INSTRUMENTATION

The Model 560 Excel is equipped with a Primus 1000 Integrated Avionics System which includes display, flight director guidance, autopilot, yaw damper and pitch trim functions. The system consists of the following components:

- IC-600 Integrated Avionics Computer (IAC) that includes:
  - Flight Guidance System (FGS)
  - Electronic Flight Instrument System (EFIS)
- AZ-850 Air Data System (ADS)
- Primus 880 Weather Radar
- Attitude and Heading Reference System

The IAC system is a fail-passive autopilot/flight director and display system that has full complement of horizontal and vertical flight guidance modes. These include all radio guidance modes, long range navigation system tracking modes, and air data vertical modes. Either pilot's flight director (FD) can be coupled to control the airplane.

The IAC is the focal point of information flow in the system. It converts input data and information to the pilot-selected formats, and displays then on the attitude director indicator (ADI) and the horizontal situation indicator (HSI) within the confines of the primary flight display tube(s). The IAC also generates information that is displayed on the multifunction display (MFD), and it computes the flight director steering information for the autopilot function.

The two IACs are connected with high level data link control lines. This and other interconnects are used so that the flight guidance functions and symbol generator functions share, compare, and communicate blocks of information.

When engaged and coupled to the flight director commands, the system's autopilot controls the aircraft using the same commands that are displayed on the attitude director indicator. When the autopilot is engaged and uncoupled from the flight director commands, manual pitch and roll commands can be entered using the touch control steering (TCS) button or the autopilot PITCH wheel and TURN knob.

A secondary flight display is installed, which displays the airplane attitude, altitude, and airspeed, as well as Mach number. All of this information is displayed in one DC powered cathode ray tube instrument, which is powered by its own battery. It receives its data from a small standby air data computer connected to the standby pitot-static system.

A mechanical standby HSI is also installed to provide heading, short range navigation and approach information. It is comprised of a course deviation indicator (CDI or localizer) and a glide slope indicator.

PITOT-STATIC SYSTEMS

The airplane is equipped with three separate and independent pitot-static systems. The two primary systems serve the pilot's and copilot's systems. The third (backup) system provides pitot and static air pressure to the backup airspeed indicator and altimeter indicators in the secondary flight display, and provides a source of static pressure for the cabin pressure differential pressure gauge.

Pitot pressure from the tube on the left side of nose of the airplane supplies pressure to the pilot's AZ-850 micro air data computer which, after converting the data into digital information, forwards the data through the system to the pilot's primary flight display via the IC-600s. Pitot pressure from the tube of the right side of the nose of the airplane serves the same function in the copilot's system.

The pitot tube on the right side of the fuselage, approximately below the copilot's aft window, provides pitot pressure to the backup airspeed indicator/altimeter in the secondary flight display. Three static ports are located on each side of the airplane, approximately at fuselage station 153. The lower port on the left side and the upper port on the right side provide the static source for the pilot's system. The upper port on the left side and the lower port on the right side provide the static source for the copilot's system. The center ports on each side provide static pressure for the backup pitot-static system.

The two pitot tubes and four static ports of the primary pitot-static systems, as well as the two static ports and single pitot tube of the backup system, are electrically heated for ice protection.

AIRSPEED AND ALTIMETER INDICATIONS

Altitude and airspeed data to the primary flight displays (PFDs) is provided by information generated through the AZ-850 micro air data computers, which is transmitted in digital form through the IC-600 Display Guidance Computers to the PFDs. This information is then presented in color on the display in the PFDs. The micro air data computers also generate the altitude information which is used by the mode S (altitude) function of the transponders.

AIRSPEED INDICATION

The indicated airspeed display is to the left of the attitude display on the primary flight display. The display consists of a "rolling digit" window in the center of an airspeed vertical tape. The resolution of the rolling digits is one knot. The moving vertical tape moves behind the window and displays digital airspeed at 20 knot intervals, with the larger numbers at the top of the scale. The range of the airspeed scale is 40 to 450 knots with tick marks at ten knot intervals.

An airspeed trend vector, which displays an indication of the direction and rate of airspeed change, extends vertically from the apex of the current airspeed value display window. It extends upward for acceleration and downward for deceleration. The trend vector represents a prediction of what the airspeed will be in ten seconds if the current change in airspeed is maintained.

