Operations Group Chairman Factual Report

Attachment 6 – PC-12 Systems

WPR09MA159

FLIGHT CONTROLS

GENERAL

The flight control system is conventional using push-pull rods and carbon steel cables. Electric trim systems are provided for the aileron, rudder, and elevator. All trim systems can be disconnected in the event of a runaway condition.

An aileron/rudder interconnect system is installed to improve lateral stability and turn coordination. The system operates:

- MSN 101-683. When a turn is initiated with the flaps extended
- MSN 684 & UP. Permanently active regardless of the flap position

When the pilot initiates a turn by giving a roll control input, the spring package in the interconnect systems applies a force to the rudder cables that tends to deflect the rudder in the direction of the turn. Alternatively, when the pilot gives a yaw control input by pushing one of the rudder pedals, the spring package applies a force to the aileron control system which tends to roll the aircraft in the direction of turn.

AILERON

The ailerons are connected to the cockpit control wheels by control cables in the fuselage and push-pull rods in the wings. Each aileron is attached to the wing at two hinge points. Each aileron is equipped with a minimum of two static wicks to dissipate static charges to the atmosphere.

The left aileron incorporates a trim tab which is electrically operated from the cockpit. Refer to Trim system, this section, for more information. MSN 684 & UP. The left aileron trim tab also acts, together with the geared tab installed on the right aileron, as balance tabs when the ailerons are moved.

ELEVATOR

The elevator is a two piece unit attached to the horizontal stabilizer at a total of five hinge points and is connected to the cockpit control wheel by carbon steel control cables. A down spring is installed in the control circuit to improve longitudinal stability. The elevator is equipped with static wicks to dissipate static charges to the atmosphere.

Pitch trim is provided by positioning the horizontal stabilizer. Refer to Trim system, this section, for more information.

RUDDER

The rudder is a single piece unit attached to the vertical stabilizer at two hinge points and is connected to the cockpit rudder pedals by carbon steel control cables. Both pilot and copilot rudder pedals are adjustable by use of a crank located between each set of rudder pedals. Clockwise rotation of the crank moves the pedals aft. The rudder is equipped with static wicks to dissipate static charges to the atmosphere.

The rudder incorporates a trim tab that is electrically operated from the cockpit. Refer to Trim system, this section, for more information.

TRIM

The aileron, horizontal stabilizer and rudder trim are electrically operated. Aileron and horizontal stabilizer trim operation are controlled by a switch on the outboard horn of each control wheel while rudder trim operation is controlled by a switch located on the Engine Power Control Lever. Prior to selecting pitch and aileron trim press and hold the pitch trim engage switch located on the forward side of each outboard control wheel horn.

Pitch trim is accomplished by an electrically controlled actuator connected to the moveable horizontal stabilizer. The secondary trim motor, installed in the same actuator, is controlled by the autopilot and can also be used as a backup system (alternate stabilizer trim) by the pilot. Alternate pitch trim can be accomplished by pressing the ALTERNATE STAB TRIM switch in the desired direction.

The leading edge of the stabilizer moves down for nose up trim and up for nose down trim. At the root of the leading edge of the left horizontal stabilizer there is a trim range indicator which has markings to show full travel in either direction and a takeoff trim range. During the preflight inspection this external trim indicator should be used to verify cockpit trim position indication.

In the event of uncommanded trim operation, all trim operation can be stopped by pressing the TRIM INTR switch located ahead of the Engine Control Quadrant on the center console.

FLAPS

Each wing trailing edge has a single piece Fowler type flap supported by three flap arms. The flaps are controlled by a selector handle located to the right of the power controls on the center console. The flaps may be set to one of the four preset positions 0°, 15°, 30° and 40° by moving the handle to the appropriate position. If the flap lever is not at one of the four preset positions, the Flap Control and Warning Unit (FCWU) will drive the flaps to the nearest preset position. A flap position indicator is located near the top of the left instrument panel.

The flaps are electrically actuated. There is a single flap Power Drive Unit (PDU) installed below the cabin floor at the rear main frame. It drives screw actuators at the inboard and middle stations through flexible shafts. The screw actuators are connected to the flap actuating arms.

The flap control system incorporates a failure detection system. The system can detect a failure of a flexible shaft by disconnection or jamming, potentially resulting in flap asymmetry or failure of the system to achieve the selected flap position. The system can detect a failure of a single actuator, potentially resulting in single flap panel twisting. If a failure is detected, the FCWU disconnects the power to the PDU and the CAWS FLAPS caution will come on. This condition cannot be reset by pilot action, a landing should be made IAW the EMERGENCY PROCEDURES as maintenance action is required.

A rotation sensor is installed on each of the outer flap screw actuators. These sense the rotation of the flexible shafts and give signals to the FCWU. The FCWU monitors these signals

for asymmetrical flexible shaft rotation of more than 20 rotations (caused by a broken inner flap drive shaft). If failure is detected the FCWU disconnects the power to the PDU and the CAWS FLAPS caution will come on. This condition cannot be reset by pilot action. To detect satisfactory system operation, the FCWU monitors the left sensor for 10 rotations of the flexible shaft in the first 5 seconds (7 seconds with a modified FCWU) of a flap up or down selection. If the selected flap position is not achieved the FCWU disconnects the power to the PDU and the CAWS FLAPS caution will come on.

There are five position sensors in the flap system, one at each center flap actuating arm, one at each inner flap actuating arm and one on the flap position lever, which give signals to the FCWU. The FCWU monitors the signals from the left and right flap sensors for flap asymmetry (caused by a broken inner flap drive shaft). If an asymmetry of 5° is sensed, power to the PDU is disconnected and the CAWS FLAPS caution will come on. The FCWU also monitors the signals from the left and right flap sensors for twisting of the left or right flap (caused by a broken outer flap drive shaft or unequal movement of the flap screw actuators). If a failure is detected, the FCWU disconnects the power to the PDU and the CAWS FLAPS caution will come on.

Additionally if flap asymmetry or twist is detected and the flap angle is greater than 2°, the stick pusher will default to a 'safe' mode and the CAWS PUSHER caution will come on 10 seconds later. In the 'safe' mode the stick pusher will operate at approximately 5 kts higher airspeed for the failed flap position.

If the Power Drive Unit (PDU) motor overheats or a stalled motor condition is detected, a signal from the PDU will open the FLAP circuit breaker on the Battery Bus circuit breaker panel. The FCWU then removes the up or down command to the PDU and the CAWS FLAPS caution will come on. After waiting for a period of 5 minutes the FLAP circuit breaker can be reset and normal flap operation resumes. This is the only pilot re-settable failure and cycling the flap circuit breaker if it has not opened will not reset any other failure mode detected.

To avoid an inadvertent flap down command at high speed, flap down enable is disabled when the flap selector handle is in the 0° position.

Flap system operation may be stopped at any time by lifting the switch guard and pressing the INTERRUPT FLAP switch on the center console to INTR. The CAWS FLAPS caution will then come. If the switch is moved back to the NORM position, normal operation will not resume, even if the FCWU does not detect any failures.

A FLAP GROUND RESET switch is installed on the maintenance test panel (right sidewall behind the co-pilot seat). The FLAP GROUND RESET switch is only operational on the ground for maintenance purposes.

INDICATION / WARNING

A three-axis trim position indicator is located on the center console. The triple trim indicator shows a pictorial presentation of the trim position of the aileron trim tab (roll), horizontal stabilizer (pitch) and rudder trim tab (yaw). The triple trim indicator include three white indicator lights, one for each trim axis. When the autopilot activates the autotrim system, the white light for the applicable axis illuminates.

A warble tone at 850 and 854 Hz will sound when a stabilizer trim runaway of the main system is sensed.

The Central Advisory and Warning System (CAWS) annunciator panel includes a STAB TRIM warning light. The illumination of this warning caption will illuminate after 60 seconds when weight is on the wheels and the trim position is unsafe for takeoff. A voice callout “Warning Trim” will also be heard. On start up the voice callout will not be heard until 120 seconds after the engine has reached 50% Ng.

The Central Advisory and Warning System (CAWS) annunciator panel includes a FLAPS caution light. This caution will come on together with an aural gong when the FCWU shuts down the system. If the FCWU detects a flap asymmetry or a twist and the flap angle is greater than 2° it will make the CAWS FLAP caution come on will also make the CAWS PUSHER caution come on 10 seconds after the FLAPS caution, to annunciate the condition. A CAWS voice callout “Flap Asymmetry Detected, Pusher Safe Mode” will also be given. The CAWS FLAP caution will also come on if the FLAP circuit breaker on the Battery Bus circuit breaker panel opens.

A flap position indicator is located on the pilots left instrument panel. The indicator face is marked with the positions 0°, 15°, 30° and 40° and has a red warning caption. Flap position is shown by a pointer which moves in relation to flap movement. The red warning caption and a 1600 Hz aural warning tone interrupted at 5 Hz are activated anytime the airspeed is above the maximum limit for the current flap setting.

