Honeywell

FLIGHTLINE MAINTENANCE MANUAL

BENDIX/KING®

KAP 140

FLIGHT CONTROL SYSTEM

MANUAL NUMBER 006-15574-0002
REVISION 2 DEC, 2002

WARNING

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REVISION HISTORY

REV	DATE	CHANGES
0	October, 1998	Initial Release
1	April, 2002	Add unit versions -2603, -5403, -7703
2	December, 2002	Add unit versions -2704, -5504, -7904

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SECTION I
GENERAL INFORMATION

1.1 INTRODUCTION

This manual provides general system maintenance instructions and theory of operation for the KAP 140 Automatic Flight Control System. This manual is intended to be a supplement to an aircraft level maintenance manual specific to a particular aircraft type. The information provided here is to assist in flight line check-out and troubleshooting of suspected problems in the KAP 140 Flight Control System.

Abbreviations used in this manual are defined below.

Abbreviation	Description
A/D	Analog to Digital converter
AFCS	Automatic Flight Control System
ALT	Altitude
AFMS	Aircraft Flight Manual Supplement
ALT	Altitude mode (FD)
AP	Autopilot
APR	Approach mode (FD)
ARINC	Aeronautical Radio, Inc
Arm	Enable automatic mode engagement
C	Centigrade (or Celsius)
Capture	Transition mode from arm to track or hold
Coupled	AP command-generating mode
CPU	Central Processing Unit
DG	Directional Gyro (senses Heading)
ECAL	Embedded Control Algorithm Language
EPROM	Erasable Programmable Read Only Memory
FCC	Flight Control Computer
FMS	Flight Management System
FPM	Feet Per Minute
G	Constant for acceleration of gravity (approximately 9.81 meters/second^2 or 32.2 feet/second^2)
GPS	Global Positioning System
GS	Glideslope
HDG	Heading

Abbreviation	Description
Hold	Maintain current reference
HSI	Horizon Situation Indicator
HW	Hardware
ILS	Instrument Landing System
in.	inches
kg	kilograms
knots	nautical miles per hour
KPN	Bendix/King Part Number
LNAV	Long-range Navigation
LOC	Localizer
LRU	Line Replaceable Unit
LSB	Least Significant Bit/Byte (depending upon context)
MHz	MegaHertz
ms	milliseconds
MSB	Most Significant Bit/Byte (depending upon context)
MTBF	Mean Time Between Failure
MUX	Multiplexer
NAV	Navigation
NVM	NonVolatile Memory
PC	IBM Personal Computer (or compatible)
PFT	Pre-flight Test
RAM	Random Access Memory (read/write)
Ref	Reference
REV	Reverse Localizer Mode (Backcourse)
ROM	Read Only Memory
RTI	Remote Terminal Interface
sec	seconds
STC	Supplemental Type Certificate
TBD	To Be Determined
TC	Type Certificate
Track	Follow navigation reference
TSO	Technical Standard Order

Abbreviation	Description
V	Volts
VDC	Volts - DC (direct current)
VOR	VHF (Very High Frequency) Omni Range
VS	Vertical Speed

1.2 SYSTEM DESCRIPTION

1.2.1 GENERAL SYSTEM DESCRIPTION

The KAP 140 Automatic Flight Control System (AFCS) provides pilot workload relief when installed in single-engine and light twin airplanes with non-pressurized cabins. The system is offered in several upgradeable flavors for customer flexibility. This system can be configured as a Roll-only (single-axis) system or as a Pitch and Roll (two-axis) system. The single-axis system has roll stabilization with heading select and navigation arm and coupled modes. The two-axis systems provide vertical speed select and altitude hold, with altitude alerting and preselect as an option. Manual electric trim can be added to any system and pitch autotrim can be added to any two-axis system.

1.2.2 SYSTEM UNITS AND INTERFACES

The KAP 140 autopilot system is composed of the KC 140 flight control computer, KCM 100 configuration module, KS 271 Roll Servo, KS 270C Pitch Servo, KS 272C Pitch Trim Servo, and KM 275 or KM 277 servo mounts. The system receives a combined yaw rate and roll rate signal from a turn coordinator (rate gyro). A VOR/ILS or GPS receiver can be interfaced to the AFCS system via analog deviations and valids. AFCS systems with altitude alerting are interfaced to an encoding altimeter via parallel digital inputs. A remote analog baro correction input is also provided for interface to a KEA130A or equivalent altimeter. The system interfaces to a Directional Gyro (DG) or HSI, receiving analog heading datum and/or course datum. The system also may interface to the audio panel, flaps motor, and various switches on the control wheel (i.e. CWS, AP DISC, MET).

Table 1-1 lists the components and part numbers that comprise the KAP 140 system. Figure 1-1 shows a block diagram of the system.

MODEL NO.	**UNIT DESCRIPTION**	**PART NUMBER**
KCM 100	Configuration Module	071-00073-xxxx
KC 140	Flight Computer	065-00176-xxxx
KEA 130A (Optional)	Encoding Altimeter	
KS 270C	Pitch Servo Actuator	065-00178-xxxx
KS 271C	Roll Servo Actuator	065-00179-xxxx
KS 272C	Pitch Trim Servo Actuator	065-00180-xxxx
1394T100-xxRZ	Rate Gyro	Supplied by Mid-Continent
1U262-04x-x	Directional Gyro	Supplied by Sigma-Tek

TABLE 1-1 KAP 140 SYSTEM COMPONENTS AND SUPPORT EQUIPMENT

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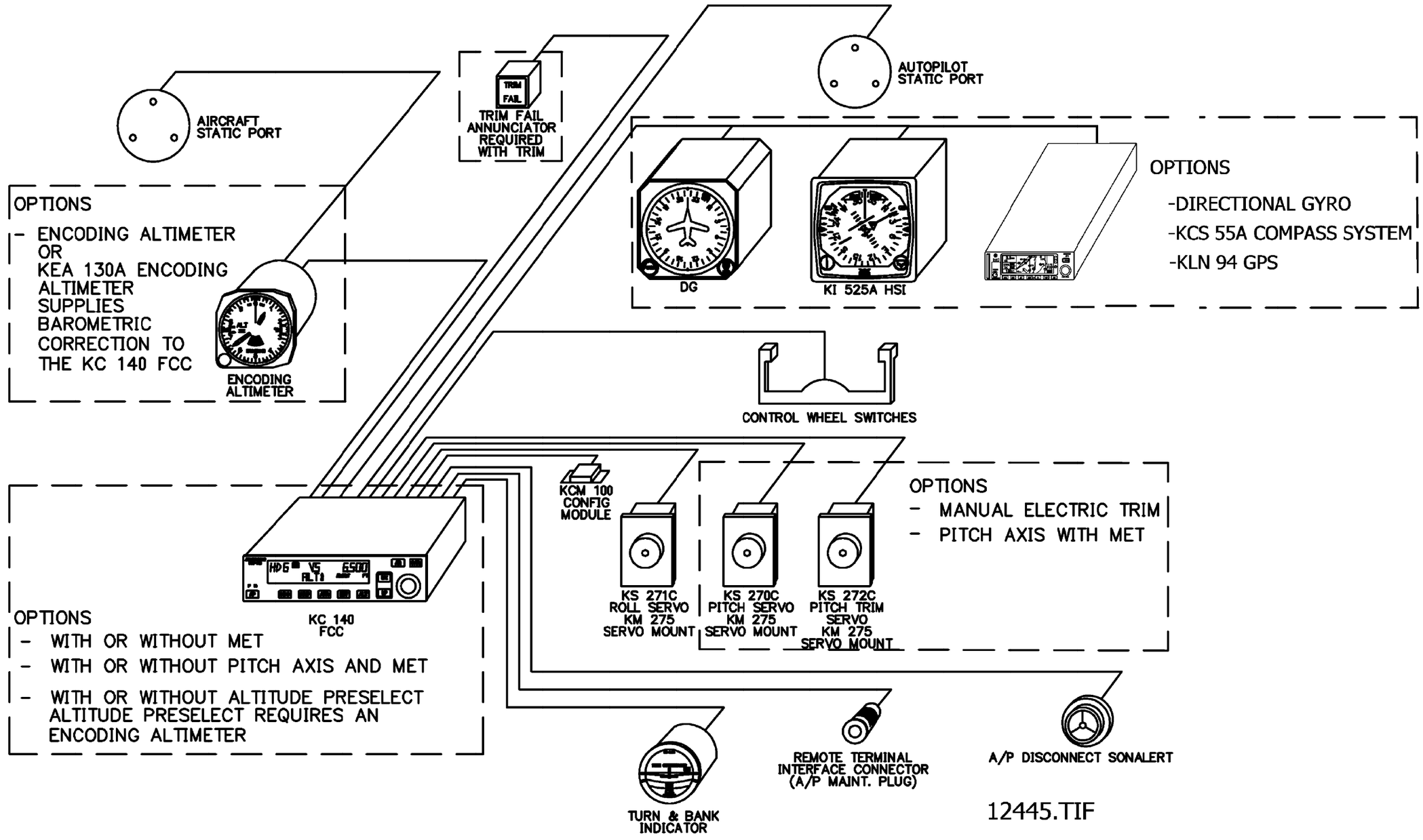

FIGURE 1-1 KAP 140 SYSTEM BLOCK DIAGRAM
(File Name 12445.tif, Sheet 1 of 1)

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1.3 PRODUCT SUPPORT

When a component of the KAP 140 Flight Control system exhibits a failure, it must be repaired by an Honeywell Approved Sales and Service Center with an Honeywell service category rating of 5H. These Approved Sales and Service Centers have maintenance manuals, test sets, tools and trained personnel approved by Honeywell to perform troubleshooting and repair on the equipment on which they are rated. Maintenance and troubleshooting information that would normally be available at these Approved Sales and Service Centers is not duplicated in this document. A list of Honeywell Approved Sales and Service Centers can be obtained from Honeywell Product Services, (USA) 913-782-0600.

1.4 AIRWORTHINESS LIMITATIONS

The FCCs with mod 2 are limited to a total of 300 hours of service before they must be returned to the factory for testing. FCCs with mod 3 (which have been factory tested) are limited to 800 hours between factory tests. -2xxx, -xxx2, -xxx3, -xxx4 as well as -5101 and -5201 FCCs with mod 4 (01/06 SW) have no required service limitations. Servo slip clutches need to be checked every 1000 hours or as specified in the STC maintenance manual.

1.5 COMPONENT DESCRIPTION

1.5.1 GENERAL

This section provides an illustration and a brief description of each component used in the KAP 140 AFCS.

1.5.2 KC 140 FLIGHT CONTROL COMPUTER

The KC 140 Flight Control Computer (FCC) contains all of the mode logic, command computations, servo control, and system monitoring for coupled flight. It interfaces with the systems and equipment listed in Table 1 of this document. The FCC is housed in a panel mounted package which slides into a rack installed behind the aircraft panel. The unit is secured in the rack by tightening a locking rod screw accessible from the front panel. The unit uses two rear-mounted subminiature-D shell connectors (37 pin and 50 pin) for interface to the aircraft harness. The unit also contains a static pressure port that automatically mates into a receptacle in the rack when the unit is installed.

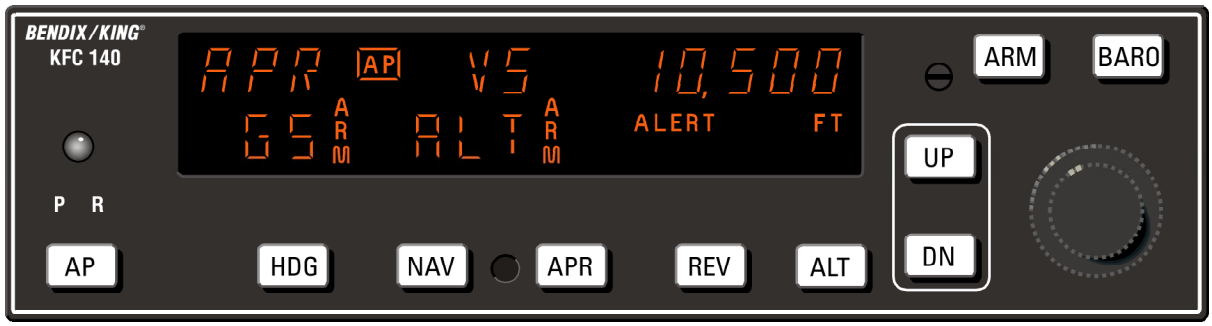

FIGURE 1-2 KC 140 FLIGHT CONTROL COMPUTER

1.5.3 KCM 100 CONFIGURATION MODULE

The KCM 100 Configuration Module is a nonvolatile memory that is used to store the certification gains, installation options and adjustments, as well as the error log for a KAP 140 system installation. It is mounted near the FCC in the aircraft harness.

1.5.4 KS 270C PITCH SERVO

The KS 270C pitch primary servo, used to provide AFCS control of the elevators, contains a servo motor with amplifier and engage clutch, as well as a torque sensor for trim command generation. The servo outputs a differential trim sense signal with a scale factor of 100mV/in-lb, with a positive differential voltage representing CW torque. Maximum sensed torque is at least 20 in-lb in each direction. Pitch servos also contain a tach feedback signal to provide servo motion sensing. The servo outputs a differential signal with a scale factor of approximately 5.3 V for full servo speed.

In installations using the -27XX, -5201, -54XX, -55XX, -77XX and -79XX FCCs, the tach signal is used to disable the FCC acceleration monitor when servo motion is not causing the sensed aircraft acceleration.

Each primary servo is installed with a KM 275 servo mount, which contains a slip clutch for pilot override. The servo receives a differential command input and drives the servo motor with a speed proportional to the magnitude of the command. The command polarity will determine direction of servo rotation. The command inputs have an impedance of at least 15K ohms. The interface is designed such that an open command signal will not cause a servo drive of more than 25% of full-scale speed.

The pitch servo also contains a validity circuit which compares the motor voltage against the servo command. The servo actuator outputs a open/ground discrete signal, where ground represents a valid servo. If the comparison fails, the servo outputs an invalid (open) signal to the FCC.

NOTE

Removing power to the servo (e.g. by pressing the AP DISC switch) will also cause the servo to be sensed as invalid.

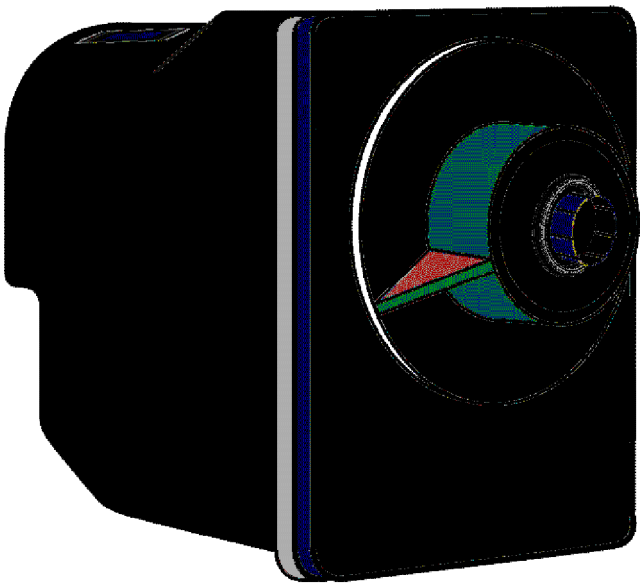

FIGURE 1-3 KS 270C PITCH SERVO

1.5.5 KS 271C ROLL SERVO

The KS 271C roll primary servo actuator is used in the roll axis to provide AFCS control of the aircraft ailerons. It contains a servo motor with amplifier and engage clutch solenoid. The roll servo is installed with a KM 275 servo mount, which contains a slip clutch for pilot override. The servo receives a differential command input and drives the servo motor with a speed proportional to the magnitude of the command. The command polarity will determine direction of servo rotation. The command inputs have an impedance of at least 15K ohms. The interface is designed such that an open command signal will not cause a servo drive of more than 25% of full-scale speed.

The roll servo also contains a validity circuit which compares the motor voltage against the servo command. The servo actuator outputs a open/ground discrete signal, where ground represents a valid servo. If the comparison fails, the servo outputs an invalid (open) signal to the FCC.

NOTE

Removing power to the servo (e.g. by pressing the AP DISC switch) will also cause the servo to be sensed as invalid.

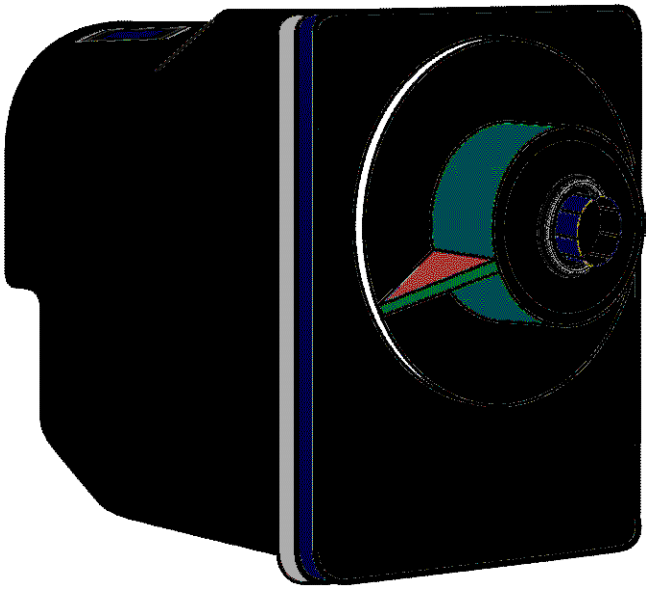

FIGURE 1-4 KS 271C ROLL SERVO

1.5.6 KS 272C TRIM SERVO

The KS 272C trim servo actuator is used in the pitch axis to provide automatic and manual electric trim control of the aircraft. It contains a servo motor with amplifier and engage clutch. The servo receives a differential command input and drives the servo motor with a speed proportional to the magnitude of the command. The command polarity will determine direction of servo rotation. The command inputs have an impedance of at least 15K ohms. The interface is designed such that an open command signal will not cause a servo drive of more than 25% of full-scale speed. The servo motor voltage is output to the FCC for monitoring. A trim servo disable discrete input allows the FCC to remove power from the servo motor drive. The trim actuator can be installed with either a KM 275 or a KM 277 trim servo mount.

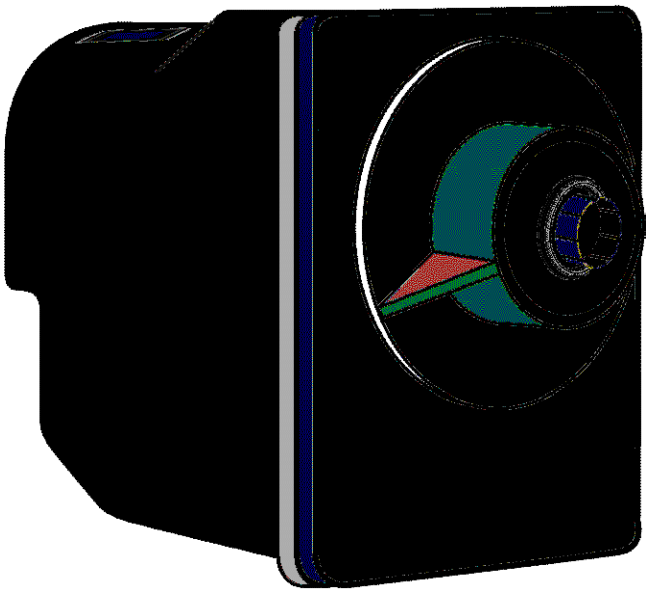

FIGURE 1-5 KS 272C PITCH TRIM SERVO

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SECTION II
SYSTEM OPERATION

2.1 GENERAL

2.1.1 OPERATING MODES (OVERVIEW)

The -7xxx FCC flavors provides the following roll modes: Roll Stabilization (default mode), NAV and Approach Arm and Track (including Reverse Localizer approaches), and Heading Select. The pitch axis provides: Vertical Speed Select (default), Altitude Arm, Capture and Hold, Glideslope Arm, Capture and Track, and altitude alerting. Pitch autotrim and Manual Electric Trim are also provided.

The -5xxx FCC flavors do not provide altitude alerting nor altitude arm and capture functions. The -2xxx FCC flavors do not provide any pitch modes, but do allow for Manual Electric Trim.

2.2 KC 140 MONITORS

This section will give a brief description of the monitors that are implemented in the KC 140 flight computer. The following monitors detect potentially unsafe AFCS operation. They will disengage and/or prevent operation of certain modes.

2.2.1 HARDWARE MONITORS

The following monitoring functions are implemented in the FCC hardware.

2.2.1.1 Acceleration Monitor (Pitch engaged):

Whenever the normal acceleration is invalid or outside of the range -0.4g to +0.4g for 0.4 seconds, the pitch axis will be disengaged (i.e. engage clutch unpowered). The axis automatically re-engages (if previously engaged) when the acceleration is valid and less than 0.2 g absolute for 0.4 seconds. If the acceleration input is invalid or outside the above monitor limits for 1.0 seconds, the FCC disconnects the pitch axis and provides disconnect alerting. The AP mode can be re-engaged after the excessive acceleration is removed. This monitor runs continuously whether the AP is engaged or not.

For the -5101, -5302, and -7802 flavors: If the acceleration output is greater than +0.4 g's or -0.4 g's for 0.4 seconds, then the accelerometer monitor will fail and disengage the pitch, roll, and trim clutches.

For the -5201, -54XX, -55XX, -77XX and -79XX flavors: If the acceleration output is greater than +0.4 g's or -0.4 g's for 0.4 seconds and the pitch tachometer output (greater than +/-0.36 V) is in the direction of the sensed acceleration, then the accelerometer monitor will fail and disengage the pitch, roll, and trim clutches.

2.2.1.2 Autotrim Runaway Monitor (Pitch engaged):

In a two axis system with the autopilot pitch axis engaged, the trim runaway monitor detects if the trim motor drive is in opposition to the pitch servo command (See below for details on thresholds and time durations). If this condition is detected, the pitch trim is disabled until a subsequent Preflight test is performed. Pitch modes are still allowed and manual trim indications made available to the pilot. When a trim runaway is detected, a continuous audio tone is generated until the AP DISC button is pressed. "PT" is displayed on the FCC and an external TRIM FAIL annunciation is also illuminated.

For five seconds after a trim runaway is detected, the acceleration monitor (described above) is disabled. This allows primary pitch servo authority to oppose a trim runaway. The trim modes (MET and autotrim) can only be re-engaged by cycling AP power and successfully passing pre-flight test. This monitor runs continuously when the pitch axis is engaged.

For the -5101, -5302, and -7802 flavors: If the trim voltage exceeds +/-2.7 V for 0.7 seconds and the pitch command is greater than +/-0.61 V and is in opposition to the direction the trim servo is running in the aircraft then the autotrim runaway monitor will fail and disengage the trim clutch.

For the -5201, -54XX, -55XX, -77XX and -79XX flavors: If the trim voltage exceeds +/-2.7 V for 1.1 seconds and the pitch command is greater than +/-0.36V and is in opposition to the direction the trim servo is running in the aircraft, then the autotrim runaway monitor will fail and disengage the trim clutch.

