Pilot's Guide

KFC 250

Bendix/King Flight Control System

Table of Contents

Introduction to the KFC 250 Flight Control System

The KFC 250 Flight Director/Autopilot is a complete 3-axis integrated system with large, 4-inch electric (or 3-inch vacuum/electric) Flight Command and Pictorial Navigation Indicators.

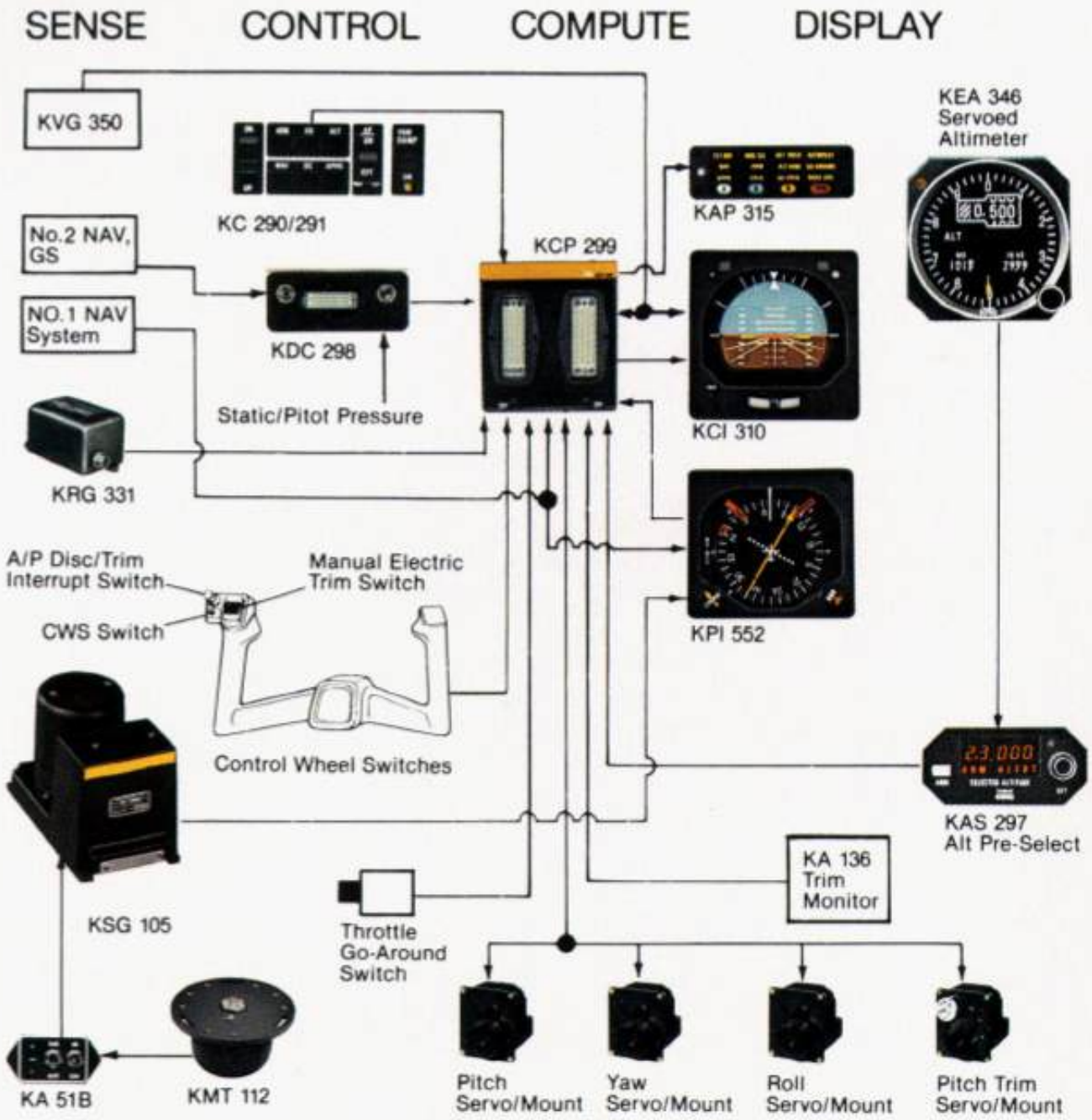
An all solid-state Flight Computer provides computed Flight Director commands along with complete 3-axis Autopilot control. The system provides all standard operating modes plus altitude preselect capability.

This system is designed specifically to bring the advantages of advanced technology to single pilot instrument flying in turboprops and cabin class twins.

King Radio also offers a Flight Director only version, named the KFD 250 which offers virtually the same performance as the 4" KFC 250 system without servo control of the aircraft control surfaces. Presentation of the flight sequences shown in this handbook can be used as a guide for the KFD 250 by ignoring comments regarding autopilot operation.

Control System Components

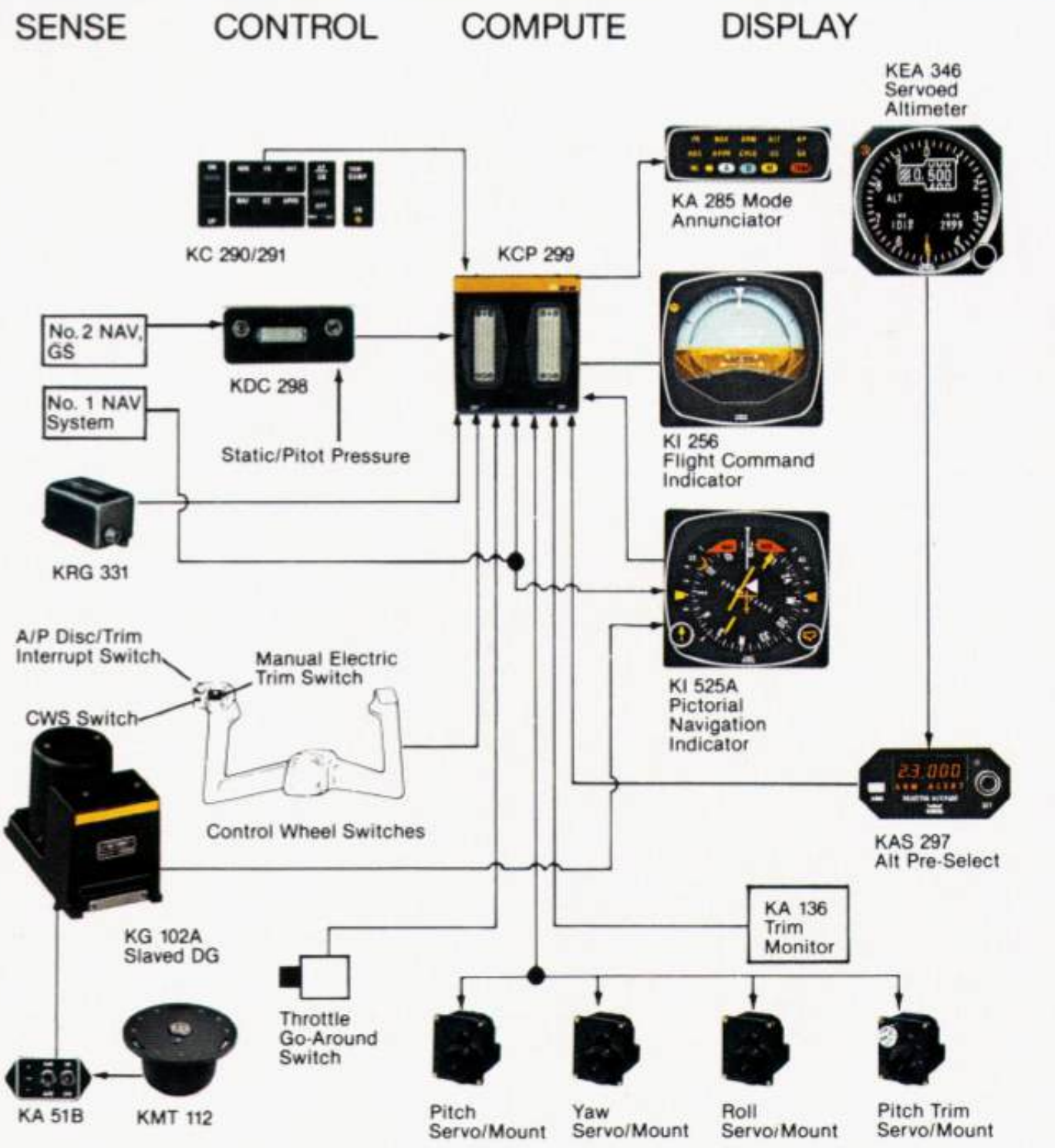
(4 Inch Instruments)