PITOT-STATIC SYSTEM SCHEMATIC

A26599

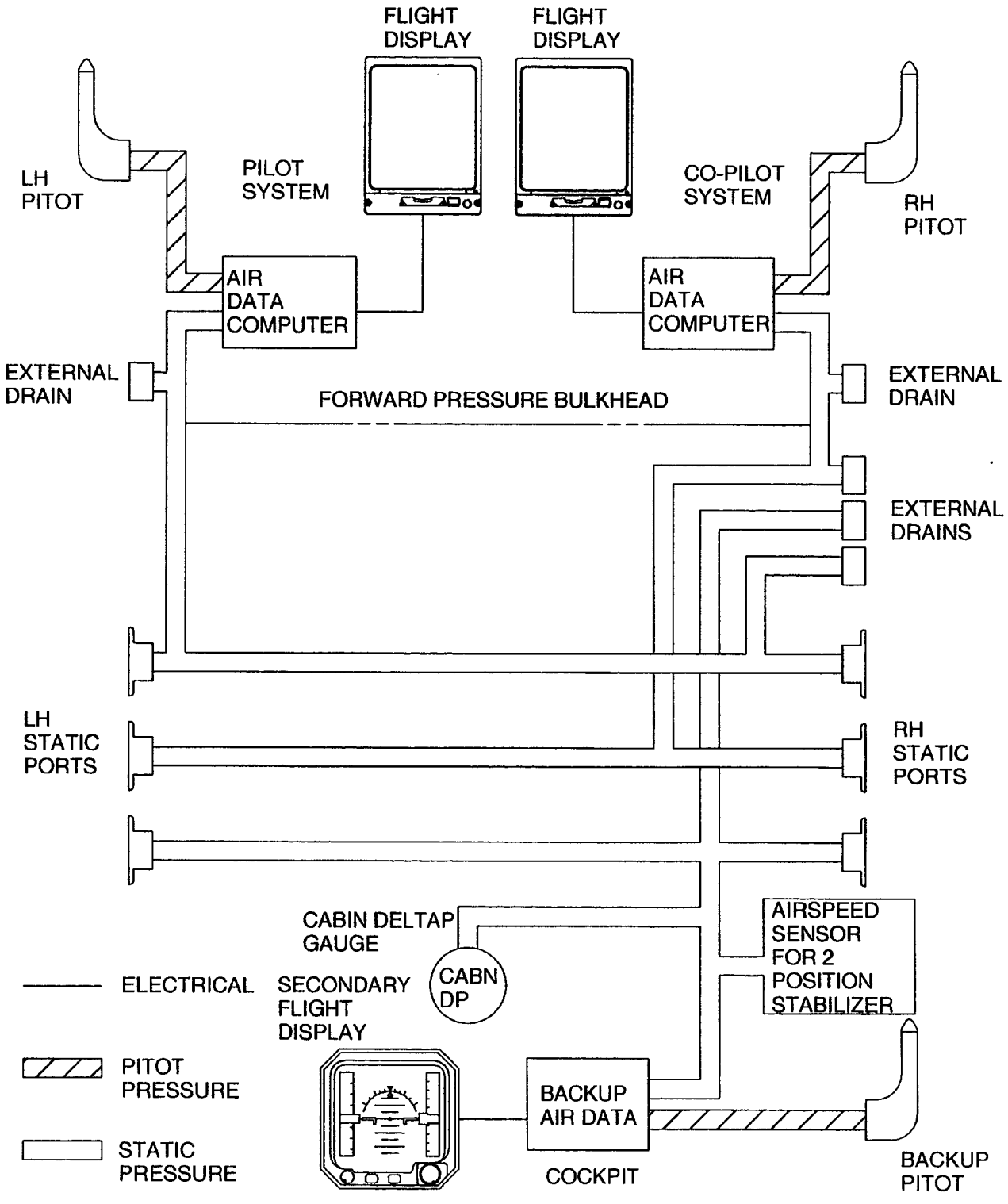


Figure 3-1

"Bugs" for six V-speeds are provided to allow pilots selection of key airspeeds by means of the PFD SET button and bezel knobs. The bugs are labeled 1, (V_1) R (V_R), 2, (V_2) and E (V_{ENR}) (this airspeed is automatically displayed whenever V_1, V_R, or V_2 is selected for display; V_{ENR} is permanently selected to 160 knots) and RF (V_{REF}) and AP (V_{APP}). When the speeds are selected digital indications appear at the bottom of the PFD display as well as the bugs being placed into position. The bugs are positioned on the right outside edge of the airspeed tape. They consist of a horizontal T-shaped symbol with its respective label positioned to the right of the symbol. All the takeoff set bugs will be removed from the display when the airplane airspeed exceeds 230 knots and the landing speed bugs are removed upon touchdown.

When the airspeed is below 40 knots, V_1, V_R, V_2, and V_E are displayed in the bottom portion of the airspeed tape in the form of a digital readout. The digital readout of the set value is displayed along with the bug symbol and are labeled in ascending order, starting with V_1. Upon power up, the digital readouts for the set bugs will be amber dashes. As the V speeds are set, the digital readouts will follow the readout on the PFD and set accordingly. The digital readouts are removed from the display when the first V speed value comes into view on the airspeed tape.

Standby altitude and airspeed are available, in case of main electrical system failure, from the standby altimeter and the standby airspeed indicator, which are located in the secondary flight display. These indicators receive their data from a standby micro air data computer (MADC). The standby MADC, powered by its own battery source, obtains its pneumatic data from the standby pitot-static system and converts it to digital electrical outputs for the indicators.