2.2.1.3 Manual Trim Runaway Monitor (Pitch not engaged):

If the absolute trim motor drive is greater than 2.7 volt and is in absence of a corresponding MET trim command for a certification determined time (0.7 or 1.1 seconds). If this condition is detected, the pitch trim is disabled until a subsequent Preflight test is performed. Pitch modes are still allowed and manual trim indications made available to the pilot. When a trim runaway is detected, a continuous audio tone is generated until the AP DISC button is pressed. “PT” is displayed on the FCC and an external TRIM FAIL annunciation is also illuminated. This monitor runs continuously when the AP pitch axis is not engaged.

2.2.1.4 Manual Trim Latent Switch Monitor:

If the manual trim up or trim down switch is active for 3 seconds without the corresponding trim arm switch being active or the manual trim arm switch is active for 3 seconds without a corresponding manual trim up or trim down switch being active, the manual trim latent switch monitor will disengage the trim clutch, thus preventing trim operation. After this type of failure, “PT” is displayed on the FCC and manual trim operation will only be allowed after manual trim up, manual trim down, and manual trim arm are no longer active. This monitor runs continuously whether the AP mode is engaged or not.

In units with SW version 01/04 or earlier, this monitor is latched and trim operation (MET and autotrim) will be disabled until PFT is performed.

2.2.2 SOFTWARE MONITORS

The following monitoring functions are implemented in the FCC software.

2.2.2.1 Acceleration Reasonability check:

For -5302, -54XX, -55XX, -77XX, -7802, -79XX versions or -5101 and -5201 units with SW version 01/06: If the absolute difference between the current accelerometer output and the average value for accelerometer is greater than 0.8g's for 1.0 seconds the accelerometer reasonability check will fail and the autopilot will be disconnected. The Pitch LED will turn on and dashes appear across the pitch coupled display field of the FCC. Engagement of the roll axis will be allowed, but pitch axis operation will be disallowed until the excessive acceleration is removed. This monitor runs continuously whether the autopilot is engaged or not.

Note: If after preflight test successfully passes, the Pitch LED turns on and dashes appear across the pitch coupled display field of the FCC for a short period of time, the accelerometer reasonability check monitor may have failed due to accelerometer offset. This condition should not occur once the acceleration offset has been stored in the KCM 100 configuration module. The acceleration offset is stored automatically by the software after the KC 140 has been operating in normal mode for 10 minutes.

2.2.2.2 Low Voltage Monitor:

For -5302, -54XX, -55XX, -77XX, -7802 and -79XX versions or -5101 and -5201 units with SW version 01/06: If the aircraft voltage goes below 10V, the AP will be disconnected and MET will be disabled. Autopilot and MET operation will be allowed after the aircraft voltage goes above 10V. This monitor runs continuously whether the AP is engaged or not.

2.2.2.3 Baro Reference Monitor:

(-7xxx FCCs only) If the remote barometer input is <7.5% or >113% of the Baro Reference voltage (nominally, <0.3V or >4.5 V), the monitor will fail and revert to using the baro select knob on the KC 140. These values correspond to a valid range of 28.00 to 32.00 in Hg . If this monitor fails, the selected altitude window will be dashed and altitude alerting and altitude arm mode will be disabled.

2.2.2.4 Pressure Sensor Monitor:

If the pressure sensor output is < -2,500 ft or > +40,000 ft, the monitor will fail and disconnect all pitch modes. Pitch Axis operation will be disallowed until the pressure sensor output is in a valid range.

In -7xxx flavors, the selected altitude display will be dashed and altitude alerting will be disabled during this condition.

2.2.2.5 Encoding Altimeter Monitor:

In -7xxx flavors, if the encoding altimeter code is invalid, the ALT ARM mode will be disconnected. The selected altitude display will be dashed and altitude alerting will be disabled during this condition.

2.3 PERFORMANCE SPECIFICATIONS

The AFCS will provide the following performance in smooth air.

2.3.1 ROLL AXIS

Roll Stabilization will maintain wings level with a maximum heading rate of 6 degrees per minute (with roll offset nulled). The Heading Select mode will hold heading within ±2.0 degrees (with the heading offset nulled). The NAV Track will provide up to 30 degrees of crosswind correction for VOR tracking and reversion to heading hold for VOR station passage. No sustained oscillations will be noticeable in the VOR tracking, and sustained tracking errors should be less than 1.0 degree. Localizer will track within ±0.25 degrees down to 200 feet AGL (front course) with no sustained oscillations. Coupling to a GPS will provide sustained tracking errors less than 1.0 nm in Enroute mode and .05 nm in Approach mode.

2.3.2 PITCH AXIS

Vertical Speed Hold will maintain its reference within +/- 150 FPM (up to 1000 FPM) in roll-level flight. Altitude Hold will maintain its reference within +/-50 Feet in level flight; altitude gain or loss in turns should not exceed 50 feet. Glideslope Track will track to 200 feet AGL without sustained oscillations. Altitude Arm and Capture will operate with vertical speeds up to +/- 2000 FPM with less than 0.2 g normal acceleration and less than 100 feet overshoot over the altitude range of the aircraft (when armed prior to the capture point).

2.3.3 PITCH TRIM

If installed, pitch autotrim should maintain the long-term effort of the pitch primary servo to less than 3 pounds force, as reflected into the pilot controls, or +/-200 FPM (when Altitude Hold mode is disengaged), whichever is greater. The system also indicates the need for manual pitch trim whenever the required servo effort exceeds the autotrim threshold for 5.0 seconds (15 seconds on -5403, -5504, -7703 and -7904), if trim is installed). If autotrim is not supplied, this provides a manual trim indication to the pilot; otherwise, it indicates a (passive) autotrim failure.

2.4 KC 140 FCC

2.4.1 GENERAL DESCRIPTION

The FCC accepts mode selections from its panel buttons and cockpit switches and provides mode and failure annunciations for the system. It also uses sensor inputs to calculate commands for the servo actuators. Pilot control of the mode reference is also provided for Vertical Speed and Altitude Hold modes. The FCC is available in several versions: roll-stabilizer with heading and NAV, two-axis (pitch and roll) without preselect, and two-axis with altitude preselect. The two-axis systems include autotrim and Manual Electric Trim functions as an option. Pilot control of the mode reference is provided for Vertical Speed and Altitude Hold modes. The two-axis FCCs include a normal accelerometer and static pressure sensor for vertical modes. In systems with altitude preselect, the FCC uses a baro-correction input to provide optional selected altitude and altitude alerting functions.

The FCC is designed to operate from 11.0VDC to 33VDC. A separate audio power input is used for alerting functions. All backlighting illumination uses 5V incandescent bulbs for reliability. Backlighting inputs are used as signal inputs and do not source illumination power to the unit. The FCC is designed to operate in an ambient temperature from -40° C to +70° C.

2.4.2 SINGLE AXIS VERSION

The following figure shows the roll-only FCC.

NOTE

AP Lamp is only on -2xx3 versions and above.

FIGURE 2-1 SINGLE-AXIS FCC (-2XXX FLAVORS)

2.4.3 TWO-AXIS VERSIONS

The following figures shows the two-axis FCCs, with and without altitude preselect capability. The last figure shows all KC 140 display segments.

NOTE

AP Lamp is only on -5xx3 and -7xx3 versions and above.

FIGURE 2-2 TWO-AXIS FCC (-5XXX VERSIONS)

FIGURE 2-3 TWO-AXIS FCC W/ALTITUDE PRESELECT
AND ALERTING (-7XXX VERSIONS)

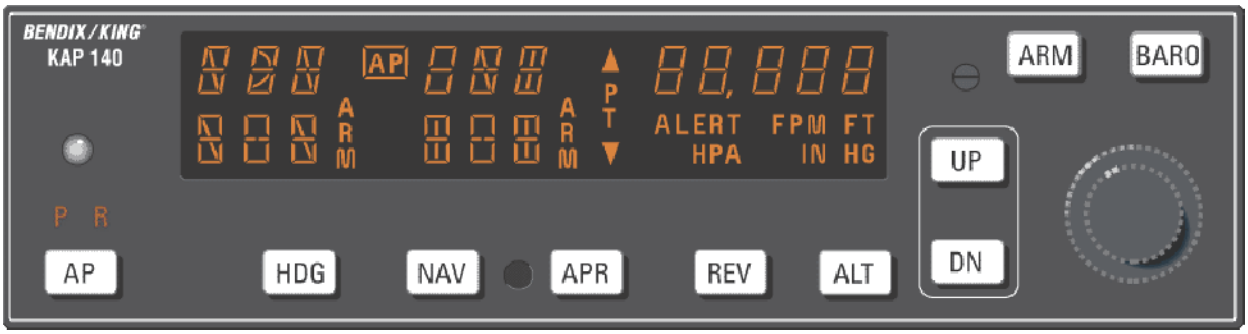

FIGURE 2-4 FULL KAP 140 DISPLAY (LAMP TEST)

2.5 USER CONTROLS

2.5.1 PANEL BUTTONS

All flavors of the FCC are functional subsets of the full-featured system FCC. Therefore, the description of functions for the high-end FCC also applies to lower-level systems containing the same feature. The full-featured flavor of the FCC provides the following pushbuttons:

Switch	Function
AP	Couples Autopilot in default modes. Required before engaging all other modes in -xxx3 versions and above.
HDG	Engages/disengages Heading Select mode
NAV	Engages/disengages arm/tracking of VOR , GPS (Enroute) or Localizer
APR	Engages/disengages arm/tracking of VOR (Approach) , GPS (Approach) or ILS (with GS)
REV	Engages/disengages Reverse Localizer (Backcourse) tracking
ALT	Engages/disengages Altitude Hold
ARM	Engages/disengages Altitude Arm mode.
BARO	Momentarily allows use of rotary knobs to adjust the baro-setting. If held for more than 2.0 seconds, toggles baro units between hPa and in Hg.
UP	Changes VS or ALT reference to cause aircraft to nose upward.
DN	Changes VS or ALT reference to cause aircraft to nose downward.

2.5.2 COCKPIT SWITCHES

The FCC also accepts the following cockpit switches:

Switch	Function
CWS	(Control Wheel Steer) Momentarily releases autopilot control and synchronizes mode reference in VS and ALT modes.
AP DISC	(Autopilot Disconnect) Disengages the autopilot, clearing modes.
TRIM UP/DN/ARM	Controls Manual Electric Trim (if installed).

2.5.3 ROTARY KNOBS

The rotary knobs provide control of the Selected Altitude. The outer knob changes Selected Altitude by 1000 foot steps. The inner knob changes Selected Altitude by 100 foot steps.

If remote baro-correction is not selected, the rotary knobs can also be used to enter baro-correction. For 3.0 seconds after pressing the BARO pushbutton and for an additional 3.0 seconds following any subsequent rotary knob movement, the numeric display will show the present baro correction and the rotary knobs will adjust the baro-setting instead of Selected Altitude. In this mode, the outer knob will change the baro-setting by 0.1 in Hg or 10 hPa. The inner knob will change the baro-setting by .01 in Hg or 1 hPa.

2.6 ANNUNCIATORS

2.6.1 MODE ANNUNCIATIONS

The FCC provides four alphabetic display fields for mode annunciations. The four fields provide annunciations for the roll coupled mode, roll arm mode, pitch coupled mode, and pitch arm mode. The roll coupled mode annunciations are: ROL, HDG, NAV, APR, and REV. The roll arm mode annunciations are: NAV, APR, and REV (with “ARM”). The pitch coupled mode annunciations are: VS, GS, and ALT. The pitch arm mode annunciations are: GS and ALT (with “ARM”). NOTE: GS ARM is displayed in the roll arm mode field (to allow simultaneous display of ALT ARM in the pitch arm mode field). A boxed AP  is displayed along with all the above annunciations indicating the autopilot is engaged.

2.6.2 FAILURE ANNUNCIATIONS

A failure that prevents engagement of the roll axis (i.e. invalid roll servo) is indicated by the red “R” annunciator, signifying loss of roll servo control. Failures that prevent continued roll command generation (e.g. invalid turn coordinator) are indicated by “---” in the roll coupled field. Pitch failures are similarly indicated, with a red “P” annunciator and “---” in the pitch coupled field. A failure that prevents roll axis control will also inhibit autopilot engagement. Failures in the pitch axis will disengage the autopilot, but will allow subsequent engagement of the roll axis, with the pitch coupled field dashed.

The FCC also provides a manual pitch trim indication of UP and DN. This indicates a passive trim failure if autotrim is installed. After ten seconds, the trim indications flash. A failure of the trim axis is indicated by a solid “PT” display, as well as an external TRIM FAIL annunciator.

If the Gilham code is invalid or the pressure sensor input is invalid, the altitude alerting and altitude arm functions are disabled. This is indicated by a dashed display of selected altitude.

2.7 NUMERIC DISPLAY

2.7.1 GENERAL

If preselect capability is installed, the numeric window normally displays Selected Altitude in units of "FT". This window also displays the reference for Vertical Speed mode (if engaged) for 3 seconds after engagement or the last press of the UP or DN buttons or when CWS is pressed. However, the display will default back to displaying selected altitude if the inc/dec knobs are turned. The display units will change to "FPM" when displaying the VS reference. If preselect capability is not installed, the numeric display will always display the VS reference when VS is engaged.

2.7.2 PITCH REFERENCE CONTROL

The vertical reference may be changed by use of the UP or DN buttons, as shown in the following table. The continuous rate change is used when the UP or DN button is pressed continuously for more than 0.75 seconds. The VS reference is limited to the certified limits.

Mode	**Discrete Step**	**Continuous Rate**
VS	100 FPM	300 FPM/sec
ALT	20 Ft	500 FPM *

*The ALTitude hold reference is not displayed and synchronizes to aircraft upon trim switch release.

2.7.3 BARO SET

The numeric window will also display the baro-setting for 3 seconds after pressing the BARO button. If remote baro-set is not selected, this also enables the rotary knobs to input the baro-setting. Remote baro-set selection is used to accept baro input from a KEA 130A altimeter. Holding the BARO button for at least 2 seconds will toggle the baro set display units between "HPA" (hecto-Pascals) and "IN HG" (inches of Mercury).

If remote baro-correction is not selected, the current baro setting will flash on the display after PFT. To cancel the flashing, the pilot must press the BARO button (to acknowledge the current baro set) or turn the inc/dec knobs until the proper baro set is displayed.

If remote baro-set is selected, but the baro set input is invalid, the unit will "prompt" the pilot for baro setting, as described above, after the failure is detected. In addition, it prompts each time the selected altitude is changed.

2.8 ALERTING

The FCC will provide aural and visual alerting for the conditions described below. The aural alerts consist of standard-frequency alerting tones, followed, if enabled, by a voice synthesized message describing the event. The audio alerting circuitry is powered from a separate audio power bus, to provide independence from autopilot power.

2.8.1 AP DISCONNECT ALERTING

Whenever the autopilot is disengaged, the FCC provides an aural alert. In addition to the audio alert (unless the disconnect is caused by a loss of autopilot power), the alert tone is then followed by the voice message: “Autopilot disconnect”. With voice messaging disabled, the disconnect aural alert simply consists of a continuous 2.0 second tone.

In addition to the aural alert, the FCC generates a visual alert by flashing an external disconnect annunciation for 5.0 seconds following the disconnect. The flashing duty cycle is 66% +/-10%, with a period of 600-800 ms. The FCC also provides a flashing “AP” display in the roll coupled field with the same duration and flashing.

2.8.2 ALTITUDE ALERTING

Aural alerting (five “beeps”) is provided for altitude alerting. Two alert regions are defined: an outer band (200 to 1000 feet from the selected altitude) and an inner band (less than 200 feet from the selected altitude). The altitude aural alert output is active when the aircraft enters into the outer band from the outside. The alert is followed by the voice message: “Altitude”. The FCC also provides an alert followed by the message “Leaving altitude” when the aircraft is leaving the inner band. No alert tone or message should be generated when the selected altitude is changed; these are generated only in response to a pressure altitude change.

An ALERT annunciation is also provided for the Altitude Alerting function. This annunciation is illuminated continuously anytime the aircraft is in the outer band. It is solid (i.e. not flashing) if the aircraft was previously outside the outer band; it is flashing if the aircraft was previously in the inner band. It also flashes for 2.0 seconds the first time the aircraft crosses the Selected Altitude after being in the outer band.

2.8.3 TRIM RUNAWAY ALERTING

When a trim failure is detected by the trim runaway monitor, the FCC provides a continuous alert tone (500 ohms and tone alert) until the AP DISC switch is pressed. The tone then ceases. If PFT detects a failure of the trim runaway monitor, it also produces the same alerting tone and ensures that the monitor is left in the failed state (to provide a remote TRIM FAIL annunciation).

2.8.4 OTHER VOICE MESSAGES

In addition to the three voice messages described above, if autotrim is not installed, the FCC shall provide a “check pitch trim” message whenever the autopilot is engaged and pitch mistrim indications have been flashing for ten seconds.

On -5403, -5504, -7703 and -7904 versions: If autotrim is installed, the FCC shall provide a “check pitch trim” message concurrently with pitch mistrim indications whenever the autopilot is engaged. If the absolute trim motor drive is greater than 3.0 volts and in the same direction for greater than five seconds, the FCC shall provide the message “trim in motion”. When either trim voice message is active, it shall be repeated every three seconds as long as the condition exists. If conditions for both trim messages exist, only the “check pitch trim” message will be played. If any other enabled voice message is required while one of the trim messages is playing, the FCC shall interrupt the trim message to play it and then resume the repeating trim message as long as the condition exist.

If the baro set input is out of range, the message “autopilot baro set fail -- set manually” shall be output when the condition is detected.

2.9 BUILT-IN TEST

The AFCS provides Built-In-Test capabilities to assist service personnel in installing and troubleshooting the system. This capability is accessed via an RS232 port in the cockpit, using a portable PC or dumb terminal.

2.9.1 MANUAL ADJUSTMENTS

The FCC contains a single adjustment potentiometer, which is used to make user/installer adjustments. To make an adjustment, the operator selects the appropriate mode, as shown in the following table. This activates the adjustment pot to adjust the selected offset/parameter.

MODE	**OFFSET/PARAMETER**
ROL (default)	Rate gyro/Roll servo command
VS mode engaged, ALT and DN switches pressed	Pitch servo command
AP engaged and AP switch pressed	Display Brightness (minimum and slope)
AP disengaged and AP switch pressed	Backlighting Brightness

2.9.2 OFFSET COMPENSATION

The FCC also provides offset compensation for the following parameters: Heading Datum, Course Datum, VOR Deviation, Localizer Deviation, GPS Deviation, and Glideslope Deviation. This compensation is accomplished by storing the actual input value when the parameter is at the desired zero condition. These values are stored in nonvolatile memory.

2.9.3 POWERUP TESTS

After application of DC power, the FCC will automatically perform tests of program memory and RAM. Checksum tests will also be performed on all nonvolatile parameters.

2.9.4 PREFLIGHT TEST

After Powerup tests have passed, the FCC will initiate a preflight test sequence to check monitoring hardware for possible latent failures. The accelerometer, acceleration monitor, MET monitor, autotrim/runaway monitor and the trim disable function of the trim servo (if installed) are tested. The maximum trim servo voltage is also checked against the certification value. A minimum of 6.0 VDC is also required from the trim servo, to ensure continuity. If all PFT tests pass, the test ends with a 2.0 second tone on the AFCS Alert output and a flashing visual alert. A lamp test will be performed on the display and annunciators at the same time. If any PFT tests fail, modes associated with the tests will not be allowed. Failure of PFT tests for the acceleration monitor will prevent pitch axis engagement, as indicated by a pitch LED and dashed pitch coupled field, but roll axis will still be allowed. Failures in trim monitoring, indicated by “PT”, will allow autopilot engagement, but autotrim and MET will not be allowed. Manual trim indications will still be presented to the pilot during autopilot operation.

2.10 OPERATING MODES

Normal mode operation will be inhibited until the preflight test has been performed. When the CWS switch is active, the autopilot control will be momentarily released and the pitch mode reference will synchronize to the aircraft if engaged in VS or ALT HOLD modes.

2.10.1 ROLL COUPLED MODES

2.10.1.1 Roll Default Mode (ROL)

The ROL mode uses the combined yaw/roll rate gyro sensor to provide a servo command which will maintain a level roll attitude (by holding yaw rate to zero). This mode is the default roll mode when all other roll modes have been deactivated. The loss of the required sensor for a particular roll mode results in a reversion to the default roll mode. This mode is annunciated by displaying “ROL” in the roll coupled field. The FCC receives roll/yaw rate from the turn coordinator. Invalid rate for 1.0 second results in an autopilot disconnect.

2.10.1.2 Heading Select Mode (HDG)

The HDG select mode provides roll FD commands to track the heading bug on the DG or HSI. The heading datum (err from selected heading) is received from the DG/HSI. The HDG select mode is activated when the HDG button is pressed and HDG select is not already active. Activating HDG select cancels any other lateral tracking mode. It remains active if an ARM mode is selected (such as NAV ARM or APR ARM) until the ARM mode is captured. The HDG select mode can be deactivated by selecting another lateral mode or by pressing the HDG pushbutton again.

When in the HDG select mode, the FCC displays “HDG” in the roll coupled field. In the event the DG becomes invalid for 3.0 seconds, the FCC flashes the “HDG” annunciation and revert to the roll default mode. The flashing of the HDG select annunciation continues until canceled by pressing the HDG pushbutton or until another lateral mode has been selected. Upon deactivation of the flashing, the current selected mode is annunciated.

2.10.1.3 NAV Sensor Selection

The KAP 140 recognizes three types of navigation sensors: VOR, Localizer (ILS), and GPS (or other long-range sensor). This is accomplished by two discrete inputs to the FCC: ILS Energize and GPS Select, according to the following table. If the selected sensor changes when NAV, APR, or REV modes are selected (including ARM modes), the mode will be canceled. If the coupled mode changes due to this cancellation, ROL default mode will be engaged. This forces the new sensor type to be armed before allowing tracking.

GPS SELECT	**ILS ENERGIZE**	**SELECTED SENSOR**
Ground	Ground	GPS Approach
Ground	Open	GPS Enroute
Open	Ground	Localizer (ILS)
Open	Open	VOR

2.10.1.4 Navigation Coupled Mode (NAV)

The NAV coupled mode provides roll commands to capture and track the selected NAV course on the HSI. The preferred intercept is between 30 and 60 degrees, however, the AFCS performs all angle intercepts if course datum is provided. When passing over the VOR station, the FCC commands values that provide stable heading and ignore the erratic VOR deviations in the "cone of confusion". While over the station, course changes are made by selecting a new outbound course on the HSI.

The NAV coupled mode is activated automatically following the selection of the NAV mode, as described in the section below on NAV Arm mode. When NAV capture occurs, the NAV coupled mode cancels any other lateral coupled mode. The NAV coupled mode can be deactivated by selecting another lateral mode or by pressing the NAV pushbutton again.

