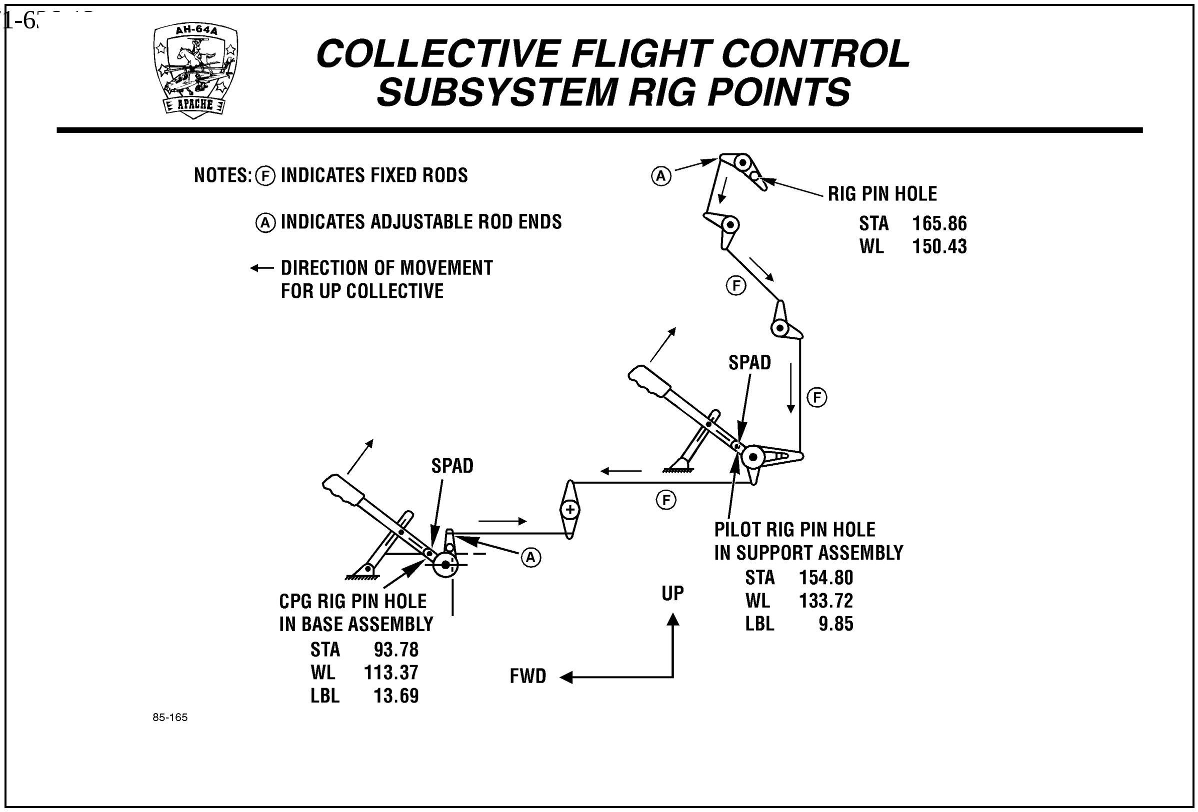
NOTES

A. Rigging of mechanical controls

1. Ensures that both the pilot's and CPG's controls provide the same amount of input to the servoactuators for the same amount of induced movement.

2. Flight control movements of the pilot's and CPG's cyclic sticks, collective sticks, and directional pedals should be identical with regard to distance of travel and direction. This results from the two sets of controls being mechanically connected by a series of bellcranks and push-pull rods. (Selected push-pull rods are adjustable for flight control rigging).

3. Provisions exist in the following areas for performing rigging procedures in the mid-position/mid-stroke plane of reference for the piston rod at the servoactuator.


COLLECTIVE FLIGHT CONTROL
SUBSYSTEM RIG POINTS
NOTES: (F) INDICATES FIXED RODS
(A) INDICATES ADJUSTABLE ROD ENDS
DIRECTION OF MOVEMENT
FOR UP COLLECTIVE
RIG PIN HOLE
STA 165.86
WL 150.43
SPAD
SPAD
PILOT RIG PIN HOLE
IN SUPPORT ASSEMBLY
STA 154.80
WL 133.72
LBL 9.85
CPG RIG PIN HOLE
IN BASE ASSEMBLY
STA 93.78
WL 113.37
LBL 13.69
UP
FWD
85-165

NOTES

B. Collective flight control subsystem rig points consist of

1. Collective flight control subsystem rig points

a. CPG rig pin hole in base assembly

STA	93.78
WL	113.37
LBL	13.69

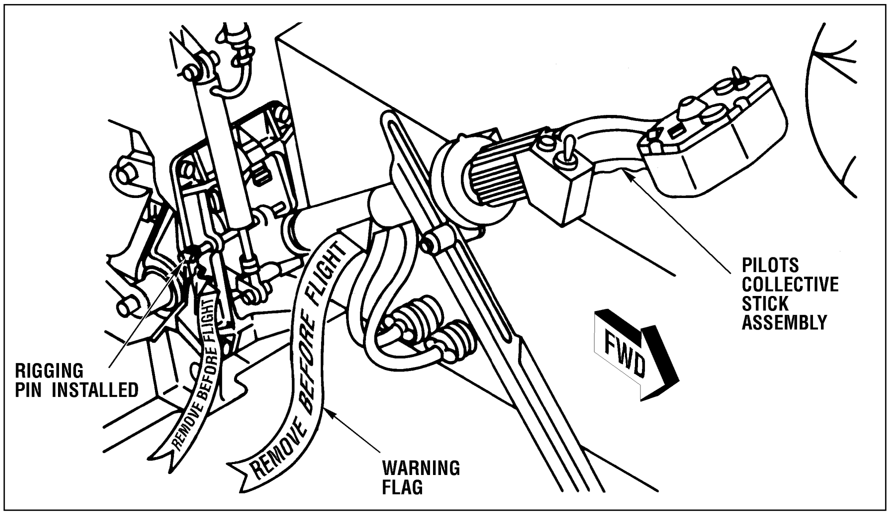
b. Pilot rig pin hole in support assembly

STA	154.80
WL	133.72
LBL	9.85

c. Rig pin hole in bellcrank assembly

STA	165.86
WL	150.43

COLLECTIVE FLIGHT CONTROL SUBSYSTEM RIGGING (1)

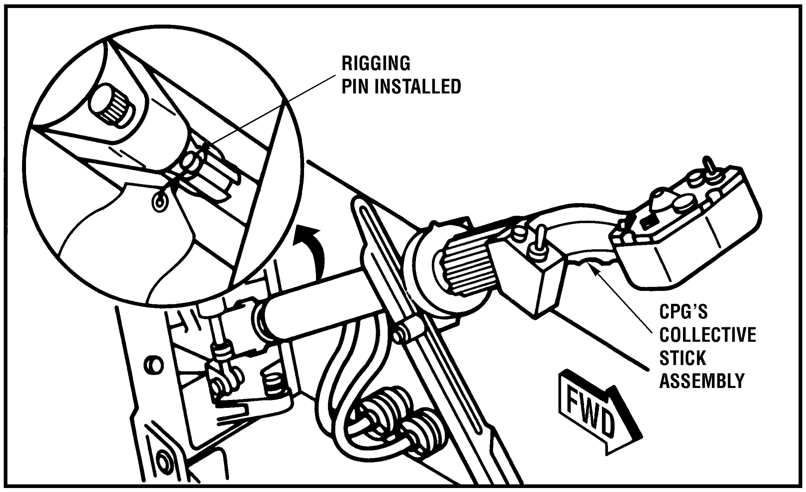


85-511

NOTES

2. Pilot's collective stick and stick housing rig pin holes at fuselage station 154.8.

COLLECTIVE FLIGHT CONTROL SUBSYSTEM RIGGING (2)

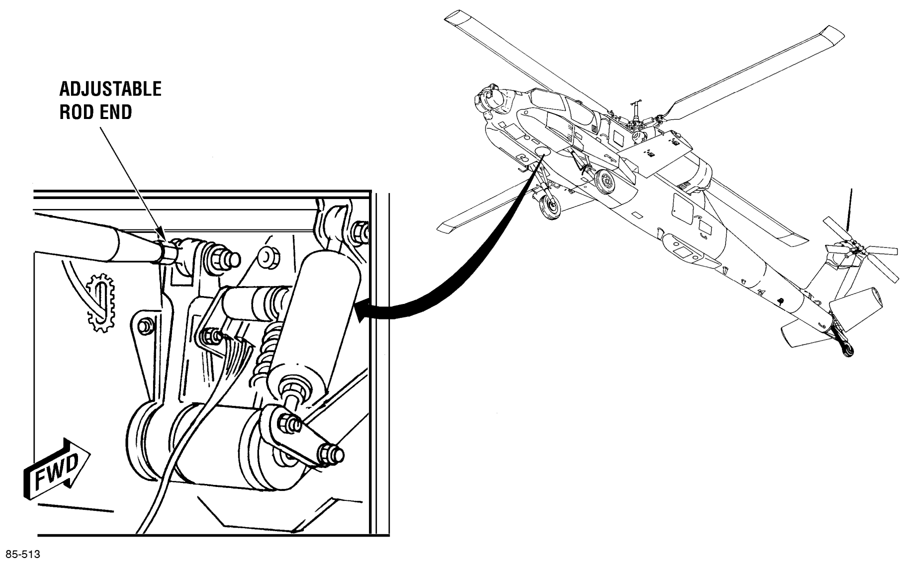


85-512

NOTES

3. CPG's collective stick and stick housing rig pin holes at fuselage station 93.7.

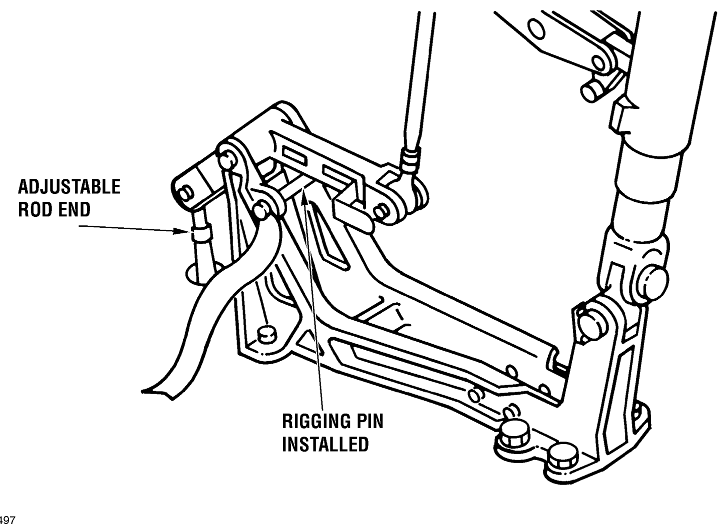
COLLECTIVE FLIGHT CONTROL SUBSYSTEM RIGGING (3)



NOTES

4. Adjustable rod end at forward end of push-pull rod at fuselage station 96.0. (Area weapon system must be removed to access this rod end for adjustment).

COLLECTIVE FLIGHT CONTROL SUBSYSTEM RIGGING (4)



NOTES

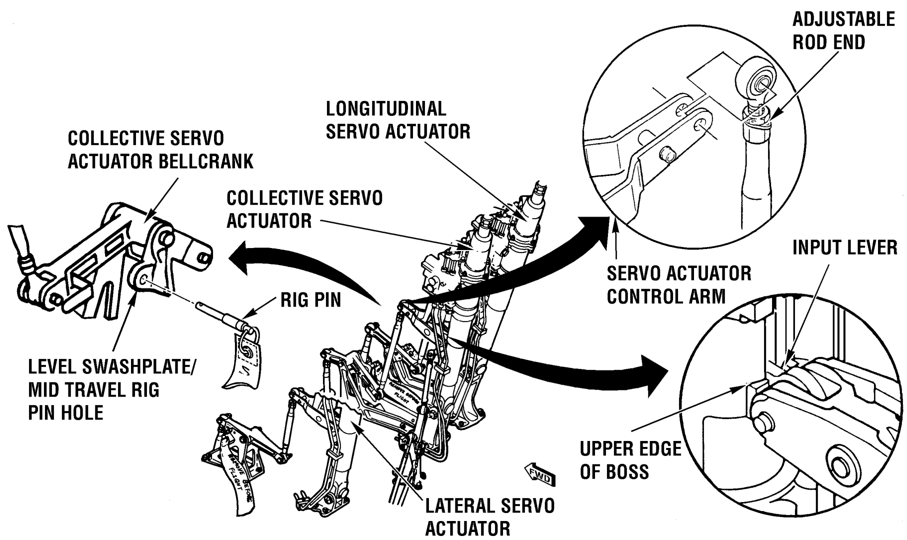
5. Adjustable rod end at upper end of push-pull rod station 161.0.