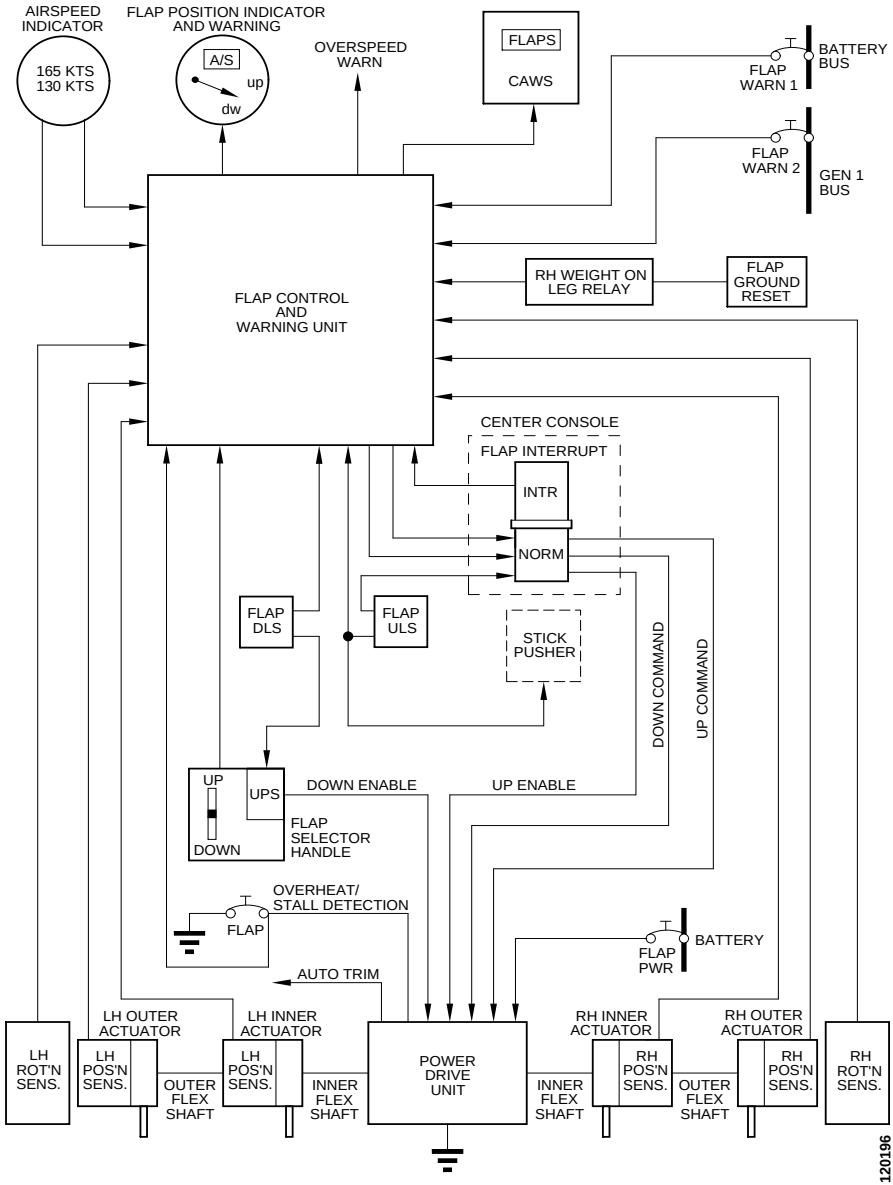


Fig 7-1. Flap System

FUEL

GENERAL

Fuel is contained in two integral wing tanks and is supplied to the engine in excess of that required for all ground and flight operations. Each wing tank contains drain valves. The transfer and delivery of fuel is achieved using a motive flow jet pump system and two engine driven pumps (low pressure pump and the FCU high pressure pump). Electric fuel pumps provide pressure only during the engine start sequence and as a standby function when the normal system cannot maintain adequate pressure. Fuel symmetry is maintained automatically by a Fuel Balancing Device.

Refueling is accomplished using over-wing filler caps. Fuel quantity and fuel flow rate are displayed on the Engine Instrument System (EIS). Electric pump operation, low fuel pressure, and low fuel quantity conditions will be indicated on the Central Advisory and Warning System (CAWS) annunciator panel. In an emergency, fuel flow to the engine can be stopped by pulling the FUEL EMERG SHUT OFF handle, located at the aft end of the center console, left of the airplane centerline.

DESCRIPTION

The fuel storage system includes integral wing tanks, fuel drains, refueling ports, and vents. The main fuel tank is between ribs 6 and 16, forward of the rear and main spars. A collector tank is forward of the main spar between ribs 3 and 6. Fuel drains are located in the lower wing-skins and in the fuel service bay on the left side of the fuselage, left of the nose wheelwell. These fuel drains allow the removal of water and other contaminants during preflight.

Refueling is accomplished through an overwing filler cap located at the outer, upper section of each wing. Each wing has a usable fuel capacity of 201 US gal (761 liters).

The fuel vent bay allows venting of the fuel system through inward and outward vents located on the lower surface of the outer fuel bay.

A check valve is installed in the motive flow line at each collector tank. The check valves stop fuel flow between the left and right wing tanks.

The distribution system transfers fuel from left and right wing tanks and delivers fuel from the collector tanks to the engine fuel control unit. Within the wing tank are electric boost pumps, transfer ejector pumps, and delivery ejector pumps. From the wing tank the fuel flows through a fuel filter, maintenance and firewall shutoff valves, an air separator, a low pressure engine driven pump, an oil/fuel heat exchanger, and a high pressure engine driven pump to the fuel control unit.

OPERATION

During normal operation with the engine running, fuel is transferred from the wings to the engine by a motive flow system. Fuel under pressure from the low pressure engine driven pump is returned to the wings to provide motive flow through the transfer ejector pump and the delivery ejector pump. The transfer ejector pump transfers fuel from the wing tank to the collector tank. The left and right wing delivery ejector pumps transfer fuel to a common manifold. Fuel then flows through the maintenance shutoff valve and the fuel filter. The fuel filter incorporates a bypass valve in case the filter becomes blocked, and a spring loaded drain valve. Fuel is then directed into the air separator. The air separator passes air in the fuel system to the vent return line and incorporates the fuel low pressure switch. The fuel then passes through the firewall shutoff valve to the low pressure engine driven fuel pump. The firewall shutoff valve is mechanically connected to the FUEL EMERG SHUT-OFF handle in the cockpit. The low pressure engine driven fuel pump includes a pressure relief valve that maintains a fuel pump outlet pressure of 43.5 psi (3 bar). A bypass valve allows for fuel flow around the engine driven fuel pump in the event of a fuel pump failure.

An electric boost pump, located within each collector tank, provides fuel pressure during engine start and is used to maintain system pressure when required. Each boost pump LH and RH is controlled by a two position (ON or AUTO) switch located on the FUEL PUMPS section of the overhead panel. When the switch is pressed the system toggles between AUTO and ON an arrow symbol in the switch is annunciated to show which selection is made. When set to ON, the boost pump will operate continuously and a green LFUEL PUMP or RFUEL PUMP caption on the CAWS is illuminated. This indicates that the applicable fuel boost pumps are operating. With the switch set to AUTO (the normal operating setting), the boost pump will operate automatically whenever fuel system pressure falls below 2 psi (0.14 bar). The boost pump will shutoff automatically 10 seconds after the fuel system pressure reaches 3.5 psi (0.24 bar). A boost pump is capable of supplying the engine in case the low pressure pump fails.

Fuel supply greater than engine demand is returned from the fuel control unit to the vent bays.

Refer to Engine Fuel System, this section, for engine fuel supply.

Fuel symmetry is automatically maintained by a Fuel Balancing Device when the Fuel Pump switches are set to AUTO. Left and right fuel quantities are monitored to detect fuel asymmetry exceeding 5% of each wing total fuel capacity (approximately 10.5 US gallons, 2 LCD segments) and will activate the fuel boost pump in the tank with the higher quantity. Fuel booster pump activation is delayed one minute to avoid pump cycling during flight in turbulence. The fuel boost pump will continue to operate until the left and right fuel levels are sensed to be equal. Automatic activation of the fuel boost pumps will only occur when the condition lever is out of the CUT-OFF position. To cater for refueling errors, up to 40 gallons (150 liters), up to 6 LCD segments will be automatically handled by the automatic fuel balance system. In the event of a system failure, the fuel load symmetry can be maintained by manually selecting the Fuel Pump switch to ON for the fuel tank with the higher quantity until a balanced fuel condition is restored and then turning OFF the fuel boost pump. During normal operation the pilot should monitor the fuel quantity gauges to verify that the Fuel Balancing Device is operating properly.

Normal system operation is indicated by the left and right fuel quantity gauges remaining within 2 LCD segments of each other. (When a difference of 3 LCD segments is observed, the fuel boost pump for the tank with the higher quantity should be turned ON until the quantities are even. Monitor the fuel quantity gauges for fuel symmetry for the remainder of the flight.)

INDICATION/WARNING

Each wing tank contains four capacitance type fuel quantity probes that are connected to the EIS.

Power for the fuel analog indications is taken from the BATTERY BUS. Fuel level switches in the collector and main tanks powered from the GEN 1 BUS and BATTERY BUS, cause the CAWS captions to illuminate at low fuel levels. A fuel flow sensor located forward of the FCU sends a signal to the EIS to indicate fuel flow in lbs per hour. The EIS calculates and displays fuel quantity, fuel remaining and endurance. The fuel flow indication requires power from Engine Acquisition Unit. A Fuel Reset switch is used to re-datum the total fuel quantity and fuel used value of the totalizer function after each time fuel is added to the wing tanks. These values are stored in non-volatile memory when power is removed. To reset the totalizer, momentarily press the Fuel Reset switch after engine start. Verify that the fuel quantity indication increases to the new fuel quantity and the fuel used indication is reset to zero. Refer to Engine Instrument System, this section, for additional information.

The CAWS captions that indicate fuel system status are:

L FUEL PUMP, R FUEL PUMP	Indicates fuel boost pump operation.
L FUEL LOW, R FUEL LOW	Indicates fuel level in tank less than 13360 lbs (20 US gal, 75 liters).
FUEL PRESS	Indicates fuel system pressure less than 2 psi (0.14 bar).