When in the NAV coupled mode, "NAV" will be annunciated in the roll coupled field. If the NAV Valid remains invalid for 5 seconds (15 seconds for VOR) or DG Valid remains invalid for 5 seconds, the NAV annunciation flashes and the system reverts to the roll default mode. The flashing of the NAV annunciation continues until canceled by pressing the NAV pushbutton or until another lateral mode has been selected. Upon deactivation of the flashing, the current selected roll coupled mode is annunciated. For -27XX, -55XX and -79XX versions, roll steering is also active in this mode.

2.10.1.5 Approach Coupled Mode (APR)

The APR coupled mode provides commands to capture and track the selected NAV sensor within the required approach accuracies. The APR coupled mode is activated automatically following the selection of the APR mode, as described in the section on APR Arm mode. When APR capture occurs, the APR coupled mode cancels all other lateral modes. The APR coupled mode can be deactivated by pressing the APR button again or by selecting another roll mode.

When in the APR coupled mode, "APR" is displayed in the roll coupled field. In the event the NAV deviation information becomes invalid for 5 seconds (15 seconds with VOR) or DG Valid remains invalid for 5 seconds, the APR annunciation flashes and the FCC reverts to the roll default mode. The flashing of the APR indicator on the MSP continues until canceled deactivated by pressing the APR button again or by selecting another roll mode. Upon deactivation of the flashing, the current selected mode(s) is annunciated. For -27XX, -55XX and -79XX versions, roll steering is also active in this mode.

2.10.1.6 Reverse Localizer Coupled Mode (REV)

Reverse Localizer mode is similar to the APR mode (described above) except the GS mode is disabled and the deviation gains are reduced to provide backcourse tracking.

2.10.2 ROLL ARM MODES

2.10.2.1 Navigation Arm Mode (NAV ARM)

The NAV arm mode determines when to automatically activate the NAV coupled mode. The NAV mode is activated whenever the NAV button is pressed and NAV (arm or coupled) mode is not already active. The NAV ARM mode can be deactivated by selecting APR ARM or REV ARM mode or by pressing the NAV pushbutton again. When the NAV mode is selected, if the NAV deflection exceeds the forced capture requirements of the NAV mode, then the NAV ARM mode is activated and a compatible lateral mode (i.e., HDG) can be used to intercept the desired course or track. If the aircraft deviation from the selected course centerline is sufficiently small, or if the rate of closure with the new course is sufficiently high, NAV coupled mode is initiated immediately.

When in the NAV arm mode, “NAV ARM” will be annunciated in the roll arm field. If the NAV Valid remains invalid for 30 seconds or the DG Valid remains invalid for five (5) seconds while in the ARM mode, the NAV ARM mode automatically deactivates, leaving the current coupled mode active.

2.10.2.2 Approach Arm Mode (APR ARM)

The APR arm mode determines when to automatically activate the APR coupled mode. The APR mode is activated when the APR button is pressed and the APR mode is not already active. The APR mode can be deactivated by disengaging the AP or by pressing the APR, NAV, or REV pushbutton. When the APR mode is selected, if the NAV deviation exceeds the forced capture requirements of the APR mode, then the APR ARM mode is activated and a compatible lateral mode (i.e., HDG) can be used to intercept the desired course or track. If the NAV deviation is sufficiently small, or if the rate of closure is sufficiently high, APR Capture is activated immediately.

When in the APR ARM mode, “APR ARM” is displayed in the roll arm field. If the NAV sensor becomes invalid for a period of 30 seconds or the DG Valid becomes invalid for 5.0 seconds while in the ARM mode, the APR ARM mode automatically deactivates, leaving the current coupled mode active.

2.10.2.3 Reverse Localizer Arm Mode (REV ARM)

Reverse Localizer arm mode is similar to APR arm mode, but determines the transition point for REV coupled mode. It is annunciated by “REV ARM” in the roll arm field.

2.10.2.4 ARM modes with DG

The lateral mode logic and annunciation described in the rest of this document applies to an HSI installation. DG installations provide the following differences. When the installation uses a DG instead of an HSI, the heading bug will be used in place of the course pointer for lateral arm modes. Therefore, HDG mode is not compatible with arm modes, since it also uses the heading bug. To compensate for this, DG installations have an additional coupled mode, known as autointercept mode.

2.10.2.5 Autointercept Mode

For DG installations, the FCC provides an automatic 45 degree intercept of the selected navigation course when the system is in HDG mode and NAV ARM or APR ARM or REV ARM is engaged. The system will transition to autointercept mode. This mode is indicated by a blank roll coupled field with a lateral arm mode annunciated (e.g. NAV ARM). For the first five seconds after engagement, autointercept mode will ignore the datum input (to allow the pilot to reposition the heading bug to the desired course). After the five seconds have elapsed, an offset of 45 degrees to the heading bug ("course pointer") will be tracked (with the proper polarity to intercept the NAV deviation).

2.10.2.6 Heading Bug Prompting

Whenever a lateral arm mode is selected in a DG installation, the roll coupled field will flash HDG for five seconds to remind the pilot to set the heading bug to the proper course. After five seconds, the annunciation will change to the proper annunciation for the engaged roll mode: ROL for the default mode or blank for the autointercept mode.

2.10.3 PITCH COUPLED MODES

2.10.3.1 VERTICAL SPEED MODE (VS)

The VS mode is the default pitch mode and provides pitch FD commands to hold the reference vertical speed. The vertical speed reference is initialized to the altitude rate current upon mode selection. The reference is limited to the certified limits. The VS mode is activated when the AP is engaged and another pitch mode has not been selected. It is also activated whenever the AFCS cancels another pitch mode due to invalid sensor(s). Activating VS mode cancels any other vertical tracking mode. It remains active if an ARM mode is selected (such as ALT ARM) until the ARM mode is captured. The VS mode can be deactivated by selecting another vertical mode. When in the VS mode, “VS” is annunciated in the pitch coupled display field.

2.10.3.2 ALTITUDE HOLD MODE (ALT)

The Altitude Hold mode maintains the aircraft altitude at engagement or the reference established by altitude capture or after engagement (with the UP/DN reference inputs). If baro-correction is provided, the mode will track baro-corrected altitude. Otherwise, pressure altitude will be used. The ALT hold mode is activated when the ALT button is pressed and Altitude Hold is not already active. The ALT hold mode can also occur through automatic capture from the altitude arm mode. Activating ALT hold cancels any other vertical tracking mode. It remains active if a vertical ARM mode is selected (GS ARM or ALT ARM) until the ARM mode is captured. The ALT hold mode can be deactivated by selecting another vertical mode or by pressing the ALT pushbutton again.

When in the ALT hold mode, “ALT” is annunciated in the pitch coupled field. In the event the baro-correction information is unavailable or becomes invalid, pressure altitude is used.

2.10.3.3 ALTITUDE CAPTURE PHASE

The Altitude Capture phase of Altitude Hold mode provides pitch commands to capture the selected altitude. Commanded accelerations should not exceed 0.2 g.

2.10.3.4 GLIDESLOPE COUPLED MODE (GS)

The GS coupled mode provides commands to track the glideslope path within the required approach accuracies. An invalid GS Valid or an invalid NAV Valid during GS coupled mode causes a reversion to the default pitch mode. The GS coupled mode is activated automatically, as described in the section titled “Glideslope Arm Mode”. The GS coupled mode can be deactivated by disengaging the AP, by pressing the APR pushbutton, or by selecting another pitch coupled mode (if not within the forced capture limits on GS deviation).

When in the GS coupled mode, “GS” is displayed in the pitch coupled field. In the event the glideslope is invalid for 3 seconds, the GS annunciation flashes and the FCC reverts to the pitch default mode. The flashing of the GS annunciation continues until canceled by selection of another pitch coupled mode. Upon deactivation of the flashing, the current selected mode(s) is annunciated.

2.10.4 PITCH ARM MODES

2.10.4.1 ALTITUDE ARM MODE (ALT ARM)

The Altitude Arm mode determines when Altitude Capture mode should automatically activate, which captures the selected altitude. The flight crew must initiate a maneuver to fly toward the preselected altitude (using the VS mode). Upon reaching the altitude capture point, the VS mode is canceled automatically and the system engages Altitude Capture. The Altitude Arm mode is activated when the ARM button is pressed and the Altitude Arm mode is not already active. The Altitude Arm mode also activates automatically after any change in the selected altitude. Activating Altitude Arm does not cancel any existing pitch coupled mode. When activated, the Altitude Arm mode can be deactivated by pressing the ARM pushbutton. When in the Altitude Arm mode, “ALT ARM” is displayed in the pitch arm field.

2.10.4.2 GLIDESLOPE ARM MODE (GS ARM)

When the GS ARM mode is activated, if the GS deviation exceeds the forced capture requirements of the GS mode, then the GS ARM mode is activated and a compatible pitch coupled mode (i.e., VS) can be used to intercept the glidepath. If the GS deviation is sufficiently small, or if the rate of closure is sufficiently high, GS coupled mode is initiated immediately. When ALT ARM and GS ARM are both active at the same time, if the altitude capture point is reached first, the altitude capture and hold mode is activated leaving GS ARM active. However, if glideslope is captured first, the ALT ARM mode is canceled. The GS Arm mode is activated when the APR coupled mode is active, GS deviation is valid, and GS coupled mode is not active. The GS arm mode can be deactivated by disengaging the AP or by canceling the APR coupled mode (see 3.4.3.2.4.1).

When in the GS ARM mode, “GS ARM” is displayed in the roll arm field. In the event the Glideslope becomes invalid for 10 seconds or the APR coupled mode is deactivated, the GS Arm mode cancels, leaving the current active pitch coupled mode unchanged.

2.10.5 TRIM FUNCTIONS

2.10.5.1 Mistrim Annunciation

If autotrim is not installed, the system shall indicate the need for manual pitch trim whenever the required pitch servo effort exceeds the certified threshold for five seconds. If autotrim is installed, the FCC shall indicate a mistrim after the required pitch servo effect exceeds the certified threshold continuously for ten, or fifteen seconds in -5403, -5504, -7703 and -7904 versions. The mistrim indication shall be a flashing “PT” and either the up or down arrow (to indicate mistrim direction). Trim related voice messages shall be played in accordance with section 2.8.4.

2.10.5.2 Manual Electric Trim

If trim is installed, the FCC commands the trim servo up or down as requested by the MET switch inputs. An up command is generated whenever UP and ARM switches are active; a down command is generated whenever DOWN and ARM switches are active. If both UP and DOWN switches are active simultaneously, no command is generated.

In a two-axis FCC system, pressing the ARM switch for 125 ms causes the autopilot to disengage. This prevents the pitch autotrim from trying to oppose the pilot’s manual trim commands.

2.11 BIT/DIAGNOSTICS

The FCC provides Built-In-Test capabilities to assist the system installer and maintenance personnel. This capability is available through the Remote Terminal Interface, which uses an RS 232 port connected to a portable PC or dumb terminal. The FCC provides nonvolatile storage of codes associated with all types of mode disengagements not requested by pilot. This storage can also be reset by the service person. The FCC also provides status indication of all hardware inputs, monitors and conditions associated with mode logic. This includes sensor valids, mode pushbuttons, and cockpit switches.

2.12 NORMAL ACCELEROMETER

The normal accelerometer provides a signal with a full scale range of at least 0.0 to 2.0 g (absolute). Short-term drift rates should not exceed +/-.005 g/sec.

2.13 STATIC PRESSURE SENSOR

The static sensor provides pressure information from -1,000 ft to 35,000 ft with a 16-bit resolution (approximately 1 foot).

2.14 ALTITUDE/VS COMPUTATION

The static pressure sensor is used to provide differential altitude which is blended with the encoding altimeter input to provide absolute pressure altitude. If available, a baro-correction term is then added to pressure altitude to provide baro-corrected altitude (used for altitude select and altitude alerting functions). Normal acceleration is blended with a high-passed version of the pressure altitude value to produce vertical speed, for pitch control.

2.15 ENCODING ALTIMETER INPUTS

The FCC uses the encoding altimeter inputs to calibrate data from the pressure sensor, yielding an absolute pressure altitude. The baro-correction term can be input either remotely with an analog voltage from the altimeter or via the inc/dec knobs on the FCC. If remote control is selected, the knobs will not be allowed to change baro correction.

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SECTION III
REMOTE TERMINAL INTERFACE

3.1 GENERAL

The FCC provides an RS232 interface for diagnostic and installation capabilities. This interface is required for setting up installation parameters for any new installation and recommended for system troubleshooting. The RS232 interface is provided through a Remote Terminal Interface (RTI) jack located in the cockpit. Plug the compatible computer cable assembly 155-02794-0001 or 155-02794-0002 into the RTI jack. Connect the computer cable connector to the desired COM port on the PC.

3.2 TERMINAL EMULATOR SETUP

The PC will communicate through the RTI by using the terminal emulator in the "ACCESSORIES" group of Microsoft™ Windows version 3.1 or later (Hyper Terminal in Windows95/NT). Use of other interface software is acceptable. The displays are identical when using an alternate terminal emulator. Regardless of software, configure the communications port as follows: 9600 baud rate, 8 data bits, 1 stop bit, no parity (none), Xon/Xoff flow control, and the desired COM port (typically COM1).

NOTE

Verify that the terminal emulator being used is configured to strip out all line feeds and carriage returns (this is the windows terminal emulator default setting). Failure to do so will result in a "CHECKSUM ERROR".

A. Windows 3.1

Double click the "TERMINAL" icon. Upon entering the terminal emulator, select the "Settings" menu item then select "Communications" menu option. Configure the communication port as described above. Click on the "OK".

Select the "Settings" menu item again, and select "Terminal Emulation…" menu option. Select the "DEC VT-100 (ANSI) terminal option. Click the "OK".

Select the "Settings" menu item again, and select "Terminal Preferences…" menu option. Deselect the "Use Function, Arrow, and Ctrl Keys for Windows" option at the bottom of the dialogue box. Click the "OK".

B. Windows 95/NT

Select the Hyper Terminal folder in accessories. Double click the "HPTERM" icon in the Hyper Terminal program group.

Enter a name for your connection (i.e. 140) and select an icon (this setup will work regardless of which icon is chosen). Click "OK".

The COM 1 Properties pop-up box will now appear. Configure this box as described above. Click "OK".

The terminal is now ready to communicate with the KC 140. Press the Enter key to establish communication. If communication is not established verify the computer cable assembly is properly installed.

3.3 NAVIGATING THE REMOTE TERMINAL INTERFACE (RTI) SCREENS

The following discussion of RTI screens assumes that a properly configured terminal is connected to the RTI. If the RTI screen cannot be obtained by pressing the ENTER key or CTRL-W (screen refresh), check the terminal connections and that the terminal is configured as described above.

NOTE

The example screens shown throughout this discussion may include sample data which will not necessarily be seen by the user.

3.3.1 MAIN MENU SCREEN

Upon initial power-up of the FCC, the RTI Main Menu screen will be displayed as shown in Figure 3-1. The Main Menu screen provides selections for entering diagnostics mode, displaying the error log, displaying the software identification number, or configuring the system. The following sections provide specific instructions on using these options.

Note that the built-in preflight test (PFT) mode must finish before these selections can be accessed. This usually takes less than one minute after power up. After PFT is complete, pressing the 'ENTER' key will refresh the Main Menu screen and the system mode displayed at the top of the screen will change from "PFT" to "Normal Mode". This indicates that the options are now available to use.

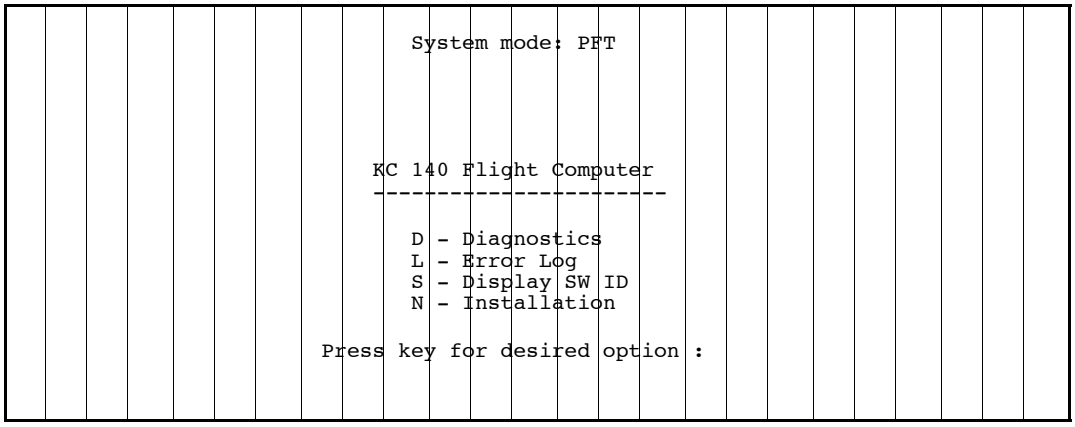


FIGURE 3-1 MAIN MENU SCREEN

NOTE

If the terminal is turned on after the power is applied, the terminal screen will be redrawn when the 'ENTER' key is pressed. Whenever a screen other than the Main Menu screen is active, the Main Menu screen can be returned to by continually pressing the 'ENTER' key, pausing long enough between key presses to allow a new screen to be displayed on the terminal.

3.3.2 DIAGNOSTIC MODE SCREENS

Pressing 'D' while the Main Menu screen is displayed will bring up a diagnostic mode confirmation message on the terminal (Refer to Figure 3-2). At this point, the user should type in "KC140" (upper or lower case) followed by the 'ENTER' key. If successful, the Diagnostics Menu screen shown in Figure 3-3 should be displayed. The diagnostic screen allow the user to view the FCC inputs and control FCC outputs, to validate FCC operation and system interfaces.

NOTE

Pressing the 'ENTER' key at the Diagnostics Menu screen will cause diagnostic mode to be exited.

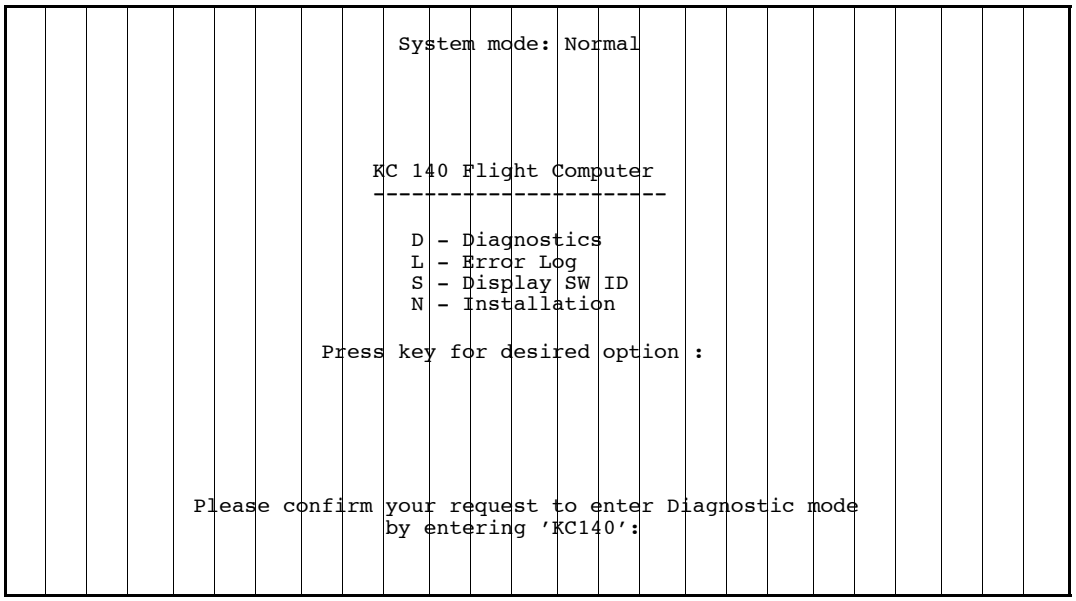


FIGURE 3-2 DIAGNOSTICS CONFIRMATION SCREEN

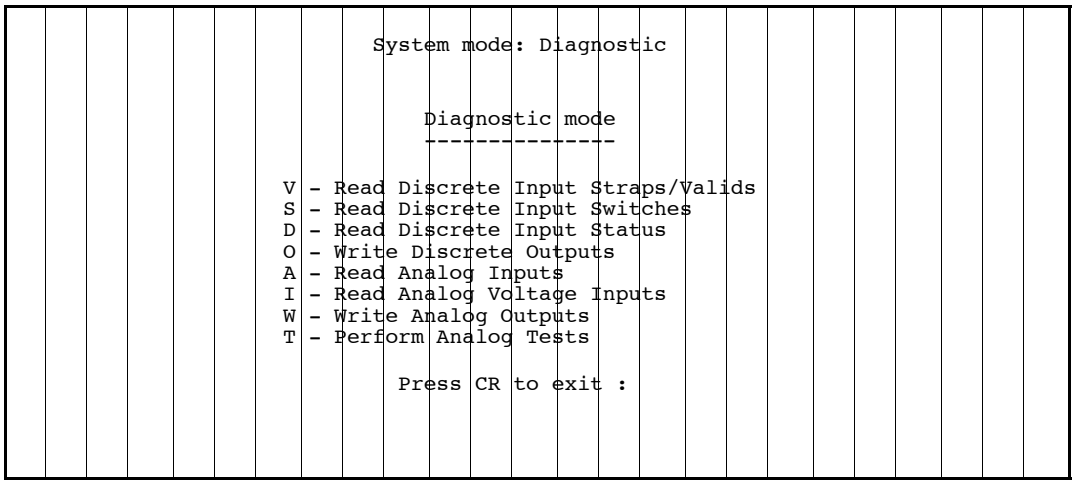


FIGURE 3-3 DIAGNOSTICS MENU SCREEN

3.3.3 DISCRETE INPUT STRAPS/VALIDS SCREEN

Pressing 'V' when the Diagnostics Menu screen is displayed will cause the Discrete Inputs Straps/Valids screen, shown in Figure 3-4, to be displayed. Pressing the 'ENTER' key at this point will return the user to the Diagnostics Menu screen.

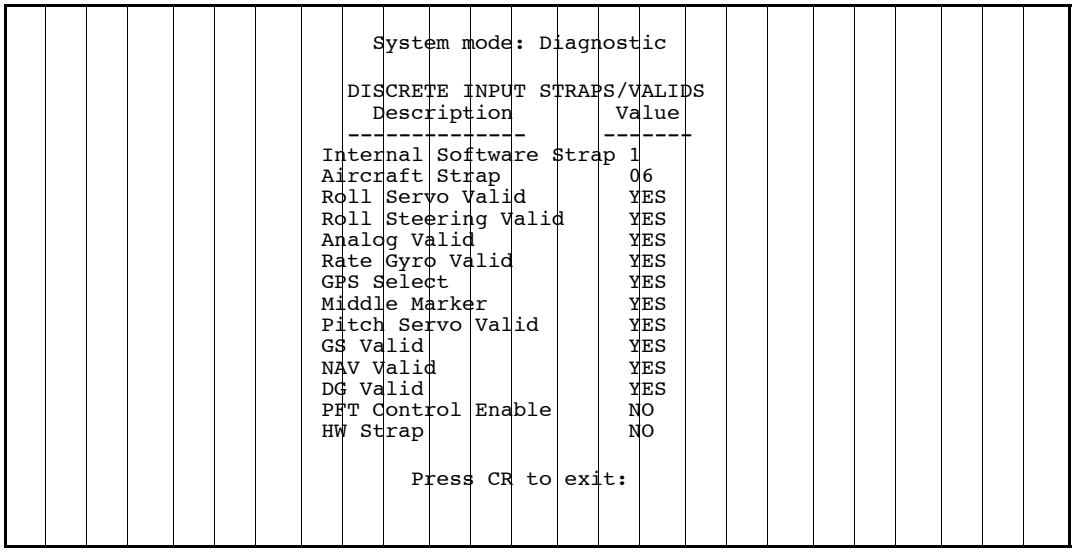


FIGURE 3-4 DISCRETE INPUT STRAPS/VALIDS SCREEN

The Discrete Input Straps/Valids screen contains the current status of internal and external configuration straps and validity discretes and Middle Marker.