6. Rig pin hole in bellcrank assembly station 165.8.

    a. The collective bellcrank at station 165.8 has only one rig pin hole for rigging the collective flight control system in both the level swashplate and mid-stroke positions.

    b. Level swashplate and mid-stroke in the collective system are in the same plane of reference.

COLLECTIVE FLIGHT CONTROL SUBSYSTEM RIGGING (5)



NOTES

7. There is an adjustable rod end at the upper end of the push-pull rod at station 165.

8. The adjustable rod end is for adjustment of the servoactuator input lever to the mid-stroke position (lower lever aligned to the upper edge of the boss on the servoactuator body).

9. The dimensional length of the push-pull rod must be correctly adjusted to ensure mid-stroke position of the servoactuator, prior to installation of the push-pull rod end bolt to the input lever.

WARNING

CONTROL MOVEMENT

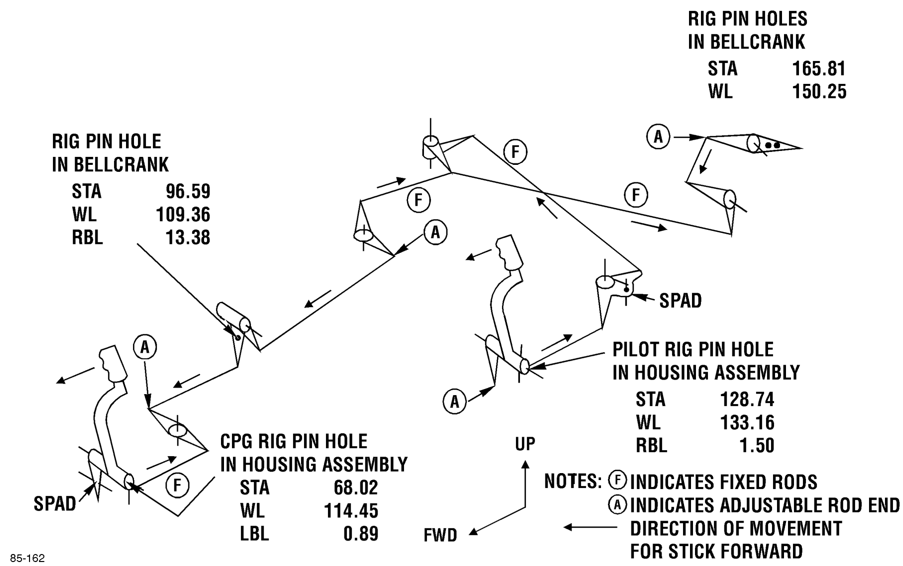
Maintenance personnel must be warned verbally prior to moving the collective, cyclic sticks or directional pedals. Any control activated can result in sudden blade movement that can sever or crush fingers or hands.

CAUTION

HYDRAULIC POWER

If controls bind, check problem prior to continuing procedure. Failure to clear controls of binding may result in sheared pins in the control axis.

LONGITUDINAL FLIGHT CONTROL SUBSYSTEM RIG POINTS



NOTES

A. Longitudinal flight control subsystem rig points consist of

1. Longitudinal flight control subsystem rig points

a. CPG ring pin hole in housing assembly

STA 68.02
WL 114.45
LBL 0.89

b. Rig pin hole in bellcrank

STA 96.59
WL 109.36
RBL 13.38

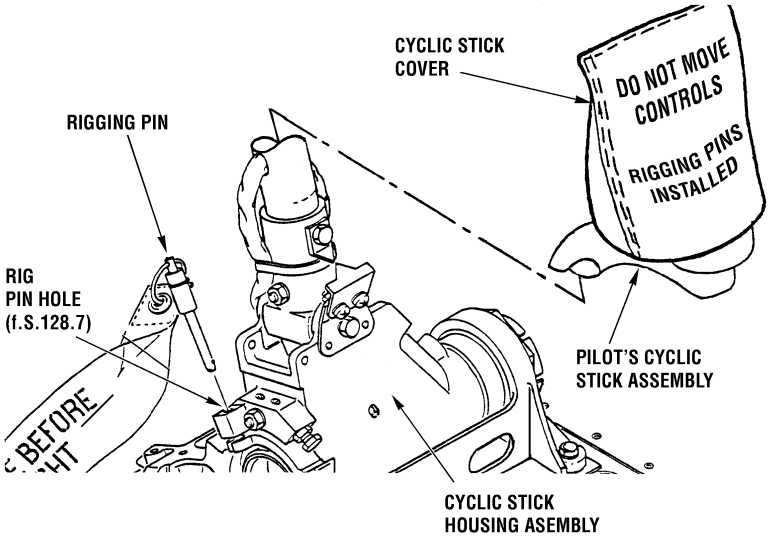
c. Pilot rig pin hole in housing assembly

STA 128.74
WL 133.16
RBL 1.50

d. Rig pin holes in bellcrank

STA 165.81
WL 150.25

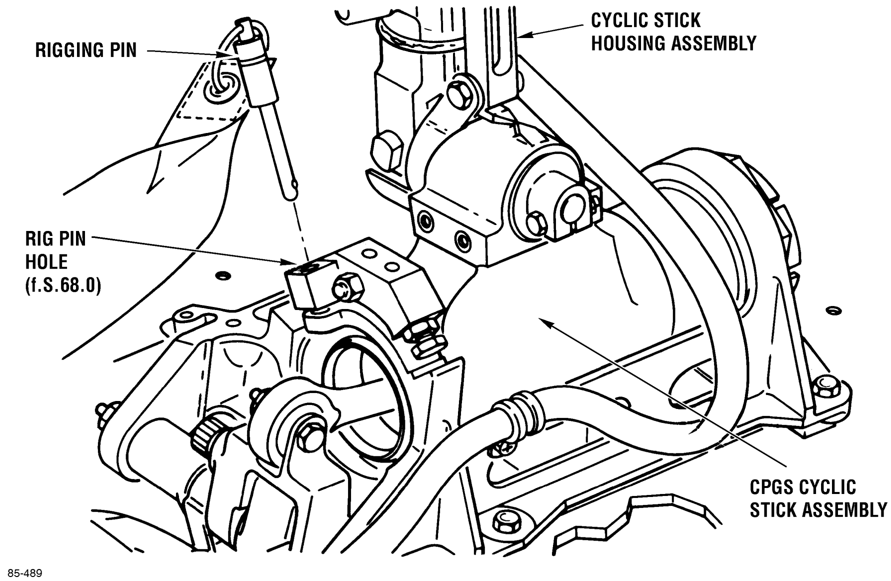
LONGITUDINAL FLIGHT CONTROL SUBSYSTEM RIGGING (1)



NOTES

2. Pilot's cyclic stick and stick housing rig pin holes at fuselage station 128.7.

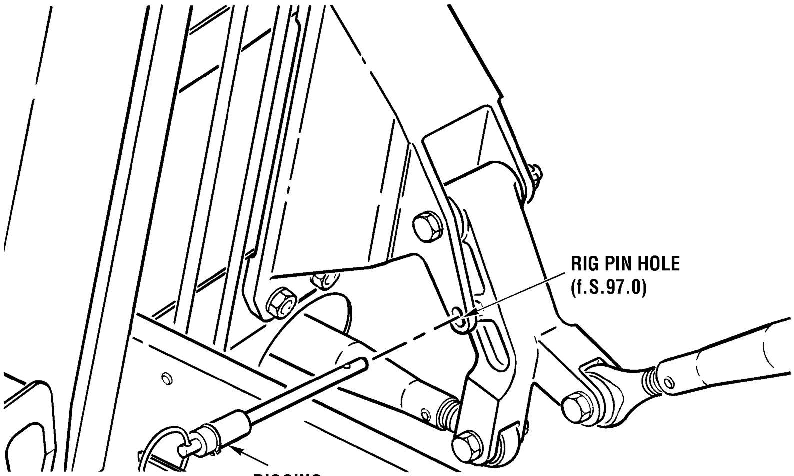
LONGITUDINAL FLIGHT CONTROL SUBSYSTEM RIGGING (2)



NOTES

3. CPG's cyclic stick and stick housing rig pin holes at fuselage station 68.0.

LONGITUDINAL FLIGHT CONTROL SUBSYSTEM RIGGING (3)

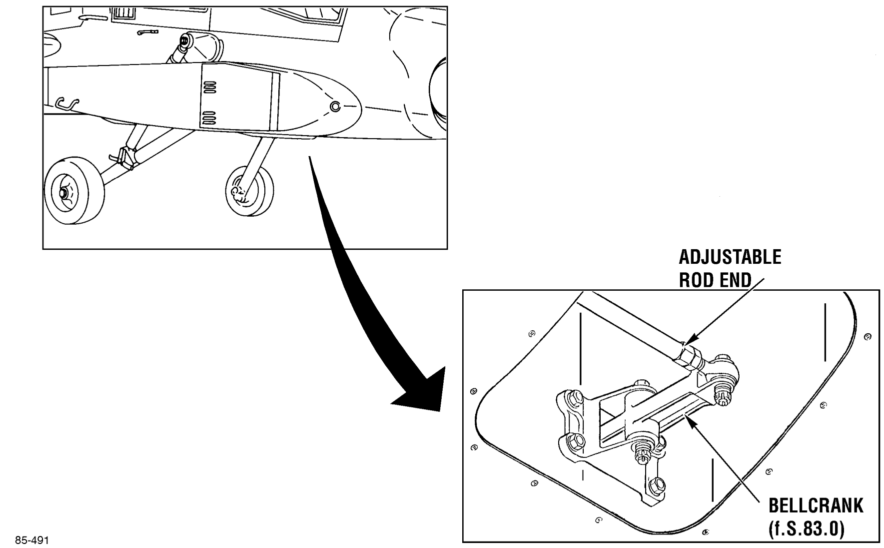


NOTES

4. Rig pin holes in bellcrank assembly fuselage station 97.0.

   a. Adjustable rod end at aft end of push-pull rod fuselage station 97.0 (123.0).

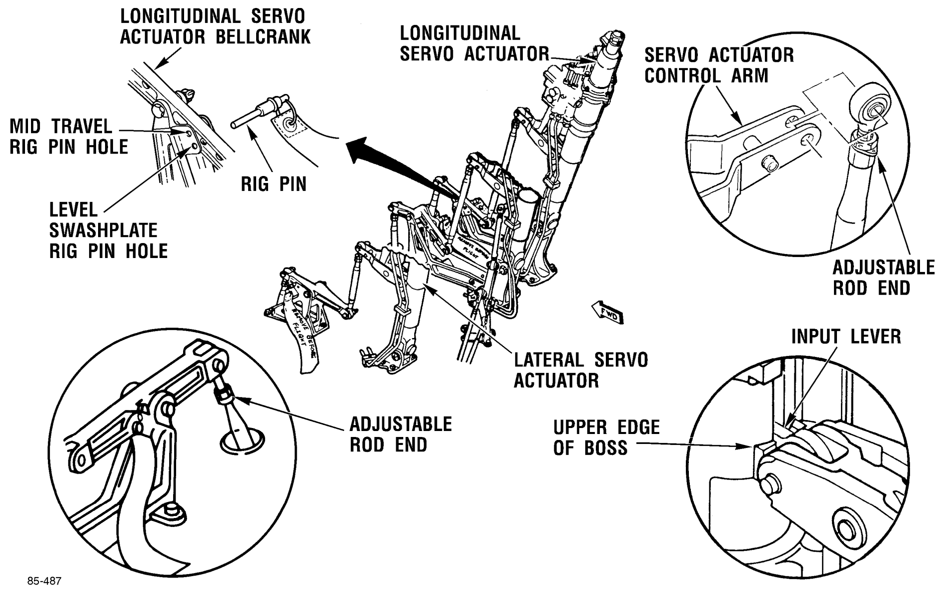
LONGITUDINAL FLIGHT CONTROL SUBSYSTEM RIGGING (4)



NOTES

5. Adjustable rod end at forward end of push-pull rod fuselage station 83.0.

LONGITUDINAL FLIGHT CONTROL SUBSYSTEM RIGGING (5)



NOTES

6. Adjustable rod end at upper end of push-pull rod fuselage station 160.00.

7. Rig pin holes in bellcrank fuselage station 165.8.

   a. The longitudinal bellcrank at station 165.8 has two rig pin holes for rigging the longitudinal flight control system. The upper rig pin hole is for rigging the servoactuator to the mid-stroke position; the lower rig pin hole is to facilitate the rigging of the mixer assembly to the level swashplate position.

   b. There is an adjustable rod end at the upper end of the push-pull rod at station 165 for adjustment of the servoactuator input lever to the mid-stroke position (lower lever aligned to the upper edge of the boss on the servoactuator body). The dimensional length of the push-pull rod must be correctly adjusted to ensure mid-stroke position of the servoactuator, prior to installation of the push-pull rod end bolt to the input lever.