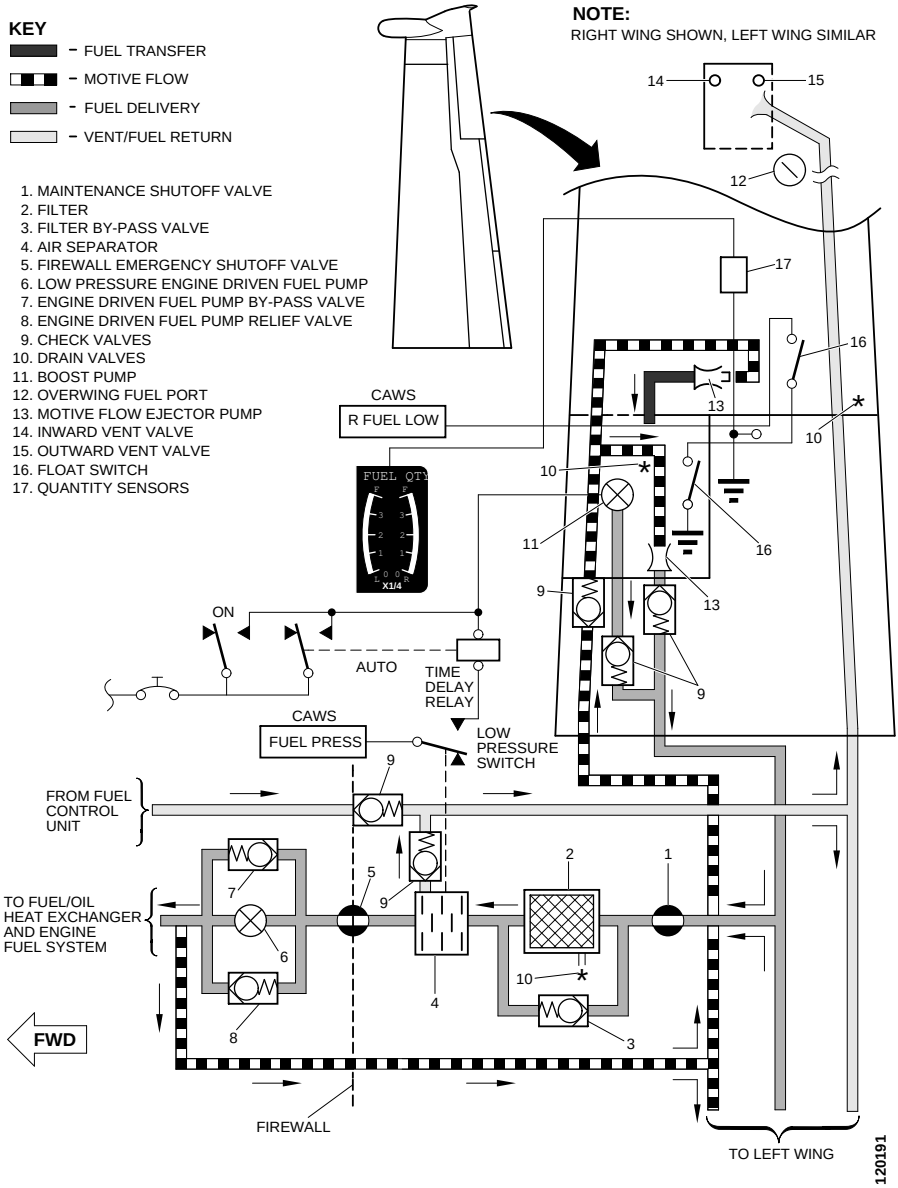


Figure 7-12. Fuel System
(Sheet 1 of 4)

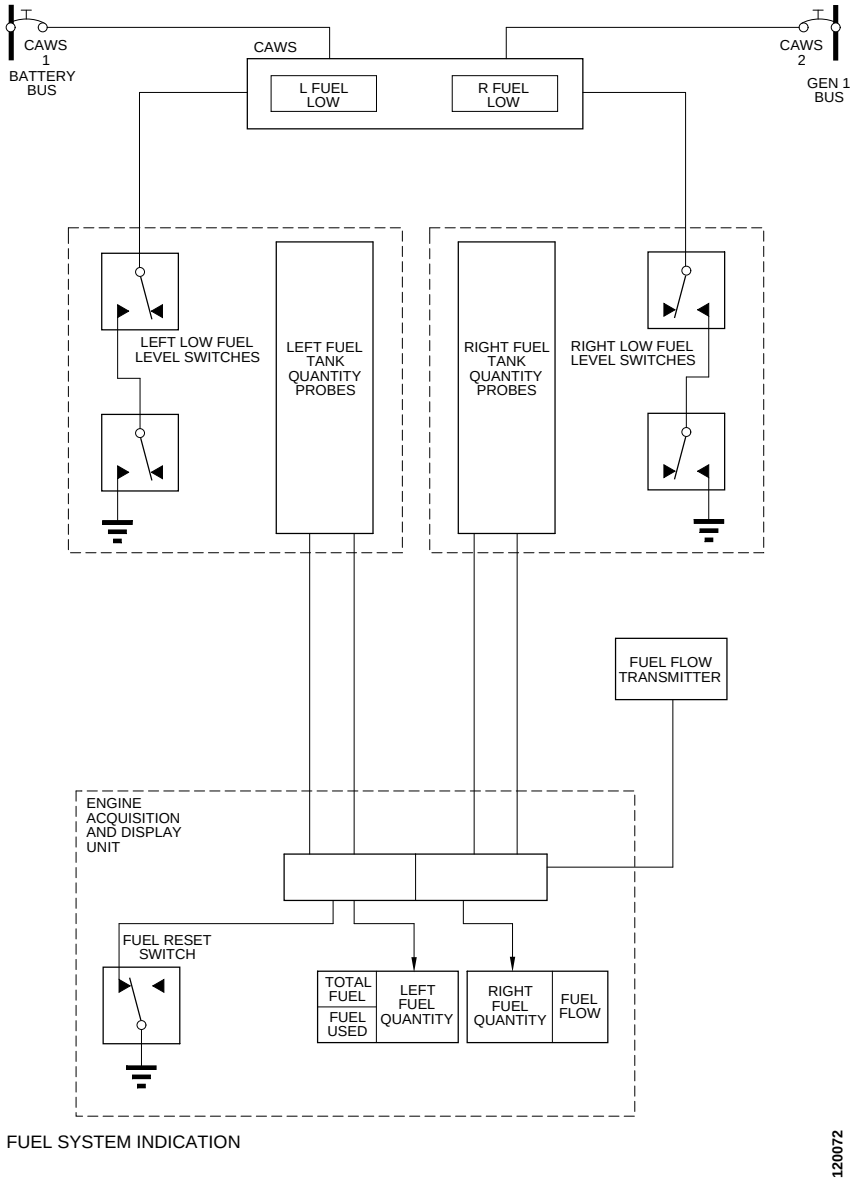


Figure 7-12. Fuel System
(Sheet 2 of 4)

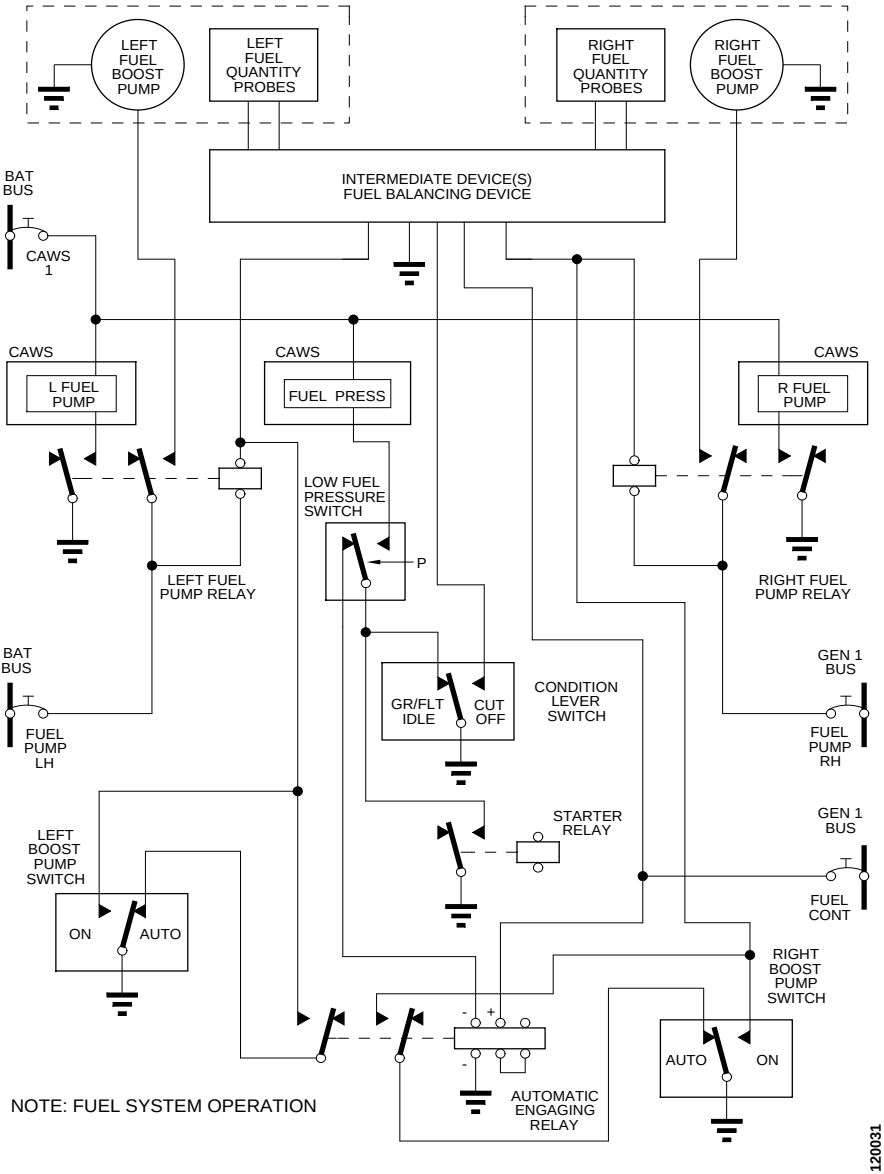


Figure 7-12. Fuel System
(Sheet 3 of 4)