KFC 250 System Integration

The system diagrams show the components of the KFC 250 Integrated Flight Control

The Flight Computer computes pitch and roll steering commands. These two com-



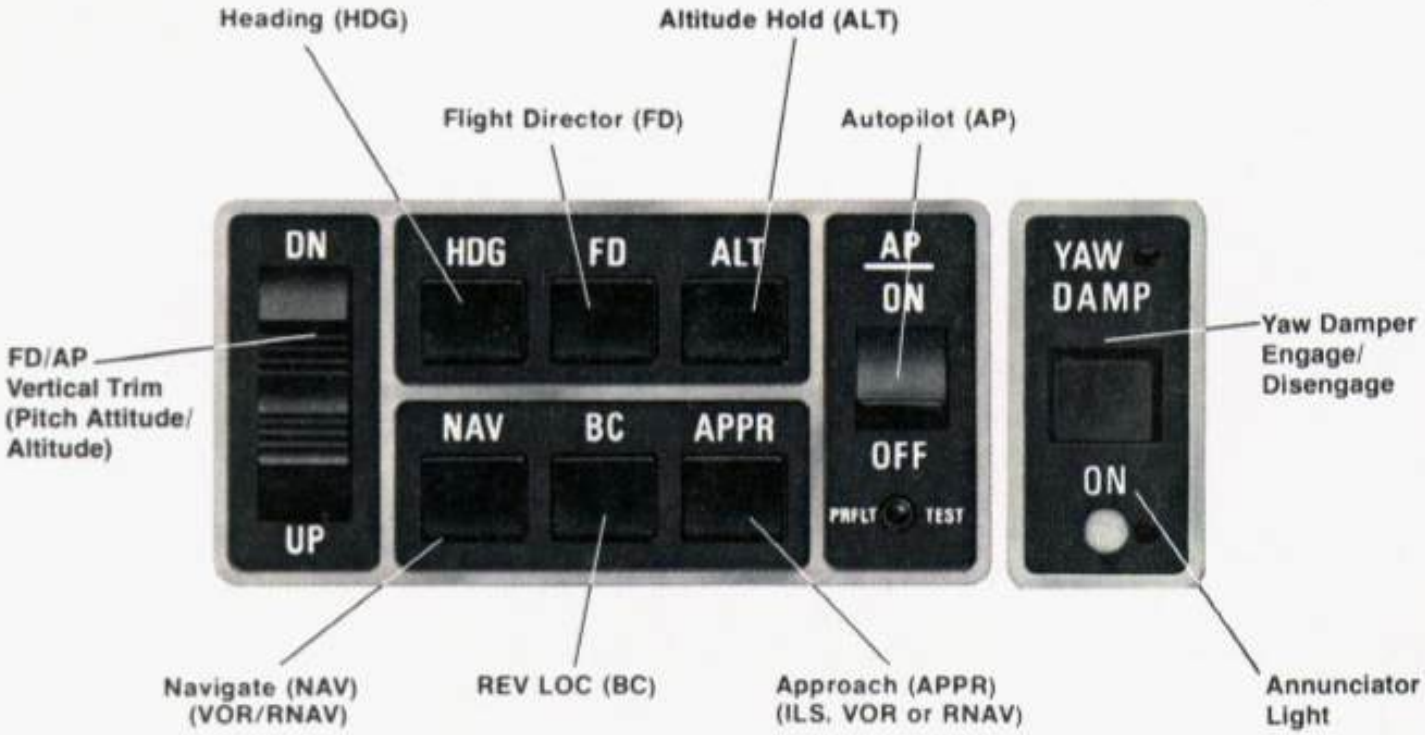
are combined to generate the aileron, elevator trim, and rudder drive commands for the

displayed on the V-bar in the FCI, into the required elevator and aileron position commands.

KING KFC 250 Flight Control System Specifications

KFC 250		Current Drain	Weight (lbs)	Weight (Kgs)
(Common components)				
KC 290	Mode Controller		.50	.22
KC 291	Yaw Controller		.10	.04
KCP 299	Flight Computer		5.90	2.67
KDC 298	Air Data		1.70	.77
KA 136	Trim Monitor		.50	.22
KS 27X (4)	Servo/Mount		13.40	6.07
KRG 331	Yaw Rate Sensor		.76	.34
KAS 297	Altitude Selector		1.20	.54
KEA 346	Servoed Altimeter		2.90	1.31
		10.45 A 28 VDC 4.5 VA 26 VAC	26.96	12.18
4-Inch				
KCI 310	Flight Command Indicator		5.00	2.27
KPI 552	Pictorial Navigation Indicator		4.80	2.18
KAP 315	Mode Annunciator		1.40	.63
KVG 350	Vertical Gyro		6.00	2.72
KCS 305	Slaved D.G.		5.60	2.54
		11.95 A 28 VDC 43.6 VA 26 VAC		
Total 4-Inch		95 VA max 115 VAC	49.76	22.52
3-Inch				
KI 256	Flight Command Indicator		3.30	1.50
KI 525A	Pictorial Navigation Indicator		4.00	1.82
KA 285	Mode Annunciator		.50	.20
KG 102A/ KMT 112/ KA 51B	Slaved D.G. System		5.50	2.50
		13.85 A 28 VDC 4.5 VA 26 VAC		
Total 3-Inch			40.26	18.20

Flight Director System Modes of Operation



Flight Director Guidance and Command to Autopilot

Basic Attitude Reference Mode — Activated with "power on" but with no modes selected. The Flight Command indicator and Pictorial NAV indicator will display existing attitude and heading. The Command V-bar is retracted out of view until a Flight Director/Autopilot mode has been selected.