ITEM	DESCRIPTION
Internal Software Strap	Internal strap code derived from internal circuit jumpers CJ1 and CJ2 located in the unit bezel assembly. These internal straps are used by software to identify the version of unit hardware: 0 = Dual Axis with Altitude Preselect (-7xxx), 1 = Dual Axis (-5xxx), 2 = Single Axis (-2xxx).
Aircraft Strap	Strap code derived from open/ground discrete inputs which represent the harness strap value for a particular aircraft installation. Identified as STRAP_6 through STRAP_1 in the harness, STRAP_6 represents the most significant bit and STRAP_1 the least significant bit. A ground on the input represents logic "one" and an open represents a logic "zero". During preflight test, these inputs are compared against the strap code defined in the certification data stored in the configuration module.

ITEM	DESCRIPTION
Roll Servo Valid	Open/Ground discrete input driven by the roll servo valid discrete output. A 'YES' implies the input is grounded and therefore the roll servo is valid. Otherwise, 'NO' indicates input is open and roll servo is invalid.
Roll Steering Valid	>11V/Open discrete input driven by the roll steering valid discrete ouput. A 'YES' implies that the input is greater than 11 volts and therefore the roll steering is valid. Otherwise 'NO' indicates input is invalid.
Analog Valid	Internal discrete which reflects the status of internal ± 15V power supply references within the unit. A 'YES' implies these references are within monitor tolerances. A 'NO' implies supply references are outside acceptable tolerances.
Rate Gyro Valid	9V/open discrete input driven by rate gyro valid output. A 'YES' implies the input is >9V and therefore the rate gyro is valid. Otherwise, 'NO' implies the input is open and the rate gyro is invalid.
GPS Select	Open/Ground discrete input connected to output of a GPS receiver. A 'YES' implies the input is grounded and therefore GPS is the selected NAV sensor to the autopilot. Otherwise, 'NO' implies the input is open and GPS is not selected.
Middle Marker	Comparator input connected to the middle marker annunciator located in the audio panel. A 'YES' implies input is above 2.3V threshold and therefore middle marker is active. Otherwise, 'NO' implies the input is below 1.8V threshold and the middle marker is not active.

NOTE

An open input to the Middle Marker may also appear to be active in -2501, -5101, and -5201 flavor FCCs.

Pitch Servo Valid	Open/Ground discrete input connected to the pitch servo valid discrete output. A 'YES' implies the input is grounded and therefore the pitch servo is valid. Otherwise, 'NO' implies input is open and the pitch servo is invalid.

ITEM	DESCRIPTION
GS Valid	Differential analog input connected to the GS receiver valid output. A 'YES' implies the glideslope valid signal is greater than a 140mV threshold and therefore the receiver is valid. Otherwise, 'NO' implies the signal is less than this threshold and the receiver is invalid.NAV Valid Differential analog input connected to the NAV receiver valid output. A 'YES' implies the navigation valid signal is greater than a 140mV threshold and therefore the receiver is valid. Otherwise, 'NO' implies the signal is less than this threshold and the receiver is invalid.
DG Valid	Open/Ground discrete input connected to the directional gyro valid output. A 'YES' implies the input is grounded and therefore the gyro is valid. Otherwise, 'NO' implies input is open and gyro is invalid.
PFT Control Enable (-xxx2, -xxx3, -xxx4 versions only)	Open/Ground discrete input used during production bench test only. It enables the use of internal control signals for evaluation purposes, normally disabled after completion of preflight test. A 'YES' implies the input is grounded and the function is enabled. A 'NO' implies the input is open and the function is disabled. This function should be always be disabled in the aircraft.
HW Strap	Internal hard-wired strap used on certain versions of software to identify internal functional differences in hardware. A 'YES' implies -5201 FCC and a 'NO' implies all other flavors.

3.3.4 DISCRETE INPUT SWITCHES SCREEN

Pressing ‘S’ when the Diagnostics Menu screen is displayed will cause the Discrete Inputs Switches screen, shown in Figure 3-5, to be displayed. Pressing the ‘ENTER’ key at this point will return the user to the Diagnostics Menu screen.

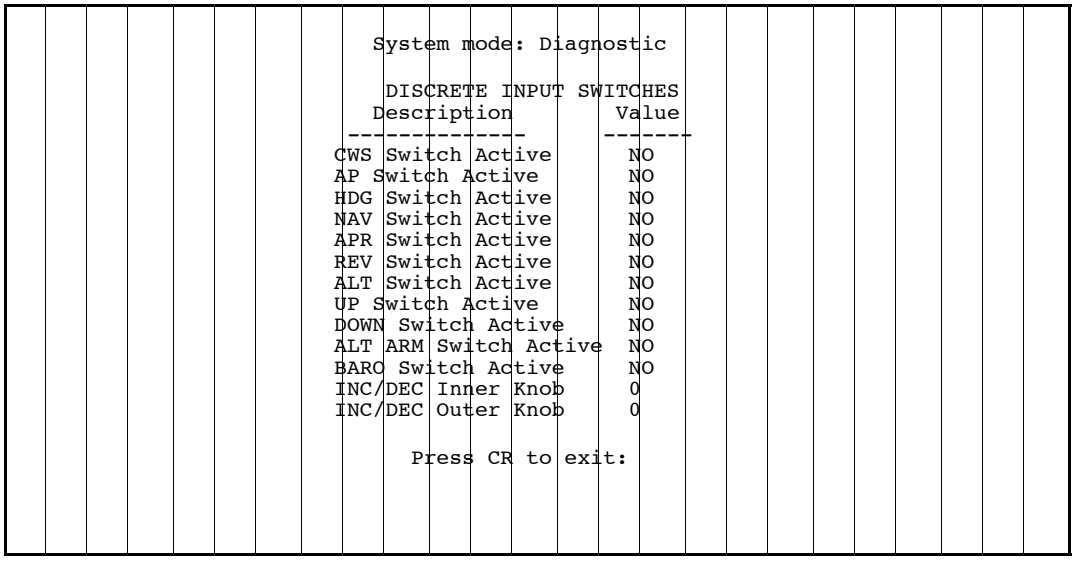


FIGURE 3-5 DISCRETE INPUT SWITCHES SCREEN

The Discrete Input Switches screen contains the current status of the FCC front panel pushbuttons, rotary select knob, and external switches in the aircraft.

ITEM	DESCRIPTION
CWS Switch	Momentary pushbutton on aircraft control wheel used to temporarily release autopilot control and synchronize reference in Vertical Speed and Altitude Hold modes. ‘YES’ implies input is grounded and therefore CWS switch is being pressed. ‘NO’ implies input is open and CWS switch is not pressed.
AP Switch	Momentary pushbutton on front panel of the FCC used to engage default autopilot modes. ‘YES’ implies switch is pressed. ‘NO’ implies switch is not pressed.
HDG Switch	Momentary pushbutton on front panel of the FCC used to engage/disengage Heading Select mode. ‘YES’ implies switch is pressed. ‘NO’ implies switch is not pressed.
NAV Switch	Momentary pushbutton on front panel of the FCC used to engage/disengage Navigation Arm and Tracking modes. ‘YES’ implies switch is pressed. ‘NO’ implies switch is not pressed.

ITEM	DESCRIPTION
APR Switch	Momentary pushbutton on front panel of the FCC used to engage/disengage Approach Arm and Tracking mode. 'YES' implies switch is pressed. 'NO' implies switch is not pressed.
REV Switch	Momentary pushbutton on front panel of the FCC used to engage/disengage Reverse Localizer Tracking mode. 'YES' implies switch is pressed. 'NO' implies switch is not pressed.
ALT Switch	Momentary pushbutton on front panel of the FCC used to engage/disengage Alt Hold mode. 'YES' implies switch is being pressed. 'NO' implies switch is not pressed.
UP Switch	Momentary pushbutton on front panel of the FCC used to change vertical speed or altitude reference to cause aircraft to nose upward. 'YES' implies switch is pressed. 'NO' implies switch is not pressed.
DN Switch	Momentary pushbutton on front panel of the FCC used to change vertical speed or altitude reference to cause aircraft to nose downward. 'YES' implies switch is pressed. 'NO' implies switch is not pressed.
ALT ARM Switch	Momentary pushbutton on front panel of the FCC used to engage/disengage Altitude Arm mode. 'YES' implies switch is being pressed. 'NO' implies switch is not pressed.
BARO Switch	Momentary pushbutton on front panel of the FCC used with rotary knobs to adjust baro setting. Also toggles baro units between hPa and Hg. 'YES' implies switch is pressed. 'NO' implies switch is not pressed.
INC/DEC Inner Knob	Rotary switch used to adjust baro setting by 0.01 in Hg / 10 hPa increments or change selected altitude in 100 ft steps. The value displayed on the diagnostic screen represents the current position of the switch. As the switch is rotated clockwise the value will change according to the sequence 0, 2, 3, 1, 0, 2, 3, 1 and continue to repeat. A counter-clockwise rotation will produce the reverse sequence 0, 1, 3, 2, 0, 1, 3, 2 and repeat.

ITEM	DESCRIPTION
INC/DEC Outer Knob	Rotary switch used to adjust baro setting by 0.1 in Hg / 100 hPa increments or change selected altitude in 1000 ft steps. The value displayed on the diagnostic screen represents the current position of the switch. As the switch is rotated clockwise the value will change according to the sequence 0, 2, 3, 1, 0, 2, 3, 1 and continue to repeat. A counter-clockwise rotation will produce the reverse sequence 0, 1, 3, 2, 0, 1, 3, 2 and repeat.

3.3.5 DISCRETE INPUT STATUS SCREEN

Pressing 'D' when the Diagnostics Menu screen is displayed will cause the Discrete Inputs Status screen, shown in Figure 3-6, to be displayed. Pressing the 'ENTER' key at this point will return the user to the Diagnostics Menu screen.

This screen contains the current status of external switches and discrete signals from various components in the aircraft. It also includes internal status discretes associated with hardware monitors within the FCC.

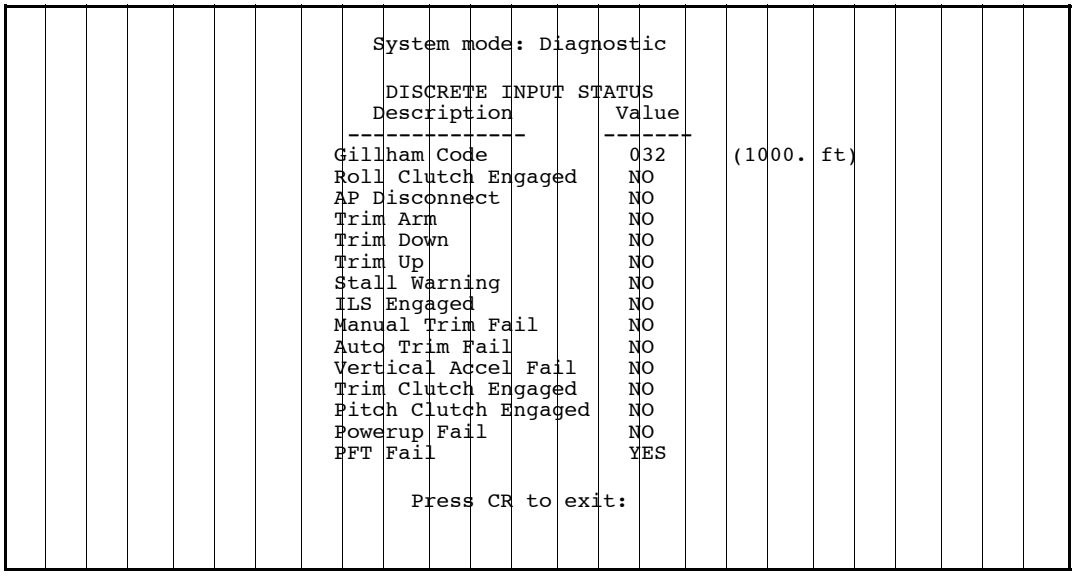


FIGURE 3-6 DISCRETE INPUT STATUS SCREEN

ITEM	DESCRIPTION
Gillham Code	Encoded altitude used to calibrate pressure sensor data to yield an absolute altitude. Provided to autopilot through gray-coded (Gillham) altitude discrete signals from an encoding altimeter: D4, A1, A2, A4, B1, B2, B4, C1, C2, C4. Values displayed on diagnostic screen include a 10 bit binary number where the bit weighting is ordered as above, and its representative scaled altitude in feet (when inputs represent a valid code).

ITEM	DESCRIPTION
Roll Clutch Engaged	Indicates engagement status of roll clutch solenoid based on sensing current flow through the low side solenoid driver in the FCC. The detection threshold is set at 120mA with a hysteresis of 30mA. A 'YES' implies solenoid current is greater than the detection threshold and therefore the roll clutched is engaged. A 'NO' implies solenoid current is less than the detection threshold and therefore the roll clutch is not engaged.
AP Disconnect	Momentary pushbutton on the control wheel which disengages the autopilot and interrupts power to the trim servos when pressed. The switch interfaces to a 28V/Open discrete input on the FCC. A 'YES' implies the input is open and therefore the switch is pressed. A 'NO' implies the input is at 28V and the switch is not pressed.
Trim Arm	Momentary pushbutton on the control wheel used in conjunction with the manual trim up and down switches to issue a trim command to the autopilot. Interfaces to a Open/Ground discrete input on the FCC. A 'YES' implies the input is grounded and therefore the switch is pressed. A 'NO' implies the input is open and the switch is not pressed.
Trim Down	Momentary pushbutton on the control wheel used to issue a trim up command to the autopilot. Interfaces to a Open/Ground discrete input on the FCC. A 'YES' implies the input is grounded and therefore the switch is pressed. A 'NO' implies the input is open and the switch is not pressed.
Trim Down	Momentary pushbutton on the control wheel used to issue a trim down command to the autopilot. Interfaces to a Open/Ground discrete input on the FCC. A 'YES' implies the input is grounded and therefore the switch is pressed. A 'NO' implies the input is open and the switch is not pressed.
Stall Warning	Reserved for future use.

ITEM	DESCRIPTION
ILS Engaged	Open/ground discrete input connected to a discrete output of either a VOR/ILS or GPS receiver. For a VOR/ILS receiver, a 'YES' implies the input is grounded and the receiver is in ILS mode. A 'No' implies the input is open and the receiver is in VOR mode. When GPS is the selected receiver, a 'YES' implies the receiver is in Approach mode. A 'NO' implies the receiver is not in Approach mode.
Manual Trim Fail	Internal discrete which reflects the status of the manual trim switch monitor. This monitor detects invalid manual trim switch inputs that exist for more than 2.5 seconds. A 'YES' implies the monitor has detected a stuck switch. 'NO' implies the switch states are valid.
Auto Trim Fail	Internal discrete which reflects the status of the trim runaway monitor. When the autopilot is engaged in the pitch axis, this monitor detects a trim servo drive that is in opposition to the pitch servo command. When the autopilot is not engaged in the pitch axis, this monitor detects trim servo drive in the absence of a corresponding manual trim switch command. A 'YES' implies the monitor has detected an invalid trim condition. A 'NO' implies the trim drive is valid.
Vertical Accel Fail	Internal discrete which reflects the status of the acceleration monitor. This monitor detects excessive accelerations that exceed ± 0.4g for greater than 0.4 seconds. In certain flavors, the pitch servo must also be moving in a direction that would produce the acceleration. A 'YES' implies the monitor has detected an excessive acceleration. A 'NO' implies that the monitor is not tripped.
Trim Clutch Engaged	Indicates engagement status of trim clutch solenoid based on sensing current flow through the low side solenoid driver in the FCC. The detection threshold is set at 120mA with a hysteresis of 30mA. A 'YES' implies solenoid current is greater than the detection threshold and therefore the trim clutch is engaged. A 'NO' implies solenoid current is less than the detection threshold and therefore the trim clutch is not engaged.

ITEM	DESCRIPTION
Pitch Clutch Engaged	Indicates engagement status of pitch clutch solenoid based on sensing current flow through the low side solenoid driver in the FCC. The detection threshold is set at 120mA with a hysteresis of 30mA. A 'YES' implies solenoid current was greater than the detection threshold and therefore the pitch clutched is engaged. A 'NO' implies solenoid current is less than the detection threshold and therefore the pitch clutch is not engaged.
Power Up Fail	Internal discrete which reflects the result of the built in self-test of the core functions of the FCC when power is first applied. This includes the microcontroller, read-only and random access memory, and watchdog timer. A 'YES' indicates the power-up test has failed. A 'NO' indicates the test has passed.
PFT Fail	Internal discrete which reflects the result of the built in self test of primary functions of the flight control system when power is first applied. A 'YES' indicates that one or more pre-flight test steps has failed. A 'NO' indicates all tests passed. PFT failures inhibit one or more of the following functions: trim (autotrim and MET), autopilot (pitch and roll), or pitch modes (allowing roll operation).

3.3.6 DISCRETE OUTPUTS SCREEN

Pressing ‘O’ when the Diagnostics Menu screen is displayed will cause the Discrete Outputs Status screen, shown in Figure 3-7, to be displayed. Pressing the ‘ENTER’ key at this point will return the user to the Diagnostics Menu screen.

```
                System mode: Diagnostic

              SET DISCRETE OUTPUTS
              --------------------
        (Enter 1 or 0 [0-7 for Audio Volume])

        1 - Audio Alert                  0
        2 - Visual Alert                 0
        3 - Roll Fail Annunciator        0
        4 - Pitch Fail Annunciator       0
        5 - AP Annunciator               0
        6 - Audio Volume                 4
        7 - PFT                          0
        8 - PFT Clear                    0
        9 - MET/PFT Up                   0
        10 - MET/PFT Down                 0
        11 - MET/PFT Arm                  0
        12 - Normal Acceleration Test     0
        13 - PFT Pitch Clutch             0
        14 - Roll Clutch                  0
        15 - Pitch Clutch                 0
        16 - Pitch Trim Clutch            0

      Press key for desired option (<CR> to exit)
```

FIGURE 3-7 NO TAG DISCRETE OUTPUTS SCREEN

This screen consists of FCC discrete outputs which can be manually activated and deactivated. This is accomplished by entering the desired option number, for example ‘15’ for Pitch Clutch. The following message will appear.

```
Enter value for Pitch Clutch            ():
```

Entering a ‘1’ will activate the discrete output, and entering a ‘0’ will deactivate it. The discrete outputs will remain active even though the Discrete Outputs screen is exited but will automatically deactivate if Diagnostics mode is exited.

ITEM	DESCRIPTION
Audio Alert	A “1” on this output generates the AP disconnect tone to the 500 ohm output and to the TONE_ALERT output, used to drive an external sonalert.
Visual Alert	A “1” on this output turns on an external AP DISC annunciator.
Roll Fail Annun, Pitch Fail Annun	A “1” on these outputs turns on the R or P LED axis failure indicators on the FCC.
AP Annunciator	A “1” on this output “arms” the AP disconnect alerting, causing a disconnect tone to be generated when it is written to “0”.

ITEM	DESCRIPTION
Audio Volume	This output can be set from “0” (minimum volume) to “7” (maximum volume), to adjust the 500 ohm audio output level. NOTE: Audio Volume settings made on this screen will only affect the volume while in diagnostics, except in units with 01/04 SW or earlier. With these SW versions, the user should set the volume back to the installation value when finished with diagnostic tests.
PFT	A “1” on this output changes the inputs to the hardware monitors, allowing the software to exercise them during PFT.
PFT Clear	A “1” on this output resets the trim runaway monitor latch.
MET/PFT Up, MET/PFT Dn, MET/PFT Arm	When the PFT output is asserted (“1”), these outputs can be used to test the MET latent switch failure monitor, replacing the MET switch inputs from the harness.
Normal Acceleration Test	A “1” on this output causes the accelerometer to bias its output by 5 g, allowing the interface circuitry to be checked during PFT.
PFT Pitch Clutch	A “1” on this output causes the hardware monitors to act as if the pitch clutch were engaged, i.e. provide autotrim and acceleration monitoring. This is used during PFT to exercise these monitors without actually engaging the pitch servo.
Roll Clutch, Pitch Clutch, Pitch Trim Clutch	A “1” on these outputs will engage the associated servo clutch unless power is removed form the servo (e.g. via the AP DISC switch) or a hardware monitor has failed that prevents clutch engagement (see servo interface sections for details).

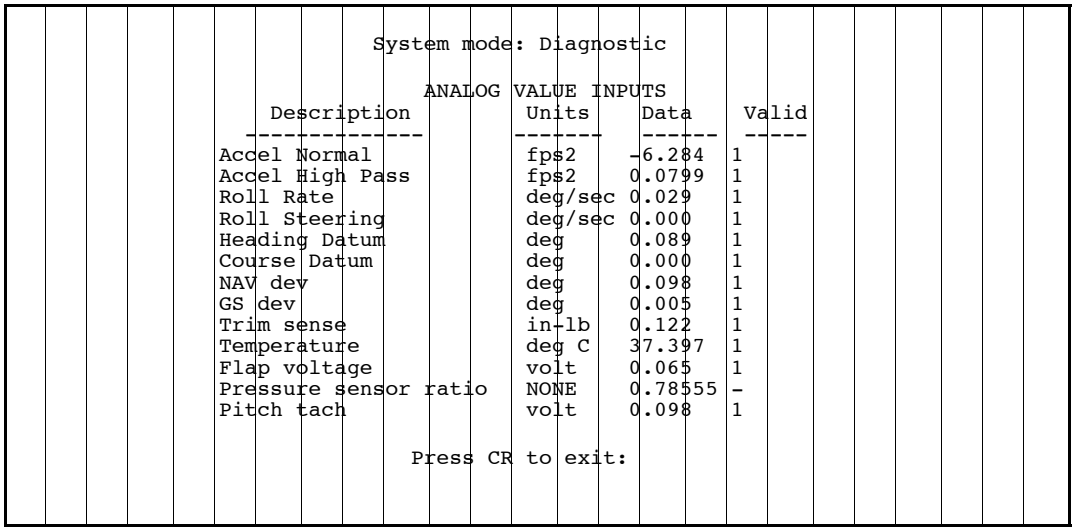
3.3.7 ANALOG INPUTS SCREEN

Pressing 'A' when the Diagnostics Menu screen is displayed will cause the Analog Inputs screen, similar to Figure 3-13, to be displayed. Pressing 'ENTER' when this screen is displayed returns the user to the Diagnostics Menu screen.