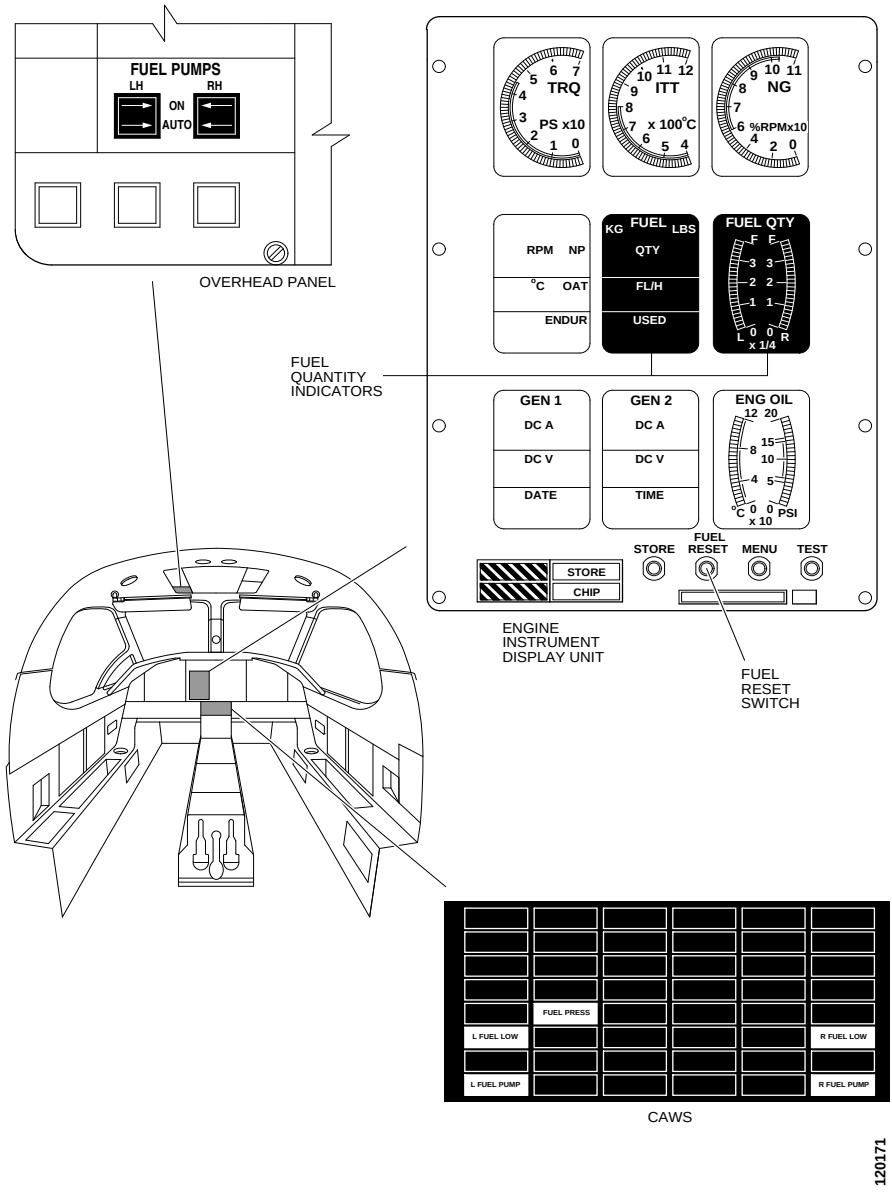


Figure 7-12. Fuel System
(Sheet 4 of 4)

CENTRAL ADVISORY AND WARNING SYSTEM (CAWS)

GENERAL

Refer to Figure 7-18, Central Advisory and Warning System (CAWS), for more information on the warning/caution/advisory lights and voice callouts.

DESCRIPTION

The Central Advisory and Warning System (CAWS) integrates the control and display functions of aircraft systems status into a single unit. The CAWS comprises a Central Advisory Computer Unit (CACU) and a Central Advisory Display Unit (CADU). The CACU is installed under the cabin floor between frames 20 and 21. The CADU is installed in the lower center section of the instrument panel.

The CACU is supplied with 28 VDC from the BAT BUS and the GEN 1 BUS. It monitors the aircraft systems, processes the data and passes the information to the CADU via the serial bus to display the appropriate annunciation. For system failures the CACU generates a voice output or a gong that is sent to the aircraft audio system.

The CADU receives information regarding which annunciator to illuminate from the CACU via the serial bus. The CADU displays 48 individual captioned annunciations. Each annunciator comprises six colored Light Emitting Diodes (LED) connected in parallel covered with a legend panel. The CADU annuciators indicate warning, caution, and advisory conditions.

A warning light is red and indicates a condition that requires an immediate corrective action by the pilot. It is accompanied by a voice callout and the master WARNING light will come on.

A caution light is amber and indicates a condition that requires a pilots attention but not an immediate reaction. It is accompanied by the master CAUTION light coming on and an aural gong will sound.

An advisory light is green and indicates that a system is in operation.

Red master WARNING and amber master CAUTION lights are positioned on the instrument panel directly in front of the pilot and copilot. They alert the crew to changes in status of the CADU annunciators. Any condition that causes a red or amber annunciator to come on also causes the applicable master WARNING or CAUTION light to come on. A voice callout will sound through the overhead speaker and/or headset(s) anytime a master WARNING light comes on. Pushing the applicable master WARNING or CAUTION light will extinguish that light. The CADU warning or caution annunciator that triggered the master WARNING or CAUTION light will remain on.

OPERATION

The CAWS must be tested when the aircraft is on the ground before takeoff. Pressing the TEST LAMP switch on the overhead panel will check the system and make all the annunciator LED's and the master WARNING and CAUTION lights illuminate. Pressing the TEST LAMP switch in the air will only make all the CAWS annunciator LED's illuminate.

The voice callouts from the CAWS are inhibited until 60 seconds after the engine start cycle has reached 50% Ng.

The CAWS continuously checks the communication between the CACU and CADU. In the event of a communication error the master CAUTION light will illuminate and the CAWS FAIL amber caption will come on.

The voice messages, the warnings voice callouts and the cautions have been given a priority status. The purpose of the priority status is that during an active voice callout any new incoming signals are held in a queuing system based on the following priorities.

If an EGPWS is installed it will send a suppression signal to inhibit the voice callouts of the CAWS and the TCAS (if installed) when it is sending voice messages to the flight crew.

If a TCAS is installed its voice messages will be delivered to the flight crew after EGPWS and CAWS voice messages.

WARNING / CAUTION AND ADVISORY INDICATIONS

Caption	Color	Voice Callout	Description
PASS DOOR	Red	Warning Passenger Door	Indicates main entry door and/or handle is not locked.
CAR DOOR	Red	Warning Cargo Door	Indicates cargo door and/or handle is not locked.
CAB PRESS	Red	Warning Cabin Pressure	Indicates cabin altitude above 10,700 ft. or if the maximum pressure differential is exceeded.
AIR/GND	Red	Warning Air Ground	Indicates a disparity between LH and RH AIR/GND switch inputs to the Stick Pusher computers.
PROP LOW P	Red	Warning Prop Pitch	Indicates propeller has gone to a low pitch (below minimum in-flight pitch) with aircraft not on the ground.
A/P TRIM	Red	Warning Autopilot Trim	Indicates autopilot and/or auto trim failure.
ESNTL BUS	Red	Warning Essential Bus	Indicates voltage of the Bat, Gen 1, or Gen 2 busses less than 22 VDC.
AV BUS	Red	Warning Avionics Bus	Indicates avionic busbar 1 or 2 voltage less than 22 VDC.
STAB TRIM	Red	Warning trim	Indicates stabilizer trim is unsafe for takeoff (on ground only).
OIL QTY	Red	Warning Oil	Indicates low engine oil quantity (engine not running).
ENG FIRE	Red	Fire Fire Fire	Indicates overtemperature condition and/or possible engine fire.

WARNING / CAUTION AND ADVISORY INDICATIONS (CONT'D)

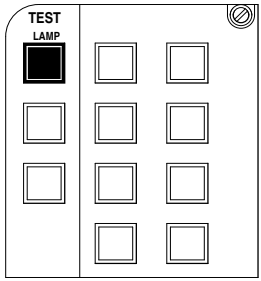
Caption	Color	Voice Callout	Description
GEN 2 OFF	Amber	None	Indicates that generator 2 is off-line.
BUS TIE	Amber	None	Indicates generator 1 bus tie isolation relay is open.
PUSHER	Amber	None	Indicates Stall Warning/Stick Pusher System malfunction.
FIRE DETECT	Amber	None	Indicates a malfunction in the engine fire detection circuit.
GEN 1 OFF	Amber	None	Indicates that generator 1 is off-line.
INVERTER	Amber	None	Indicates inverter output less than 20 VAC.
BAT HOT	Amber	None	Indicates a battery over-temperature or temperature sensor disconnected (inoperative on aircraft with optional lead acid single or dual batteries installed)
FLAPS	Amber	None	Indicates a flap system failure (mechanical or electrical)
FLAPS & PUSHER (10 sec delay)	Amber	Asymmetry Detected, Pusher Safe Mode	Indicates a flap asymmetric condition
CHIP	Amber	None	Indicates metal particles in the engine oil system.
CAWS FAIL	Amber	None	Indicates a CAWS internal failure.
BAT OFF	Amber	None	Indicates a battery is off-line.

WARNING / CAUTION AND ADVISORY INDICATIONS (CONT'D)

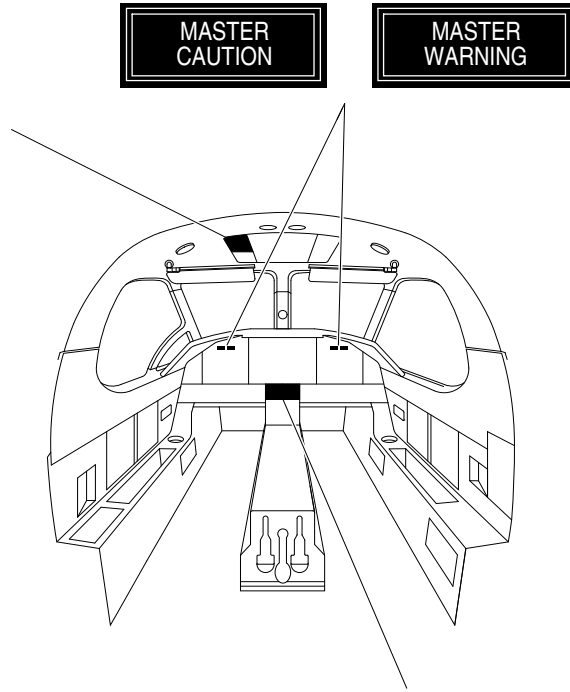
Caption	Color	Voice Callout	Description
FUEL PRESS	Amber	None	Indicates fuel system pressure is less then 2 psi (0.14 bar). Light goes off when fuel system pressure is greater than 3.5 psi (0.24 bar).
HYDR	Amber	None	Continuously illuminated in flight indicates low hydraulic pressure. Continuously illuminated on the ground indicates that the hydraulic pump cycled too often during flight and requires maintenance.
ECS	Amber	None	Indicates Environmental Control System malfunction. Post SB 21-007 and MSN 611 & UP also when the ECS switch is in the OFF position
AOA DE ICE	Amber	None	Indicates AOA deice malfunction or DE ICING PROBES switch set to OFF (3 minute delay).
N ESNTL BUS	Amber	None	Indicates non essential busbar voltage less than 22 VDC.
L FUEL LOW	Amber	None	Indicates fuel quantity in left wing tank has reached 20 US gal (75 liters).
A/P DISENG	Amber	None	Indicates autopilot pitch and aileron servos disengaged.
DE ICE BOOTS	Amber	None	Indicates a pressure sequence failure.
INERT SEP	Amber	None	Indicates an inertial separator door operation failure
STATIC	Amber	None	Indicates a static port heater failure.