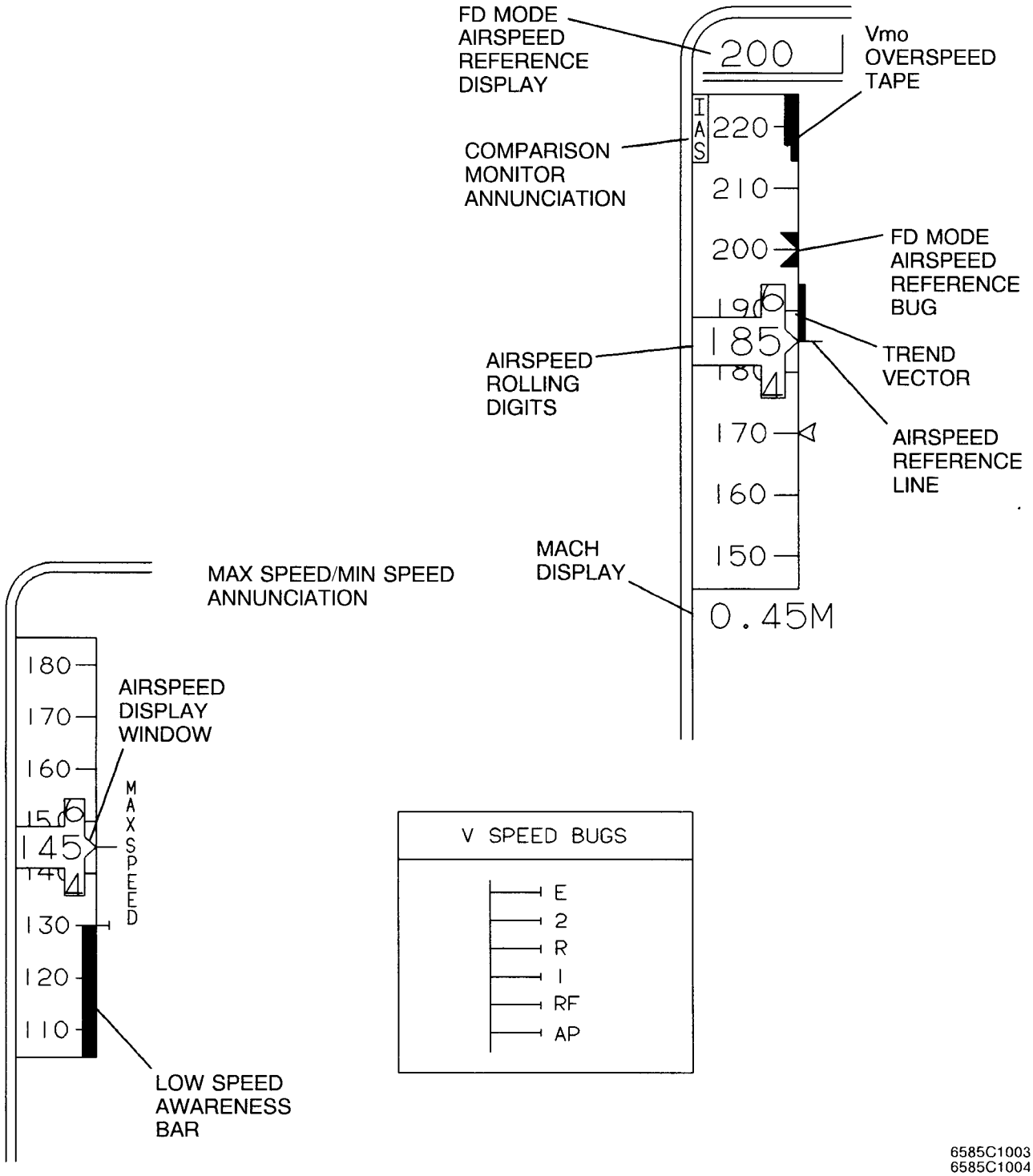
OVERSPEED INDICATIONS

Below 8000 feet altitude the limiting airspeed (V_{MO}) is 260 KIAS; between 8000 feet and 28,907 feet the limiting airspeed is 305 KIAS. When one of these limits is exceeded, the airspeed indication in the window to the left of the attitude display in the PFD will be changed to red and an amber annunciation, also to the left of the attitude sphere, will announce MAX SPEED. A red thermometer type tape is also presented on the inside of the airspeed scale. The thermometer extends from V_{MO}/M_{MO} to larger airspeeds on the tape and appears in the indication as the airspeed reaches into the range near V_{MO}/M_{MO}. When the limiting airspeed is exceeded the overspeed warning aural alert will sound, and will continue to sound until the airspeed is reduced below the limit speed.

NOTE

The aural warning system consists of two separate units which receive input from airplane anomalies of overspeed, autopilot off and altitude alert. The units will output aural signals to both the headphones and speakers.