Flight Director (FD) — Command V-bar will call for wings level. The pitch attitude of the aircraft will remain the same as at the time of mode selection.

Heading (HDG) — Select desired heading on PNI, then select the HDG mode and the system will command the necessary bank to turn to and maintain the selected heading.

NAV (VOR/RNAV) — Set desired course on PNI and select NAV mode. The system's all-angle NAV Course Capture feature gives the pilot complete freedom to select any intercept

Approach (APPR) (ILS or VOR) — Set the inbound front approach course on the PNI and select Approach mode. The system's all-angle Approach Course Capture feature allows the pilot to select any intercept angle in response to ATC vectors, as in the NAV mode. The Approach mode will be "armed," and at the appropriate capture point the system will "couple" and command the necessary bank and pitch to capture and track LOC and Glideslope beams for precision approaches . . . or bank command to capture and track VOR courses for non-precision approaches.

Back Course (BC) — With back course selected in Approach mode, the system when capturing will command the bank necessary to capture and track a reverse LOC course . . . Glideslope is locked out. The inbound front approach course is always set on the PNI to enable you to make course corrections toward the needle rather than away from the needle on the PNI.

Go Around (GA) — Push the "Go Around" button and the system will command wings level and nose up to a preset missed approach climb attitude.

Altitude Hold (ALT) — Pitch command to maintain engaged altitude.

Vertical Trim — Provides capability to adjust or slew the Altitude up or down without disengaging and then reengaging ALT Hold. If Altitude Hold is not engaged, the Vertical Trim knob will adjust the pitch attitude up or down.

Altitude Preselect — Permits preselection of a desired altitude and automatic capture upon reaching that altitude.

Autopilot (AP) — Control surfaces respond to all selected Flight Director mode commands in both pitch and roll axis plus automatic pitch trim. A full time yaw damper is in operation any time the Autopilot is engaged. Separate Autopilot servos and capstans make it easy to remove and service the control surface servos without de-rigging the surface control cables.

Control Wheel Steering — Allows manual flight maneuvering without the need to disengage and reengage the Autopilot. With the CWS switch depressed, the system pitch axis is syn-

KFC 250 System Panel Checklist:

1. THE KAP 315 ANNUNCIATOR PANEL provides the pilot with continuous information on system operating status. It shows modes in operation, as well as modes "armed" prior to capture. It also displays Marker Beacon lights and a Trim Fault warning.

2. THE KPI 552 PICTORIAL NAVIGATION INDICATOR displays slaved gyro magnetic heading information. By positioning the "Heading Bug" on the PNI with the "heading select" knob, the pilot selects the desired aircraft heading. For VOR/LOC/RNAV course selection, the "course select" knob is used. Glideslope deviation is shown on the left side of the instrument face when a valid Glideslope signal is received. TO/FROM indications and appropriate warning flags are also displayed on this indicator.

A KPI 553A PNI with built in DME display and RMI pointer is available as an option (see picture on page 11).

3. THE KCI 310 FLIGHT COMMAND INDICATOR displays the following information:

- Pitch and roll attitude
- Pitch and roll commands
- Decision Height (DH)
- RNAV Annunciation (RNV)
- Skid/Slip on inclinometer

Separate wiring from the remote vertical gyro to the attitude indicator and strict separation of attitude and command bar power circuits assure the pilot of attitude reference even in the event of a Flight Computer failure.

4. THE KC 290 MODE CONTROLLER provides pushbutton selection of all Flight Director/Autopilot modes, plus Vertical Trim. This trim switch allows the pilot to adjust the aircraft's altitude or pitch attitude without

1A. THE KA 285 ANNUNCIATOR PANEL provides the same functions as the KAP 315 with the exception of the ALT ARM light.

2A. THE KI 256 3-INCH VACUUM/ELECTRIC FLIGHT COMMAND INDICATOR displays the following information:

- Pitch and roll attitude
- Pitch and roll commands
- Decision height (DH)

3A. THE KI 525A PICTORIAL NAVIGATION INDICATOR displays slaved gyro magnetic heading information and operates similarly to the KPI 552.

6. KEA 346 SERVOED ALTIMETER provides barometric corrected altitude information to the KAS 297 Altitude Selector and encoding for an ATC transponder.

5. THE OPTIONAL KC 291 YAW MODE CONTROLLER can be installed alongside the KC 290 Mode Controller. In this configuration the yaw axis is wired so that it automatically engages when the Autopilot is engaged. Disengagement of the yaw damper is accomplished by using the control wheel mounted disengage switch or the KC 291 engage/disengage switch.

Operating the KFC 250 System

There are twelve (12) modes of operation that are provided by the KFC 250 system to offer the pilot Flight Director/Autopilot commands in response to his selection of desired modes on the Mode Controller.

Most of these modes are activated by pushbutton switches on the Mode Controller. These pushbuttons operate with alternate action. The first depression of the pushbutton

flight sequence without the inconvenience of having to manually cancel modes. For example, if in NAV CPLD mode, selection of Heading will automatically cancel NAV.

THE BASIC MODE OF SYSTEM OPERATION

The system will be in the Basic Attitude Reference or "Gyro" mode with engines run-

System Safety Is Assured By Integrity Monitors

The KFC 250 monitors the validity of the system sensors and the Flight Computer to alert the pilot when the system cannot respond correctly to command signals.

"Invalid" signals provide visual warning by means of the flags and annunciators. "Invalid" signals are also routed to the KFC 250 switching logic to "lock out" modes which will not operate reliably.

Most failures in the slaved compass system would be annunciated by a compass flag and the system would not allow selection of the Heading, NAV or APPR modes.

The illustrations above show the KFC 250 Flight Director cockpit displays with all warning flags in view.

When an ILS channel is selected on the NAV receiver and a valid Glideslope signal is received, the Glideslope pointer will appear. Glideslope coupling usually occurs at Outer Marker, when the Glideslope is intercepted (glideslope pointers centered) and APPR CPLD. If, after GS coupling, the GS pointer disappears, the system will flash the GS Annunciator and go from GS coupled to Pitch Attitude Hold. If the GS pointer reappears, the system will revert back to GS coupled. The NAV warning flag indicates an invalid Localizer but has no effect on Glideslope operation.