WARNING / CAUTION AND ADVISORY INDICATIONS (CONT'D)

Caption	Color	Voice Callout	Description
R FUEL LOW	Amber	None	Indicates fuel quantity in right wing tank has reached 20 US gal (75 liters).
BATTERY	Amber	None	Indicates a battery over voltage or over current condition
OIL QTY	Amber	None	Indicates low engine oil quantity, engine running (not operative)
WSHLD HEAT	Amber	None	Indicates a windshield heating system failure.
PITOT 1	Amber	None	Indicates a pilot pitot head heater failure.
PITOT 2	Amber	None	Indicates a copilot pitot head heater failure.
PROP DE ICE	Amber	None	Indicates a propeller de ice system failure.
L FUEL PUMP	Green	None	Indicates left fuel boost pump is operating.
A/P Trim	Green	None	Indicates autopilot trim is operating.
PUSHER ICE MODE	Green	None	Indicates that the pusher computer is set to ice mode.
DE ICE BOOTS	Green	None	Indicates boots deice operating and pressure sequence correct
PASS OXY	Green	None	Indicates adequate pressure of oxygen to the passenger masks
R FUEL PUMP	Green	None	Indicates right fuel boost pump is operating.



OVERHEAD PANEL



PASS DOOR	CAR DOOR	CAB PRESS	AIR/GND	PROP LOW P	A/P TRIM
ESNTL BUS	AV BUS	STAB TRIM	OIL QTY	ENG FIRE	=
=	GEN 2 OFF	BUS TIE	PUSHER	FIRE DETECT	=
GEN 1 OFF	INVERTER	BAT HOT	FLAPS	CHIP	CAWS FAIL
BAT OFF	FUEL PRESS	HYDR	ECS	AOA DE ICE	N ESNTL BUS
L FUEL LOW	A/P DISENG	DE ICE BOOTS	INERT SEP	STATIC	R FUEL LOW
BATTERY	OIL QTY	WSHLD HEAT	PITOT 1	PITOT 2	PROP DE ICE
L FUEL PUMP	A/P TRIM	PUSHER ICE MODE	DE ICE BOOTS	PAS OXY	R FUEL PUMP

KEY:
RED
AMBER
GREEN

CAWS

120178

Figure 7-18. Central Advisory and Warning System (CAWS) Annunciator Panel

STALL WARNING / STICK PUSHER SYSTEM

GENERAL

The airplane is equipped with a stick shaker-pusher system to improve aircraft handling in the low speed flight regime by preventing the airplane from inadvertently entering a stall condition. The stick shaker-pusher system contains two Angle-of-Attack (AOA) sensors, two computers, a single stick shaker, a single aural warning device and a single stick pusher. The two computers are connected in such a way that either computer can, independently, provide stall warning (stick shaker and aural warning) but both computers are required to actuate the stick pusher.

DESCRIPTION

Refer to Figure 7-20, Stall Warning/Stick Pusher System, for system operation.

The left and right Stick Pusher Computers are each provided power from the Battery and Generator 1 bus. Each computer receives inputs from its respective AOA vane and AIR/GND switch. Both computers receive inputs from the engine torque, flap position, and self test. From these various inputs, each computer independently determines the "Defined Angle of Attack" for stall warning (aural stall warning and stick shaker activation), stick pusher activation, and stick pusher disengagement following an actual push.

The stick pusher, shaker, and the aural stall warning are disabled on the ground through the AIR/GND switches, except for the self test function. The stick pusher is inhibited for 5 seconds after lift-off. The shaker and the aural stall warning are operative immediately after lift-off.

The stick pusher actuator has a built-in g-switch which inhibits the stick-pusher when the airplane's normal acceleration becomes less than 0.5 g. The output torque of the stick-pusher actuator is electronically-limited to have a force of 60 to 65 lbf on the control wheel. A slip-clutch on the stick-pusher capstan allows control on the elevator with a force of 85 to 90 lbf on the control wheel, in the event of stick-pusher jam. The force on the control wheel is defined when the longitudinal control is pulled to 3/4 of its travel. This allows the pilot or copilot to override the stick-pusher in the instance of an inadvertent operation.

Each outboard control wheel horn is equipped with a PUSHER INTR push switch providing a means to quickly disengage the stick pusher actuator in the event of an inadvertent operation.

When operated in PUSHER ICE MODE (to provide protection in icing conditions), all the shaker and pusher actuating points are shifted down by 8° AOA. The pusher ICE mode is set when the propeller de-icing system is switched ON and the inertial separator is set to OPEN. When both pusher computers are set in ICE mode, the green CAWS PUSHER ICE MODE advisory is activated. If only one computer is set in ICE mode, or if no computer is set in ICE mode while conditions for ICE mode are present, the amber PUSHER caution is activated and an aural gong will sound.

The system is provided with a self test function that can be activated at any time by pressing and holding the PUSHER switch located on the TEST section of the overhead panel. The amber PUSHER and green PUSHER ICE MODE annunciator on the CAWS will remain illuminated until the self test is passed.

The system must be tested when the airplane is on the ground before takeoff. The engine must be operating at a minimum of 5 psi torque, the flaps set to 15°, then press and hold the PUSHER test switch to initiate the test. If the test switch is pressed and the test sequence does not occur and/or the PUSHER annunciator remains illuminated, the system has failed the self test and further flight before maintenance is not approved. If the test switch is pressed without the engine operating above 5 psi torque and the flaps are not set to 15°, the PUSHER annunciator will remain illuminated, the aural warning and the test sequence will not occur. The pusher test will not function when the propeller de-ice system is switched on.

The system function may be tested in the air anytime the engine is operating with the flaps at any setting. Press and hold the test switch and observe the following sequence; PUSHER ICE MODE advisory, aural stall warning with stick shaker for 2 seconds followed by a 1 second pause, and aural stall warning with stick shaker for 2 seconds. The pusher will not activate when the system is tested in flight. If the test switch is pushed and the test sequence does not occur and/or the PUSHER caution remains illuminated, the system has failed the self test.

WARNING

STALLS MUST BE AVOIDED WHEN THE STICK PUSHER IS INOPERATIVE. EXCESSIVE WING DROP AND ALTITUDE LOSS MAY RESULT DURING STALL WITH FLAPS DOWN AND/OR WHEN POWER IS APPLIED.

The AOA vanes and mounting plates are electrically heated by internal heating elements. AOA vane and mounting plate heat is controlled by the PROBES switch located on the DE-ICE section of the overhead panel. Refer to Figure 7-20, Stall Warning/Stick Pusher System for system schematic.

OPERATION

The vane attached to the AOA probe aligns itself with the relative airflow. As it moves, it positions a wiper unit in the probe. This wiper unit adjusts the electrical output to its respective pusher computer. As the airplane approaches the artificial stall (5 to 10 knots before pusher actuator), the stick shaker and the aural stall warning will activate when one of the AOA pusher computers senses the defined angle of attack for stall warning/stick shaker activation. If the stall warnings are ignored and the approach to stall is continued, the stick pusher will activate when both AOA pusher computers sense the defined angle of attack for stick pusher activation. The stick shaker and aural stall warning remain active during pusher operation.

Pusher operation will be stopped when either AOA computer senses an angle of attack lower than the angle of attack required to active the pusher or when the airplane acceleration is less than 0.5 g.

Activation of the stick shaker disengages the autopilot if engaged, in order to give full authority to a possible stick pusher activation. The autopilot can be manually reconnected after the angle of attack is reduced and the stick shaker has ceased operation.

WARNING

IF ACCELERATED STALLS ARE PERFORMED IN THE LANDING CONFIGURATION WITH HIGH POWER AND SIDESLIP, A RAPID PITCH-DOWN MAY RESULT WITH AN ALTITUDE LOSS OF UP TO 500 FEET.

INDICATION / WARNING

A digital serial output, from the left hand computer, provides the data for the FAST/SLOW pointer on the EFIS EADI. (Refer to EFIS section for more information).

In the instance of disparity between the LH and RH weight-on-wheels inputs, the Central Advisory and Warning System annunciator AIR/GND and PUSHER are activated to warn the pilot of the malfunction.

The stick pusher computers have an internal-fault monitoring system which will illuminate the CAWS PUSHER annunciator when one of the following events occur:

- a built-in test failure
- a push signal from only one computer that is longer than 3 seconds
- no output torque during a push
- if either of the pilot or copilot DISC switches is pressed
- if the aircraft normal acceleration is below 0.5 g for longer than 3 seconds.

A malfunction in either pusher computer activates the Central Advisory and Warning System annunciator PUSHER to warn the pilot about a system malfunction and the pusher becoming inoperative.

The stick shaker and aural stall warning devices may still be operational if the stick pusher is inoperative.

The CAWS AOA DE ICE caution annunciator will illuminate when a malfunction is sensed in the AOA vane or mounting plate heater circuits (current sensing).

The CAWS PUSHER ICE MODE advisory annunciator will illuminate when the propeller de-ice system is set ON and the inertial separator is set OPEN. In the ICE mode, the shaker and pusher activation points are coming 8° earlier than in the NORMAL mode and the FAST/SLOW pointer is set for a 15° flap landing.

If the Flap Control and Warning Unit detects a flap asymmetry or a twist and the flap angle is greater than 2° it will make the CAWS FLAP caution come on and will send a signal to the stick pusher computers. This will set the stick pusher computers to a ‘safe’ mode irrespective of the actual flap position. The ‘safe’ mode will make the stick pusher operate at approximately 5 kts higher airspeed for the failed flap position. The setting of the stick pusher computers to the ‘safe’ mode will also make the CAWS PUSHER caution come on 10 seconds after the FLAPS caution, to annunciate the condition. A CAWS voice callout “Flap Asymmetry Detected, Pusher Safe Mode” will also be given.