WARNING

CONTROL MOVEMENT

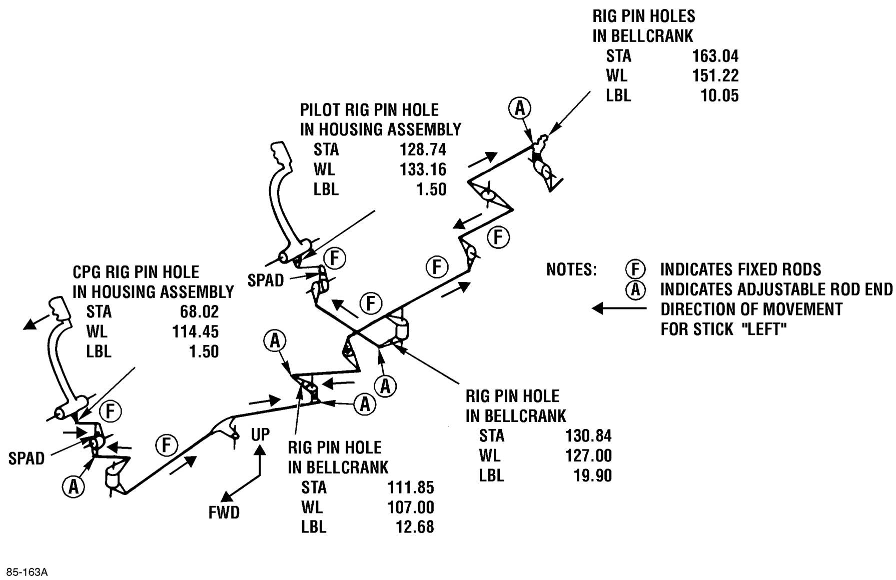
Maintenance personnel must be warned verbally prior to moving the collective, cyclic sticks or directional pedals. Any control activated can result in sudden blade movement that can sever or crush fingers or hands.

CAUTION

HYDRAULIC POWER

If controls bind, check problem prior to continuing procedure. Failure to clear controls of binding may result in sheared pins in the control axis.

LATERAL FLIGHT CONTROL SUBSYSTEM RIG POINTS



NOTES

A. Lateral flight control subsystem rig points consist of

1. Lateral flight control subsystem rig points

a. CPG rig pin hole in housing assembly

STA 68.02
WL 114.45
RBL 1.50

b. Rig pin hole in bellcrank

STA 111.85
WL 107.00
LBL 12.68

c. Rig pin hole in bellcrank

STA 130.84
WL 127.00
LBL 19.90

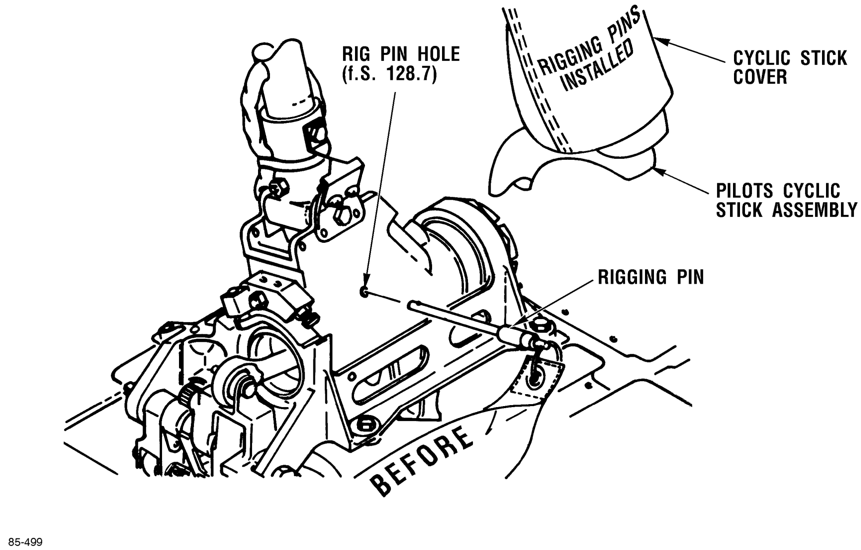
d. Pilot rig pin hole in housing assembly

STA 128.74
WL 133.16
RBL 1.50

e. Rig pin holes in bellcrank

STA 163.04
WL 151.22
RBL 10.05

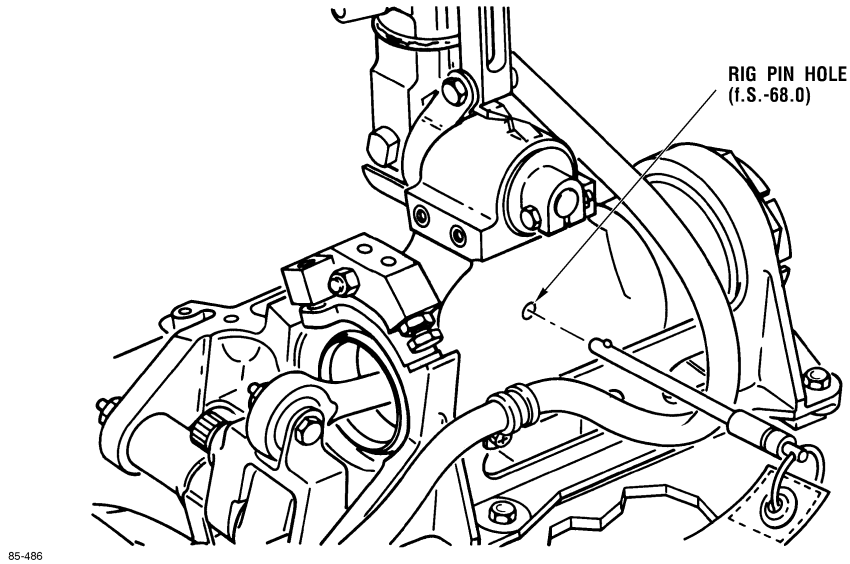
LATERAL FLIGHT CONTROL SUBSYSTEM RIGGING (1)



NOTES

2. Pilot's cyclic stick and stick housing rig pin holes at fuselage station 128.7.

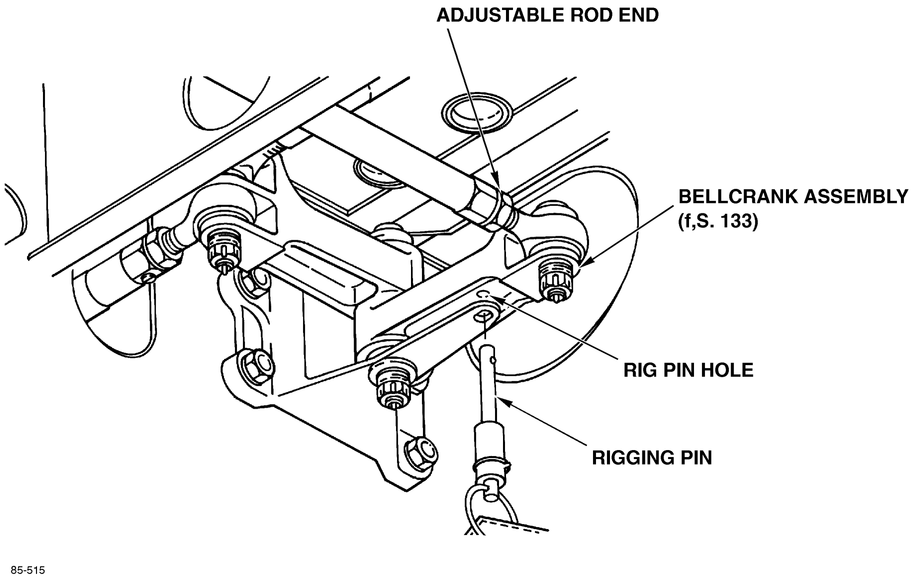
LATERAL FLIGHT CONTROL SUBSYSTEM RIGGING (2)



NOTES

3. CPG's cyclic stick and stick housing rig pin holes at fuselage station 68.0.

LATERAL FLIGHT CONTROL SUBSYSTEM RIGGING (3)

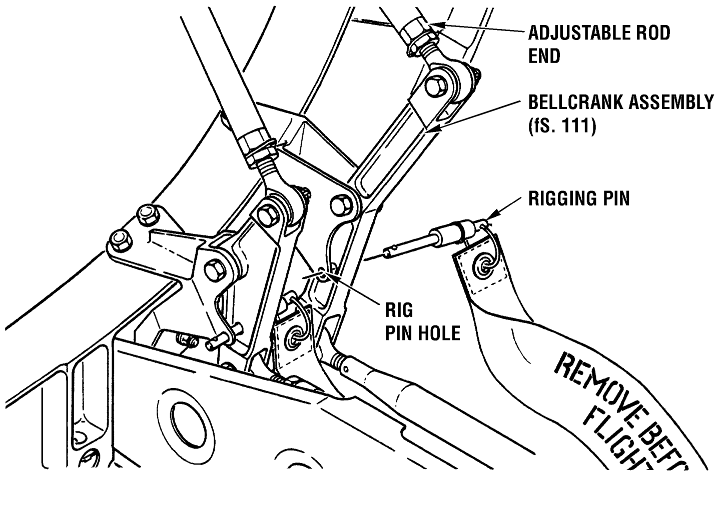


NOTES

4. Rig pin holes in bellcrank assembly fuselage station 133.0.

5. Adjustable rod end at aft end of push-pull rod fuselage station 133.0 (156).

LATERAL FLIGHT CONTROL SUBSYSTEM RIGGING (4)

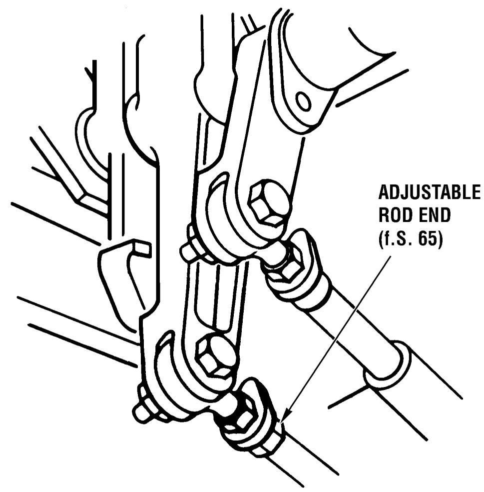


NOTES

6. Rig pin holes in bellcrank assembly fuselage station 111.0.

7. Adjustable rod end at forward end of push-pull rod fuselage station 111.0.

LATERAL FLIGHT CONTROL SUBSYSTEM RIGGING (5)

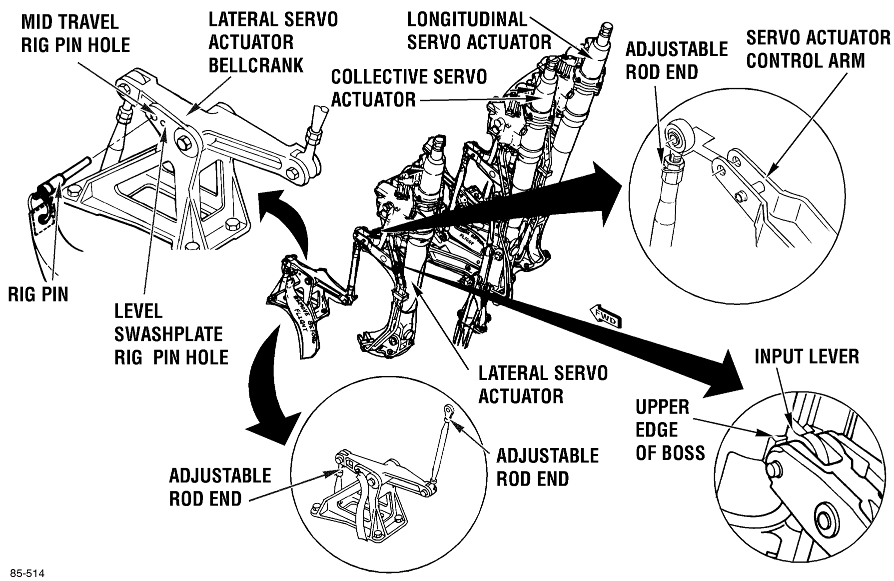


85-502

NOTES

8. Adjustable rod end at forward end of push-pull rod fuselage station 65.0.

LATERAL FLIGHT CONTROL SUBSYSTEM RIGGING (6)



NOTES

9. Adjustable rod end at upper end of push-pull rod fuselage station 159.0.

10. Rig pin holes in bellcrank assembly fuselage station 165.0.

    a. The lateral bellcrank at station 165.0 has two rig pin holes for rigging the lateral flight control system. The forward rig pin hole is for rigging the servoactuator to the mid-stroke position; the rear rig pin hole is to facilitate the rigging of the mixer assembly to the level swashplate position.

    b. There is an adjustable rod end at the upper end of the push-pull rod at station 165 for adjustment of the servoactuator input lever to the mid-stroke position (lower lever aligned to the upper edge of the boss on the servoactuator body). The dimensional length of the push-pull rod must be correctly adjusted to ensure mid-stroke position of the servoactuator, prior to installation of the push-pull rod end bolt to the input lever.