TYPICAL AIRSPEED DISPLAY



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6585C1004

Figure 3-2

LOW AIRSPEED AWARENESS

A red, amber, and white thermometer type display located on the inside of the airspeed scale gives indication of low airspeed. The white extends from 1.3 V_{S1} to 1.2 V_{S1}, the amber band extends from 1.2 V_{S1} to 1.1 V_{S1} (approximately stick shaker speed), and the red extends from stick shaker speed to the smaller airspeeds on the tape.

MACH NUMBER DISPLAY

A digital readout of indicated Mach number is displayed below the airspeed dial. The Mach number will come up on the display when Mach exceeds 0.390, and is removed when it is falls below 0.380 Mach. Resolution of the Mach display is 0.01 Mach. The secondary flight display has a Mach indication which begins to read out when the Mach reaches a minimum of 0.35.

ALTITUDE INDICATION

The altitude display is located to the right of the attitude display on the primary flight display. The altitude is indicated by means of a vertical tape display which has a "rolling digit" window in the center of an altitude vertical tape. The resolution of the digits to 20 feet. The hundreds, thousands, and ten thousands digits are larger digit numerals than the others. The vertical tape moves behind the window and displays a tape 550 feet both above and below the present indicated altitude, with the larger numbers at the top of the scale. The range of the altitude window is from 1,000 to 60,000 feet with tick marks located at 500 foot increments. The scale is labeled in 500 foot intervals, and single line chevrons are located at each 500 foot increment. Double line chevrons are located at each 1000 foot increment. The chevrons extend back to the approximate midpoint of the altitude tape and are connected with each other by a vertical line. The left side of the "rolling digit" window will has the same angle as the chevrons.

The barometric pressure setting is controlled by a BARO knob at the bottom right of the primary flight display. A STD button, located next to the BARO knob, allows a change to a baro setting of 29.92 in. Hg. (or 1013 millibars) by simply pressing it. The baro correction setting display is located just below the altitude dial. The BARO knob will change the altitude correction by 0.01 in. Hg. per click.

An altitude trend vector is displayed on the left edge of the altitude tape and provides an indication of the rate of altitude change. The trend vector extends vertically from the apex of the current altitude display window. The vector extends up for positive vertical trends and down for negative values. The vector represents a prediction of what the altitude will be in six seconds if the current vertical speed is maintained.

Standby altitude indications are available from the secondary flight display (standby airspeed/ altitude/attitude indicator) which is discussed under Secondary Flight Display System below in this section.

TYPICAL ALTITUDE DISPLAY

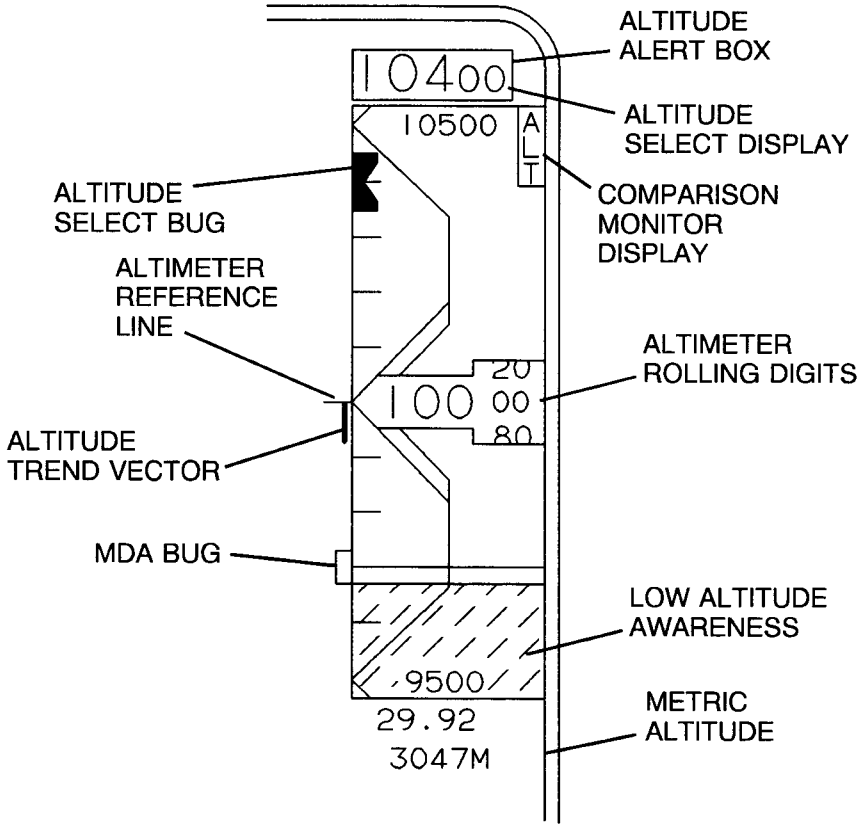

Figure 3-3

VERTICAL SPEED INDICATION

Vertical speed data is developed in the AZ-850 Micro Air Data Computers, which sense the rate-of-change of altitude from inputs of the static system. The computers convert the data into digital form and transmit it through the digital data bus system to the IC-600 Display Guidance Computers, which forward it to the DU-870 Primary Flight Displays where it is generated into a visual display.