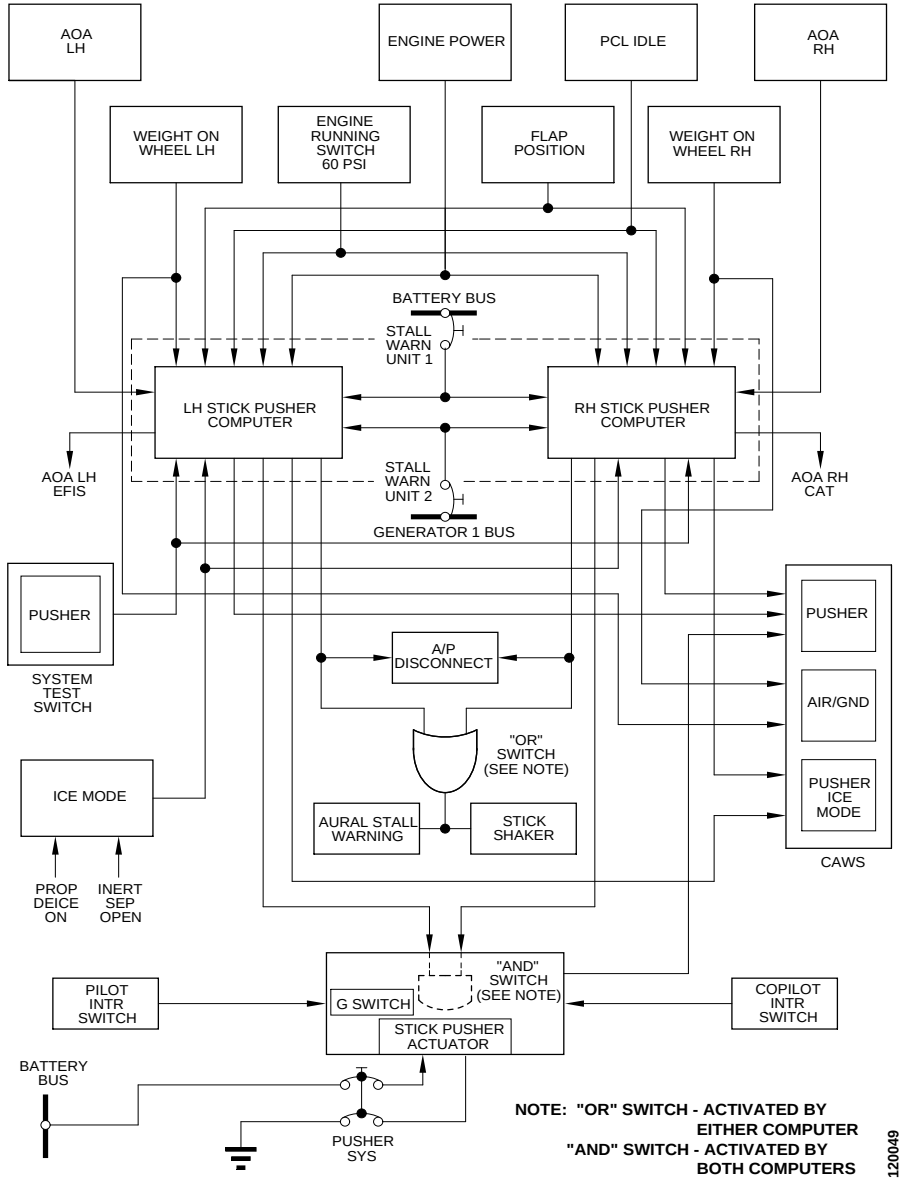


Figure 7-20. Stall Warning/Stick Pusher System
(Sheet 1 of 3)

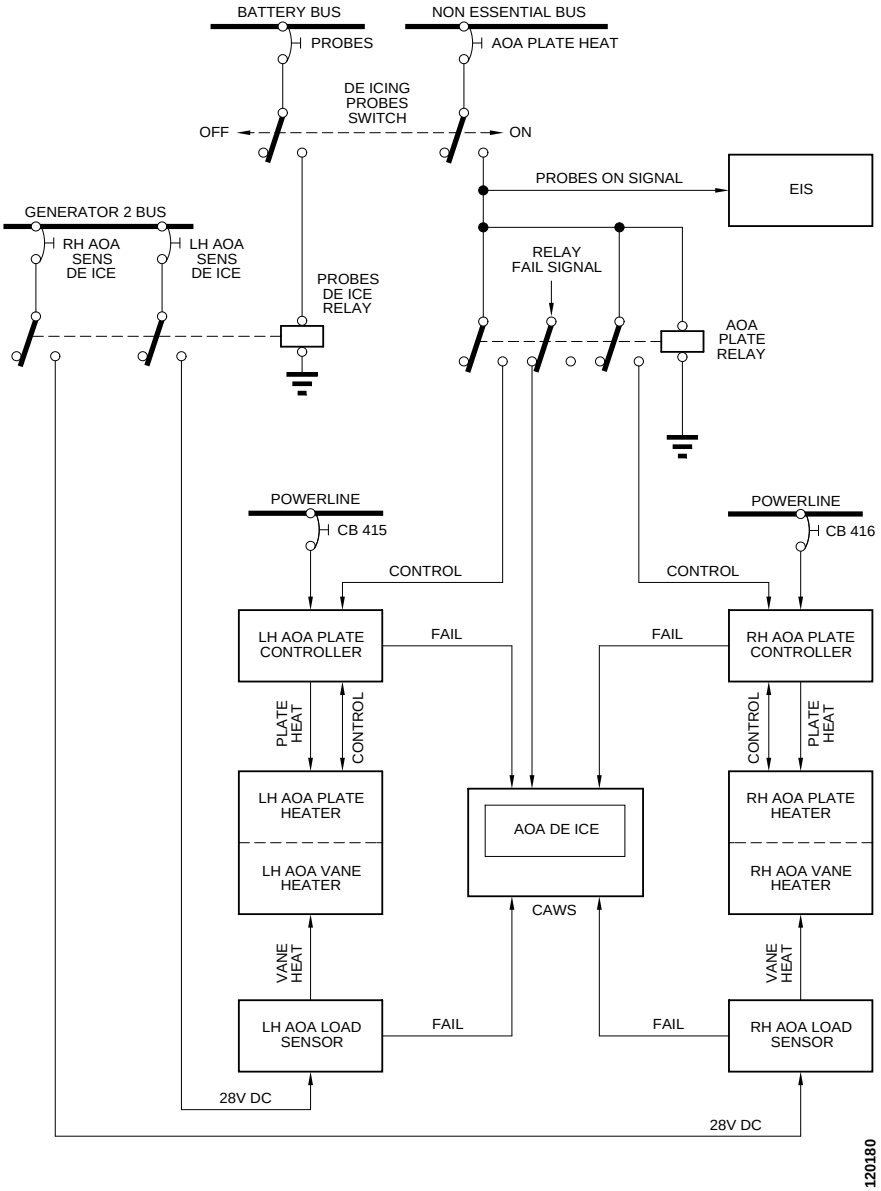


Figure 7-20. Stall Warning/Stick Pusher System
(Sheet 2 of 3)

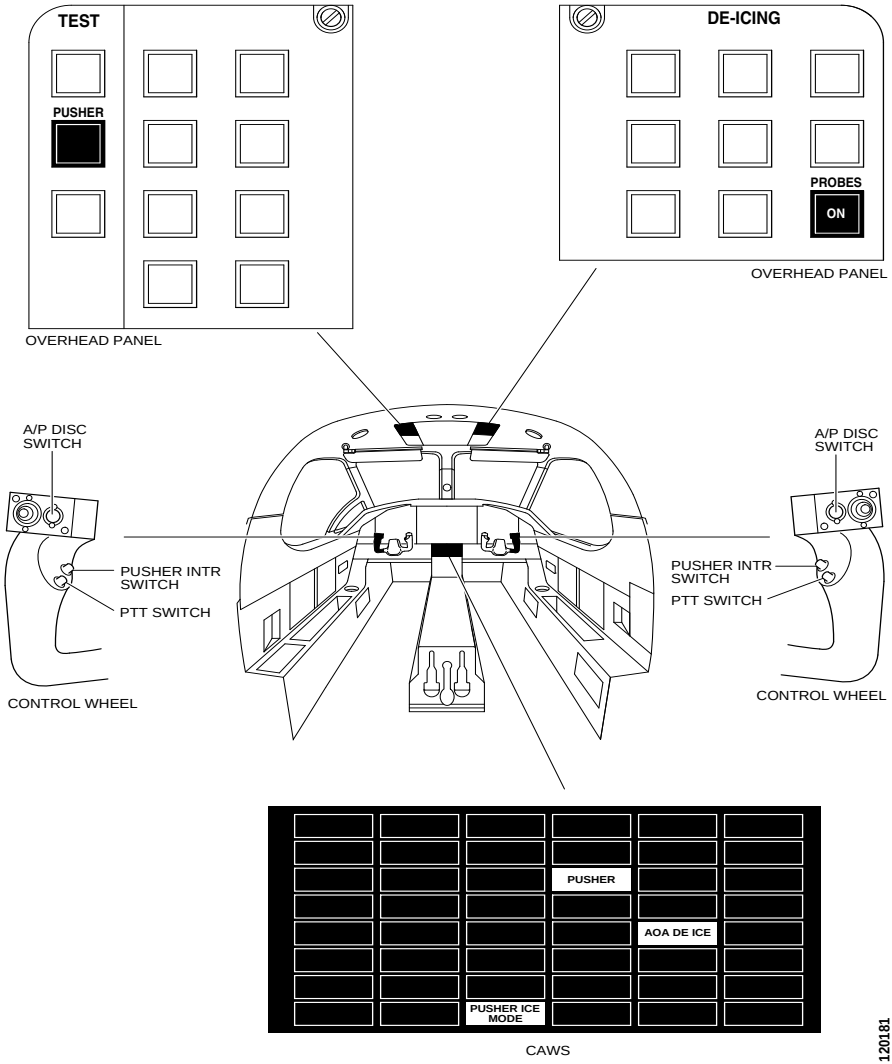


Figure 7-20. Stall Warning/Stick Pusher System
(Sheet 3 of 3)

AUTOPILOT

GENERAL

The autopilot installed in the PC-12 aircraft is the Bendix/King KFC 325 Digital Automatic Flight Control System (AFCS). The limitations presented in Section 2 of this Handbook are pertinent to the operation of the KFC 325 AFCS as installed. The Automatic Flight Control System must be operated within the limitations specified. Refer to the appropriate sections of this Handbook for the Emergency and Normal Procedures associated with this installation.