WARNING

CONTROL MOVEMENT

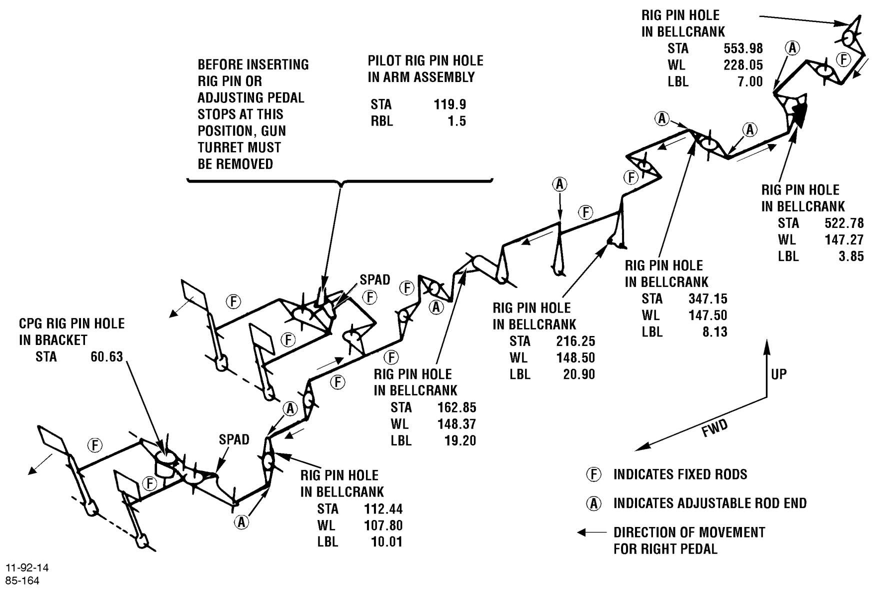
Maintenance personnel must be warned verbally prior to moving the collective, cyclic sticks or directional pedals. Any control activated can result in sudden blade movement that can sever or crush fingers or hands.

CAUTION

HYDRAULIC POWER

If controls bind, check problem prior to continuing procedure. Failure to clear controls of binding may result in sheared pins in the control axis.

DIRECTIONAL FLIGHT CONTROL SUBSYSTEM RIG POINTS



NOTES

A. Directional flight control subsystem rig points consist of

1. Directional flight control subsystem rig points

a. CPG rig pin hole in arm assembly

STA 60.63

b. Rig pin hole in bellcrank

STA 112.44
WL 107.80
LBL 10.01

c. Pilot rig pin hole in arm assembly

STA 119.9
RBL 1.5

d. Rig pin hole in bellcrank

STA 162.85
WL 148.37
LBL 19.20

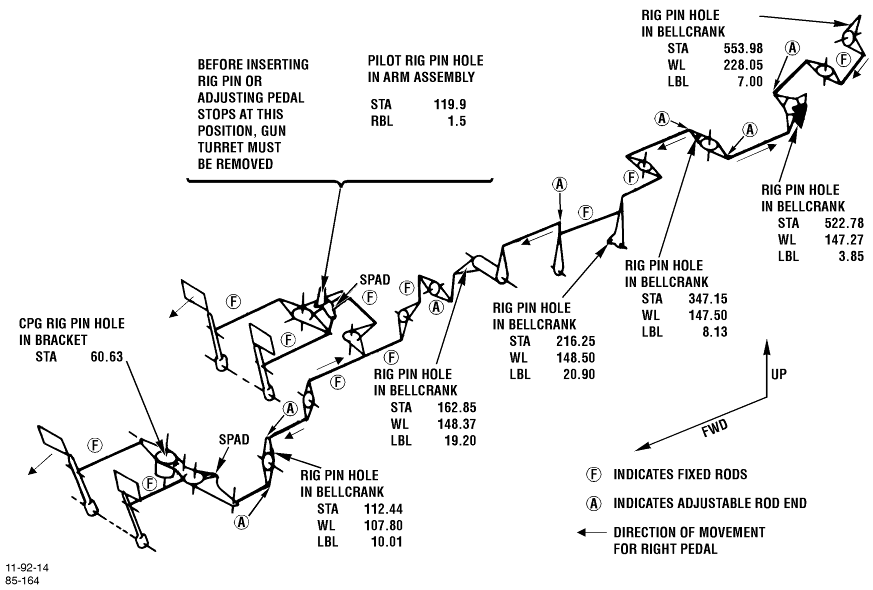
e. Rig pin hole in bellcrank

STA 216.25
WL 148.50
LBL 20.90

f. Rig pin hole in bellcrank

STA 347.15
WL 147.50
RBL 8.13

DIRECTIONAL FLIGHT CONTROL SUBSYSTEM RIG POINTS



NOTES

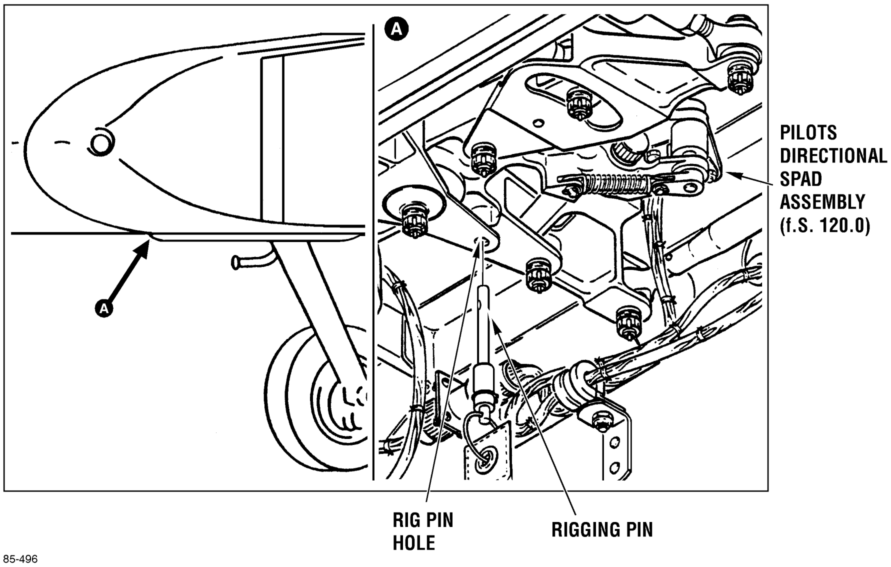
g. Rig pin hole in bellcrank

STA	522.78
WL	147.27
LBL	3.85

h. Rig pin hole in bellcrank

STA	553.98
WL	228.05
LBL	7.00

DIRECTIONAL FLIGHT CONTROL SUBSYSTEM RIGGING (1)

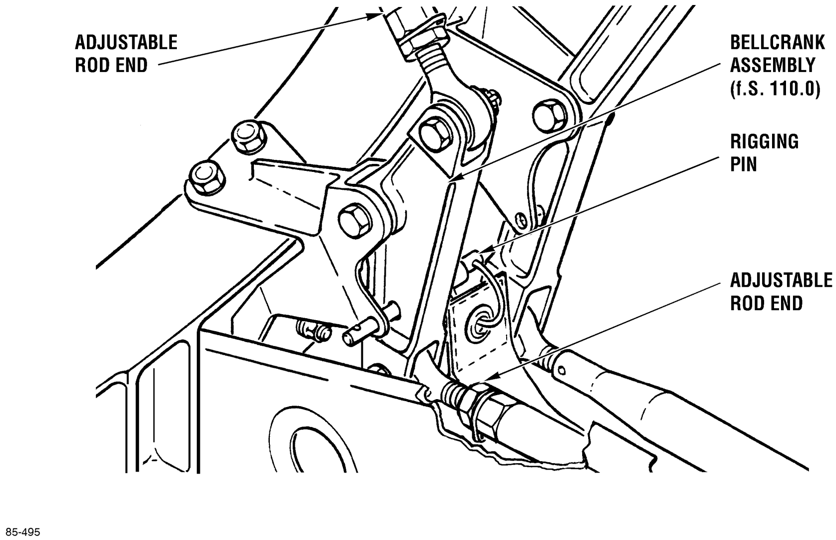


NOTES

2. Pilot's directional SPAD assembly rig pin holes fuselage station 120.0

    a. Area weapon system must be removed to gain access to the pilot's directional SPAD assembly.

DIRECTIONAL FLIGHT CONTROL SUBSYSTEM RIGGING (2)



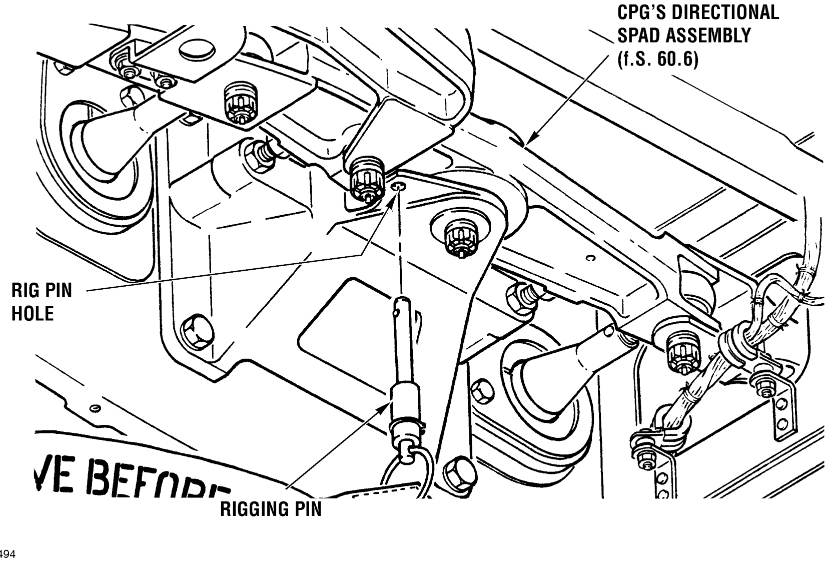
NOTES

3. Rig pin holes in bellcrank assembly fuselage station 110.0.

4. Adjustable rod end at forward end of push-pull rod fuselage station 110.0.

5. Adjustable rod end at aft end of push-pull rod fuselage station 59.0 (110.0).

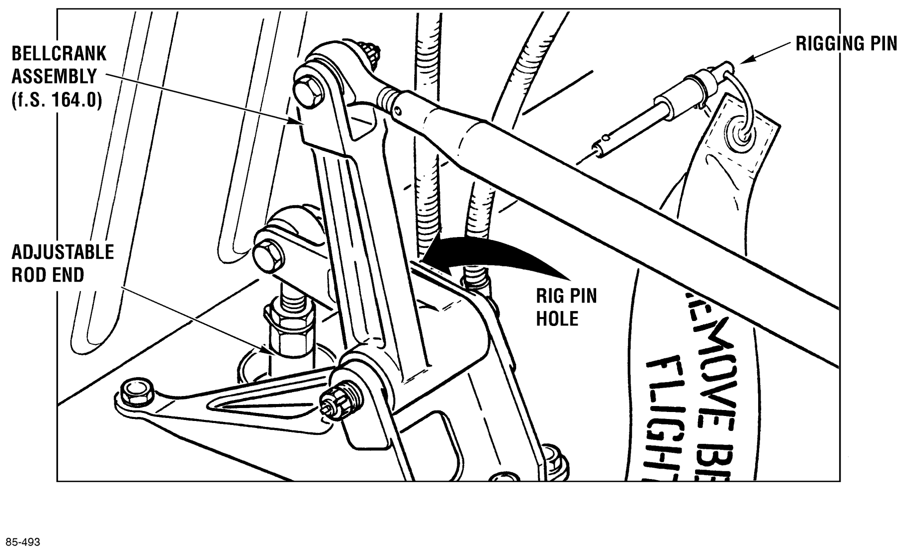
DIRECTIONAL FLIGHT CONTROL SUBSYSTEM RIGGING (3)