The vertical speed display is a fixed scale meter movement type display; a pointer rotates about a point which is outside of the actual display. The scale is non-linear, which provides increased resolution around zero vertical speed. In the center of the scale a digital readout of the actual vertical speed is displayed. The digital display has a resolution of 50 feet per minute and can accommodate rates of climb or descent of 6600 feet per minute. On the display scale tick marks are located at the positive and negative values of 500, 1000, 1500, 2000, 2500, and 3000 feet per minute. The pointer will continue to move up to plus or minus 6600 feet per minute but will have a reduced sensitivity.The digital display and the digital readout box will be removed from the display for vertical speeds of plus or minus 550 feet per minute, leaving only the meter type display.

VERTICAL SPEED DISPLAY

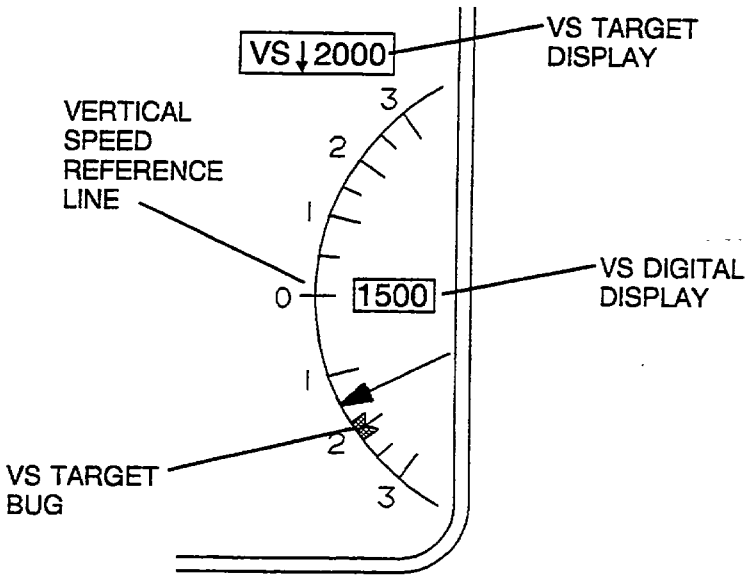

Figure 3-4

INCLINOMETER

Conventional inclinometers (slip indicators) are fixed to the bezel of each PFD and to the standby flight display. In addition, the primary flight displays also show split sky pointers.

MAGNETIC COMPASS

A standard liquid filled magnetic compass is mounted above the glareshield.

RAM AIR TEMPERATURE INDICATOR

A ram air temperature (RAT) indicator, located high and to the left on the center instrument panel, displays air temperature uncorrected for ram rise. Either Celsius or Fahrenheit readings may be selected by a switch on the face of the instrument. The indicator receives temperature signals from the right engine-mounted T_{T0} probe.

TRUE AIRSPEED PROBE

A true airspeed probe is located below the windshield on the fuselage right side. This temperature reading is fed directly into the Air Data Computers for computation purposes only and does not provide a viewable readout.

ENGINE INSTRUMENTS

Each engine is equipped with the following instruments located on the center instrument panel:

- Fan RPM
- Inter-Turbine Temperature (ITT)
- Turbine RPM
- Fuel Flow
- Oil Temperature
- Oil Pressure
- Fuel Temperature

All engine instruments are of the vertical tape readout design except for the turbine RPM, fuel flow, and fuel temperature which are digital readout only The gauges are powered by 28 VDC through circuit breakers on both cockpit circuit breaker panels. The fan tachometer also has a digital RPM display as well as the vertical tape. The digital display is provided above the N_1 tape for a more accurate readout. The loss of DC power or instrument failure is indicated by OFF flags in each instrument, except the fan (N_1) and turbine (N_2), digital tachometers and the digital fuel temperature indicator.

The fan RPM (% RPM N_1) and turbine RPM (% RPM N_2) are calibrated in percent from 0-110% (100% Fan RPM = 13,034; 100% Turbine RPM = 32,700) (maximum takeoff and maximum continuous turbine RPM is 100%). The fan (N_1) tachometers are powered from the emergency bus and are thus available in case of electrical system failure. They are powered by engine monopoles (magnetic speed sensors) mounted on the applicable engine shaft and require airplane electrical power for operation. The N_2 gauge will illuminate the small red lights just below the digits and flash the display if a turbine overspeed occurs.

The ITT indicator is calibrated from 150°C to 800°C. The temperature displayed is a synthetic inter-turbine temperature which is computed by measuring the exhaust gas temperature and then adding to it three times the temperature rise across the bypass duct.

The FUEL FLOW indicator displays fuel flow in pounds per hour. Readings are accurate at stabilized power settings.