In the Approach mode, in an aircraft equipped with dual LOC and GS receivers, Ap-

1.

2.

Preflight Test Determines, Before Takeoff, that the System is Operating Normally.

With power on, all circuit breakers in, and engine running, allow 3 minutes for the gyros to come up to speed.

Make sure you are in slaved gyro mode by confirming the status on the KA 51B Slaving Meter and compare the compass card on the KPI 552 or KI 525A with your magnetic compass.

With no modes engaged, depress the Preflight Test button on the Mode Controller. All modes will be annunciated on the Annunciator Panel, including the 3 Marker lights, and the red Autotrim light will flash. At least four and not more than six flashes must be be observed to indicate proper operation of the Autotrim monitor feature. The KCI 310 computer flag engages the Autopilot. The Autopilot will not engage when the Flight Director is not operating.

Now depress the CWS switch, center the display on the Flight Command Indicator and release the CWS switch. Then apply force to the controls to determine if the Autopilot can be overpowered.

CAUTION: Operation of the Autopilot on the ground may cause the autotrim to run because of back force generated by elevator downsprings or pilot induced forces.

Some aircraft have preflight test sequences required in addition to the general procedures described here. See the FAA approved

FLIGHT DIRECTOR Mode (FD)

The Flight Director mode is activated by depressing the "FD" button on the Mode Controller.

The FCI Command V-bar will appear and provide the pilot with steering commands to maintain wings level and the pitch attitude that existed at the time of Flight Director engagement.

If pitch or roll attitude are changed, re-cycling the FD button will synchronize the Command V-bar to the new situation.

If a change only in the commanded pitch attitude is desired, the Control Wheel Steering (CWS) button installed on the pilot's control wheel allows the pilot to synchronize the Command V-bar (in the FD mode with Autopilot disengaged) without removing his hand from the control wheel.

The Flight Director can also be activated by direct selection of any specific mode, which will activate the Command V-bar. Such selection will annunciate both FD and the appropriate mode.

The Vertical Trim switch on the Mode Controller may also be used to adjust the selected pitch attitude up or down at approx. 1 degree/second.

Special note: The FD mode must be activated before the Autopilot can be engaged.

AUTOPILOT Engagement

The AUTOPILOT is engaged by moving the solenoid-held AP toggle switch on the Mode Controller to the ON position. Note that the AP and the YAW DAMP (YD) switches are wired so that the YAW DAMP mode is automatically engaged with the AP switch.

The Autopilot, together with the Yaw Damper, provides three-axis stabilization, automatic turn coordination and automatic elevator trim as well as automatic response to all selected Flight Director commands.

CAUTION: When the autopilot is engaged, manual application of a force to the pitch axis of the control wheel for a period of 3 seconds or more will result in the autotrim system operating in the direction to create a force opposing the pilot. This opposing mistrim force will continue to increase as long as the pilot applies a force to the control wheel and will ultimately overpower the autopilot. If the autopilot is disengaged under these

HEADING SELECT/PRESELECT Mode (HDG SEL)

Select a desired heading by positioning the heading "bug" on the PNI. This is done with the HDG knob on the PNI.

Depress the HDG button on the Mode Controller to activate the HDG SEL mode. "HDG SEL" will light on the Annunciator Panel and a computed, visually displayed bank command is shown on the FCI. Following this bank command, the aircraft will bank and roll out on the desired preselected heading.

The Command V-bar on the FCI will deflect in the direction of the shortest turn to satisfy the commanded turn to the preselected heading. The aircraft may be manually banked to realign the V-bar and satisfy the command or, if the Autopilot is engaged, the aircraft will automatically bank, turn to, roll out and hold the preselected heading. As the aircraft approaches the selected heading the V-bar will command a rollout to wings level.

With the HDG SEL mode in operation, subsequent changes made in the heading "bug" position on the PNI will immediately cause the V-bar on the FCI to call for a turn to the new heading.

The HDG SEL mode is cancelled when NAV or APPR coupling occurs, or whenever the FD or HDG mode buttons are depressed.

CAUTION: An invalid heading source (compass flag in view) will automatically disengage the autopilot. The autopilot may then be re-engaged, however, only the vertical modes will be useable.

YAW DAMP Mode

The KC 291 Yaw Mode Controller is installed beside the KC 290 Mode Controller and the yaw axis is wired so that it automatically engages when the Autopilot is engaged. Disengagement of the Yaw Damper

NAVIGATION (NAV ARM and NAV CPLD) Mode

The NAV mode provides visual bank commands on the Flight Command Indicator and deviation guidance on the PNI to intercept and track a VOR course or an RNAV course.

Operation of the NAV mode requires the pilot to:

1. Tune the frequency of the selected VOR (or VORTAC) station. For RNAV operation, set in waypoint distance and bearing from the VORTAC station.

2. Set the PNI course pointer on the desired course.

3. Establish angle of intercept by setting heading "bug" and activate "HDG" mode.

4. Depress the NAV button on the Mode Controller.

When the "NAV" button on the Mode Controller is depressed, "NAV/ARM" will be lighted on the Annunciator Panel and the automatic capture circuit is armed. Heading select, if operating, is retained until capture occurs.

The VOR or RNAV "course-capture" point is variable to prevent overshoot and depends on angle of intercept and the rate the course deviation is changing. Upon capture, a bank command will be displayed on the FCI; the HDG, if on, will be cancelled and "NAV/CPLD" will be lighted on the Annunciator Panel.

The pilot can manually bank the aircraft to satisfy the command display which will call for a rollout to level flight when on course centerline to track the course. Crosswind compensation is provided in the "track" state.

If the NAV mode is selected with the aircraft level within ±4° of bank and within three dots of course deviation, NAV/ARM will be bypassed and NAV/CPLD will engage directly.

If the Autopilot is engaged, the aircraft will bank to satisfy the command display and rollout on course automatically.

Upon station (or waypoint) passage, an outbound course other than the inbound reciprocal can be selected by resetting the NAV course arrow on the PNI. This will cause an immediate V-bar deflection on the FCI directing a turn to the new course.

The NAV mode is cancelled by depressing the NAV button, or selecting HDG (when in NAV coupled) or APPR modes, or pushing

APPROACH (APPR/ARM, APPR/CPLD and GS CPLD) Mode

The APPR mode provides visual roll and pitch commands on the FCI V-bar to capture and track precision ILS (LOC and Glideslope) beams, or non-precision VOR radials. Lateral and vertical deviation can be monitored on the PNI.

Operation of the APPR mode requires the pilot to:

1. Set the NAV receiver frequency.

2. Set the PNI course pointer to the inbound runway heading or.the front course in case of ILS precision approach. Do this even on back course approach.