This screen includes analog inputs from various sensor sources, typically scaled in engineering units. Each data value displayed is updated at 8 Hz. Also included is the unit of measure and an indication as to whether the signal is valid ("1" = valid; "0" = invalid), based upon an associated valid input (if available) or a general analog valid (based upon internal ±15V supplies).

NOTE

For units with SW version 01/04 or earlier, the analog value is not updated if the signal is considered invalid. Therefore, for these units, the value does not necessarily represent the current input if the signal is flagged invalid.



System mode: Diagnostic

ANALOG VALUE INPUTS

Description	Units	Data	Valid
Accel Normal	fps2	-6.284	1
Accel High Pass	fps2	0.0799	1
Roll Rate	deg/sec	0.029	1
Roll Steering	deg/sec	0.000	1
Heading Datum	deg	0.089	1
Course Datum	deg	0.000	1
NAV dev	deg	0.098	1
GS dev	deg	0.005	1
Trim sense	in-lb	0.122	1
Temperature	deg C	37.397	1
Flap voltage	volt	0.065	1
Pressure sensor ratio	NONE	0.78555	-
Pitch tach	volt	0.098	1

Press CR to exit:

FIGURE 3-8 ANALOG INPUTS SCREEN

ITEM	DESCRIPTION
Accel Normal	Normal accelerometer sensor internal to the FCC. This input may have a large offset (up to 64 fps^2); only relative measurements are meaningful. Input range is ±161 fps^2. Displayed resolution is 0.32 fps^2 per bit. Validity based on internal Analog Valid.
Accel High Pass	(-xxx2, -xxx3, -xxx4 versions only) High-pass filtered and re-scaled version of internal Accel Normal signal. High-pass filter time constant is 35 seconds. Input range is ±40.2 fps^2 . Displayed resolution is 0.08 fps^2 per bit. Validity based on internal Analog Valid.

ITEM	DESCRIPTION
Roll Rate	Combined roll rate and yaw rate output signal supplied from the turn coordinator with a scale factor of 333 mV per deg/sec. Input range is ± 7.5 deg/s. Displayed resolution is 0.014 deg/s per bit. Validity based on Rate Valid input.
Roll Steering	Roll steering signal is supplied from the KLN 94 with a scale factor of 2 volts per deg/sec. Input range is ± 6 deg/sec. Displayed resultion is 0.012 deg/sec per bit. Validity based on Roll Steering valid.
Heading Datum	Heading datum signal supplied from a horizontal situation indicator with a scale factor of 550 mV per degree. Input range is ± 25 degrees. Displayed resolution is 0.089 degrees per bit. Validity based on DG Valid input.
Course Datum	Course datum signal supplied from a directional gyro or horizontal situation indicator with a scale factor of 210 mV per degree. Input range is ± 60 degrees. Displayed resolution is 0.116 degrees per bit. Validity based on DG Valid input.
NAV dev	Navigation deviation signal supplied from the VOR/ILS or GPS receiver with a scale factor of 15mV per degree VOR (equivalent to 10% of Full Scale deflection). Input range is ± 16.7 degrees. Resolution of display value is 0.033 degrees per bit. Validity based on NAV Valid input.
GS dev	Glideslope deviation signal supplied from the VOR/ILS receiver with a scale factor of 214mV per degree. Input range is ± 1.17 degrees. Resolution of display value is 0.0023 degrees per bit. Validity based on GS Valid input.
Trim sense	Torque output supplied from KS270C Pitch servo with a scale factor of 100mVper in-lb. Input range is ± 31 in-lb where positive implies CW torque. Resolution of display value is 0.061 in-lb per bit. Validity based on internal Analog Valid.
Temperature	Temperature sensor internal to the FCC. Input range is -273 °C to + 227 °C. Displayed resolution is 0.49 °C per bit. Validity based on Analog Valid.

ITEM	DESCRIPTION
Pressure sensor ratio	Pressure sensor internal to the FCC. The displayed value is a ratio of sensor output to supply reference. Sensor range is from 0.89500 (-2500 ft) to 0.00000 (+51,800 ft). Note an increase in altitude corresponds to a decrease in pressure sensor ratio. Sensor ratio scale factor is -0.03047 per in-Hg where 1 in-Hg is approximately 1000 ft near sea level. Resolution of display value is 0.0000153 per bit. There is no validity displayed, but the sensor must be within a range of 0.89500 (-2500 ft) to 0.07378 (+40,000 ft) to be considered valid by unit.
Pitch tach	Tachometer output supplied from the KS270C Pitch servo. Scale factor is flavor dependent therefore displayed value is in volts. Each servo flavor is scaled so that output signal is approximately 5.3V at full speed (unloaded). Therefore signal can be expressed in terms of percentage no load speed, where %NL Speed = Vtach / 5.3V. Input range is ± 25V. Resolution of display value is 49mV per bit. Validity based on internal Analog Valid.

3.3.8 ANALOG VOLTAGE INPUTS SCREEN

Pressing 'I' when the Diagnostics Menu screen is displayed will cause the Analog Inputs screen, similar to Figure 3-9, to be displayed. Pressing 'ENTER' when this screen is displayed returns the user to the Diagnostics Menu screen.

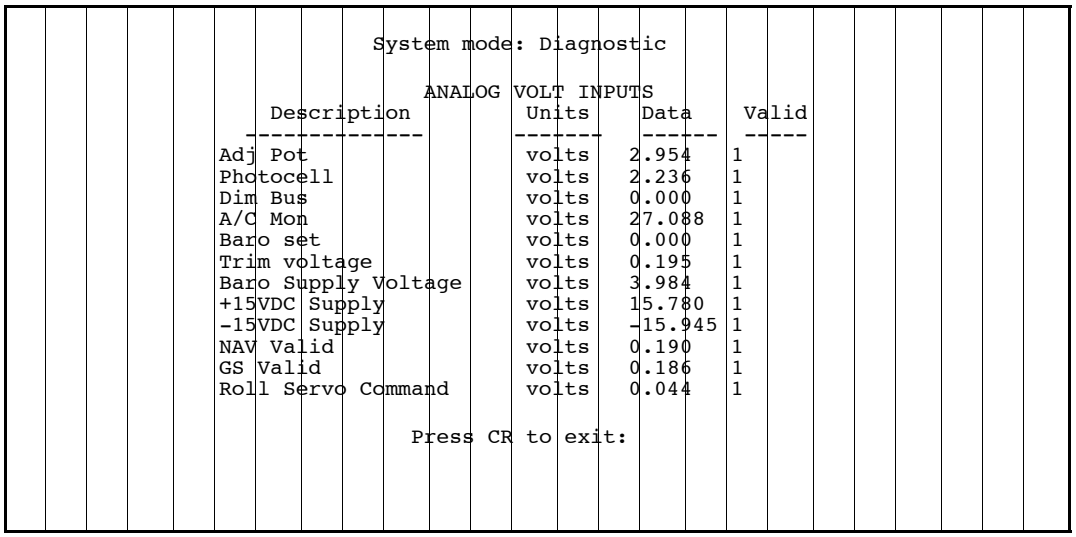


FIGURE 3-9 ANALOG VOLTAGE INPUTS SCREEN

This screen includes analog inputs associated with internal references with scaled values in volts. The data values displayed are updated at 8 Hz. Also included is the unit of measure and an indication as to whether the signal is valid.

ITEM	DESCRIPTION
Adj. Pot	Adjustment potentiometer accessible through the FCC front panel, used to make installation adjustments. This value is from a single turn, 270-degree rotation potentiometer with an adjustment range of 0 to 5V. Validity based on internal Analog Valid.
Photocell	Photocell embedded in FCC front panel used to automatically adjust intensity of gas-discharge display based on ambient light level. Displayed value will be near 0V when photocell is covered and 4.5V when photocell is exposed to bright light. Resolution of display value is 4.9mV per bit. Validity based on internal Analog Valid.

ITEM	DESCRIPTION
Dim Bus	Aircraft lighting power bus input to the FCC to adjust brightness of pushbutton and panel nomenclature. Input range is 0 to 34.5 VDC. Resolution of display value is 34 mV per bit. Validity based on internal Analog Valid.
A/C Mon	Aircraft +28V/+14VDC power bus input to the FCC. Input range is 0V to +34.5 VDC. Resolution of display value is 34mV per bit. Validity based on internal Analog Valid.
Baro set	Adjustment potentiometer located in the KEA 130A altimeter used to supply a baro correction signal to the FCC. The potentiometer has a resistance of 2500 ohms and is energized by a 4.0V reference supplied by the FCC. Input range is 0 to 5V. Resolution of display value is 4.9mV per bit. Validity based on internal Analog Valid.
Trim Voltage	Motor voltage supplied from Trim servo and monitored by FCC. Input range is ± 33.4V. Resolution of display value is 65 mV per bit. Validity based on internal Analog Valid.
Baro Supply Voltage	Reference voltage supplied by FCC to power a baro correction adjustment pot located in the KEA 130A altimeter. Reference voltage is 4.0V ± 0.2V. Resolution of display value is 4.9mV per bit. Validity based on internal Analog Valid.
+15V Supply	Internal reference voltage used to power analog signal conditioning circuits within the FCC. Reference voltage is 15V ± 1.5V. Input range is 0 to 17.5V. Resolution of display value is 17.0 mV per bit. Validity discrete is always '1'.
-15V Supply	Internal reference voltage used to power analog signal conditioning circuits within the FCC. Reference voltage is -15V ± 1.5V. Input range is -25.5V to +5V. Resolution of display value is 30 mV per bit. Validity discrete is always '1'.
NAV Valid	Low-level analog validity signal supplied from the VOR/ILS receiver. Amplitude is based on strength of radio signal. The NAV deviation signal is considered valid when this output is above 180mV. Input range is ± 402 mV. Resolution of display value is 0.78mV per bit. Validity based on internal Analog Valid.

ITEM	DESCRIPTION
GS Valid	Low-level analog validity signal supplied from the VOR/ILS receiver. Amplitude is based on strength of radio signal. The GS deviation signal is considered valid when this output is above 180mV. Input range is ± 402 mV. Resolution of display value is 0.78mV per bit. Validity based on internal Analog Valid.
Roll Servo Command	Roll Servo command output signal from FCC looped back internally for verification during preflight test. Input range is ± 2.5V. Resolution of display value is 4.9mV per bit. Validity based on internal Analog Valid.

3.3.9 ANALOG OUTPUTS SCREEN

Pressing 'W' when the Diagnostics Menu screen is displayed will cause the Set Analog Outputs screen, Figure 3-10, to be displayed. Pressing 'ENTER' when this screen is displayed returns the user to the Diagnostics Menu screen.

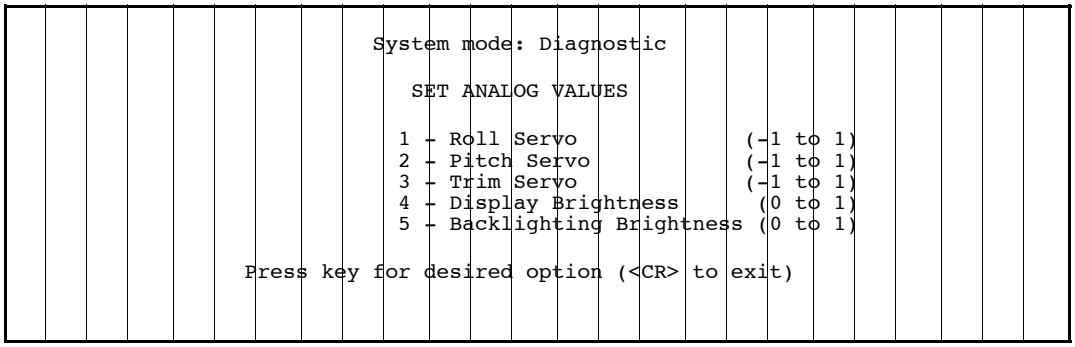


FIGURE 3-10 ANALOG OUTPUTS SCREEN

This screen consists of the FCC servo command outputs and internal display and panel lighting brightness controls. Each output can be manually controlled through this screen. This is accomplished by entering the selected option number, for example '1' for Roll Servo. The following message will appear.

```
Enter value for Roll Servo       (-1 to 1) ():
```

Entering a value between 1 and -1 will generate a voltage at the Roll Servo command output between +10V and -10V when a servo is connected. The output level will remain even though the Analog Outputs screen is exited but will return to zero if Diagnostics mode is exited.

The above values also apply to the Pitch Servo and Trim Servo command outputs.

For display and backlighting brightness, a value from 0 to 1 must be entered. This value represents a percentage of the maximum voltage available to the circuit. For example a value of 0.2 represents 20% of the maximum voltage. Brightness levels increase and decrease relative to this percentage but are not directly proportional.

3.3.10 ANALOG TESTS SCREEN

Pressing ‘T’ when the Diagnostics Menu screen is displayed will cause the Analog Tests screen, shown in Figure 3-11, to be displayed. Pressing ‘ENTER’ when this screen is displayed returns the user to the Diagnostics Menu screen. Pressing a key corresponding to a particular test on the Analog Test screen will cause that test to be performed.

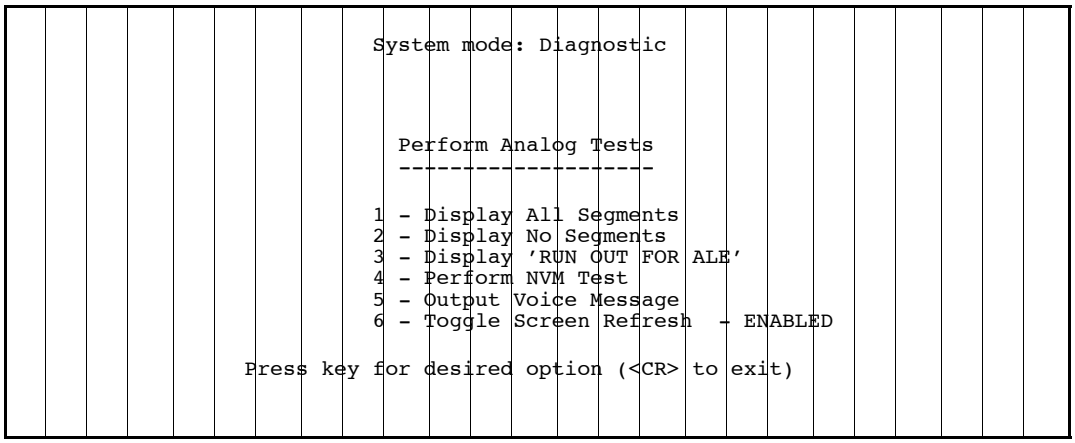


FIGURE 3-11 ANALOG TESTS SCREEN

Test selections 1 through 3, ‘Display All Segments’, ‘Display No Segments’, and Display ‘RUN OUT FOR ALE’ are designed to exercise the gas-discharge display. These tests allow the user to check for missing segments, verify all segments turn off, and evaluate display brightness settings.

Test selection 4 verifies the KCM 100 Configuration Module (Nonvolatile Memory) is working properly. The FCC copies the data stored in the configuration module to local storage. It then verifies that each memory location within the module can be read from and written to. Once complete, it restores the original data back into the configuration module and reports the pass/fail status with a message as shown below.

```
Result of the specified test: PASS
```

Test selection 5, ‘Output Voice Message’, generates the voice message: “Autopilot baro set fail, set manually” on the audio output. NOTE: This test only applies to versions of the FCC with voice messaging capability.

Test selection 6, ‘Toggle Screen Refresh’, allows the user to ENABLE or DISABLE continual update of data to the remote terminal display. When ENABLED, the data values on the Analog Input screens will be constantly updated. When DISABLED, the analog data will only be sampled once upon entry into the analog screens.

3.3.11 ERROR LOG SCREEN

Pressing ‘L’ when the Main Menu screen is displayed will cause the Error Log Menu screen, shown in Figure 3-12, to be displayed.

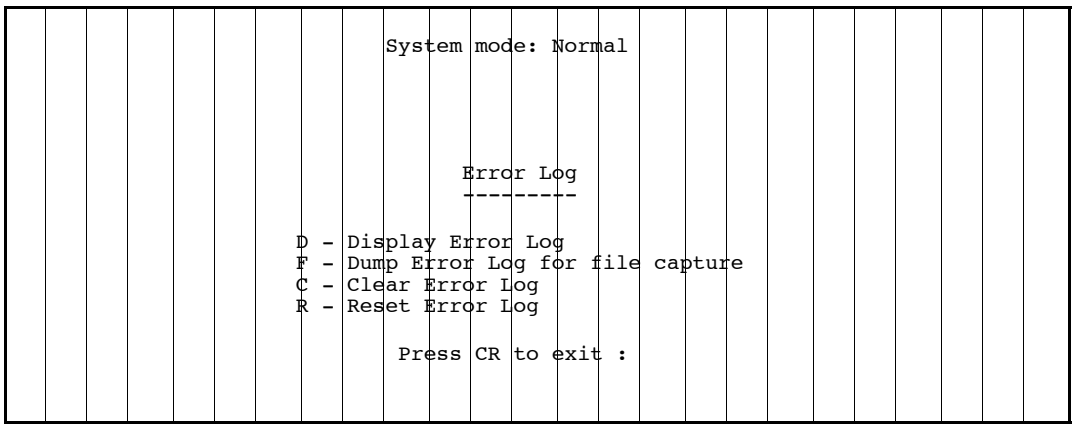


FIGURE 3-12 ERROR LOG MENU SCREEN

Pressing ‘D’ when the Error Log Menu screen is displayed will cause the Error Log Data screen, similar to Figure 3-13, to be displayed. The top of this screen indicates the total number of errors stored in non-volatile memory (available for display), the current power cycle number and the amount of elapsed time since the beginning of the current power cycle (at the time the Error Log Data screen was entered) in hours:minutes:seconds format. The power cycle number is incremented each time power is cycled to the unit.

The error log data table displayed on this screen contains one line (row) of information for each error stored. The most recent error stored in the error log is the last error in the table (has the highest sequence number). The first column (“#”) contains the error sequence number. The second column (“Power cycle”) contains the power cycle number in which the error occurred and was recorded. The third column (“Delta Time”) contains the elapsed time (in hours:minutes:seconds format) since the beginning of the power cycle in which the error was recorded until the time the error occurred. The fourth column (“Error”) contains the error number. The fifth column (“Description”) contains a brief description of the error. For more details on a particular error logged, see Appendix A, Error Codes.

A maximum of seventeen (17) errors can be displayed on this screen at any one time. The error log table may be scrolled one line (row) at a time with the up or down arrow keys, or a page at a time with the right or left arrow keys.

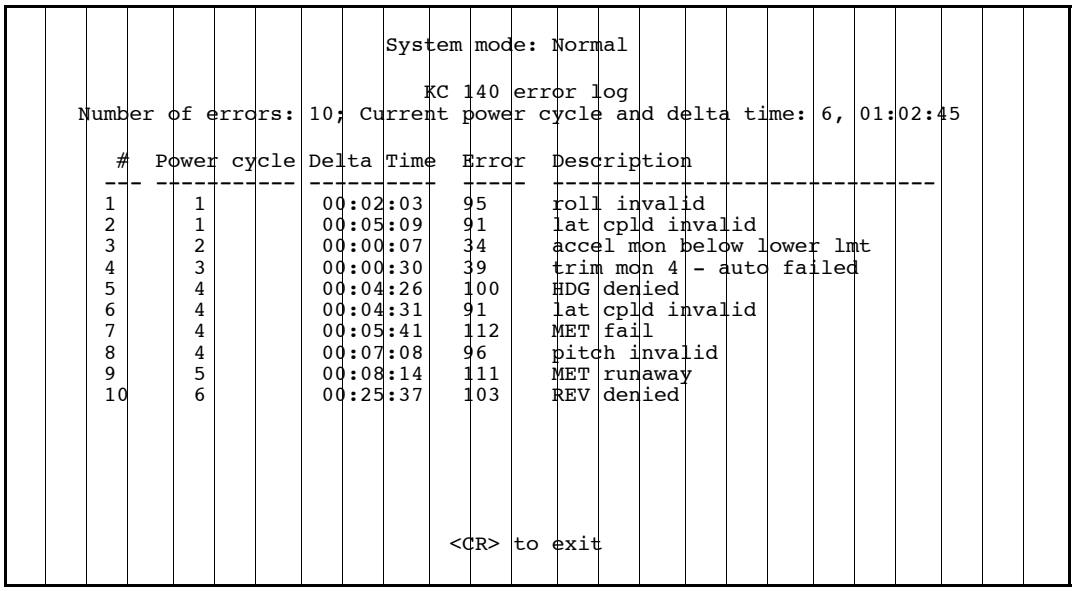


FIGURE 3-13 ERROR LOG DATA SCREEN

Pressing ‘C’ while the Error Log Menu screen is displayed will clear all errors stored in non-volatile memory.

Pressing ‘R’ while the Error Log Menu screen is displayed will clear all errors stored in non-volatile memory and reset the power cycle number to zero (0).

Pressing ‘F’ when the Error Log Menu screen is displayed will allow the user to capture the logged error code data to a file. When ‘F’ is pressed, the following two lines will appear at the bottom of the Error Log Menu screen:

```
Setup for file capture now.
press <CR> to dump error log, any other key to abort.
```

At this point, the terminal emulator program used for the RTI should be configured to receive a file. Once this is done, the ‘ENTER’ key should be pressed to start the file transfer. Once the file transfer is complete (new error log information will stop being scrolled on the display), the file transfer should be terminated using the communication program. The file set up by the file transfer configuration will then contain the error log information as text. To return to the Error Log Menu screen, the ‘ENTER’ key should be pressed once more.

3.3.12 SOFTWARE IDENTIFICATION SCREEN

Pressing ‘S’ when the Main Menu screen is displayed will cause the Software Identification screen, similar to Figure 3-14, to be displayed. Pressing ‘ENTER’ when this screen is displayed returns the user to the Main Menu screen. This screen displays the part number of the software installed in the FCC.

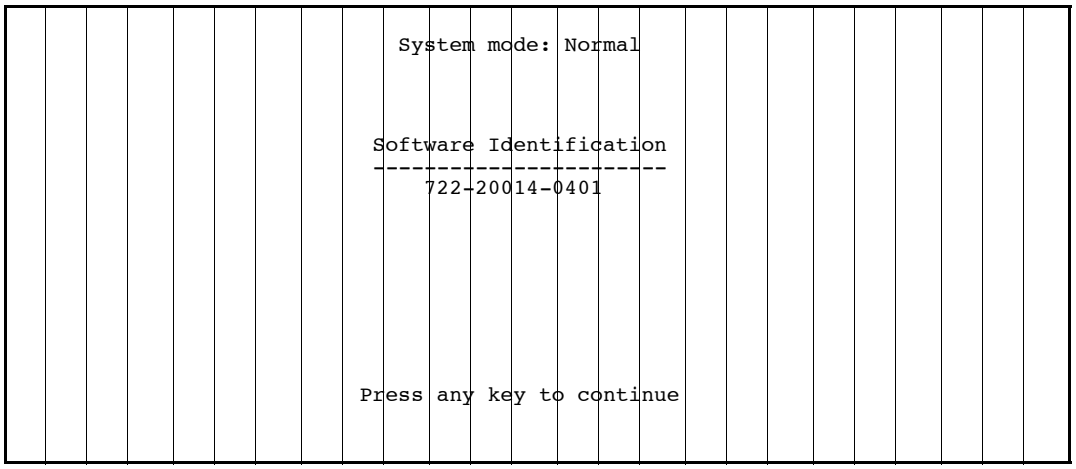


FIGURE 3-14 SOFTWARE IDENTIFICATION SCREEN

3.3.13 INSTALLATION MODE SCREENS

Pressing ‘N’ when the Main Menu screen is displayed will cause the Installation Menu screen, shown in Figure 3-15, to be displayed. Pressing the ‘ENTER’ key at this point will return the user to the Main Menu screen. This screen includes the options necessary to configure the FCC for proper operation for a particular aircraft installation.