The FUEL QUANTITY indicator is calibrated in pounds of fuel and accurately displays fuel remaining in the left and right tanks.

The OIL TEMPERATURE indicator, in degrees Celsius and the OIL PRESSURE indicator in pounds per square inch (PSI), show system limitations with red, yellow and green markings.

FLIGHT HOUR METER

The quartz hour meter, on a panel next to the right circuit breaker panel, displays the total flight time on the airplane in hours and tenths. The landing gear squat switch activates the meter when the weight is off the gear. A small indicator on the face of the instrument rotates when the hour meter is in operation. It receives DC power from a circuit breaker (FLT HR METER) on the left circuit breaker panel.

SECONDARY FLIGHT DISPLAY

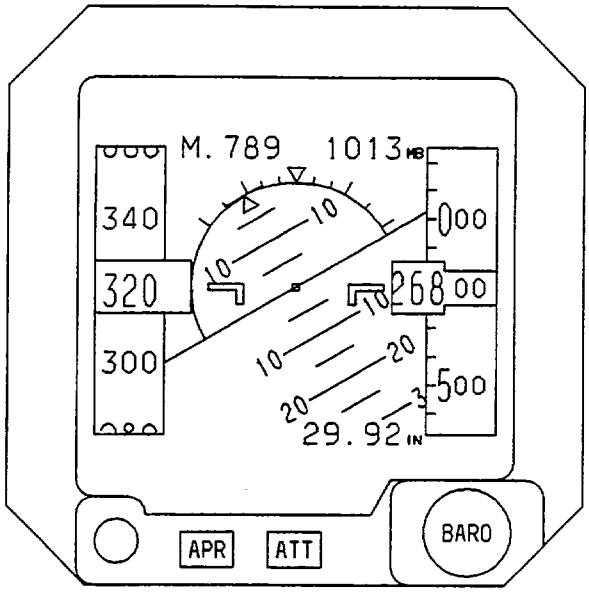

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Figure 3-5

A Meggitt Avionics Secondary Flight Display (SFD) System indicator is located on the left side of the center instrument panel. This DC-powered cathode ray tube indicator combines standby attitude indicator, and altimeter, and airspeed indications into one composite instrument. A Mach indication is also included in the instrument. Pneumatics inputs, which are received from the standby pitot-static system, are fed into a standby micro air data computer (MADC) which is powered from the DC emergency bus. The MADC converts the data to digital information and forwards it to the indicator.

The SFD contains a gyro solid state inertial sensors for the measurement and presentation of aircraft pitch and bank attitudes. Application of 28-volt DC power to the display system initiates the attitude initialization process, which is identified by the display of the message "attitude initializing" in yellow on the SFD. The duration of the initialization process is normally less than 180 seconds.

The attitude display has an instantaneous display range of 360° of bank and 50° of pitch. A moving tape on the right side of the display includes a "rolling digit" depiction of altitude; the tape is calibrated in 100 foot increments. Baro data is set in the altitude display by a knob on the bottom right of the bezel; clockwise rotation increases the pressure setting and counterclockwise decreases it. The setting is displayed simultaneously in millibars at the top right of the display and in inches of mercury at the bottom right. On the left side of the display is a moving tape showing airspeed. The tape is marked in ten knot increments with a "rolling digit" display in the center. The airspeed display becomes active at 40 knots. The Mach number is displayed in the upper left corner of the display. The Mach display range is 0.30 to 0.999 Mach.

Failure flag indications for airspeed and altitude are red crosses covering the appropriate tape box, with all indications removed from within the box. The failure flags for the Mach indication and Baro Setting are a series of four red dashes in the appropriate display area.

A light sensor is located on the bottom left side of the instrument case. It provides ambient light level data to the backlight control system to ensure optimum display brightness. The lighting level can still be controlled manually from the center instrument panel light rheostat control.

The navigation display is selected by the APR button on the bottom of the display bezel. Pressing the button results in display of ILS localizer and glideslope information from NAV 1 receiver. The ILS can be flown by reference to the ILS localizer and glideslope display on the standby horizontal situation indicator.

Power to the SFD is controlled by a switch marked STDBY PWR ON/OFF/TEST located on the lower right of the pilot's instrument panel. The SFD has an emergency source of power from an emergency battery pack located in the nose avionics compartment of the airplane. This battery pack also provides emergency instrument lighting for the secondary flight display system, the dual fan (N_1) tachometers, and the interturbine temperature (ITT) indicators.

The battery pack is constantly charged by the airplane's electrical system, and should therefore be fully charged in the event of an electrical power failure. The STDBY PWR switch must be ON for automatic transfer to battery power to occur. The SFD will operate for a minimum of 30 minutes on battery power. An amber POWER ON light next to the STDBY PWR switch illuminates when the SFD is turned ON and the airplane's electrical system is not charging the emergency power supply batteries. When the SFD switch is held to the spring-loaded TEST position, a self-test of the battery and circuits is accomplished. The green GYRO TEST light, also next to the STDBY GYRO switch, will illuminate if the test is satisfactory and the battery is sufficiently charged.