NOTES

6. CPG's directional SPAD assembly rig pin hole fuselage station 60.6.

DIRECTIONAL FLIGHT CONTROL SUBSYSTEM RIGGING (4)

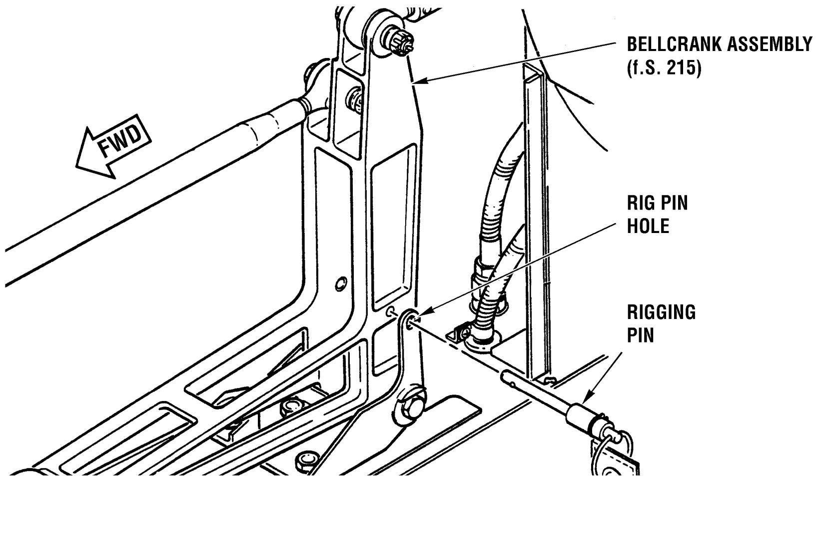


NOTES

7. Rig pin holes in bellcrank assembly fuselage station 164.0.

8. Adjustable rod end upper end of push-pull rod fuselage station 160.0.

DIRECTIONAL FLIGHT CONTROL SUBSYSTEM RIGGING (5)

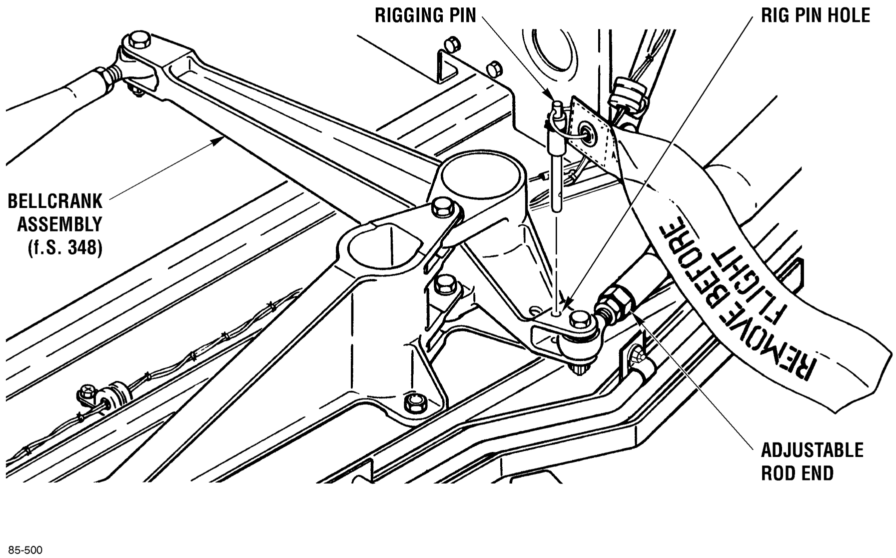


NOTES

9. Rig pin holes in bellcrank assembly fuselage station 215.0.

10. Adjustable rod end aft end of push-pull rod fuselage station 199.0.

DIRECTIONAL FLIGHT CONTROL SUBSYSTEM RIGGING (6)

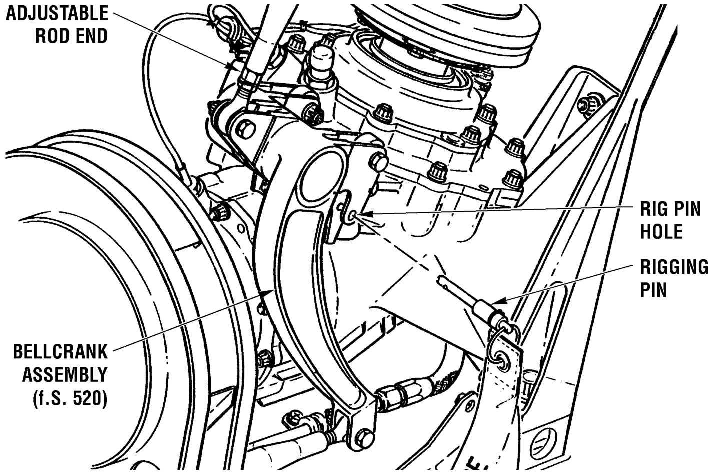


NOTES

11. Rig pin holes in bellcrank assembly fuselage station 348.0.

12. Adjustable rod end aft end of push-pull rod fuselage station 275.0.

DIRECTIONAL FLIGHT CONTROL SUBSYSTEM RIGGING (7)



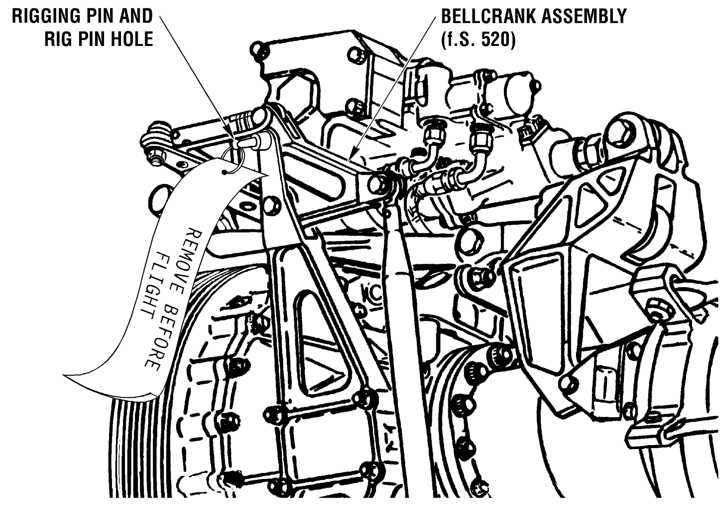
85-504

NOTES

13. Rig pin holes in bellcrank assembly fuselage station 520.0.

14. Adjustable rod end aft end of fuselage station 348.0.

DIRECTIONAL FLIGHT CONTROL SUBSYSTEM RIGGING (8)

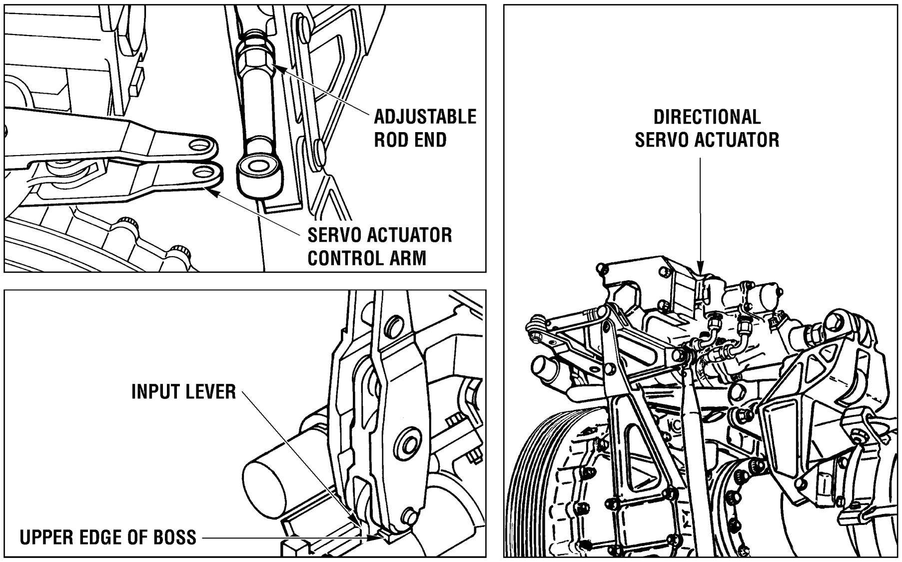


NOTES

15. Rig pin holes in bellcrank assembly fuselage station 542.0.

16. Adjustable rod end lower end of push-pull rod fuselage station 520.0.

DIRECTIONAL FLIGHT CONTROL SUBSYSTEM RIGGING (9)



85-506

NOTES

17. Adjustable rod end inboard end of push-pull rod fuselage station 542.0.

18. The adjustable rod end at fuselage station 542.0 is for adjustment of the directional servoactuator to basic dimension. The procedure for setting basic dimension remains the same as that for the collective, longitudinal, and lateral servoactuators.

WARNING

CONTROL MOVEMENT

Maintenance personnel must be warned verbally prior to moving the collective, cyclic sticks or directional pedals. Any control activated can result in sudden blade movement that can sever or crush fingers or hands.

CAUTION

HYDRAULIC POWER

If controls bind, check problem prior to continuing procedure. Failure to clear controls of binding may result in sheared pins in the control axis.

AH-64A MECHANICAL STOPS

Rigging of mechanical stops are required in:

1. Pilot's station
- **a. Collective subsystem**
- **b. Longitudinal subsystem**
- **c. Lateral subsystem**
- **d. Directional subsystem**

(Note: The pilot's station mechanical stops are the master reference point for rigging)

2. CPG's station
- **a. Collective subsystem**
- **b. Longitudinal subsystem**
- **c. Lateral subsystem**
- **d. Directional subsystem**

(Note: The CPG's station mechanical stops are rigged .020" off the stops in the Pilot's station)

85-510A

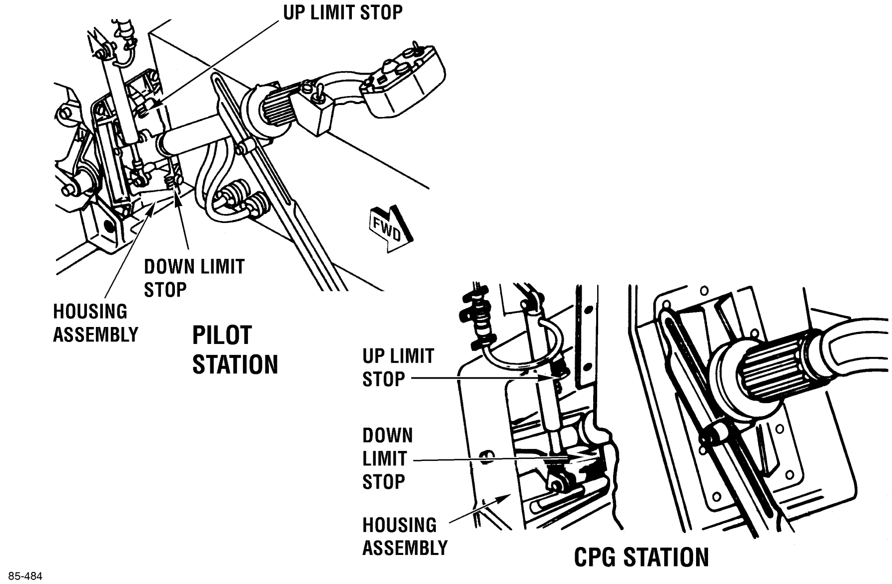
NOTES

A. Rigging the flight control subsystem mechanical stops

1. Rigging of the stops in the pilot's and CPG's stations are performed to ensure that the proper amount of travel takes place in the respective servoactuator piston assembly, for induced mechanical input at the servoactuator control arm. The stops in the pilot's and CPG's station must be rigged in the collective, longitudinal, lateral, and directional flight control axis.

2. The flight control subsystem mechanical stops in the pilot's and CPG's stations restrict the amount of full travel motion that can be input through the mechanical flight controls to the servoactuator control arms. The mechanical stops are adjustable to ensure that the proper amount of maximum and minimum servoactuator piston assembly travel is achieved during rigging of the mechanical flight controls.