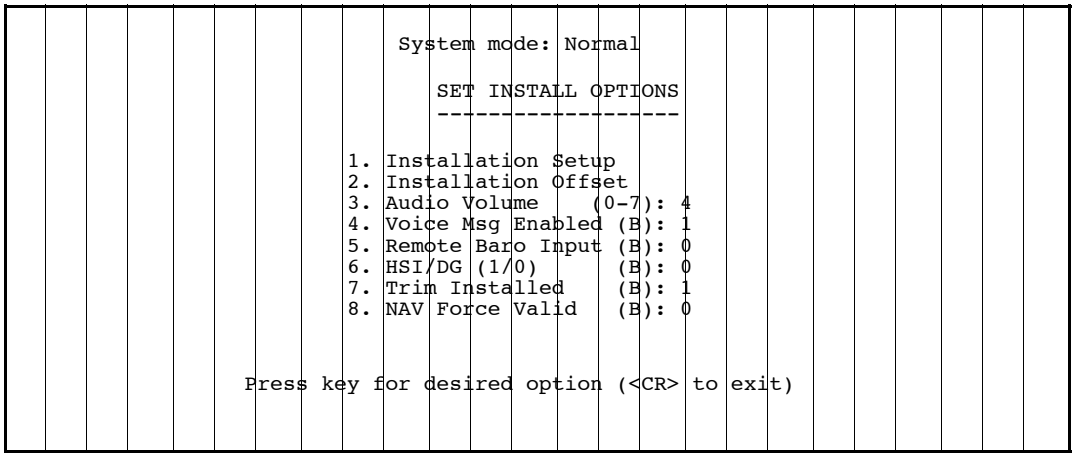


FIGURE 3-15 INSTALLATION MENU SCREEN

3.4 INSTALLATION SETUP

3.4.1 INSTALLATION SETUP SCREEN

Pressing ‘1’ followed by ‘ENTER’ when the Installation Menu screen is displayed will prompt the user to upload an installation file (i.e. *.CER file), as shown in Figure 3-16. Pressing the ‘ESC’ key at this point will return the user to the Installation Menu screen.

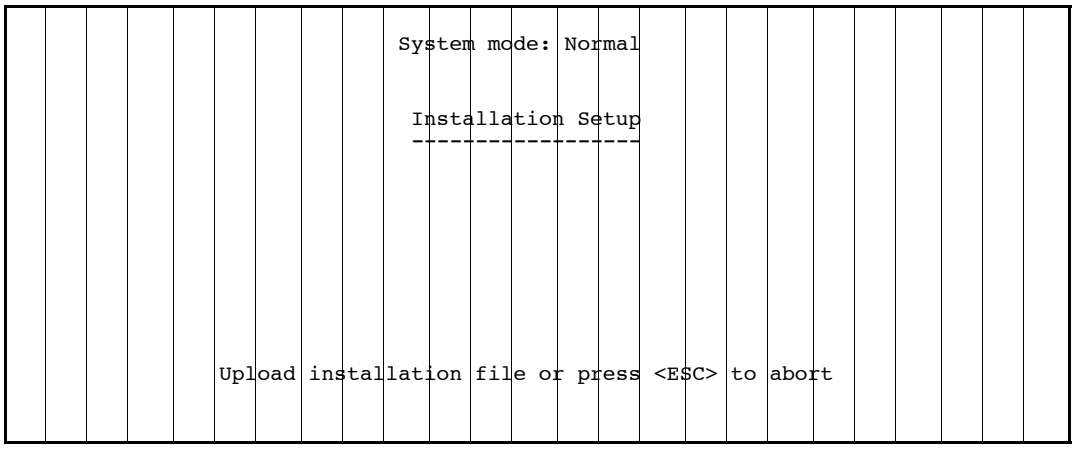


FIGURE 3-16 INSTALLATION SETUP SCREEN

File transfer is accomplished by configuring the terminal emulator program used for the RTI to send a text file. The certification file for a particular aircraft is selected from the certification diskette.

NOTE

The certification diskette contains the files associated with each aircraft certification. These files define certain parameters that are specific to the aircraft. For each aircraft there are three separate files with the following extensions: .CER, .DAT, and .TXT. The .CER file contains the actual data that is uploaded to the configuration module and used by the FCC. The .DAT file lists the data that is uploaded to the configuration module in a human readable format. The .TXT file describes which aircraft the data pertains to and the expected aircraft harness strap code.

The data is received by the FCC and stored in the configuration module. During upload, the FCC verifies the file type is correct and that data transfers without corruption. If the upload was unsuccessful, one of the following messages is displayed and it may be necessary to press the 'ESC' key to return to the Installation Menu screen.

```
Upload installation file failed: CHECKSUM ERROR
```

```
Upload installation file failed: MEMORY OVERRUN
```

The FCC also compares the strap code stored in the certification file with the harness strap code. If they don't match, the following message will be displayed.

```
Invalid strap code, installation aborted
```

If the file transfer is successful and the strap codes match, the following message will be displayed.

```
Installation data have been saved in non-volatile memory
```

3.4.2 INSTALLATION OFFSETS

Pressing ‘2’ followed by ‘ENTER’ when the Installation Menu screen is displayed will cause the Installation Offsets screen to be displayed, as shown in Figure 3-17. Pressing the ‘ENTER’ key at this point will return the user to the Installation Menu screen.

This screen lists sensor inputs to the FCC whose offsets can be compensated for by software in order to optimize system performance. These adjustments are stored in the configuration module and may be repeated without performing installation setup again.

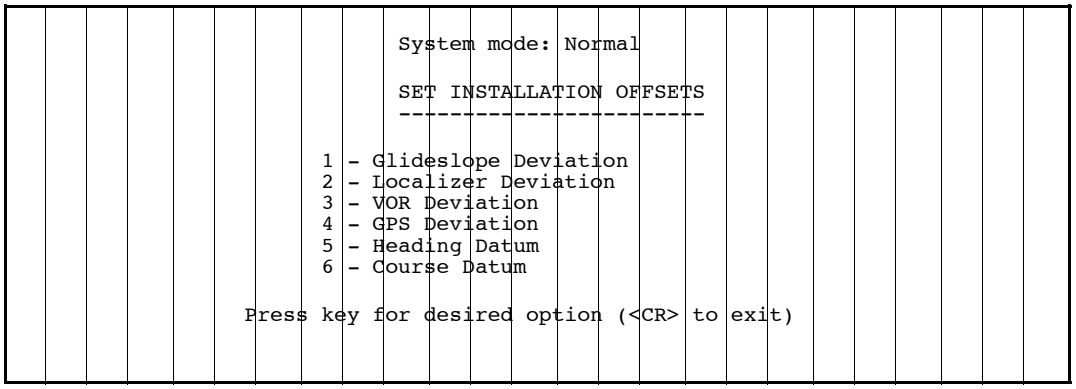


FIGURE 3-17 INSTALLATION OFFSETS SCREEN

When a sensor input is selected, as shown in Figure 3-18, the FCC prompts the user to press the ‘ENTER’ key when the sensor NULL position is reached. The installer should make sure the sensor input is nulled before proceeding. When the ‘ENTER’ key is pressed, the analog value is read by the FCC and stored in the configuration module and used to compensate the sensor when the autopilot is engaged.

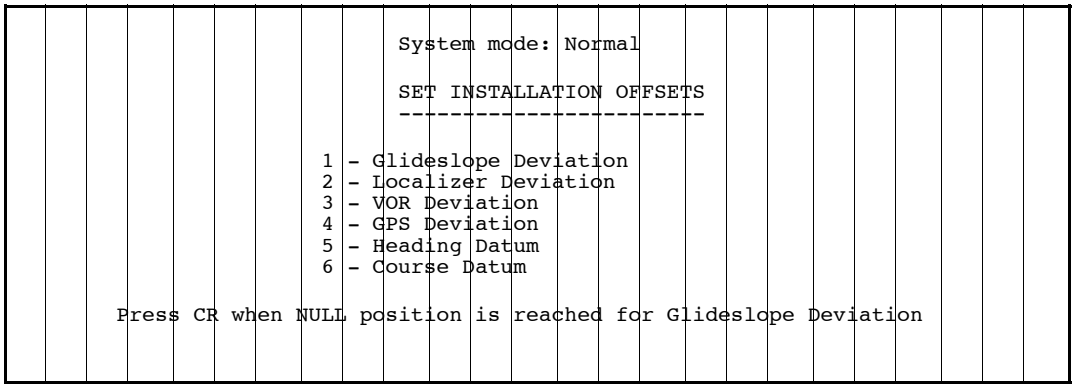


FIGURE 3-18 GLIDESLOPE DEVIATION SCREEN

3.5 OTHER INSTALLATION OPTIONS

The following are options that are selected by the installer. Some of these options depend upon aircraft certification and version of FCC and therefore may not be displayed.

OPTION	DESCRIPTION
Audio Volume	Volume setting for audio tones and voice messaging. A volume setting of '0' is the minimum setting and '7' is the maximum. The default value is a volume setting of '4'. The STC manual should be consulted for the appropriate volume setting to be used in a given installation.
Voice Msg Enabled	A '1' for "Voice Messaging" will enable voice messaging for AP disconnect and altitude alerting, in addition to the normal tones for these events. A '0' disables the voice messaging function. The default value is '0'. This feature is not functional on -2501, -5001, -5101, -5201, -7501 version computers.
Remote Baro Input	A '1' for "Remote Baro" will cause the FCC to use the baro set input from the altimeter and disable the ability to change baro set from the FCC. A '0' will cause the FCC to use the baro set from the rotary knob on its front panel. The default value is '0'. This option is available only on -7xxx version computers.
HSI/DG (1/0)	A '1' for "HSI" selects operation in an installation with an HSI. A '0' is the proper selection for a DG installation. The default value is '0'.
Trim Installed	A '1' for "Trim Installed" will configure the FCC to provide Manual Electric Trim and Autotrim functions. A '0' implies trim is not installed. The default value is '0'. This option is only available on aircraft with trim certified (as indicated in the .CER file installed in the configuration module) .
NAV Force Valid	A '1' for "NAV Force Valid" will cause the FCC to always treat the NAV deviation signal as valid, ignoring the NAV valid input. This option should be chosen only if NAV Valid is not available in the installation. A '0' will cause the FCC to monitor the NAV Valid input. The default value is '0'.

SECTION IV
TROUBLESHOOTING

4.1 GENERAL

The Remote Terminal Interface is an important resource for troubleshooting problems involving the KAP 140 system. A description of the problem as viewed from the cockpit together with the logged errors accessible via the RTI will help to narrow the focus of the troubleshooting. The time that the problem occurred should be correlated with the power cycle time in the error log. A more detailed description of the error codes is contained in section V. Some system faults can lead to multiple error codes being logged. In these instances, the first error logged is usually the most significant. It should also be kept in mind that only the first occurrence of an error code is logged within a power cycle.

The following section describes how to troubleshoot a system with problems that do not generate an error code; these are primarily related to system performance. The subsequent sections aid in the troubleshooting of systems with logged errors by describing the various interfaces to the KAP 140 system as seen through the RTI in diagnostic mode (see section 3.3.2, Diagnostic Mode Screens, and its sub-sections for more information on accessing diagnostic mode). Use of this information with the wiring harness diagrams and a multimeter should allow diagnosis of most system problems.

4.2 PERFORMANCE PROBLEMS

The following table assumes there are no logged error codes to assist in troubleshooting the system. If an error code has been stored, attempt to resolve the associated problem before using the following table.

Symptom	Possible Cause(s)	Checks to Perform
Autopilot indicates engagement on FCC, but does not drive servos.	CWS switch stuck active.	Check CWS switch in diagnostics.
Autopilot won't engage pitch modes.	If "P" LED on, pitch servo may be invalid or FCC acceleration monitor may be active.	Check servo validity and acceleration monitor outputs in diagnostics.
Autopilot won't engage any modes.	AP DISC switch pressed or stuck active (Both "P" and "R" LEDs on).	Check diagnostics for proper switch operation.
	Roll servo invalid ("R" LED on).	Check roll servo and interconnecting harness.
	Turn Coordinator invalid (dashes in mode annunciations).	Check Turn Coordinator for flag in view. Replace T.C.
	Install strap mismatch (Mode annunciations dashed with "P" and "R" LEDs.)	Check harness strap code in diagnostics and compare with STC data.
All pitch modes "porpoise" or have poor tracking behavior.	Pitch servo bridle cable below minimum allowed tension.	Check and adjust bridle cable tension to certified value.

Symptom	Possible Cause(s)	Checks to Perform
	Pitch servo slip clutch set below minimum torque.	Check and adjust slip clutch torque to certified value.
	Autotrim not working properly.	Check for normal autotrim response to induced effort on control wheel. Check trim sense signal in diagnostics for proper response to control effort.
Glideslope tracks with an offset.	GS Offset not properly adjusted.	With simulated centered GS signal, check GS offset adjustment in FCC and readjust as necessary.
	GS gain low due to improper MM activity.	Check MM in diagnostics for proper operation.
All roll modes have “wing walk”.	Roll servo bridle cable below minimum allowed tension.	Check and adjust bridle cable to certified value.
	Roll servo slip clutch set below minimum torque.	Check and adjust slip clutch to certified value.
	Turn Coordinator has excessive hysteresis or delay.	Replace Turn Coordinator.
Selected altitude display dashed.	Invalid altitude code from altimeter.	Check altimeter interconnect (Gilham code) in diagnostics. Replace altimeter, as required.
Roll default mode okay, but heading mode performance poor.	Directional Gyro or HSI has faulty output.	Replace DG or HSI.
Heading mode tracks with excessive offset.	Heading Offset not properly adjusted.	With heading set to North, check heading/course datum offset adjustment in FCC and readjust as necessary.
Localizer modes track with offset.	LOC Offset not properly adjusted.	With simulated centered LOC signal, check LOC offset adjustment in FCC and readjust as necessary.
GPS modes track with offset.	GPS Offset not properly adjusted.	With simulated centered GPS signal, check GPS offset adjustment in FCC and readjust as necessary.
VOR modes track with offset.	VOR Offset not properly adjusted.	With simulated centered VOR signal, check VOR offset adjustment in FCC and readjust as necessary.
MET not operational.	If “PT” on FCC, MET switch may be stuck active.	Using diagnostics, check that UP, DOWN, and ARM switches are all inactive when nor pressed.

4.3 UNIT INTERFACE DESCRIPTIONS

4.3.1 GENERAL

Not all KAP 140 Autopilot System configurations have all the interfaces described here. Refer to the appropriate STC manual to determine which interfaces apply to your aircraft.

In the following paragraphs certain I/O descriptions are common across different interface descriptions. For these common I/O descriptions, refer to the appropriate section in the KC 140 Interface description for additional information about the discrete inputs, the discrete outputs, the analog inputs, the clutch outputs, and the servo command outputs used in the KC 140.

4.3.2 KS 270C PITCH SERVO INTERFACE TO THE KC 140

PIN	DESCRIPTION
P1402 - 6	TRIM_SENSE_+
P1402 - 7	PITCH_SERVO_CMD_+
P1402 - 8	PITCH_CLUTCH
P1402 - 23	TRIM_SENSE_-
P1402 - 24	PITCH_SERVO_CMD_REF
P1402 - 28	PITCH_SERVO_VALID
P1402 - 47	TACH_+
P1402 - 48	TACH_-

The KS 270C Pitch Servo uses the following signals: a clutch high-side and a clutch low-side input, a command high and a command low input, a trim sense + and a trim sense - output, a servo valid output and a pitch tachometer output.

The PITCH_CLUTCH signal from the FCC is wired to the low side of the servo engage clutch solenoid. The high side of the clutch is wired to the aircraft power through the AP DISC switch. When the clutch is disengaged by the FCC, there should be 28V on the low side clutch (assuming AP DISC switch is not pressed). When the clutch is engaged, there should be >0.1V and <2.5V on the low side of the clutch. If AP DISC is pressed, 28V is removed from the clutch solenoid and the clutch will disengage. When the low-side clutch engage transistor in the FCC is turned on, the current flowing in the solenoid (nominally 600mA @ 28V or 1.2 A @ 14V) is monitored to determine that the solenoid is working correctly during pre-flight test. These outputs begin to go into foldback current-limiting around 1.8A. The FCC clutch output can be engaged or disengaged through the diagnostic pages. When the Pitch Clutch output is turned on (using the DISCRETE OUTPUTS page), the Pitch Clutch Engaged discrete input (which can be viewed on the DISCRETE INPUT STATUS diagnostic page) should also be turned on. If the clutch engaged bit is not turned on when the clutch output is set, verify that power is supplied to the servo (e.g. AP DISC is not pressed) and the hardware monitors are not tripped. If a hardware monitor has failed, the clutch outputs associated with that monitor will not be able to be engaged. (The hardware monitor status can be viewed through the diagnostic pages.)

The PITCH_CMD outputs from the KC 140 supply the servo command outputs to the KS 270C. The command high and low (REF) signals form a differential input that is used to drive the servo

motor via the internal servo amplifier. The command high input is a +/- 10V signal (through a 2Kohm series resistor) generated by the KC 140 Flight computer. The command low input is a reference back to an internal KC 140 Flight computer ground. The value of the output signal determines how fast the servo is driven. Anything greater than +/-9 volts will command full speed servo movement. The servo can be commanded to drive in either direction through the ANALOG OUTPUTS diagnostic interface.

NOTE

To be able to move the controls, the servo clutch must be engaged.

The TRIM_SENSE servo outputs are generated by a strain gauge inside the KS 270C. The strain gauge produces a voltage based on the amount of torque measured on the pinion of the KS 270C. This voltage is amplified and buffered to provide a +/- 3V signal that is proportional to the torque. If the trim sense + output is +1.2V, then the trim sense - output is -1.2V. These signals are then referenced to 3V, so the voltage measured at the servo, with respect to ground, would be +4.2V and +1.8V. The differential voltage measured from trim sense + to trim sense - has a scale factor of 100mV per inch-pound of torque. This strain gauge output is used to determine when trim needs to run in AP mode. (i.e. If the AP mode is engaged, the trim servo will start to run after a certain value is exceeded on the trim sense output.)

The TACH output of the pitch servo is a differential +/-5V signal that is used in certain flavors of the KC 140 to determine when the acceleration monitor should be disabled. The scale factor for the tachometer output is approximately 0.6V per volt of command drive. (e.g. If you provide 8V of command drive to the pitch servo you will generate approximately 4.8V of tachometer output.)

The PITCH_SERVO_VALID signal from the KS 270C is used by the KC 140 to determine if the pitch servo is working properly. If this output is grounded, the pitch servo is valid. If this output is open, the pitch servo is invalid. This output is routed to the KC 140 Open/Ground discrete input PITCH_SERVO_VALID. When it is invalid, the KC 140 locks out operation of the pitch axis.

NOTE: If there is less than 0.1V on the low side clutch, when it is engaged and AP DISC is not pressed, there is a possibility that the low side clutch has inadvertently been shorted to ground and pre-flight test will fail, since the clutch current is monitored by the KC 140.

The TRIM_SENSE and PITCH_TACH inputs can be viewed on the ANALOG VOLTAGE INPUTS diagnostic page.

DIAGNOSTIC NAME	SCALE FACTOR
Trim Sense	100 mV/in-lb
Pitch Tach	1 V/V

4.3.3 KS 271C ROLL SERVO INTERFACE TO THE KC 140

PIN	DESCRIPTION
P1401 - 1	ROLL_CLUTCH
P1401 - 5	ROLL_SERVO_VALID
P1401 - 18	ROLL_SERVO_CMD_+
P1401 - 19	ROLL_SERVO_CMD_REF

The KS 271C Roll Servo consists of the following interfaces: a clutch high-side and a clutch low-side input, and a command high and a command low input. These interfaces are similar to the equivalent interfaces for the pitch servo. See Pitch Servo Interface for more details. When ROLL_SERVO_VALID is invalid, the KC 140 locks out operation of the autopilot (since pitch operation is not allowed without roll).

4.3.4 KS 272C TRIM SERVO INTERFACE TO THE KC 140

PIN	DESCRIPTION
P1402 - 1	TRIM_CLUTCH
P1402 - 2	TRIM_VOLT_-
P1402 - 4	TRIM_VOLT_+
P1402 - 31	TRIM_SERVO_CMD_+
P1402 - 36	TRIM_SERVO_CMD_REF
P1402 - 44	

The KS 272C Trim Servo consists of the following interfaces: a clutch high-side and a clutch low-side input, a command high and a command low input, and a trim servo disable input.

The TRIM_CLUTCH output from the KC 140 is used to drive the low side of the clutch solenoid on the KS 272C. The high side of the clutch is wired to the aircraft power through the AP DISC switch. When the clutch is disengaged by the FCC, there should be 28V on the low side clutch (assuming AP DISC is not pressed). When the clutch is engaged, there should be >0.1V and <2.5V on the low side of the clutch. If AP DISC is pressed, 28V is removed from the clutch solenoid and the clutch will disengage.

NOTE

If there is less than 0.1V on the low side clutch, when it is engaged and AP DISC is not pressed, there is a possibility that the low side clutch has inadvertently been shorted to ground and pre-flight test will fail since the clutch current is monitor by the KC 140.

The TRIM_SERVO_CMD high and low signals form a differential input that is used to drive the servo motor via the internal servo amplifier. The command high input is a +/- 10V signal generated by the KC 140 Flight computer. The command low input is a reference back to the internal KC 140 Flight computer ground. The internal servo amplifier has a gain of approximately 5; therefore, a

command of 2V will produce a voltage of 10V across the motor. The servo motor drive is powered by an internal regulator, which limits the maximum voltage that can be applied to the motor.

The TRIM FAIL signal from the FCC is connected to the trim servo disable input, which turns off the internal regulator and is used to remove power from the servo motor when the trim monitoring detects a failure. In certain installations, the trim fail annunciator is isolated, through a diode, from the trim disable input.

The TRIM_VOLTAGE input to the KC 140 is taken from the drive voltage on the KS 272C servo motor. This analog input can be viewed on the ANALOG VOLTAGE INPUTS diagnostic page.