When NAV 1 is tuned for ILS operation, pressing the APR button will select ILS localizer and glideslope display. Pressing the button a second time will provide back course display, and pressing it a third time will revert the display to non-ILS format.

Maximum allowable airspeed (V_{MO}) is displayed in analog form by a red warning strip on the airspeed tape. When V_{MO} is reached, the numerals on the numeric airspeed display change from white to red. When the maximum allowable Mach number (M_{MO}) is reached, the numeric Mach number display will also change from white to red.

A built-in test system (BIT) will automatically detect any failure of the display at power up or during continuous operation. If the pilot desires to test the system after it is powered up, pressing the ATT button will initiate a self-test. If a failure is detected, the appropriate part of the display is replaced with a message indicating the failure. Where it is not possible to display an appropriate message, the display backlight is switched off.

DIGITAL CLOCK

One model M877 digital clock is mounted on the left side of the pilot's instrument panel and one on the right side of the copilot's panel. The clock can be made to display four time functions: local time, GMT, flight time and elapsed time. Two versions of the elapsed time function may be selected: count up or count down.

The clock has two control buttons: SEL (select) and CTL (control). The SEL button is used to select the desired function, and the CTL button to start and reset the selected mode.

For normal operation, either local time or Greenwich Mean Time (GMT) may be selected. GMT is displayed only in 24-hour format, and local time is 12-hour format. Pressing the SEL button sequentially displays GMT, local time, flight time and elapsed time. The displayed mode is annunciated GMT, LT, FT and ET, as applicable, under the time display window.

To set GMT or local time, select the desired function by pressing the SEL button. Simultaneously press both the SEL and the CTL buttons to enter the set mode. The tens of ours digit will start flashing and may be incremented by pressing the CTL button. The next digit is then selected by pressing the SEL button, and similarly set by means of the CTL button. When the last digit has been set, press the SEL button to exit the set mode. At that time the clock will start running and the lighted annunciator will resume flashing. When no airplane power is applied to the clock, the SEL and CTL buttons will not operate.

To use the clock as a stop watch to time approaches, etc., select ET with the SEL button and press the CTL button to start the timing. The clock will start counting elapsed time in minutes and seconds up to 59 minutes and 59 seconds. It will then switch to hours and minutes and continue up to 99 hours and 59 minutes. Pressing the CTL button will reset the elapsed time to zero.

DIGITAL CLOCK

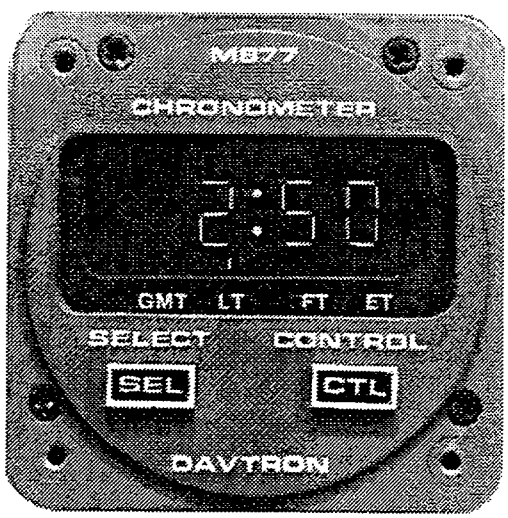

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Figure 3-6

To use the clock for an elapsed time "count down" display, select ET for display and enter set mode by pressing both buttons simultaneously. A maximum count down time of 59 minutes and 59 seconds can be set. The time from which it is desired to count is entered in the same manner as setting GMT or local time. When the last digit is set, press the SEL button to exit the set mode. Pressing the CTL button will start the countdown. The display will flash when the time reaches zero. After reaching zero, the ET counter will count up. Pressing the CTL button again resets ET to zero.

The flight time mode of the clock is enabled by a ground-in-air landing gear squat switch which causes the clock to operate any time the airplane weight is off the landing gear. The flight time may be reset to zero by selecting FT mode with the SEL button and holding down the CTL button for three seconds. Flight time is zeroed when the CTL button is released. A total of 99 hours and 59 minutes can be shown.

A flight time alarm mode is provided which will flash the clock display when the desired flight time is reached. To set the alarm function, select FT with the SEL button and enter the set mode by pressing both buttons simultaneously. Enter the desired alarm time in the identical manner that GMT or local time is set. When flight time equals the alarm time, the display will flash. If FT is not being displayed when the alarm time is reached, the clock will automatically select FT for display. Pressing either the SEL or CTL button will turn off the alarm and reset the alarm time to zero. Flight time is unchanged and continues counting.

The clock display may be tested when power is on the airplane by holding the SEL button down for three seconds. The display will show 88:88 and activate all four annunciators.