3. Set the HDG SEL "bug" on the PNI to the desired intercept angle and activate "HDG" mode.

4. Depress the "APPR" button on the mode controller.

The automatic APPR capture function will be immediately armed. "APPR/ARM" will be lighted on the Mode Annunciator Panel.

In APPR/ARM mode, prior to capture, the heading select mode is retained in order to allow the pilot to adjust heading to Approach Control vectoring instructions.

The LOC beam or VOR "capture" point will vary, depending on angle of intercept and rate of change of deviation indication. Upon capture, a bank command will be introduced on the FCI, the existing heading mode will be cancelled and "APPR/CPLD" will be lighted on the Annunciator Panel.

The pilot may manually bank the aircraft to satisfy the command display, which will command a rollout to level flight when the aircraft is on course. Automatic crosswind compensation will provide precise tracking. VOR/LOC deviation is shown on the PNI, and actual crab angle will be shown by offset of the course arrow from the lubber line.

Throughout APPR mode operation, LOC and Glideslope deviation or VOR deviation are displayed in the PNI.

If the Autopilot is engaged during operation in the APPR mode, automatic steering response will follow the command display on the FCI.

The Glideslope mode is armed for automatic capture if LOC front course capture has occurred. Automatic Glideslope capture occurs as the aircraft passes through the glide path from above or below.

Upon interception of the Glideslope, capture occurs and "GS CPLD" is lighted on the Annunciator Panel. A smooth capture

During VOR or RNAV approaches, Glideslope capture will not occur because the NAV receiver is channeled to a VOR station, not an ILS, and this locks out the Glideslope function.

APPR/CPLD mode is cancelled by

BACK COURSE (BACK CRS) Mode

Whenever a LOC or ILS frequency is selected, the BC mode may be activated by depressing the BC button on the Mode Controller, **after** selecting APPR. When in BC mode and Localizer capture occurs, the system will turn and track outbound on the front course or inbound on the back course. The BC mode reverses the LOC deviation signal and course datum to permit the FCI steering command display to operate on a fly-to rather than a fly-from basis on the reverse course. "BACK CRS" is lighted on the Annunciator Panel.

Operation on BC is identical to front course operation including setting the PNI Course Pointer to the front course heading, except that automatic Glideslope capture is "locked out" by the switching circuitry. Localizer deviation on PNI will have the proper sensing if the front inbound Localizer course was set on the PNI.

GO-AROUND Mode

The Go-Around mode is primarily designed to assist the pilot in establishing the proper pitch attitude under missed approach conditions. The Go-Around switch is located on the throttle lever for pilot convenience when applying climb-out power.

Depression of the Go-Around switch during an approach cancels all Flight Director modes and disengages the Autopilot, if it is engaged.* A wings-level and pitch-up command is displayed by the FCI and "GO AROUND" is lighted on the Annunciator Panel. The magnitude of the pitch-up command is adjustable to match Flight Manual criteria for each aircraft model.

The Go-Around mode may also be used on takeoff for climb-out attitude guidance. When used for takeoff, the Go-Around mode may be followed with HDG for continuous heading control during departure. NAV and APPR modes may also be armed for automatic capture and guidance during the departure sequence.

Go-Around may be cancelled by use of Vertical Trim, Altitude Hold mode, Control Wheel Steering mode or by turning off the Flight Director.

**Some airplanes are certified with the Autopilot remaining engaged when GA is selected. (Refer to Flight Manual Supplement to determine your type of installation.)*

ALTITUDE SELECT (ALT ARM) Mode

2. Establish a climb or descent as appropriate.

3. Depress the ARM button on the Altitude Selector. This may be done at any time during the climb or descent before the selected altitude has been attained. "ALT ARM" will light on the Annunciator Panel and on the Altitude Selector.

4. The Altitude "ALERT" annunciator in the KAS 297 will illuminate (and in most systems a two second aural tone will sound) 1,000 ft. prior to reaching selected altitude and will cancel at 300 ft. prior. An aural tone will sound upon reaching altitude.

As the aircraft approaches the selected altitude, an "adaptive" pitch rate command will automatically guide the pilot through it at a low rate. As the aircraft reaches the selected altitude, ALT HOLD will automatically engage, "ALT HOLD" will light on the Annunciator Panel and "ALT ARM" will disappear. The command bars on the FCI will call for level flight at the selected altitude. If autopilot is engaged, the system will perform the required maneuvers.

ALT ARM is disengaged by depressing the ALT ARM button, by engaging ALT HOLD, by GS capture, or selecting FLT DIR to OFF.

ALTITUDE HOLD (ALT HOLD) Mode

This mode will cause a computed visual pitch command on the FCI command bars to hold the aircraft at the pressure altitude existing at the time it was activated.

The mode is activated either automatically by the ALT ARM function, or manually by depressing the ALT button on the Mode Controller.

If the autopilot is engaged, it will automatically hold the aircraft at that altitude.

The Vertical Trim switch may be used to adjust the selected altitude up or down at a constant rate of approximately 600 fpm without disengaging the mode. This enables the pilot to conveniently adjust the aircraft altitude to match resetting of the altimeter, or to make short descent segments during a nonprecision approach.

The ALT HOLD mode is cancelled by automatic Glideslope capture or selection of ALT ARM, or GO-AROUND modes, or selection of FLT DIR to OFF.