The KFC 325 Digital AFCS has 3 axis control: pitch, roll and yaw.

The KFC 325 Digital AFCS has an automatic electric pitch trim system which provides pitch autotrim during autopilot operation. When the pitch autotrim function is in operation, a signal is sent to the triple trim indicator to illuminate the pitch trim light (if this version of indicator is installed). The autotrim system is designed to withstand any single inflight malfunction. Trim faults are visually and aurally annunciated.

The KFC 325 Digital AFCS has an automatic rudder trim relief function which provides directional trim during yaw damper and autopilot operation. When the rudder autotrim function is in operation, a signal is sent to the triple trim indicator to illuminate the rudder trim light (if this version of indicator is installed).

No aileron autotrim function is available.

Vertical autopilot functions include Altitude Select and Vertical Speed modes.

A lockout device prevents autopilot engagement until the system has been successfully preflight tested.

DESCRIPTION

MODE CONTROLLER

The KFC 325 AFCS operation is controlled by a KMC 321 Mode Controller located at the top of the center panel. Refer to Figure 7-33, Autopilot Mode Controller. Autopilot mode selection provides the following functions.

HDG:	Alternately engages and disengages the Heading Select mode. Heading information is received from the Heading Bug on the EHSI. Depressing HDG will activate the Flight Director in Heading mode.
NAV:	Alternately engages and disengages the Navigation mode. Depressing NAV will activate the Flight Director. The Flight Director will command tracking of the coupled navigation receiver based on the EHSI selected primary navigation source. Glideslope coupling is inhibited in the NAV mode.

APR: Alternately engages and disengages the Approach mode. Depressing APR will activate the Flight Director. APR mode will capture and track selected EHSI primary navigation sensor with approach accuracy. Glideslope coupling is allowed in the APR Capture or Track mode. BC is automatically engaged and disengaged. Back Course functions identically to the Approach mode except that the autopilot response to the localizer signal is reversed. Glideslope coupling is inhibited in the Back Course Approach mode.

With the EFS 40/50, Back Course is determined from aircraft heading and the Course Pointer. The APR pushbutton activates/deactivates the Back Course mode.

YD: Alternately engages and disengages the Yaw Damper and rudder trim relief independent of the autopilots pitch and roll axes

AP: Alternately engages and disengages the autopilot. Yaw Damp is automatically activated when the autopilot is engaged, however, Yaw Damp remains engaged if AP is pressed again.

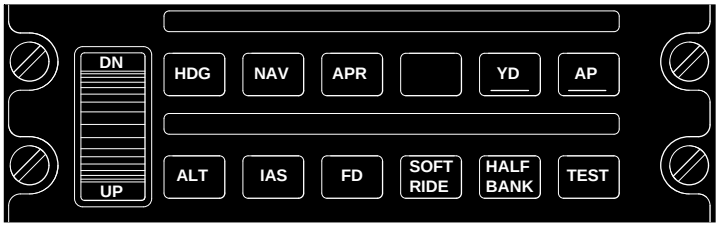
DN/UP: Controls the vertical axis of the autopilot. The rocker switch function is dependent upon the autopilots active mode. Depressing and holding the switch up or down results in the following:

In Pitch Attitude Hold mode the vertical trim switch adjusts the pitch attitude at a rate dependent upon the current airspeed.

In Altitude Hold mode the vertical trim switch adjusts the altitude which the autopilot is holding. Trim control up and down operates at a rate of up to 500 feet per minute. This does not affect the altitude selected and displayed on the Altitude Select.

In Indicated Airspeed Hold mode the vertical trim switch adjusts the indicated airspeed reference at a constant rate of three quarters of a knot per second (0.75 kt/sec).

In Vertical Speed Hold mode the vertical trim switch adjusts the vertical speed at a rate of one hundred feet per minute for each second the switch is held.



ALT: Alternately engages and disengages the Altitude Hold mode. Altitude Hold commands the aircraft to maintain the pressure altitude existing at the moment of selection. The pilot must correct for altimeter changes during flight to insure barometrically corrected altitude.

IAS: Alternately engages and disengages the Indicated Airspeed Hold mode. This mode commands the aircraft to maintain the Indicated Airspeed existing at the moment of selection. The aircraft pitch command is varied by the Flight Director to maintain the selected airspeed during changing air conditions, power and/or configuration changes.

FD: Engages the Flight Director in Pitch Attitude Hold mode and Wings Level mode. The pitch attitude of the Flight Director is synchronized to the current aircraft pitch attitude. Pressing FD when the Flight Director is engaged will disengage all Flight Director modes if the autopilot is not engaged.

SOFT RIDE: Engages the Soft Ride mode. Soft Ride mode decreases the autopilot gains thus decreasing the aggressiveness of the autopilot resulting in a more comfortable ride in turbulent conditions. Routine use of this mode during all flight conditions will result in less than optimum autopilot performance. Soft Ride mode is automatically disengaged when the Approach mode is activated.

HALF BANK: Engages the Half Bank mode. The autopilots maximum commanded bank angle is reduced to one half the normal value. This mode is provided to increase passenger comfort. This mode is automatically disengaged when the Approach mode is activated.

TEST: The Preflight Test Sequence is initiated when this button is momentarily pressed. The test includes illumination of all annunciator lights, testing of rate, acceleration and trim monitors, and testing of the computers internal logic circuits. The AP annunciator will flash for approximately six seconds upon successful completion of the Preflight Test. An aural tone

accompanies the flashing AP annunciation. The Autopilot mode will not be enabled until the Preflight Test has been successfully passed.

ALTITUDE / VERTICAL SPEED PRESELECT

The KAS 297C operation is controlled by a Controller located in the pilot's instrument panel. Refer to Figure 7-35, Altitude / Vertical Speed Preselect Controller. Mode selection provides the following functions.

VERTICAL SPEED / ALTITUDE SELECT KNOB — Concentric knobs allow selection of altitude or vertical speed. The small inner knob has two positions:

- IN - Altitude is displayed. When rotated, the small inner knob selects altitude in 100 foot increments with roll over into the 1000 digits. The large outer knob selects 1000 foot increments with roll over into the 10,000 digits.
- OUT - Vertical Speed is displayed. When rotated, the small inner knob selects vertical speed in 100 feet per minute increments. The large outer knob selects vertical speed in 1000 feet per minute increments up to a maximum of 5000 feet per minute.

ARM — Engages the autopilot Altitude Arm mode when depressed while the selected altitude is displayed. Altitude Select (ARM) mode will cancel the autopilot Altitude Hold (ALT) mode if autopilot Altitude Hold is already engaged. Glideslope coupling will cancel Altitude Select (ARM) mode. The engagement of Altitude Hold by the pilot with the Autopilot Mode Controller will cancel the Altitude Select (ARM) mode. Altitude Select (ARM) mode allows selection of a new altitude without deactivating the ARM.

NOTE

The display of the selected altitude is required to activate the Altitude Select mode. This assures pilot verification of altitude before activation.

ENG — Engages the Vertical Speed Hold mode when depressed while the selected vertical speed is displayed. When depressed with no vertical speed value selected, the Vertical Speed Hold mode is engaged and is synchronized to the current vertical speed of the aircraft. The synchronized vertical speed is momentarily displayed.

OPERATION

AUTOPILOT

Emergency and Normal Procedures are detailed in Sections 3 and 4 of this Handbook.

The following conditions will cause the autopilot to automatically disengage:

Pilot related input

Roll rates in excess of 10° per second will cause the autopilot to disengage except when the CWS switch is held depressed.

Manual trim engage pilot or copilot, FD and operational modes remain engaged.

Alternate trim action.

Activation of Trim Interrupt.

System related input

Power failure.

Internal Flight Control System failure.

Pitch rates in excess of 5° per second will cause the autopilot to disengage except when the CWS switch is held depressed.

Accelerations outside of a +1.6 g to +0.3 g envelope (1.0 g's being normal for straight and level flight). Disengagement will take place regardless of whether or not the CWS switch is activated.

The presence of an EFIS ATT/HDG flag. The flight director will also disengage.

Stall warning (approaching stall condition).

The airplane AVIONICS 2 (AV 2) SWITCH function is unchanged and can be used in an emergency to shut off electrical power to all flight control systems while the problem is isolated.

PITCH LIMITS

IAS mode	+15° -10°
PAH/VS	+20° -10°
APR (GS)	+20° -20°
ALT/ALT CAPT	rate limited

The following circuit breakers are used to protect the following elements of the King KFC 325 Autopilot:

Avionic Bus 2	A/P Disc, A/P Trim Adapter, A/P
26 V AC Bus	A/P (ref voltage only)

ALTITUDE / VERTICAL SPEED PRESELECT

Emergency and Normal Procedures are detailed in Sections 3 and 4 of this Handbook.

CONTROL WHEEL STEERING

Mounted on each inboard control wheel horn is the Control Wheel Steering (CWS) switch. Pressing the CWS pushbutton disengages the autopilot servo clutches and allows manual control of the aircraft. Upon release of the pushbutton, the autopilot clutches re-engage and the autopilot follows the new vertical reference if no lateral or vertical mode was selected or re-track the previous engaged AP mode.

If the Flight Director is not engaged when the CWS pushbutton is depressed, the Flight Director will be activated in the Pitch Attitude and Wings Level Hold mode. The Flight Director command bar will synchronize the aircraft to the attitude present upon pushbutton release. Re-synchronisation is possible by pressing the CWS button again.

AUTOPILOT DISCONNECT

Mounted on each outboard control wheel horn is the Autopilot Disconnect switch. When momentarily pressed, it disengages the autopilot and yaw damper and cancels all operating Flight Director modes. A tone will sound upon successful autopilot disconnect. Automatic pitch trim function is inhibited and the second pitch trim motor reverts to alternate pitch trim function.

MANUAL TRIM ENGAGE

Mounted on each outboard control wheel horn is the manual trim engage switch. When momentarily pressed, it disengages the autopilot but leaves the yaw damper and all selected modes including the flight director engaged. A tone will sound upon successful autopilot disconnect. Rudder trim relief function will be operational as long as the yaw damper is activated.