DIAGNOSTIC NAME	SCALE FACTOR
Trim Voltage	1 V/V

4.3.5 TURN COORDINATOR INTERFACE TO THE KC 140

PIN	DESCRIPTION
P1401 – 3	ROLL_RATE_+
P1401 – 10	RATE_VALID (“Rate Gyro Valid” in diagnostics)
P1401 – 21	ROLL_RATE_–

RATE_VALID is an active high discrete input to the KC 140. The rate information from the Turn Coordinator is determined to be valid when the RATE_VALID input is >9V. This indicates when the rate gyro is spinning at a minimum required speed. The ROLL_RATE input to the KC 140 is an analog input. The current rate value and valid from the Turn Coordinator can be displayed on the ANALOG INPUTS diagnostics page.

DIAGNOSTIC NAME	SCALE FACTOR
Roll Rate	333.3 mV/deg/sec
Roll Steering	2V/deg/sec

4.3.6 DIRECTIONAL GYRO (DG) INTERFACE TO THE KC 140

PIN	DESCRIPTION
P1401 – 11	DG_VALID
P1401 – 27	CRS_HDG_REF
P1402 – 17	CRS_DATUM_+
P1402 – 18	DG_+15VDC
P1402 – 19	DG_–15VDC

If a directional gyro is used with the KAP 140 autopilot system , four wires interface the DG to the KC 140. They are the CRS_DATUM input, CRS_HDG_REF input, the DG_+15VDC power line, and the DG_–15VDC power line. The DG_VALID signal is hard–wired to ground (always valid) in a directional gyro installation. The DG_+15VDC and DG_–15VDC power lines provide power

to the directional gyro. They are capable of supplying 30mA of current. The CRS_DATUM input (used for heading datum and course datum) is an analog input that can be viewed through the diagnostic pages.

DIAGNOSTIC NAME	SCALE FACTOR
Course Datum	210 mV/deg

4.3.7 HORIZONTAL SITUATION INDICATOR (HSI) INTERFACE TO THE KC 140

PIN	DESCRIPTION
P1401 – 2	HDG_DATUM_+
P1401 – 11	DG_VALID
P1401 – 27	CRS_HDG_REF
P1402 – 17	CRS_DATUM_+

If an HSI is used with the KAP 140 autopilot system , four wires interface to the KC 140. They are the DG_VALID input, HDG_DATUM input, CRS_DATUM input, and CRS_HDG_REF input. The DG_VALID is a Open/Ground discrete input signal provided by the HSI to inform the KC 140 when the information being received is valid. The DG_VALID status (Ground = Valid) can be viewed on the DISCRETE INPUT STRAPS/VALIDS diagnostic page. The HDG_DATUM and CRS_DATUM inputs are analog inputs that can be viewed through on the ANALOG INPUTS diagnostic page.

DIAGNOSTIC NAME	SCALE FACTOR
Heading Datum	550 mV/deg
Course Datum	210 mV/deg

4.3.8 KCM 100 CONFIGURATION MODULE INTERFACE TO THE KC 140

PIN	DESCRIPTION
P1401 – 4	CFG_+5V
P1401 – 8	CFG_DATA
P1401 – 13	CFG_ENABLE
P1401 – 30	CFG_CLK

The KCM 100 Configuration Module Interface consists of a clock, enable, data, and 5V power. All of these signals are logic level signals (0–5V). This 3–wire serial interface is used to store information for the KAP 140 autopilot system. The clock signal frequency will vary when it is transmitting or receiving data but it should always be <1 MHz and > 1KHz while transmitting or receiving data. The enable line is high during the entire time the data is being transmitted or received. The data line is a bidirectional signal and each bit of the data is clocked in on the rising edge of the clock. The KC 140 supplies +5V, current limited to 80mA, to the power line of the KCM 100. The ground of the KCM 100 is tied to airframe ground. The connection to the configuration module can be tested by performing the NVM Test on the ANALOG TESTS diagnostic page.

NOTE

If the ground wire becomes disconnected, the KCM 100 Configuration Module interface may appear to work, but it will work intermittently. Under this scenario, one may experience loss of the certification gain file information and error code logs upon power up of the unit. It is inadvisable to disconnect the KCM 100 configuration module from its connector with the KC 140 powered up; this can cause loss of certification gain file information and error code logs.

4.3.9 NAV SENSOR INTERFACE TO THE KC 140

PIN	DESCRIPTION
P1401 – 7	ILS
P1401 – 22	NAV_VALID_+
P1401 – 23	NAV_VALID_–
P1401 – 24	NAV_DEV_+
P1401 – 25	NAV_DEV_–
P1402 – 9	GS_DEV_+
P1402 – 10	GS_DEV_–
P1402 – 12	GS_VALID_–
P1402 – 26	GPS_SELECT
P1402 – 31	GS_VALID_+
P1402–40	ROLL_STEER_VALID
P1402–41	ROLL_STEER+
P1402–42	ROLL_STEER–

ILS and GPS_SELECT are Open/Ground discrete inputs to the KC 140. See the Navigation Selection section for details on usage. NAV_VALID, NAV_DEV, GS_VALID, GS_DEV, ROLL_STEER+– AND ROLL_STEER_VALID are analog inputs to the KC 140. The current value of the deviation inputs can be viewed via the ANALOG INPUTS diagnostic page. The current value of the valid inputs can be viewed via the ANALOG VOLTAGE INPUTS diagnostic page.

DIAGNOSTIC NAME	SCALE FACTOR
GS Deviation	214 mV/deg
NAV Deviation	15 mV/deg
GS Valid	1 V/V (>140 mV = valid)
NAV Valid	1 V/V (>140 mV = valid)
ROLL_STEER+	2V/Degree
ROLL_STEER–	2V/Degree
ROLL_STEER_VALID	>11v = Valid

4.3.10 ENCODING ALTIMETER INTERFACE TO THE KC 140

PIN	DESCRIPTION
P1402 – 3	C2
P1402 – 5	C4
P1402 – 11	A1
P1402 – 13	A2
P1402 – 14	A4
P1402 – 16	BARO_SET
P1402 – 20	B4
P1402 – 21	C1
P1402 – 29	D4
P1402 – 33	B1
P1402 – 34	B2
P1402 – 36	BARO_REF_SUPPLY

The BARO_SET input from the encoding altimeter is supplied by a potentiometer connected to the BARO_REF_SUPPLY output from the FCC. The value of the BARO_SET and BARO_REF_SUPPLY can be viewed on the ANALOG VOLTAGE INPUTS diagnostic page. The BARO_REF_SUPPLY voltage should be approximately 4 V. It can provide a maximum of 50mA load current to the encoding altimeter.

DIAGNOSTIC NAME	SCALE FACTOR
BARO_SET	1 V/V
BARO_SUPPLY_VOLTAGE	1 V/V

D4 (MSB), A1, A2, A4, B1, B2, B4, C1, C2, and C4 (LSB) are the encoding altimeter gray scale (Gillham) code representation of the current pressure reading. These inputs are displayed on the DISCRETE INPUT STATUS diagnostic screen in hex notation, along with their equivalent altitude.

4.3.11 RS232 INTERFACE TO THE KC 140

PIN	DESCRIPTION
P1401 – 28	TXD_RS232
P1401 – 29	RXD_RS232

The RS232 interface consists of two signal lines: RXD_RS232 (receive), and TXD_RS232 (transmit). The KC 140 uses this interface to talk to the personal computer (PC) or laptop computer. This interface allows the KC 140 flight computer to transmit error codes, save installation parameters, and enter the diagnostic pages. For more information on using the RS 232 interface with the KAP 140, see the Remote Terminal Interface section.

The RS232 receiver in the KC 140 is typically biased at –10V (without PC keyboard activity). When a key is pressed on the PC keyboard, the signal line transmits a series of short pulses (the high side of the pulse is around +12V). The RS232 transmitter in the KC 140 is typically biased at –8.5V when it is not transmitting information to the PC. When the KC 140 is sending information to the PC, the signal line transmits a series of short pulse (the high side of the pulse is around +8.5V).

4.3.12 AUDIO PANEL INTERFACE TO THE KC 140

PIN	DESCRIPTION
P1401 – 6	AUDIO_ALERT
P1402 – 38	MIDDLE_MARKER
P1402 – 49	AUDIO_LOAD

The MIDDLE_MARKER output of the audio panel is used by the KC 140 to determine gains to use when tracking glideslope and localizer. When the middle marker becomes active, the gain decreases. If the voltage is above 2.5V, the middle marker input is considered active. If the voltage is below 1.5V, the middle marker input is considered inactive. The state of the middle marker input is displayed on the DISCRETE INPUT STRAPS/VALIDS diagnostic page.

The AUDIO_ALERT output is a transformer isolated output with a series 500 ohm resistor. This output provides a 2KHz sine wave whenever the AP mode is disengaged. The amplitude of this output can be set in the installation pages or on the DISCRETE OUTPUTS diagnostic page. Generation of the aural alert can also be done via the DISCRETE OUTPUTS diagnostic page. The amplitude of the sine wave should be somewhere between 4.5 Vrms to 0.3 Vrms (assuming a 500 ohm load), depending upon the volume level setting. There is a 243 ohm load (AUDIO_LOAD) to ground in the KC 140 that can be jumpered to the AUDIO_ALERT output to decrease the maximum volume level. The AUDIO_ALERT output also provides the KC 140 voice messaging signal, if that option has been selected in the installation options.

NOTE: When the AP mode is engaged and power to the unit is lost, the audio output provides a 2KHz tone. Under this condition, the volume of the tone is set to maximum, not the level that is set in diagnostics mode.

4.3.13 COCKPIT SWITCHES INTERFACE TO THE KC 140

PIN	DESCRIPTION
P1401 – 9	AP_DISC
P1401 – 26	CWS
P1402 – 22	TRIM_UP
P1402 – 25	TRIM_ARM
P1402 – 27	TRIM_DN
P1402 – 30	STALL_WARNING

AP_DISC is a 28V/Open discrete input. AP_DISC is 28V when not pressed and open when pressed. This switch is wired to supply 28V to the high side of the servo clutches and servo motor drives. When the AP_DISC switch is pressed, the AP is disconnected and power to the servo clutches and motors is removed. This has the effect of disabling the servos. The KC 140 will register the switch as being not pressed when the voltage at the connector of the KC 140 is > 11V. The KC 140 will register the switch as being pressed if the voltage at the connector of the KC 140 is < 2V or if the impedance to aircraft power is > 200Kohms. (This assumes 28V on the aircraft power bus.)

The CWS input is an Open/Ground input. When the CWS switch in the cockpit is pressed, the CWS switch grounds the input to the KC 140. While the CWS input is active, the servo clutches disengage without disconnecting AP, allowing the pilot to control the aircraft. Once the CWS input becomes inactive, the KC 140 synchronizes the pitch axis to current aircraft condition (e.g. to current altitude, if in ALT mode).

TRIM_UP, TRIM_DN, and TRIM_ARM are Open/Ground inputs that are used by the KC 140 to determine when manual electric trim has been requested. When TRIM_UP & TRIM_ARM are both active (active is defined as that input being grounded), manual electric trim operation trims the aircraft nose up. When TRIM_DN & TRIM_ARM are both active, the manual electric trim operation trims the aircraft nose down. In some installations, the manual electric trim switch is constructed in such a way that you will always have TRIM_ARM active before having either TRIM_UP or TRIM_DN active.

STALL_WARNING is a Open/Ground input that is currently not implemented in any configuration of the KAP 140 autopilot system.

4.3.14 DIMBUS INTERFACE (BACKLIGHTING BRIGHTNESS) TO THE KC 140

PIN	DESCRIPTION
P1401 – 12	DIMBUS

The DIMBUS voltage from the aircraft lighting bus is used by the KC 140 to control the intensity of its panel backlighting. Based on the ratio of the voltage on the Dimbus and the Aircraft voltage, the KC 140 processor puts out a pulse width modulated output to drive the bulbs in the bezel. The higher the dimbus voltage ratio, the greater the duty cycle of the PWM signal. The Dimbus voltage level can be checked on the ANALOG VOLTAGE INPUTS diagnostics page. In addition to the dimbus voltage, the potentiometer on the front of the bezel can adjust the backlighting brightness curve.

4.3.15 FLAPS INTERFACE TO THE KC 140

PIN	DESCRIPTION
P1402 – 45	FLAPS_+
P1402 – 46	FLAPS_–

The FLAPS input on the KC 140 interfaces to the flaps motor in the aircraft. When the flaps are in motion, the software in the KC 140 begins running trim in the aircraft to help prevent the pitch servo from getting behind during configuration changes. If the flaps motor voltage is greater than 9 volts, the flaps motor is determined to be running (active). The voltage on the flaps input can be viewed on the ANALOG INPUTS diagnostic page.

DIAGNOSTIC NAME	SCALE FACTOR
Flap Voltage	1 V/V (>9 V or < –9V = active)

4.3.16 KC 140 ALERTING OUTPUTS

PIN	DESCRIPTION
P1401 - 20	TONE_ALERT
P1402 - 44	TRIM_FAIL

These outputs provide a low-side current sink for the cockpit annunciators. One side of the annunciator is wired to aircraft power and the other side of the annunciator is wired to the KC 140 output pin. The software and/or hardware in the KC 140 controls a transistor which turns on or off each annunciator. This transistor can sink ~120mA and begins to go into current limit around 600 mA.

The TONE_ALERT output is typically wired to a SONALERT buzzer and can be controlled via the DISCRETE OUTPUTS diagnostic page (USING Audio Alert). The TRIM_FAIL output is wired to the TRIM FAIL annunciator in the cockpit and is controlled by hardware and can be tested through diagnostics mode by setting up the hardware to fail the autotrim runaway or manual trim runaway monitor. In certain aircraft installations, the TRIM_FAIL annunciator is wired through a diode to the TRIM_FAIL output of the KC 140.

4.3.17 KC 140 PHOTOCELL (DISPLAY BRIGHTNESS)

The photocell on the front bezel of the KC 140 flight computer senses the ambient light in the cockpit of the aircraft and provides a voltage based on the amount of light it receives. Based on the voltage output by the photocell, the KC 140 processor varies the duty cycle of a PWM signal that controls the brightness of the KC 140 display. The more light the photocell receives, the greater duty cycle the KC 140 processor generates for the display. The photocell voltage can be viewed on the ANALOG VOLTAGE INPUTS diagnostic page. When the photocell is completely covered, the photocell output voltage in diagnostic pages should be ~0 V. When the photocell is completely saturated with ambient light, the photocell output voltage in the diagnostic pages should be >4.5 V. In addition to the photocell, the potentiometer on the front of the bezel can adjust the overall display brightness level.

4.3.18 KC 140 POWER INPUTS

PIN	DESCRIPTION
P1401 – 14	AUDIO_POWER
P1401 – 15	CHASSIS_GND
P1401 – 16	AIRCRAFT_POWER
P1401 – 35	POWER_GND
P1402 – 15	POWER_GND

The AUDIO_POWER input is used to provide operating power for the audio alerting circuitry. This circuitry is powered separately from the rest of the KC 140, so that in the event of loss of aircraft power the AP disconnect tone can be generated. The audio power voltage regulator will maintain regulation with input voltages on the audio power bus as low as 8V; voltages over 33V are clamped internally. The current draw from the audio power input is a 100 mA nominally with a peak current of 200 mA. This input is usually tied to one of the emergency power buses to guarantee that an AP disconnect tone will still be generated upon loss of the aircraft power input to the KC 140, if the AP was engaged at the time.

The AIRCRAFT_POWER input is used to provide operating power for the rest of the KC 140 flight computer. The power supply in the KC 140 will maintain regulation with input voltages on the aircraft power bus as low as 11V; voltages over 33V are clamped internally. The KC 140 draws 0.2A nominally during operation with peak current draws of 1.0 A. The aircraft power return line has 1.8A nominally flowing through it and 4.0A peak. The voltage on the aircraft power bus can be viewed on the ANALOG VOLTAGE INPUTS diagnostic page (as A/C MON).

DIAGNOSTIC NAME	SCALE FACTOR
A/C MON	1 V/V

4.3.19 KC 140 AIRCRAFT STRAPS

PIN	DESCRIPTION
P1401 – 17	STRAP_5
P1401 – 31	STRAP_1
P1401 – 32	STRAP_2
P1401 – 33	STRAP_3
P1401 – 34	STRAP_4
P1401 – 36	STRAP_6

The above inputs are Open/Ground discrete inputs. For each aircraft certification, the KAP 140 Autopilot System uses a different combination of inputs tied to ground and inputs left open. The strap "code" in the harness determines which certification file(s) can be downloaded to the configuration module. If the strap information contained in the certification file does not agree with the strap configuration in the harness, an error code is generated and autopilot operation is disallowed.

NOTE

All open/ground discrete inputs to the KC 140 FCC have the following characteristics. The KC 140 will register an input as being "grounded" that measures less than 1.5V at the connector of the KC 140. The KC 140 will register an input as being "open" if the voltage at the connector of the KC 140 is > 10V or if the impedance to ground of that signal is > 15Kohms. (This assumes 28V on the aircraft power bus.)

SECTION V
ERROR CODES

5.1 GENERAL INFORMATION

This document describes the error codes generated by the KC 140 Flight Control Computer. This information should be used to help in troubleshooting KAP 140 system failures. In addition, the Maintenance Manual Supplement for KAP 140 Automatic Flight Control System can be helpful for diagnostics when troubleshooting.

Each error has a unique number and text message that is displayed when the logged errors are displayed. The error log also records a power cycle and relative time within the power cycle that the error was logged. This relative time information should be corroborated with pilot/user input in troubleshooting the reason for the error. This document provides additional information concerning the possible reasons for the error.

NOTE

The text for some messages is abbreviated to fit into 30 characters.

5.2 REFERENCE DOCUMENTS

The documents listed in this section provide additional understanding of the system operation and should be used in addition to this document in troubleshooting system failures.

DOCUMENT	PART NUMBER
KAP 140 System Requirements	004-02036-0000
KAP 140 Installation Manual	006-00991-XXXX

5.3 ERROR CODE CATEGORIES

The following lists the general categories in which the KC 140 errors are grouped. It includes a category name, a description of the category, and the range of error code numbers contained in that category.

CATEGORY	ERROR RANGE	DESCRIPTION
Exception Vectors	1	Related to unintended interrupts (exceptions) detected by the common kernel interrupt service routine (generic interrupt handler which is used in all KC 140 processors)
Frame Overrun	2	Processing exceeding allowed time.
Installation	5-7	Related to configuration module setup.
CPU/Powerup	10-16	Related to Powerup tests or CPU hardware.
Watchdog	20	Watchdog timeout.
Preflight test	25-54; 240-252	Related to failures during preflight test. **NOTE: If the AP DISC Switch is active (pressed) during pre-flight test, the KC 140 may not pass pre-flight test.**
Mode Logic	55-105,	Related to failures in the mode logic.
HW Monitors	110-113	Hardware monitor detected failures.
Mode Algorithms	150-163	Failure in mode algorithm calculation.
RS 232	175-177	Related to failures in the remote terminal interface.
Altitude errors	190-192	Related to altimeter or pressure transducer failures.
Development	200-226	Reserved for failures in development.

5.4 ERROR CODE DESCRIPTIONS

The following lists the error code number, text message, unit(s) where failure may have occurred and a description for each error logged by the KC 140 flight computer.

ERR#	TEXT MESSAGE(S)	POSSIBLE FAILED UNIT(S)
	DESCRIPTION OF ERROR	
1	Exception vector error	KC 140
	The system attempted to respond to an unintended interrupt. This indicates a probable fault in the flight computer. Autopilot operation is disallowed.	
2	Frame overrun	KC 140
	The flight computer did not finish processing the last frame computations before the frame time expired. Autopilot operation is disallowed.	
3	Inst chksum mismatch	KC 140, KCM 100, harness wiring
	The checksum for the installation data in the configuration module is in error or the module has not been setup. Autopilot operation is disallowed.	
6	Inst strap mismatch	KC 140, KCM 100, harness wiring
	The strap code in the configuration module does not match the harness strap code. Autopilot operation is disallowed. Check installation setup. If this error code is recorded, the KC 140 certification gains file may need to be installed again.	
7	Inst Parity mismatch	KC 140, KCM 100, harness wiring
	The parity associated with the installer options is not correct. The configuration module has failed or has not been setup. Autopilot operation is disallowed.	
10	RAM test failed	KC 140
	The processor failed the RAM test on power up. Autopilot operation is disallowed.	
11	ROM test failed	KC 140
	The processor failed the ROM (CRC) test on power up. Autopilot operation is disallowed.	
12	CPU failed	KC 140
	The processor failed the CPU test on power up. Autopilot operation is disallowed.	
13	Watchdog timer failed	KC 140
	The processor failed the watchdog timer test on power up. Autopilot operation is disallowed.	
14	Bus error	KC 140
	The processor detected a fault on its bus, indicating a probable hardware failure. Autopilot operation is disallowed.	
15	Sys clock failed	KC 140
	Processor system clock has lost its crystal input signal, indicating a possible malfunction in the crystal oscillator. Autopilot operation is disallowed.	

ERR#	TEXT MESSAGE(S) DESCRIPTION OF ERROR	POSSIBLE FAILED UNIT(S)
16	Timer failed	KC 140
	The processor failed the timer test on power up. Autopilot operation is disallowed.	
20	Watchdog timed out	KC 140
	The watchdog was not reset in the allowed time period. This indicates a probable hardware fault in the flight computer. Autopilot operation is disallowed.	
25	Roll srv cmd over upper range	KC 140
	Preflight test failed due to improper response to roll servo command wraparound signal. This indicates a probable failure in the roll servo command circuit or the analog to digital input circuitry of the flight computer. Autopilot operation is disallowed.	
26	Roll srv cmd below upper range	KC 140
	Preflight test failed due to improper response to roll servo command wraparound signal. This indicates a probable failure in the roll servo command circuit or the analog to digital input circuitry of the flight computer. Autopilot operation is disallowed.	
27	Roll srv cmd over lower range	KC 140
	Preflight test failed due to improper response to roll servo command wraparound signal. This indicates a probable failure in the roll servo command circuit or the analog to digital input circuitry of the flight computer. Autopilot operation is disallowed.	
28	Roll srv cmd below lower range	KC 140
	Preflight test failed due to improper response to roll servo command wraparound signal. This indicates a probable failure in the roll servo command circuit or the analog to digital input circuitry of the flight computer. Autopilot operation is disallowed.	
29	Norm accel over 1g upper limit	KC 140
	Preflight test failed due to improper response of the accelerometer after self test. If this error occurs in flight, it should be ignored. Otherwise, this indicates a probable failure in the accelerometer or the associated circuitry of the flight computer. Pitch Axis operation is disallowed.	
30	Norm accel below 1g upper limit	KC 140
	Preflight test failed due to improper response of the accelerometer after self test. If this error occurs in flight, it should be ignored. Otherwise, this indicates a probable failure in the accelerometer or the associated circuitry of the flight computer. Pitch Axis operation is disallowed.	
31	Norm accel over tst upper limit	KC 140, KS 270C
	Preflight test failed due to improper response of the accelerometer during self test. This indicates a probable failure in the accelerometer or the associated circuitry of the flight computer. Pitch Axis operation is disallowed. NOTE: In -5201, -5402, and -7702 FCC flavors, this error can be caused by missing or improper tach feedback from the pitch servo.	