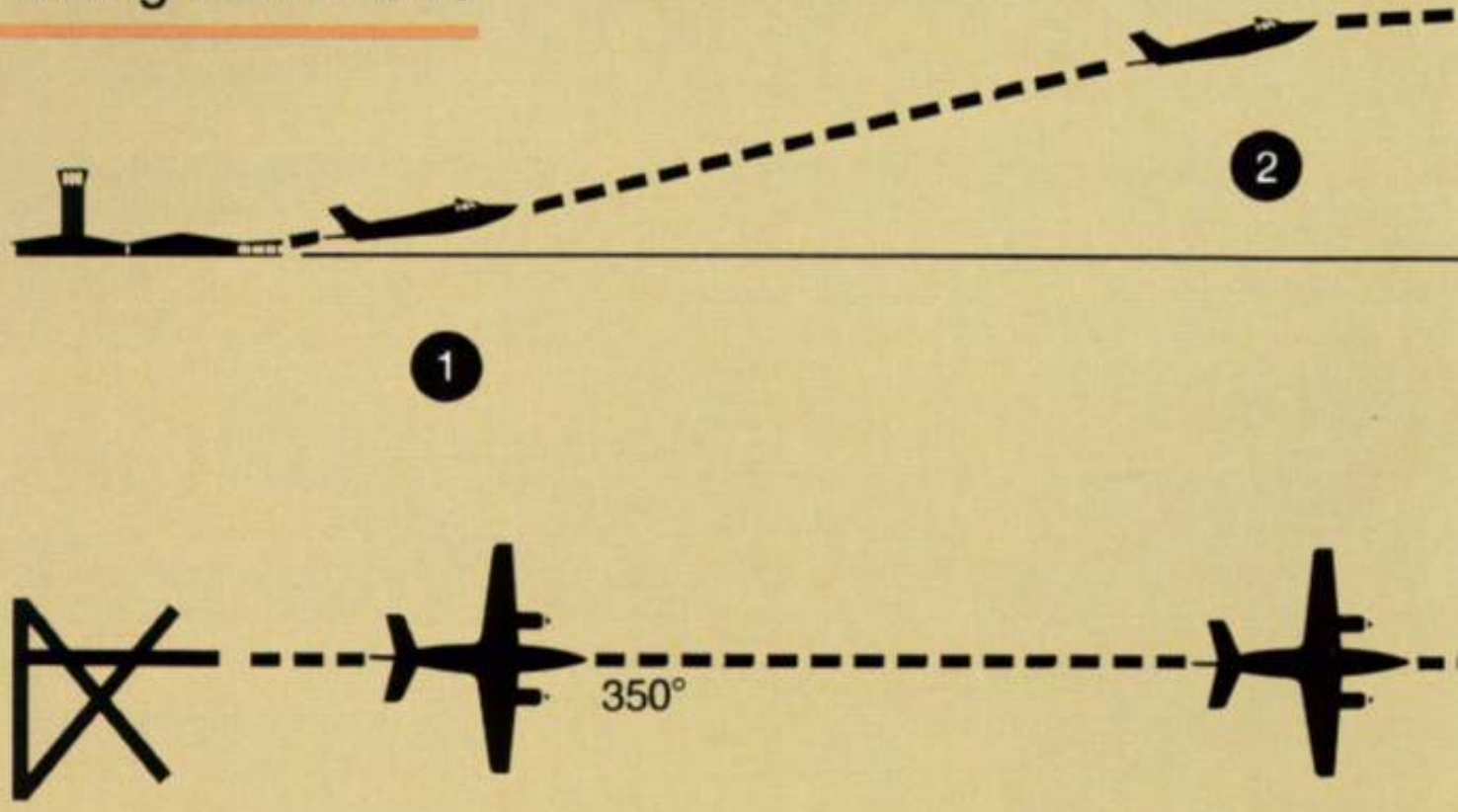
CONTROL WHEEL STEERING (CWS) Mode

When the Autopilot is engaged, Control

allows the pilot to assume manual control, while Autopilot control functions and Pitch Command and Altitude Hold modes are placed in a synchronization state.

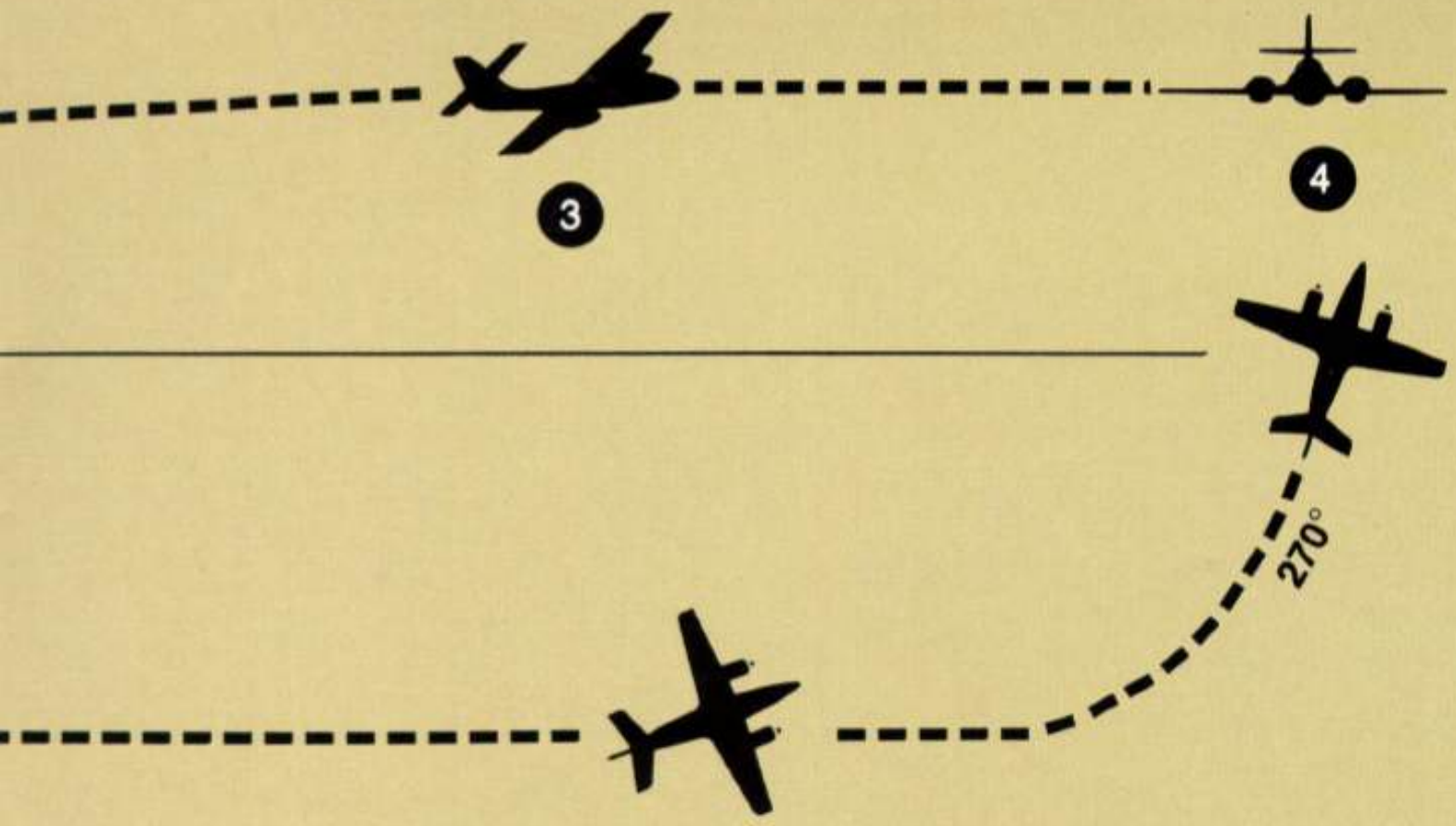
This means that these modes remain in continuous synchronization with the pilot's aircraft maneuvers so that, upon release of