RIGGING COLLECTIVE STICK MECHANICAL STPS, PILOT AND CPG's STATION



NOTES

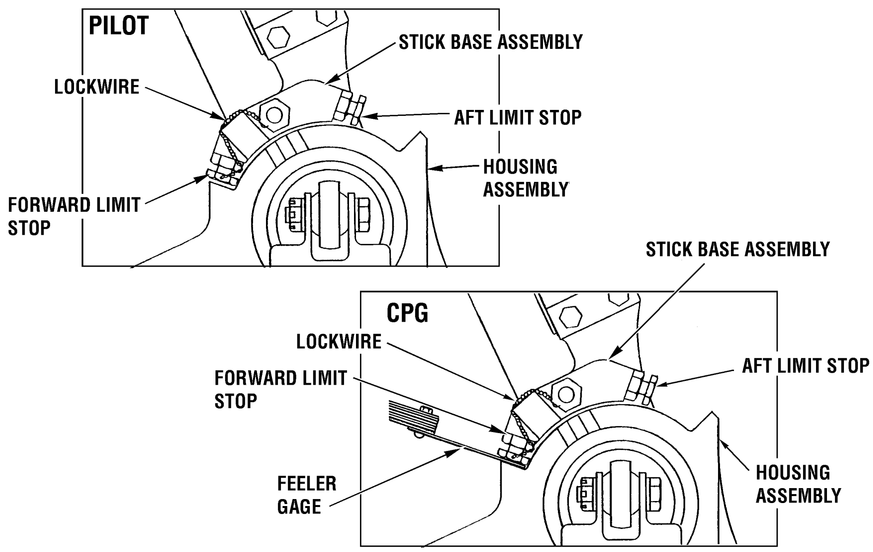
3. The rigging points for the mechanical stops in the flight control subsystems are located in the following areas

   a. Pilot's and CPG's collective stick mechanical stops

      (1) Two stops located in the pilot's collective stick housing assembly at fuselage station 154.8.

      (2) Two stops located in the CPG's collective stick housing assembly at fuselage station 93.7.

RIGGING LONGITUDINAL CYCLIC STICK MECHANICAL STOPS, PILOT AND CPG's STATION



85-482

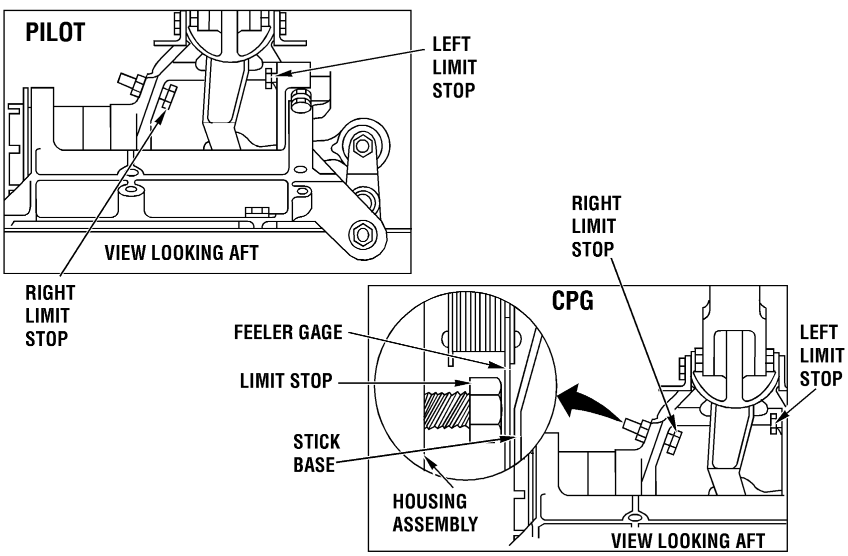
NOTES

b. Pilot's and CPG's longitudinal cyclic stick mechanical stops

(1) Two stops located in the pilot's cyclic stick housing assembly, fuselage station 128.7 at the stick base.

(2) Two stops located in the CPG's cyclic stick housing assembly, fuselage station 68.0 at the stick base.

RIGGING LATERAL CYCLIC STICK MECHANICAL STOPS, PILOT AND CPG's STATION



85-481

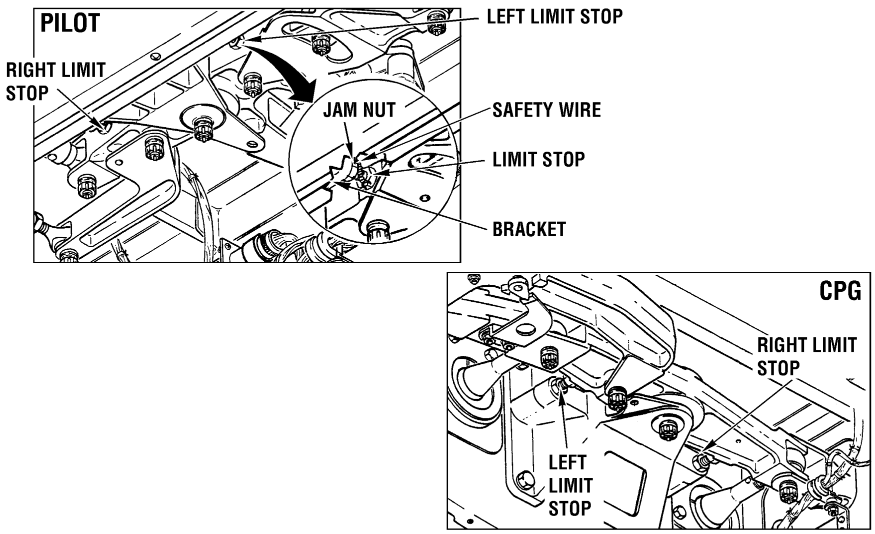
NOTES

c. Pilot's and CPG's lateral cyclic stick mechanical stops

(1) Two stops located inside the pilot's cyclic stick housing assembly, fuselage station 128.7, to the left and right hand side of the housing.

(2) Two stops located inside the CPG's cyclic stick housing assembly, fuselage station 68.0, to the left and right side of the housing.

RIGGING DIRECTIONAL CONTROL PEDAL MECHANICAL STOPS, PILOT AND CPG's STATION



85-480

NOTES

d. Pilot's and CPG's directional control pedals mechanical stops

(1) Two stops located on the pilot's directional SPAD assembly support housing at fuselage station 116.0.

(2) Two stops located on the CPG's directional SPAD assembly support housing at fuselage station 59.0.

WARNING

CONTROL MOVEMENT

Maintenance personnel must be warned verbally prior to moving the collective, cyclic sticks or directional pedals. Any control activated can result in sudden blade movement that can sever or crush fingers or hands.

CAUTION

HYDRAULIC POWER

If controls bind, check problem prior to continuing procedure. Failure to clear controls of binding may result in sheared pins in the control axis.

WARNING

SERVOCYLINDER ROD END ADJUSTMENT

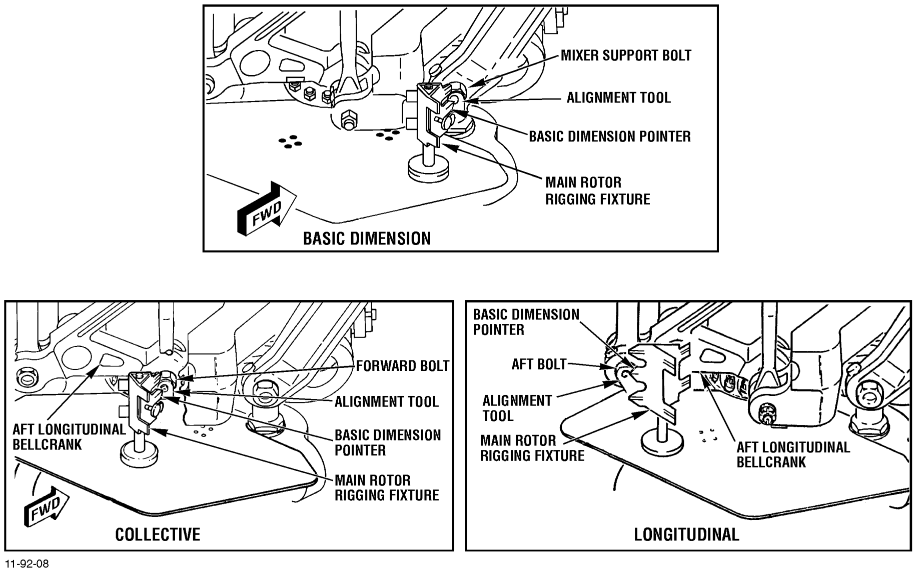
To provide enough thread engagement to maintain safe flight, the distance between center of the rod end and end of the servocylinder piston must not exceed 3.06 inches.

CAUTION

SERVOCYLINDER ROD END ADJUSTMENT

Top prevent breakdown of cylinder piston rigs, rotation of piston is limited to 90 DEGREES during rigging and installation. Adjustments are made by turning rod end, not piston.

MIXER ASSEMBLY RIGGING, LEVEL SWASHPLATE (1), COLLECTIVE AND LONGITUDINAL FLIGHT CONTROL SUBSYSTEMS



NOTES

A. The mixer assembly must be rigged in the following planes of reference to ensure proper operation of the collective, longitudinal, and lateral subsystems

1. Level swashplate, collective and longitudinal

a. The starting point for setting collective and longitudinal level swashplate is the basic dimension which is obtained at the mixer support assembly bolt head.

b. Rig pins must be installed in the respective FS 165 bellcranks level swashplate rig pin holes (Collective level swashplate rig pin hole is the same as mid-position).

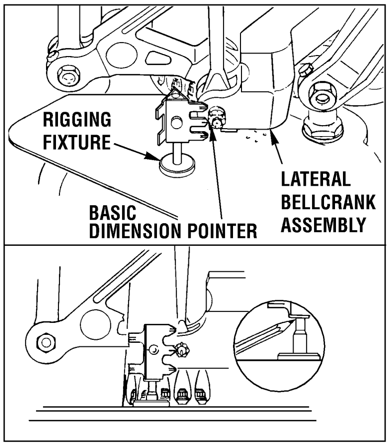
c. The basic dimension pointer of the main rotor rigging fixture is adjusted to the center of the mixer support assembly bolt head to obtain the basic dimension.

d. All adjustments for level swashplate are made at the servoactuator rod end (piston assembly) for the respective flight control subsystem.

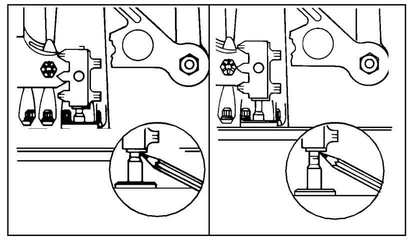
e. The collective servoactuator rod end must be adjusted until the center of the forward bolt of the aft longitudinal bellcrank is aligned with the basic dimension pointer of the main rotor rigging fixture.

f. The longitudinal servoactuator rod end must be adjusted until the center of the aft bolt in the aft longitudinal bellcrank is aligned with the basic dimension pointer of the main rotor rigging fixture.

MIXER ASSEMBLY RIGGING, LEVEL SWASHPLATE (2), LATERAL FLIGHT CONTROL SUBSYSTEM



BASIC DIMENSION/LEVEL SWASHPLATE MEASUREMENT, LATERAL BELLCRANK, RIGHT HAND SIDE



BASIC DIMENSION/LEVEL SWASHPLATE MEASUREMENT, LATERAL BELLCRANK, LEFT HAND SIDE

11-92-09

NOTES

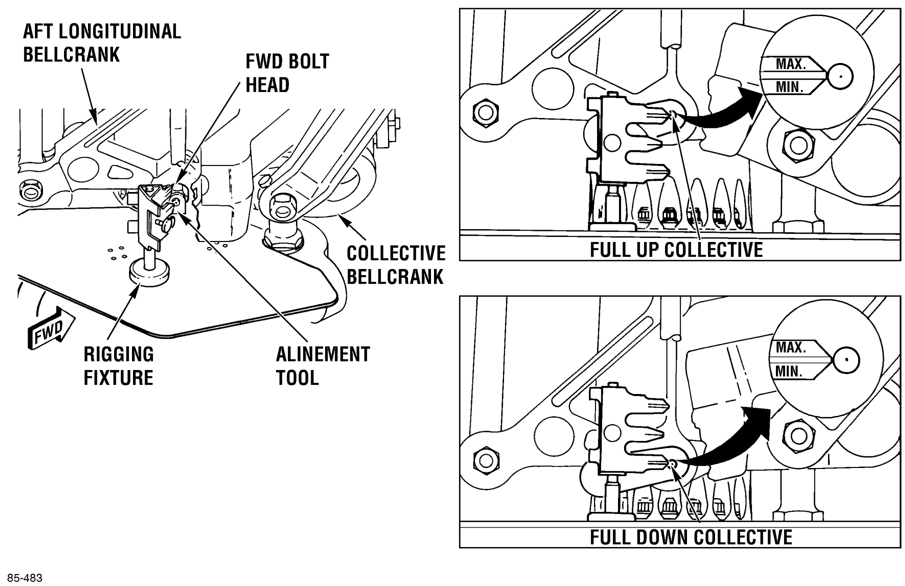
2. Level swashplate, lateral

   a. Adjust the basic dimension pointer of the main rotor rigging fixture to align with the center of the right lateral link to lateral bellcrank attach bolt. Mark the rigging fixture shaft below the pointer with a pencil.

   b. Adjust the basic dimension pointer of the main rotor rigging fixture to align with the center of the left lateral link to lateral bellcrank attach bolt. Mark the rigging fixture shaft below the pointer with a pencil.

   c. Measure the distance between the two pencil marks and divide this dimension by two. Adjust the rigging fixture to this new dimension and adjust the servoactuator rod end until the center of the right and left lateral link to lateral bellcrank attach bolts align with the basic dimension pointer of the main rotor rigging fixture.