INDICATION / WARNING

AUTOPILOT

The engaged and armed autopilot modes are annunciated on the Mode Controller and in the upper area of the EADI. Refer to Figure 7-34, Autopilot Mode Annunciations. The following annunciations are illuminated on the Mode Controller (EADI annunciations are shown in Figure 7-34).

HDG:	Illuminates when the Heading Select mode is engaged by depressing the Heading pushbutton.
NAV:	Illuminates when the Navigation mode is engaged by depressing the NAV pushbutton and normally sequenced through NAV ARM. Nav mode can be used with VOR or GPS Navigation sensors.
NAV ARM:	Illuminates when Nav mode is called for by the NAV pushbutton and the course needle deflection exceeds the capture requirements of the Nav mode. While capture requirements (needle displacement and rate of needle displacement) are exceeded, the system will remain in the Arm mode. When the requirement is achieved, the autopilot will capture and track the course needle.
APR:	Illuminates when the Approach mode is engaged by depressing the APR pushbutton and normally sequenced through Approach Arm.
APR ARM:	Illuminates when the Approach mode is called for by the APR pushbutton and the Course Needle exceeds the capture requirements of the Approach mode. Heading mode may be used to intercept the desired course while the autopilot is Approach Armed.
BC:	Illuminates when the Back Course mode is engaged. Back Course automatically activates the Approach Arm/Capture mode and illuminates the respective annunciator.
YD:	Illuminates when the Yaw Damp is engaged by depressing the YD or AP pushbutton.
AP:	Illuminates when the autopilot is engaged by depressing the AP pushbutton.
ALT:	Illuminates when the Altitude Hold mode is engaged by depressing the ALT pushbutton or by automatic sequencing through Altitude Capture when using the KAS 297C Altitude Preselect System.
IAS:	Illuminates when the Airspeed Hold mode is engaged by depressing the IAS pushbutton.

FD: Illuminates when the FD pushbutton is depressed or by default when any Flight Director mode is engaged. The Flight Director mode is Wings Level and Pitch Attitude Hold.

SR: Illuminates when the Soft Ride mode is engaged by depressing the SR pushbutton. Soft Ride mode can be activated only when the autopilot is engaged.

HB: Illuminates when the Half Bank is engaged by depressing the HB pushbutton. Half Bank can only be activated when the autopilot is engaged.

TRIM: Illuminates continuously in the absence of trim power or if the system has not been preflight tested. An audible warning accompanies the annunciator during a trim fault.

NOTE

A flashing mode annunciator indicates a loss of the selected (mode) source or a unreliable source.

EFIS

All armed or captured modes are duplicated in the EFIS EADI display. The following additional autopilot annunciators are presented in the EFIS EADI.

PTRM: (red) Illuminates when the autopilot monitors a pitch trim failure.

ROLL: (yellow) Illuminates when the autopilot monitors an aileron mistrim.

AP: (red) Illuminates when the autopilot monitors a system fault and momentarily flashes on autopilot disengagement.

CAWS

Additional autopilot annunciations are provided on the CAWS panel.

A/P TRIM: (red) Indicates an autoplot and/or auto trim failure. A voice callout “Warning Autopilot Trim” is also heard. Warning is also present prior to successful passing of the autopilot preflight test.

AP DISENG: (amber) Indicates that the autopilot pitch and aileron servo is disengaged. During CWS activation with an engaged autopilot, disengage annunciation is inhibited. A/P DISENG caution is delayed 3 seconds in order to prevent aural warning conflict with the autopilot system. A/P DISENG caution goes off after 30 seconds.

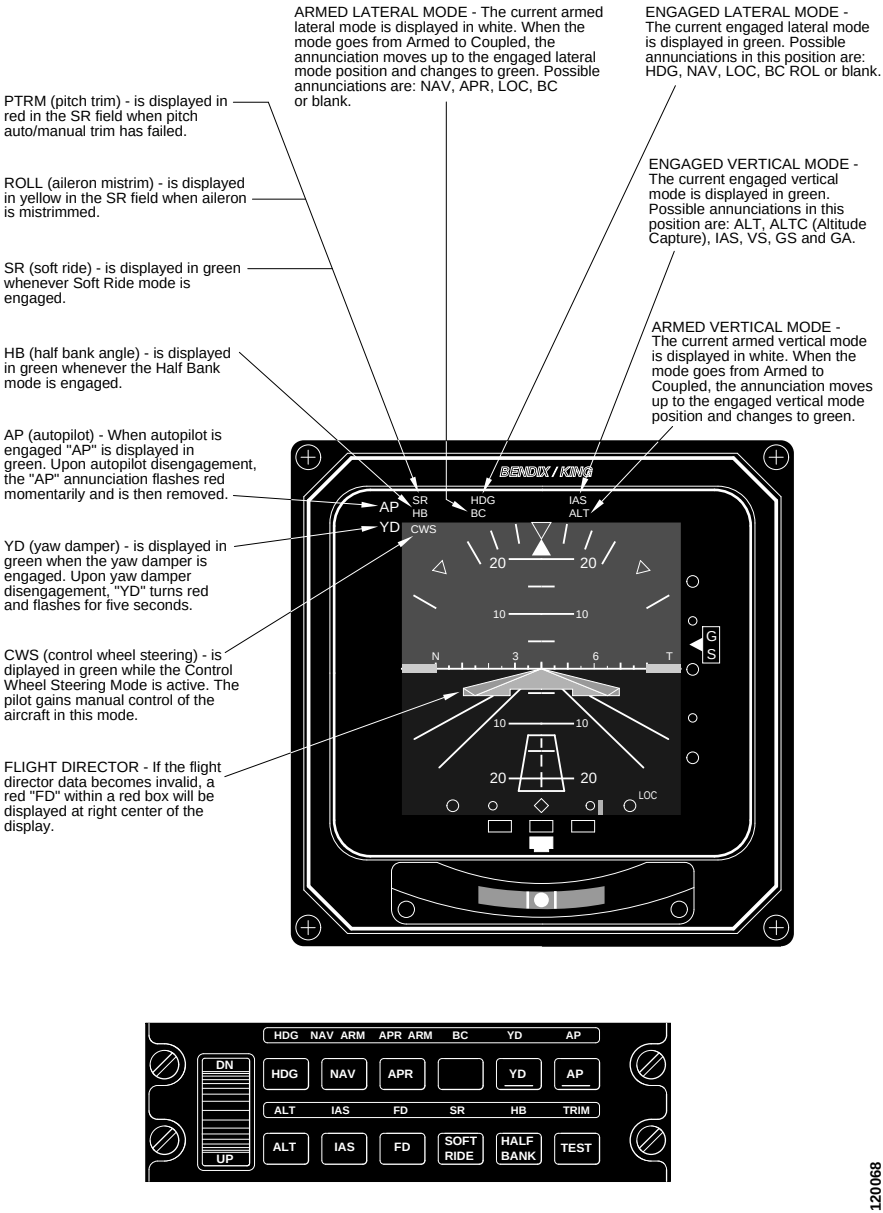


Figure 7-34. Autopilot Mode Annunciations

ALTITUDE / VERTICAL SPEED PRESELECT

The engaged and armed modes are annunciated on the Controller and in the upper area of the EADI. Refer to Figure 7-356, Altitude / Vertical Speed Preselect Annunciations. The following annunciations are illuminated on the Controller (EADI annunciations are shown in Figure 7-345).

VS: Illuminates when the Vertical Speed Hold mode is engaged by depressing the ENG pushbutton.

ALERT: Illuminates 1000 ± 50 feet prior to the selected altitude and extinguishes 200 ± 50 feet prior to the selected altitude. The ALERT annunciator will momentarily illuminate when the selected altitude is reached. Anytime the aircraft is more than 200 ± 50 feet and less than 1000 ± 50 feet from the selected altitude, the annunciator is illuminated. An aural tone accompanies the ALERT annunciator illumination.

ALTITUDE / VERTICAL SPEED: Indicates the selected altitude from 100 to 50,000 feet or the selected vertical speed ranging from zero to 5,000 feet per minute up or down. Altitude is displayed while the small inner selector knob is in the "IN" position. Selected vertical speed is displayed when the small inner selector knob is in the "OUT" position. Rotating the concentric knobs change the selected altitude or vertical speed.

NOTE

Attention is required to determine if the number selected is selected vertical speed or selected altitude, depending on the position of the small concentric knob. However, the display will start to flash after 5 seconds if it is displaying a selected vertical speed.

VERTICAL SPEED UP / DOWN CARET: Indicates whether the selected vertical speed is up or down.

ARM: Indicates that the Altitude Select mode is armed to capture the selected altitude. The ARM pushbutton activates the Altitude Select mode or whenever the adjustment knobs on the KAS 297C are rotated for a new altitude and the autopilot flight director (FD) associated with or without other modes are engaged.

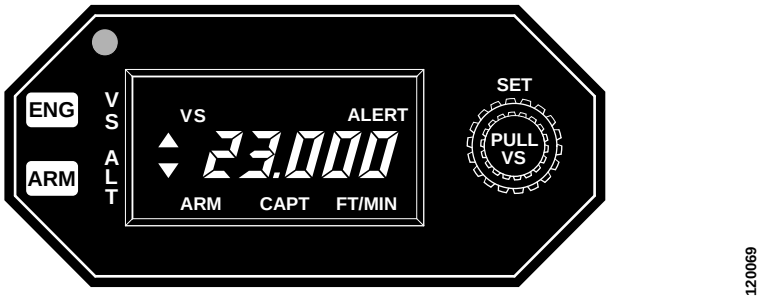


Figure 7-35. Altitude / Vertical Speed Preselect Annunciations

CAPT: Illuminates when the KAS 297C has switched the Flight Director from the active Pitch mode to Altitude Capture (CAPT) mode. The Altitude Capture mode occurs prior to the point the Flight Director engages Altitude Hold. The point at which the Flight Director initiates Capture varies with vertical speed. The higher the rate of altitude change, the sooner Altitude Capture becomes active. At a low rate of altitude change, the activation of the Altitude Capture mode and the transfer to Altitude Hold occur almost simultaneously.

FT / MIN: Indicates FT / MIN when in Vertical Speed mode. Displays FT when in Altitude Hold mode.