Takeoff and Climb to Assigned Altitude



1. The FD has been engaged. Takeoff is in the

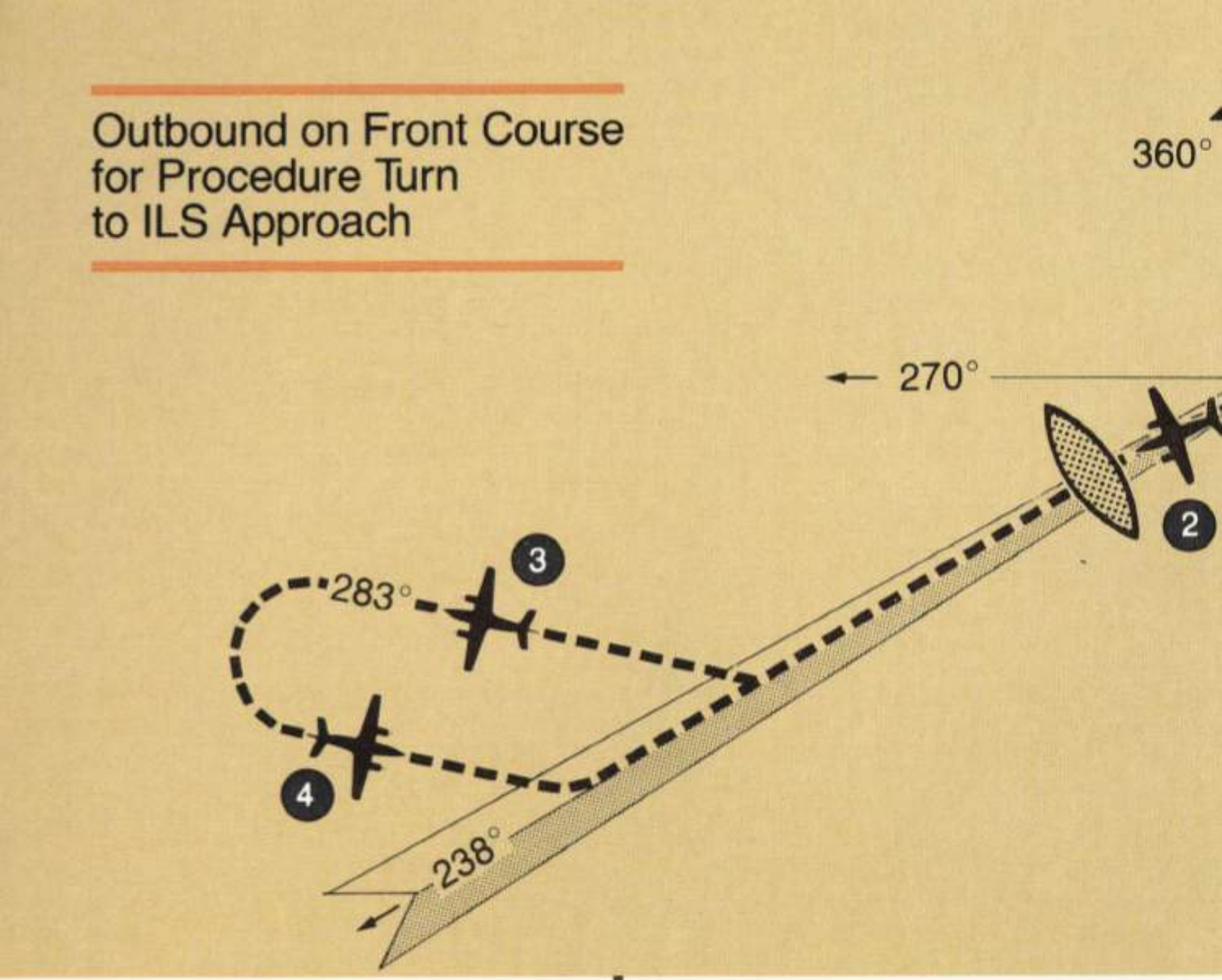
2. The aircraft is well off the ground and



3 With the Autopilot engaged, the aircraft is

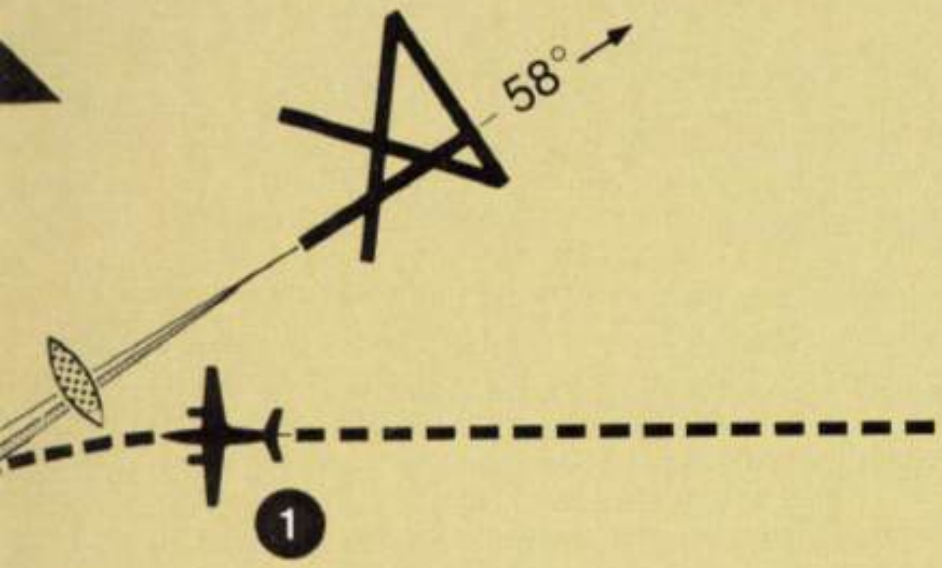
4 Desired altitude has been reached. ALT