MIXER ASSEMBLY RIGGING, FULL TRAVEL, COLLECTIVE FLIGHT CONTROL SUBSYSTEM



NOTES

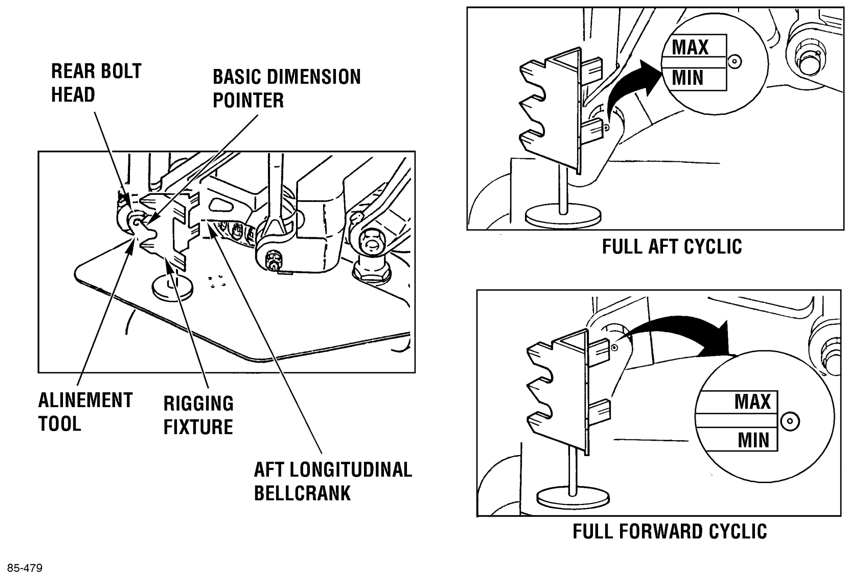
3. Full travel

   a. Must be verified at

      (1) Collective bellcrank assembly for full up and full down collective stick.

      (2) Both the longitudinal and lateral input bellcrank assemblies at fuselage station 165 must have rig pins installed in the level swashplate rigging holes to ensure an accurate measurement.

MIXER ASSEMBLY RIGGING, FULL TRAVEL, LONGITUDINAL FLIGHT CONTROL SUBSYSTEM

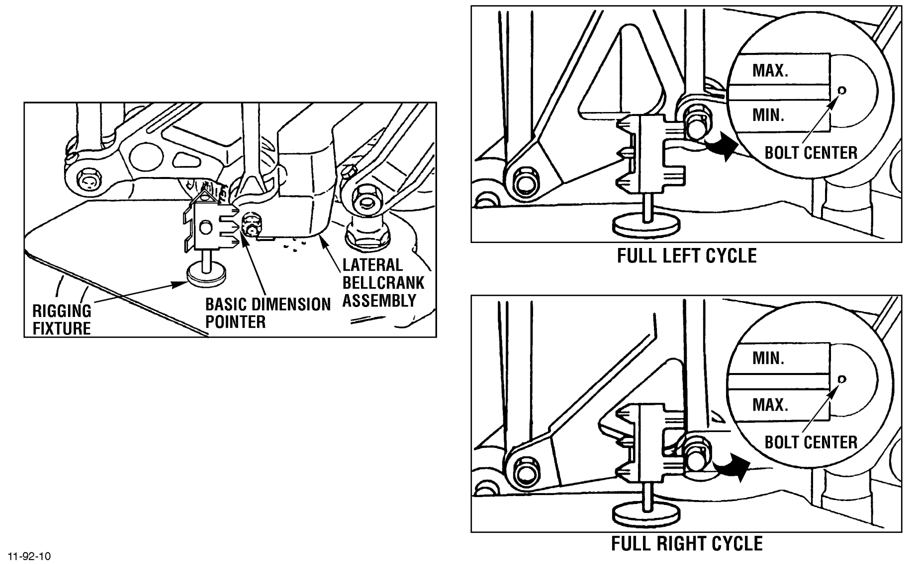


NOTES

4. Longitudinal bellcrank assembly for full forward and aft cyclic stick

   a. Both the collective and lateral input bellcrank assemblies at fuselage station 165 must have rig pins installed in the level swashplate rigging holes to ensure an accurate measurement.

MIXER ASSEMBLY RIGGING, FULL TRAVEL LATERAL FLIGHT CONTROL SUBSYSTEM



NOTES

5. Lateral bellcrank assembly for full left and right cyclic stick

   a. Both the collective and longitudinal input bellcrank assemblies at fuselage station 165 must have rig pins installed in the level swashplate rigging pin holes, to ensure an accurate measurement.

   b. Prior to verifying the full travel measurements on the lateral bellcrank assembly, level swashplate must be checked on both sides of the bellcrank assembly at the lower attachment point of the lateral links with the basic dimension pointer of the mixer assembly rigging fixture. Adjustment for the correction of this dimensional measurement is at the servoactuator rod end.

6. Adjustments of the mixer assembly for full travel are made at the mechanical stops to bring the individual flight control subsystems (collective, longitudinal, and lateral) to operational tolerances with regard to minimum and maximum travel.

WARNING

CONTROL MOVEMENT

Maintenance personnel must be warned verbally prior to moving the collective, cyclic sticks or directional pedals. Any control activated can result in sudden blade movement that can sever or crush fingers or hands.

CAUTION

HYDRAULIC POWER

If controls bind, check problem prior to continuing procedure. Failure to clear controls of binding may result in sheared pins in the control axis.

WARNING

SERVOCYLINDER ROD END ADJUSTMENT

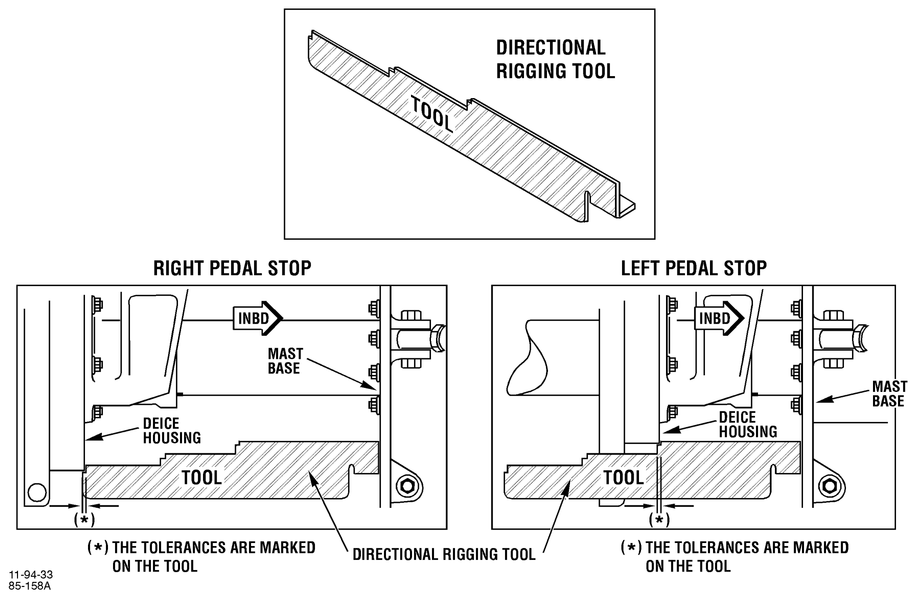
To provide enough thread engagement to maintain safe flight, the distance between center of the rod end and end of the servocylinder piston must not exceed 3.06 inches.

CAUTION

SERVOCYLINDER ROD END ADJUSTMENT

Top prevent breakdown of cylinder piston rigs, rotation of piston is limited to 90 DEGREES during rigging and installation. Adjustments are made by turning rod end, not piston.

DIRECTIONAL UPPER FLIGHT CONTROLS RIGGING



NOTES

A. The directional flight control system must be rigged in the following planes of reference to ensure proper operation

1. Full right pedal

   a. Check the outboard pedal position limitations on the directional rigging tool for measurement of fully extended servoactuator.

2. Full left pedal

   a. Check the inboard pedal position limitations on the directional rigging tool for measurement of a fully retracted servoactuator.

3. Adjustments are made at the directional servoactuator rod end.

4. If an adjustment is made to bring one pedal travel into limits, the opposite pedal travel must be checked for limits after the adjustment has been made.

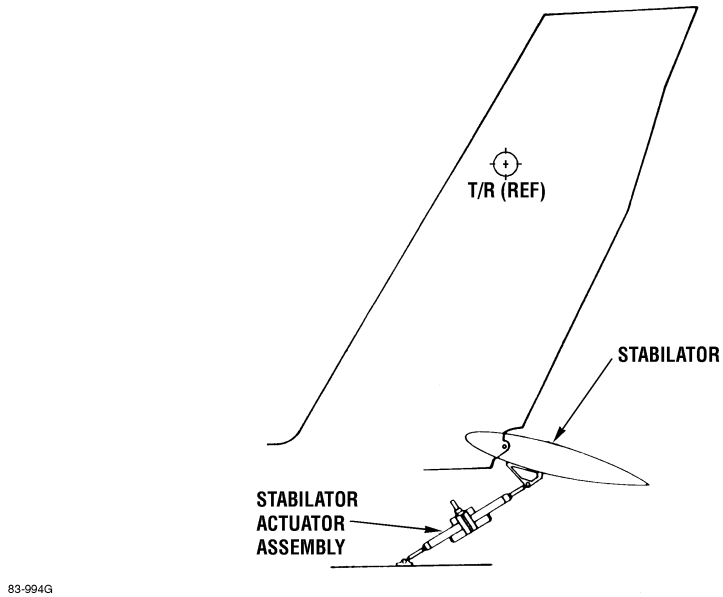
5. If adjusting the rod end will not allow both pedal travel limits to be brought in, the stops in the pilot's station should be re-checked and adjusted as necessary.

WARNING

CONTROL MOVEMENT

Maintenance personnel must be warned verbally prior to moving the collective, cyclic sticks or directional pedals. Any control activated can result in sudden blade movement that can sever or crush fingers or hands.