STALL WARNING AND ANGLE-OF-ATTACK SYSTEM

The angle-of-attack system is powered by 28 volts direct current (DC) from the left main DC bus through a circuit breaker on the left circuit breaker panel and incorporates an angle-of-airflow sensor, a signal summing unit, a vane heater monitor, an angle-of-attack indicator, and a stick shaker on each control column.

The vane type angle-of-airflow sensor, which is located on the forward right side of the fuselage, detects the angle of airflow and deflects accordingly. The wedge-shaped vane streamlines with the relative airflow and causes a transducer, at which it is mounted, to send signals to the signal summing unit (computer) located in the left nose avionics compartment. Signal inputs concerning flap position are also received by the signal summing unit. It then compensates for that variable and transmits the information to the angle-of-attack indicator. Indications are accurate throughout the weight and CG range of the airplane.

The full range type indicator is calibrated from 0.1 to 1.0., and marked with red, yellow and white arcs. Lift information is displayed on the indicator with 0.1 representing near zero lift and 1.0 representing stall. Lift being produced is displayed as a percentage and, with flap position information, is valid for all airplane configurations and weights. At 1.0 where full stall occurs, 100 percent of the available lift coefficient is being achieved. At the bottom of the scale (0.1) near zero lift is being produced.

ANGLE-OF-ATTACK INDICATOR AND INDEXER

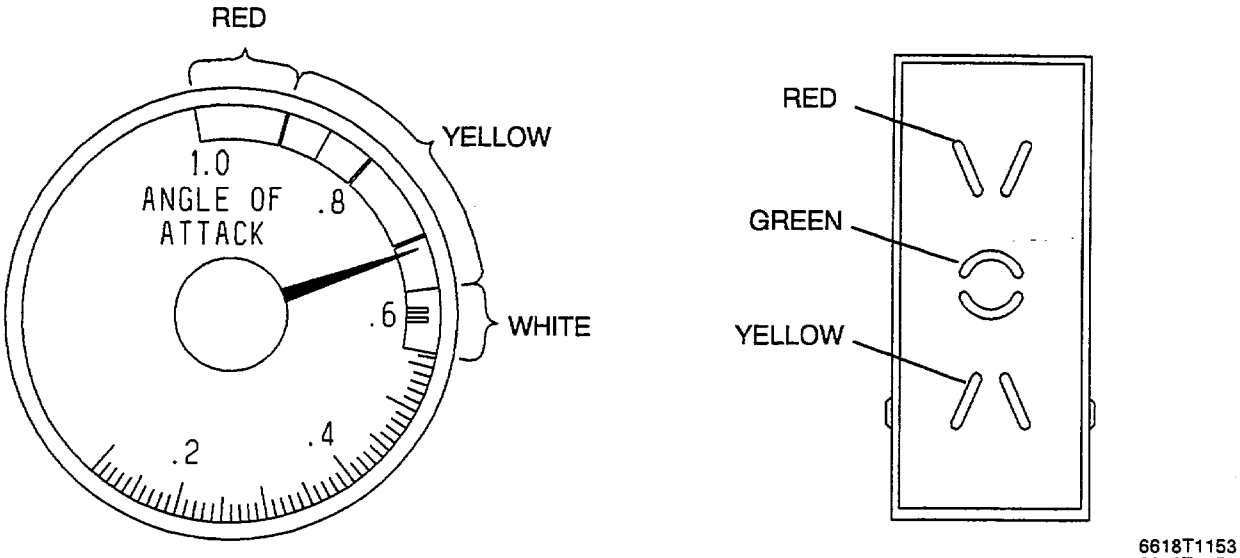

Figure 3-7

The area at the lower part of the scale (0.57 to 0.1) represents the normal operating range of the airplane, except for approach and landing. The narrow white arc (0.57 to 0.63) covers the approach and landing range and the middle of the white arc, 0.6, represents the optimum landing approach (V_{APP} or V_{REF}). The yellow range (0.63 to 0.85) represents a caution area where the airplane is approaching a critical angle-of-attack. The red arc (0.85 to 1.0) is a warning zone that represents the area just prior to stick shaker activation and continuing to full stall. At an indication of approximately 0.79 to 0.88 (depending on flap setting and rate of deceleration) in the warning range, the stick shaker will activate.

If the angle-of-attack system loses power or becomes inoperative for other reasons the needle will deflect to the top of the scale and stow at a 1.0 indication. A red X will also appear at the ADI slow/fast indication. The airplane may not be flown if the stick shaker is found to be inoperative on the preflight check, or if the angle-of-attack system is otherwise inoperative.

A stick shaker is located on both the pilots' control columns, approximately 9 inches down from the control wheel and on the forward side. The stick shaker provides tactile warning of impending stall. The angle-of-attack transmitter causes the stick shaker to be powered when the proper threshold is reached.

WARNING

IF THE ANGLE-OF-ATTACK VANE HEATER FAILS AND THE VANE BECOMES ICED, THE STICK SHAKER MAY NOT OPERATE OR MAY ACTIVATE AT NORMAL APPROACH SPEEDS.