Outbound on Front Course for Procedure Turn to ILS Approach



1. In HDG SEL and ALT Hold mode on a LOC

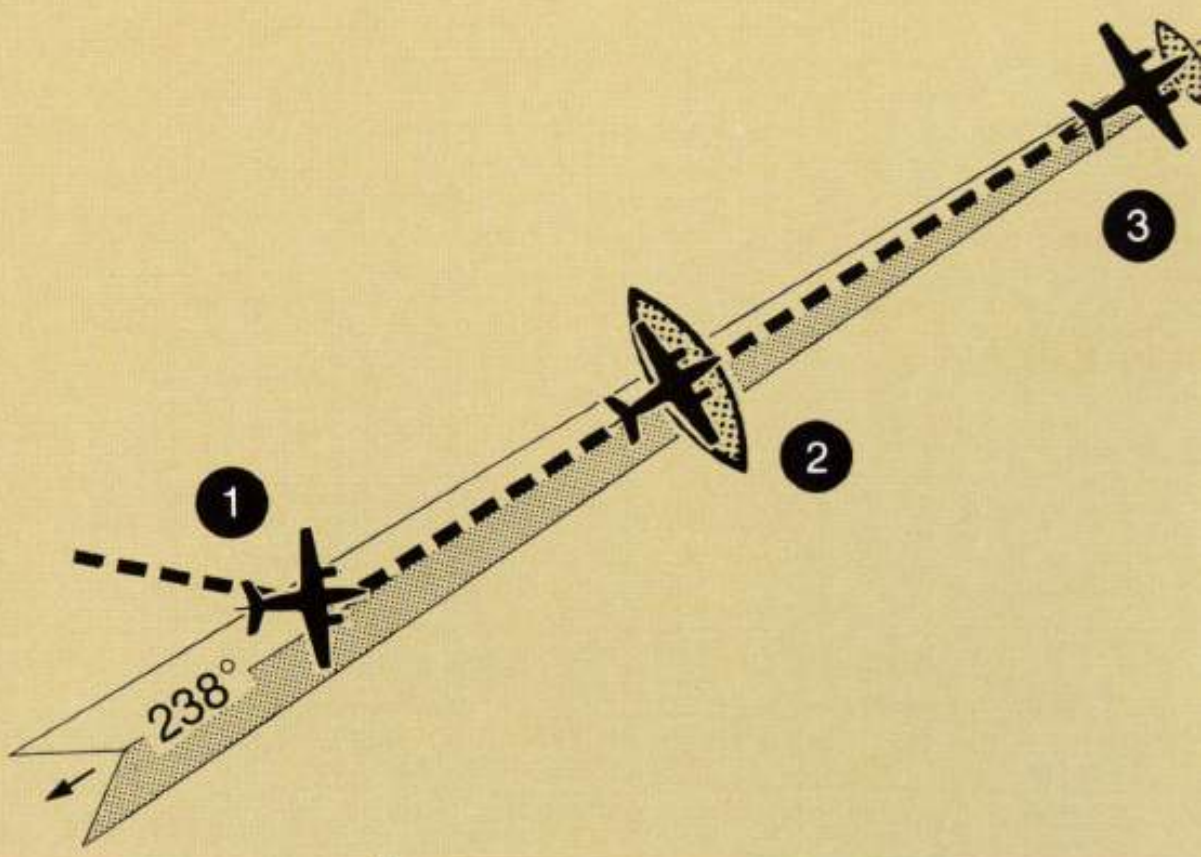
2. When the computed capture point is



3. Prior to procedure turn you will return to

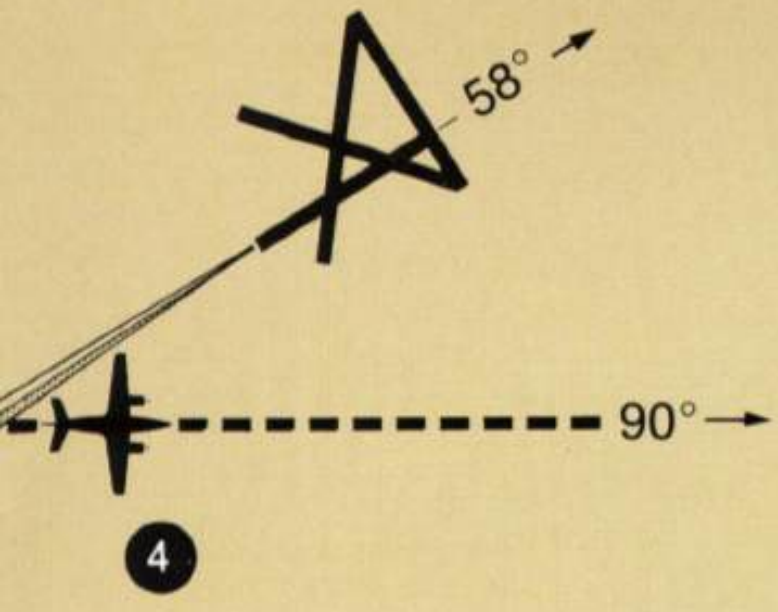
4. Now you have reset the heading select

Front course ILS approach with missed approach and Go-Around



1. Continuing the maneuver on preceding

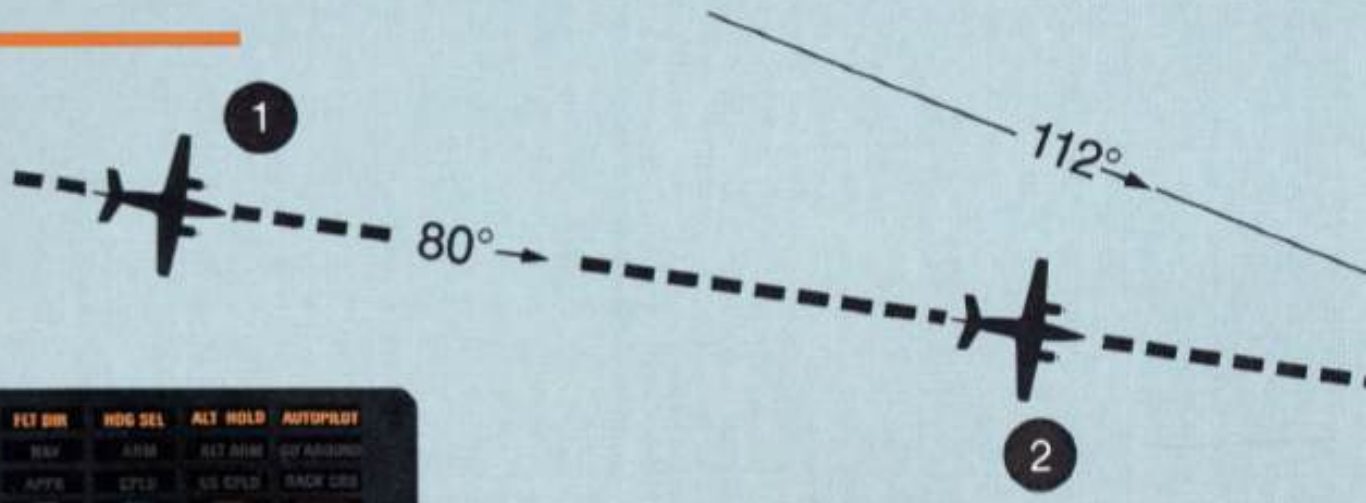
2. The Autopilot (or pilot) is following the



3. At the Middle Marker a missed approach

4. The heading "bug" has been previously

RNAV capture.



1. The aircraft is flying an OMNI airway in HDG mode on a heading of 80°.

2. A waypoint has been established and the RNAV computer is in ENROUTE mode. A 112° course to the waypoint has been selected and NAV mode pushed "on". HDG and NAV/ARM modes are activated for automatic


N
360°
3
VORTAC
4
FLT DIR
NAV
CPLD
ALT HOLD
AUTOPILOT
FLT DIR
NAV
CPLD
ALT HOLD
AUTOPILOT

BENDIX/KING

General Aviation Avionics Division
400 North Rogers Road
Olathe, Kansas 66062-1212
Telex 669916 KINGRAD · FAX 913-791-1302
Outside USA & Canada (913) 782-0700