HORIZONTAL STABILATOR RIGGING



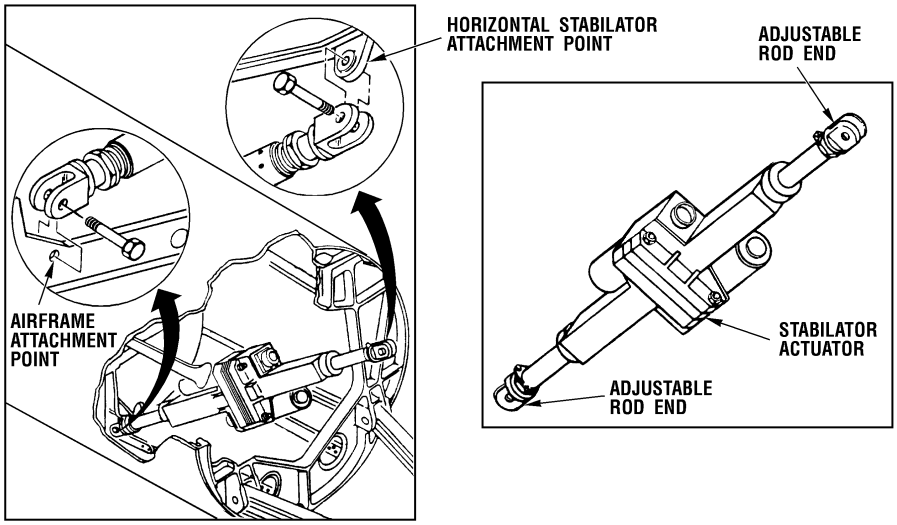
NOTES

A. Mechanical rigging of the horizontal stabilator

1. To ensure proper operation of the horizontal stabilator in both the automatic and manual modes.

2. There are two major components that require rigging in the horizontal stabilator control subsystem

HORIZONTAL STABILATOR ACTUATOR ASSEMBLY

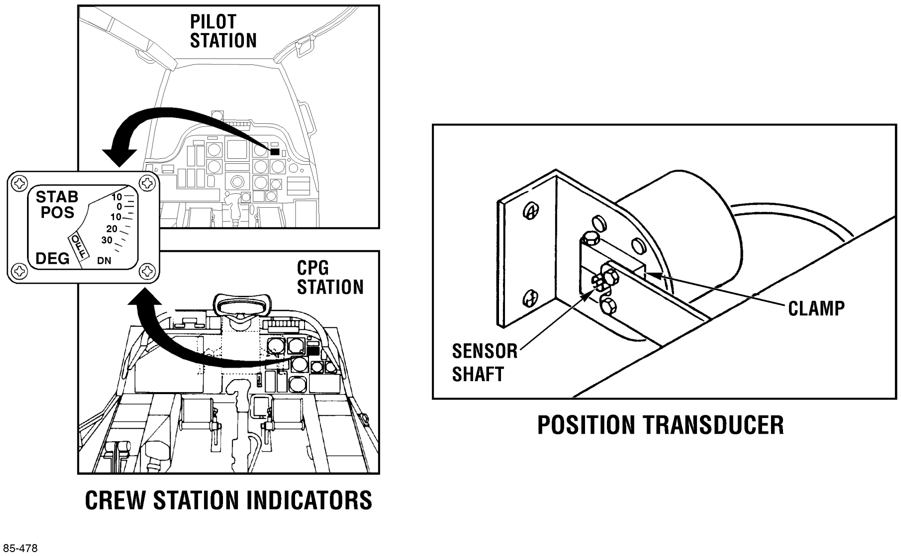


85-503

NOTES

a. The horizontal stabilator actuator adjustable rod end assemblies (2).

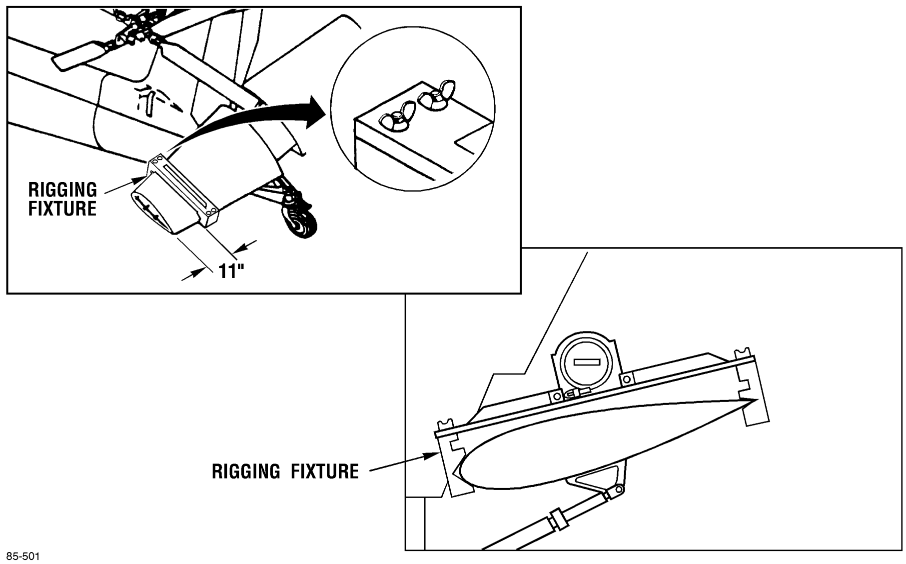
HORIZONTAL STABILATOR POSITION TRANSDUCER



NOTES

b. The horizontal stabilator position transducer.

STABILATOR RIGGING KIT (1)



NOTES

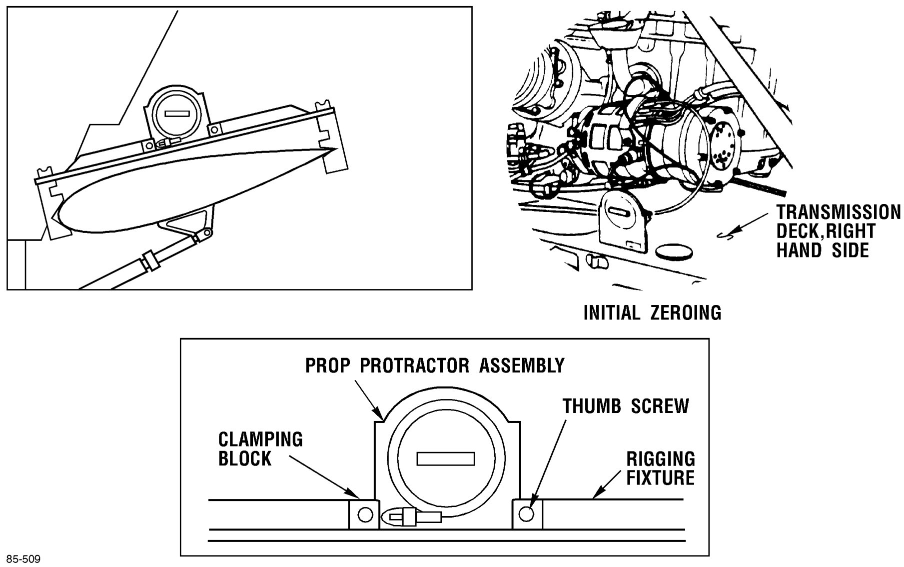
3. The stabilator rigging kit consists of

   a. Stabilator rigging fixture

      (1) Mounts to the horizontal stabilator for obtaining a flat surface for an accurate degree measurement with regard to trailing edge up and trailing edge down.

      (2) Provides a mounting point for the use of a prop protractor assembly.

STABILATOR RIGGING KIT (2)

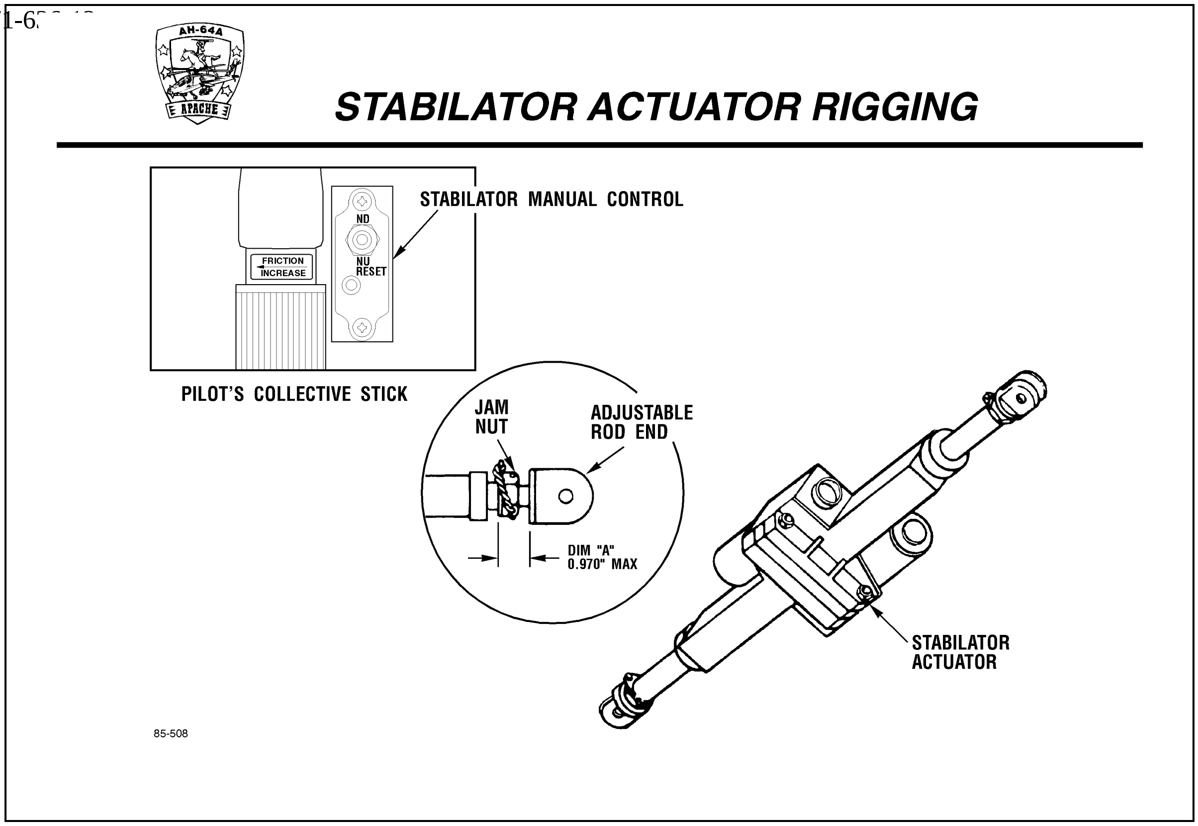


NOTES

b. Prop protractor assembly

(1) Provides the means of determining the angle of attack of the horizontal stabilator during rigging adjustment of the stabilator actuator assembly. Also provides for verification of the crewstation indicators and adjustment of the position transducer.

(2) Initial zeroing of the prop protractor is made at the main transmission deck for airframe plane of reference.


AH-64A
APACHE
STABILATOR ACTUATOR RIGGING
STABILATOR MANUAL CONTROL
ND
FRICTION
INCREASE
NU
RESET
PILOT'S COLLECTIVE STICK
JAM
NUT
ADJUSTABLE
ROD END
DIM "A"
0.970" MAX
STABILATOR
ACTUATOR
85-508

NOTES

4. Stabilator Actuator Rigging

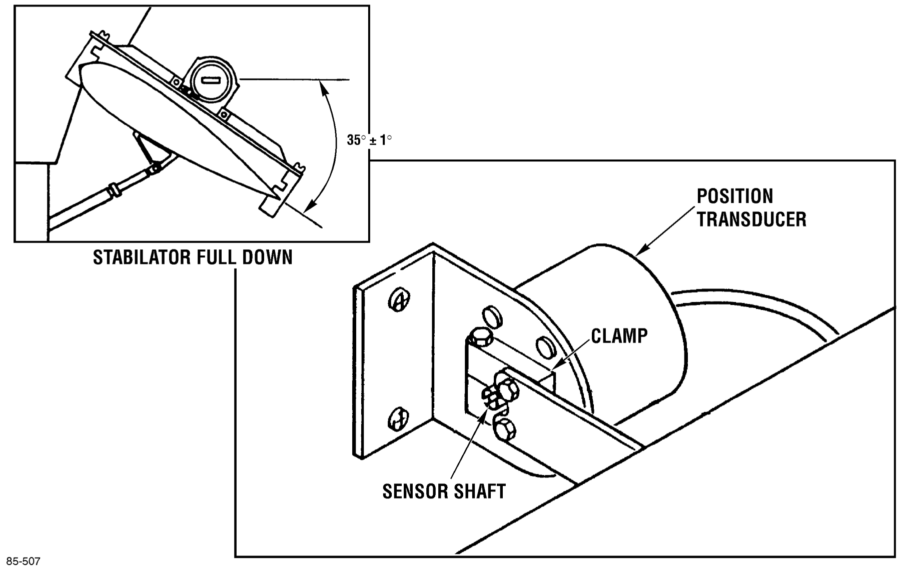
a. The stabilator actuator has two adjustable rod ends, one at either end of the actuator assembly. Adjustment of the rod end consists of the following

(1) The rod ends are adjusted an equal amount of turns to achieve the proper degree of horizontal stabilator trailing edge up or down.

(2) Rod ends are adjusted in 1/2-turn increments and cannot exceed 0.970 inch (.246 centimeter) maximum measurement for dimension A.

b. The stabilator manual control switch is used to program the stabilator to various positions during the rigging procedure.

STABILATOR POSITION TRANSDUCER ADJUSTMENT



NOTES

5. Stabilator Position Transducer Adjustment

a. The stabilator position transducer is adjusted as follows

(1) Adjustment is made with horizontal stabilator trailing edge full down (+35 "2 degrees).

(2) Crewstation indicators are verified for correct indication with stabilator trailing edge full down travel and full up travel (+35 "2 degrees and -9 "2 degrees respectively).

(3) Adjustment is accomplished by loosening the sensor shaft clamp and turning the shaft clockwise or counterclockwise to increase or decrease the signal to acceptable limits.

b. The CPG's indicator must be within two degrees of the pilot's indicator.