ERR#	TEXT MESSAGE(S) DESCRIPTION OF ERROR	POSSIBLE FAILED UNIT(S)
32	Norm accel below tst lower limit	KC 140
	Preflight test failed due to improper response of the accelerometer during self test. This indicates a probable failure in the accelerometer or the associated circuitry of the flight computer. Pitch Axis operation is disallowed.	
33	Accel mon over upper lmt	KC 140, Tach Feedback Failure from Pitch Servo
	Preflight test failed due to lack of response of the acceleration monitor to a simulated positive acceleration above the upper threshold. This indicates a probable failure of the acceleration monitor circuitry of the flight computer. Pitch Axis operation is disallowed.	
34	Accel mon below lower lmt	KC 140
	Preflight test failed due to lack of response of the acceleration monitor to a simulated negative acceleration below the lower threshold. This indicates a probable failure of the acceleration monitor circuitry of the flight computer. Pitch Axis operation is disallowed.	
35	Trim mon 0 - auto failed	KC 140, KS 270C, KS 272C, harness wiring
	Preflight test failed due to improper response of the runaway/autotrim monitor. This monitor was failed prior to beginning the preflight test sequence. This indicates a probable failure in the trim runaway/autotrim monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	
36	Trim mon 1 - auto failed	KC 140, KS 270C, KS 272C, harness wiring, Also See IB461
	Preflight test failed due to improper response of the runaway/autotrim monitor. The monitor did not detect (i.e. fail) a trim up servo drive with a trim down sense. This indicates a probable failure in the trim runaway/autotrim monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	
37	Trim mon 2 - auto failed	KC 140, KS 270C, KS 272C, harness wiring, Also See IB461
	Preflight test failed due to improper response of the runaway/autotrim monitor. The monitor did not detect (i.e. fail) a trim down servo drive with a trim up sense. This indicates a probable failure in the trim runaway/autotrim monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	
38	Trim mon 3 - auto failed	KC 140, KS 270C, KS 272C, harness wiring
	Preflight test failed due to improper response of the runaway/autotrim monitor. The monitor erroneously failed when the trim was commanded up with an UP MET switch input. This indicates a probable failure in the trim runaway/autotrim monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	

ERR#	TEXT MESSAGE(S) DESCRIPTION OF ERROR	POSSIBLE FAILED UNIT(S)
39	Trim mon 4 – auto failed	KC 140, KS 270C, KS 272C, harness wiring
	Preflight test failed due to improper response of the runaway/autotrim monitor. The monitor did not detect (i.e. fail) a trim down drive with a valid MET UP condition. This indicates a probable failure in the trim runaway/autotrim monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	
40	Trim mon 5 – auto failed	KC 140, KS 270C, KS 272C, harness wiring
	Preflight test failed due to improper response of the runaway/autotrim monitor. The monitor did not detect a trim up drive with a trim DN command. This indicates a probable failure in the trim runaway/autotrim monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	
41	Trim mon 6 – auto failed	KC 140, KS 270C, KS 272C, harness wiring
	Preflight test failed due to improper response of the runaway/autotrim monitor. The monitor failed for a valid trim down drive with a trim down command. This indicates a probable failure in the trim runaway/autotrim monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	
42	Trim mon 7 – auto failed	KC 140, KS 270C, KS 272C, harness wiring
	Preflight test failed due to improper response of the runaway/autotrim monitor. The monitor failed for a null trim drive condition. This indicates a probable failure in the trim runaway/autotrim monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	
43	Trim mon 0 – MET failed	KC 140
	Preflight test failed due to improper response of the MET latent switch monitor. This monitor was failed prior to beginning the preflight test sequence. This indicates a probable failure in the MET monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	
44	Trim mon 3 – MET failed	KC 140
	Preflight test failed due to improper response of the MET latent switch monitor. The monitor did not detect (i.e. fail) a MET UP switch without an ARM switch. This indicates a probable failure in the MET monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	
45	Trim mon 4 – MET failed	KC 140
	Preflight test failed due to improper response of the MET latent switch monitor. The monitor failed for a valid MET UP condition. This indicates a probable failure in the MET monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	

ERR#	TEXT MESSAGE(S) DESCRIPTION OF ERROR	POSSIBLE FAILED UNIT(S)
46	Trim mon 5 - MET failed	KC 140
	Preflight test failed due to improper response of the MET latent switch monitor. The monitor did not detect a DN switch in the absence of an ARM. This indicates a probable failure in the MET monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	
47	Trim mon 6 - MET failed	KC 140
	Preflight test failed due to improper response of the MET latent switch monitor. The monitor failed a valid trim down command with ARM. This indicates a probable failure in the MET monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	
48	Trim mon 7 - MET failed	KC 140
	Preflight test failed due to improper response of the MET latent switch monitor. The monitor did not detect and ARM switch without an UP or DN input. This indicates a probable failure in the MET monitor of the flight computer. Manual Electric Trim and Autotrim operation is disallowed.	
49	Trim voltage over certified value	KC 140, KS 272C, harness wiring, certification file
	Preflight test failed due to improper motor drive voltage from the trim servo. Check that trim servo is proper flavor for the certification. Manual Electric Trim and Autotrim operation is disallowed.	
50	Trim voltage below min	KC 140, KS 272C, harness wiring
	Preflight test failed due to lack of response of the trim motor voltage. This indicates a possible failure of the trim servo or interconnect. Manual Electric Trim and Autotrim operation is disallowed.	
51	Trim servo disable failed	KC 140, KS 272C, harness wiring, Open between P1402 pin 44 and P272C pin A
	During preflight test, the trim servo disable output did not inhibit the trim servo. This preflight test step fails the trim monitor, outputs maximum trim command, and verifies that the trim voltage is less than 2.5 volts. Manual Electric Trim and Autotrim operation is disallowed.	
52	Failed trim interrupt of acc mon	KC 140
	During pre-flight test, a failure of the autotrim monitor did not disable the accelerometer monitor for > 5 seconds. This preflight test step fails the autotrim and the acceleration monitors. At 3 seconds and at 5 seconds, from the start of the failure of the autotrim and acceleration monitors, the software verifies that the acceleration monitor fail output has not failed. The software verifies at 11 seconds that the acceleration monitor fail output has failed. Pitch Axis operation is disallowed.	

ERR#	TEXT MESSAGE(S) DESCRIPTION OF ERROR	POSSIBLE FAILED UNIT(S)
53	Acc mon failed clutch interrupt	KC 140, KS 270C, KS 271C, KS 272C, harness wiring
	The accelerometer monitor did not disengage the pitch, roll, or trim clutch during PFT. Probable fault in clutch engagement logic. This error code is not present in software flavors -0105, -0106, and -0201. Pitch Axis operation is disallowed.	
54	Trim mon failed clutch interrupt	KC 140, KS 272C, harness wiring
	During preflight test, the trim clutch was not disabled by a trim monitor failure. This preflight test step fails the trim monitor and checks that the trim clutch is disabled. Manual Electric Trim and Autotrim operation is disallowed.	
55	GPS armed w/ other snsr req	KC 140
	An error has occurred in the mode logic.	
56	LOC armed w/ other snsr req	KC 140
	An error has occurred in the mode logic.	
57	VOR armed w/ other snsr req	KC 140
	An error has occurred in the mode logic.	
58	Lat armed illegal xsit mode	KC 140
	An error has occurred in the mode logic.	
59	Lat armed illegal mode detail	KC 140
	An error has occurred in the mode logic.	
60	GPS tracked w/ other snsr req	KC 140
	An error has occurred in the mode logic.	
61	LOC tracked w/ other snsr req	KC 140
	An error has occurred in the mode logic.	
62	VOR tracked w/ other snsr req	KC 140
	An error has occurred in the mode logic.	
63	GPS tracked w/ GPS track req	KC 140
	An error has occurred in the mode logic.	
64	LOC tracked w/ LOC track req	KC 140
	An error has occurred in the mode logic.	
65	VOR tracked w/ VOR track req	KC 140
	An error has occurred in the mode logic.	

ERR#	TEXT MESSAGE(S) DESCRIPTION OF ERROR	POSSIBLE FAILED UNIT(S)
66	Lat cpld illegal xsit mode An error has occurred in the mode logic.	KC 140
70	GS tracked w/ GS track req An error has occurred in the mode logic.	KC 140
71	GS tracked w/ alt capture req An error has occurred in the mode logic.	KC 140
72	Alt hold w/ alt capture req An error has occurred in the mode logic.	KC 140
73	Vert cpld illegal xsit mode An error has occurred in the mode logic.	KC 140
74	Vert armed #1 illegal xsit mode An error has occurred in the mode logic.	KC 140
75	GS armed w/ GS arm req An error has occurred in the mode logic.	KC 140
76	Vert armed #2 illegal xsit mode An error has occurred in the mode logic.	KC 140
80	Roll illegal xsit mode An error has occurred in the mode logic.	KC 140
81	Pitch illegal xsit mode An error has occurred in the mode logic.	KC 140
82	Trim illegal xsit mode An error has occurred in the mode logic.	KC 140
83	Alt calc illegal xsit mode An error has occurred in the mode logic.	KC 140
90	Lat armed invalid The roll arm mode has been deactivated due to invalid inputs that prevent proper algorithm calculation. If GPS is the selected arm mode, loss of NAV valid for 30 seconds or HDG valid for 5 seconds will cancel the roll arm mode. If LOC is the selected arm mode, loss of NAV valid for 30 seconds or HDG valid for 5 seconds will cancel the roll arm mode. If VOR is the selected arm mode, loss of NAV valid for 30 seconds will cancel the roll arm mode.	KC 140, Nav Sensor, Hdg Sensor, harness wiring

ERR#	TEXT MESSAGE(S) DESCRIPTION OF ERROR	POSSIBLE FAILED UNIT(S)
91	Lat cpld invalid	KC 140, Nav Sensor, Hdg Sensor, Turn & Bank Indicator, harness wiring
	The roll coupled mode has been deactivated due to invalid inputs that prevent proper algorithm calculation. If the selected mode is HDG hold, loss of HDG valid for 3 seconds will dump the roll coupled mode. If the selected mode is GPS TRK, loss of NAV valid for 5 seconds or HDG valid for 5 seconds will dump the roll coupled mode. If the selected mode is LOC TRK, loss of NAV valid for 5 seconds or HDG valid for 5 seconds will dump the roll coupled mode. If the selected mode is VOR TRK, loss of NAV valid for 5 seconds or HDG valid for 15 seconds will dump the roll coupled mode. If the selected mode is the default lateral coupled mode and CWS is not pressed, loss of rate valid from the Turn and Bank Indicator for 1 second will dump the roll coupled mode.		
92	Vert armed #1 invalid	KC 140
	The altitude arm mode has been deactivated due to invalid inputs that prevent proper algorithm calculation. If the KC 140 Analog valid signal is invalid for 0.5 seconds the altitude arm mode will be dumped.	
93	Vert armed #2 invalid	KC 140, NAV sensor, harness wiring
	The Glideslope arm mode has been deactivated due to invalid inputs that prevent proper algorithm calculation. If the Glideslope (GS) valid signal is invalid or the accelerometer monitor has failed or the ILS sensor is no longer selected for 10 seconds the glideslope arm mode will be dumped.	
94	Vert cpld invalid	KC 140, NAV Sensor, harness wiring
	The pitch coupled mode has been deactivated due to invalid inputs that prevent proper algorithm calculation. If the selected mode is GS TRK, loss of the GS valid signal or an acceleration failure or not having the ILS selected for 3 seconds will dump the pitch coupled mode. If the selected mode is the default vertical coupled mode, loss of the KC 140 Analog valid signal for 1 second will dump the pitch coupled mode.	
95	Roll invalid	KC 140, KS 271C, Turn & Bank Indicator, harness wiring
	The roll autopilot has been deactivated due to invalid inputs that prevent proper algorithm calculation. The default roll attitude hold mode will be dumped if the KS 271C roll valid signal is invalid for 1 second or the rate valid signal from the Turn & Bank indicator is invalid for 1 second without CWS being pressed.	

ERR#	TEXT MESSAGE(S) DESCRIPTION OF ERROR	POSSIBLE FAILED UNIT(S)
96	Pitch invalid	KC 140, KS 270C, harness wiring
	The pitch autopilot has been deactivated due to invalid inputs that prevent proper algorithm calculation. The default pitch attitude hold mode will be dumped if the KS 270C pitch valid signal is invalid for 1 second or the KC 140 Accel valid signal is invalid for 1 second without CWS being pressed or the KC 140 Accel reasonability monitor has detected an unreasonable Accel output.	
97	Trim invalid	KC 140
	The trim axis has been deactivated due to invalid inputs that prevent proper algorithm calculation.	
98	Alt calc invalid	KC 140
	The altitude calculation has been deactivated due to invalid inputs that prevent proper algorithm calculation.	
100	HDG denied	KC 140, HDG sensor, harness wiring
	The HDG mode was requested but not allowed due to invalid sensor inputs. If the heading valid signal is invalid, the HDG mode will be disallowed.	
101	NAV denied	KC 140, HDG sensor, NAV sensor, harness wiring
	The NAV mode was requested but not allowed due to invalid sensor inputs. If the HDG sensor and NAV sensor valid signals are invalid, the NAV mode will be disallowed.	
102	APR denied	KC 140, HDG sensor, NAV sensor, harness wiring
	The NAV mode was requested but not allowed due to invalid sensor inputs. If the HDG sensor and NAV sensor valid signals are invalid, the APR mode will be disallowed.	
103	REV denied	KC 140, HDG sensor, NAV sensor, harness wiring
	The REV mode was requested but not allowed due to invalid sensor inputs. If the HDG sensor and NAV sensor valid signals are invalid, the REV mode will be disallowed.	
104	ALT denied	KC 140
	The ALT mode was requested but not allowed due to invalid sensor inputs. If the acceleration monitor has failed or the KC 140 analog valid is invalid, the ALT mode will be disallowed.	
105	ALT ARM denied	KC 140, Altimeter, harness wiring
	The ALT ARM mode was requested but not allowed due to invalid sensor inputs. If the acceleration monitor has failed or the KC 140 analog valid is invalid or the Gillham code is invalid or the KC 140 pressure sensor output is invalid, the ALT ARM mode will be disallowed.	

ERR#	TEXT MESSAGE(S) DESCRIPTION OF ERROR	POSSIBLE FAILED UNIT(S)
110	Autotrim runaway	KC 140, KS 272C, KS 270C, harness wiring
	The trim servo was detected in opposition to the primary servo command. This may indicate an autotrim failure. The Autotrim operation of the AP mode and Manual Electric Trim operation will be disallowed until AP power is cycled and the KC 140 successfully passes pre-flight test.	
111	MET runaway	KC 140, KS 272C, harness wiring
	A trim servo voltage was detected without the corresponding MET switch active. Manual Electric Trim operation and autotrim operation will be disallowed until AP power is cycled and the KC 140 successfully passes pre-flight test.	
112	MET fail	KC 140, MET switches, harness wiring
	A possible latent failure of the Manual Electric Trim switches was detected. Check the control wheel for a stuck switch. Manual Electric Trim operation will be disallowed until the stuck switch condition is removed.	
113	Accel fail	KC 140
	The autopilot was disengaged due to excessive normal acceleration.* Pitch Axis operation will be disallowed until the excessive acceleration is removed. The AP mode will not be disengaged due to excessive normal acceleration while CWS is pressed. *Note: Refer to the accelerometer monitor failure description for the flavors of KC 140 that are dependent on the pitch tachometer output polarity during an excessive acceleration condition.	
150	ECAL Node error	KC 140
	An error has occurred in the mode algorithm calculation.	
151	ECAL Type error	KC 140
	An error has occurred in the mode algorithm calculation.	
152	ECAL FIFO error	KC 140
	An error has occurred in the mode algorithm calculation.	
153	ECAL Stack error	KC 140
	An error has occurred in the mode algorithm calculation.	
154	ECAL Initial Condition error	KC 140
	An error has occurred in the mode algorithm calculation.	
155	ECAL Index error	KC 140
	An error has occurred in the mode algorithm calculation.	
156	ECAL Block error	KC 140
	An error has occurred in the mode algorithm calculation.	

ERR#	TEXT MESSAGE(S) DESCRIPTION OF ERROR	POSSIBLE FAILED UNIT(S)
157	ECAL Bad sign input to summer	KC 140
	An error has occurred in the mode algorithm calculation.	
158	ECAL Not enough node inputs	KC 140
	An error has occurred in the mode algorithm calculation.	
159	ECAL Filtering out of range	KC 140
	An error has occurred in the mode algorithm calculation.	
160	ECAL Default error	KC 140
	An error has occurred in the mode algorithm calculation.	
161	ECAL Bad Node Record	KC 140
	An error has occurred in the mode algorithm calculation.	
162	ECAL Bad Block Pointer	KC 140
	An error has occurred in the mode algorithm calculation.	
163	ECAL Mode Index out of range	KC 140
	An error has occurred in the mode algorithm calculation.	
170	Accel reasonability check failed	KC 140, Unstored acceleration offset in KCM 100
	The current accelerometer output was 0.8g's greater than the previous averaged value for the accelerometer for 1.0 seconds and the AP mode was disconnected. Pitch axis operation will be disallowed until the excessive acceleration is removed. This monitor runs continuously whether the AP mode is engaged or not. This error code is logged only when the monitor fails. (This means that if this error code has been logged and you clear the error codes and the monitor remains failed, the KC 140 will not log the error again. The error code will only be logged again after the monitor failure has cleared and the monitor fails a second time.) Note: This error may be logged at power up if the acceleration offset has not been stored in the KCM 100 Configuration Module.	
175	RS232 status reg error	
	An error has occurred in the serial interface. There may be an intermittent in the remote terminal interconnect or an erroneous transient occurred during terminal powerup. Unless this error occurs after normal serial communications have been established, it can probably be ignored.	
176	RS232 receive queue full	KC 140
	An error has occurred in the serial interface. The receive character buffer was filled before it could be serviced.	
177	RS232 unknown interrupt	KC 140
	An error has occurred in the serial interface. The UART interrupted the processor for unknown reasons.	

ERR#	TEXT MESSAGE(S) DESCRIPTION OF ERROR	POSSIBLE FAILED UNIT(S)
190	Error in Encoding Altimeter Input The parallel altitude information from the altimeter is not a valid Gilham code. The altimeter may be powered off or there may be a broken wire in the harness. The Altitude ARM mode will be disconnected if this occurs.	Altimeter, KC140
191	Error in remote baro input The remote baro input is outside the valid operating range. The KC 140 will revert to using its baro select knob.	KC 140, Altimeter
192	Error in pressure sensor input The pressure transducer signal is outside the valid operating range. ALT ARM mode, ALT hold mode, and AP mode will be disconnected if this occurs. Pitch Axis operation will be disallowed until the pressure transducer signal is valid again.	KC 140
193	Erroneous Altimeter Reading The software detected a greater than 100 foot change between samples of the gillham altitude.	KC 140, Altimeter
200	SREC upload memory overrun This is a development mode error and should not occur in production units. There was an error in the attempt to upload a new algorithm. The upload buffer became full before the entire file was transferred.	KC 140
201	SREC upload checksum error This is a development mode error and should not occur in production units. There was an error in the attempt to upload a new algorithm. The upload data does not match the checksum in the file.	KC 140
202	Invalid ECAL slot This is a development mode error and should not occur in production units. There was an error in the attempt to upload a new algorithm. An erroneous upload buffer number was passed to the algorithm loader.	KC 140
240	Acc Mon roll clutch eng failed An attempt to engage the roll clutch during PFT failed. No current was sensed in the roll clutch. This error code is not present in software flavors -0103, and -0104. Pitch Axis operation will be disallowed.	KC 140, KS 271C, harness wiring
241	Acc Mon pitch clutch eng failed An attempt to engage the pitch clutch during PFT failed. No current was sensed in the pitch clutch. This error code is not present in software flavors -0103, and -0104. Pitch Axis operation will be disallowed.	KC 140, KS 270C, harness wiring

ERR#	TEXT MESSAGE(S) DESCRIPTION OF ERROR	POSSIBLE FAILED UNIT(S)
242	Acc Mon trim clutch eng failed	KC 140, KS 272C, harness wiring
	An attempt to engage the trim clutch during PFT failed. No current was sensed in the trim clutch. This error code is not present in software flavors -0103, and -0104. Pitch Axis operation will be disallowed.	
243	Acc Mon roll clutch diseng failed	KC 140, KS 271C, harness wiring
	The accelerometer monitor did not disengage the roll clutch during PFT. Probable fault in clutch engagement logic. This error code is not present in software flavors -0103, and -0104. Pitch Axis operation will be disallowed.	
244	Acc Mon pitch clutch diseng failed	KC 140, KS 270C, harness wiring
	The accelerometer monitor did not disengage the pitch clutch during PFT. Probable fault in clutch engagement logic. This error code is not present in software flavors -0103, and -0104. Pitch Axis operation will be disallowed.	
245	Acc Mon trim clutch diseng failed	KC 140, KS 272C, harness wiring
	The accelerometer monitor did not disengage the trim clutch during PFT. Probable fault in clutch engagement logic. This error code is not present in software flavors -0103, and -0104. Pitch Axis operation will be disallowed.	
246	Acc HP fails self test	KC 140
	PFT failed due to insufficient response from high passed acceleration value during self test The input should have been saturated, but was below the minimum saturation value. This error code is not present in software flavors -0103, -0104, and -0105. Pitch Axis operation will be disallowed.	
247	Acc HP does not settle	KC 140
	PFT failed due to the high passed acceleration value not settling in the flight computer. This error code is not present in software flavors -0103, -0104, and -0105. Pitch Axis operation will be disallowed.	
248	Acc HP has high gain	KC 140
	PFT failed due to the gain of the high passed acceleration being too high in the flight computer. This error code is not present in software flavors -0103, -0104, and -0105. Pitch Axis operation will be disallowed.	
249	Acc HP has low gain	KC 140
	PFT failed due to the gain of the high passed acceleration being too low in the flight computer. This error code is not present in software flavors -0103, -0104, and -0105. Pitch Axis operation will be disallowed.	
250	Acc HP has short time constant	KC 140
	PFT failed due to the time constant of the high passed acceleration being too short in the flight computer. This error code is not present in software flavors -0103, -0104, and -0105. Pitch Axis operation will be disallowed.	

ERR#	TEXT MESSAGE(S) DESCRIPTION OF ERROR	POSSIBLE FAILED UNIT(S)
251	Acc HP has long time constant	KC 140
	Preflight test failed due to the time constant of the high passed acceleration being too long in the flight computer. This error code is not present in software flavors -0103, -0104, and -0105. Pitch Axis operation will be disallowed.	
252	Norm accel self-test fail	KC 140
	Preflight test failed due to improper response of the accelerometer during self test. This indicates a probable failure in the accelerometer or the associated circuitry of the flight computer. This error code is not present in software flavors -0103, -0104, and -0105. Pitch Axis operation will be disallowed.	

THE END

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