NIGHTHAWK
FLIGHT SYSTEMS, INC.

SA4550

Primary Attitude Display

Pilot's Guide

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Pilot information

Publication Date: 07-NOV-2023

This guide provides information on the use and operation of the SA4550 Primary Attitude Display.

Information in this manual is current as of publication or revision date. Specifications and operational details are subject to change without notice at the discretion of Nighthawk Flight Systems, Inc.

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Revision notice

The "Effectivity, Errata, and Revision History" allows the use of this Pilot Guide with a specific software release and specifically lists the software to which this Pilot's Guide applies and corrects any errors or omissions that may exist in this revision of the Pilot's Guide. Document number 82010-PG-ERR, Effectivity, Revision History, and Errata" can be found on page x of this Pilot's Guide.

Operational and legal issues

The information displayed on the SA4550 is generated by external equipment. It is the pilot's responsibility to ensure the correct configuration and use of the external equipment. The SA4550 is subject to all legal and operational limitations of the equipment supplying data to it. Always refer to your approved Aircraft Flight Manual Supplement for operation and limitations on the use of installed equipment.

Note: Because aircraft vary in their installed equipment, it is important to note that what is displayed on the SA4550 may vary depending on the presence or absence of equipment.

Approvals

The FAA has approved the SA4550 under the following TSOs:

C113: Airborne Multipurpose Electronic Displays

Incomplete, Display Only TSOs:

C3d: Turn and Slip Instruments

C4c: Bank and Pitch Instruments

C34e: ILS Glideslope Receiving Equipment

C36e: Airborne ILS Localizer Receiving Equipment

C52b: Flight Director Equipment

The following RTCA certification levels also apply to this product:

DO-160E: Environmental (Categories listed in Chapter 4)

DO-178B: Software Level A and C

DO-254: Hardware Level A and C

Limitations

Category I Approaches Only.

Installation of the SA4550 in a type-certificated aircraft must be performed in accordance with the NIGHTHAWK SA4550 Installation Manual, document number 82010-IM (applicable revision).

Conventions Used in This Manual

A button's name or control is placed within square brackets when the button is described in text. For example, "…press the [M] selection button to …"

This manual uses terms that should be familiar to aviation-minded readers, such as "Attitude" and "Flight Director." Terms that are specific to the SA4550 will be placed in the glossary.

Table of Contents

Table of Figures

Effectivity, Revision History, and Errata

Date: 07-NOV-2023
Revision: G
Applies to: SA4550 Software 1.10 & A1.10

Except for the superseding information in this section, the operation of the SA4550 is as described in the SA4550 Pilot's Guide referenced above.

Revision History		
Revision	Date	Comments
G	07-NOV-2023	Release for 1.10 & A1.10 software. Updated copyright notice. Page 2-19: Updated for RA (feet). Page 2-20: Added for RA (meters). Page 2-21: Added for MIN (feet). Page 2-22: Added for MIN (meters).
F	28-SEP-2012	Release for 1.09 software. Page 2-8: Added description of radar altimeter test.
E	01-MAR-2011	Effectivity updated for 1.07 software
D1	11-NOV-2008	Effectivity updated for 1.06 software
D	15-JUL-2008	Release for 1.05 software Page 2-22: New annun. added. Page 2-23: MDA annun. added. Page 2-25: RNAV annun..added. Page 3-1: New part number added. Chapter 5.: Added abbreviations.
C	27-FEB-2008	Release for 1.04 software, Update page 2-8 "Function Not Installed" message. Update physical characteristics (chapter 3)

Revision History		
Revision	Date	Comments
B2	17-OCT-2007	Page x: Effectivity updated for software 1.03. No operational changes.
B1	22-AUG-2007	Page x: Effectivity updated for software 1.02; Document number reference added; Errata updated for incorrect page reference. No operational changes.
B	18-JUN-2007	New Format
A	07-MAY-2007	Initial Release

No errata applicable to this release.

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CHAPTER 1 WELCOME TO THE SA4550

Introduction

The SA4550 Primary Attitude Display is a high-performance electronic ADI that can be used in new installations or as an upgrade for electromechanical ADIs. It features a high resolution, high brightness, and long-life LED-backlit display.

The SA4550 accepts pitch and roll input from the aircraft's Vertical Gyro to display attitude.

The SA4550 incorporates standard ADI features such as flight director command bars, a glideslope/localizer deviation scale, a fast/slow indicator, Radar Altitude / Mins, and mode annunciations. A pilot-selectable single-cue/dual-cue display option is also available.

The SA4550 typically displays data from the following sources:

- Vertical Gyro
- Navigation Receiver (ILS)
- Radar Altimeter
- Angle of Attack System
- Flight Computer

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CHAPTER 2 OPERATION

Power-On Self Test

On initial power-up, a short introduction screen will be displayed during the power on self-test which includes the software version.

It is normal for the self-test screen to flash off once during the sequence.

Figure 2-1 Introduction Screen

After display of the power-up self test, the SA4550 will immediately start normal operation.

Since it is typically powered by the aircraft main bus, it is likely that the initial display will be flagged until after engine start and avionics are switched on.

The display with no inputs available will look like this:

Figure 2-2 SA4550 Display with Flags

SA4550 Control and Display Layout

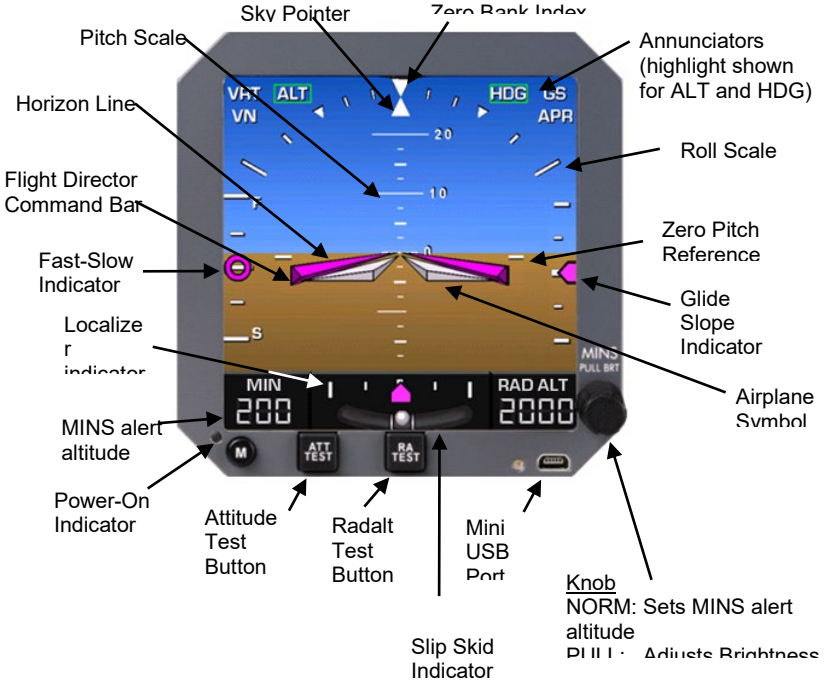


Figure 2-3 SA4550 Single Cue FD

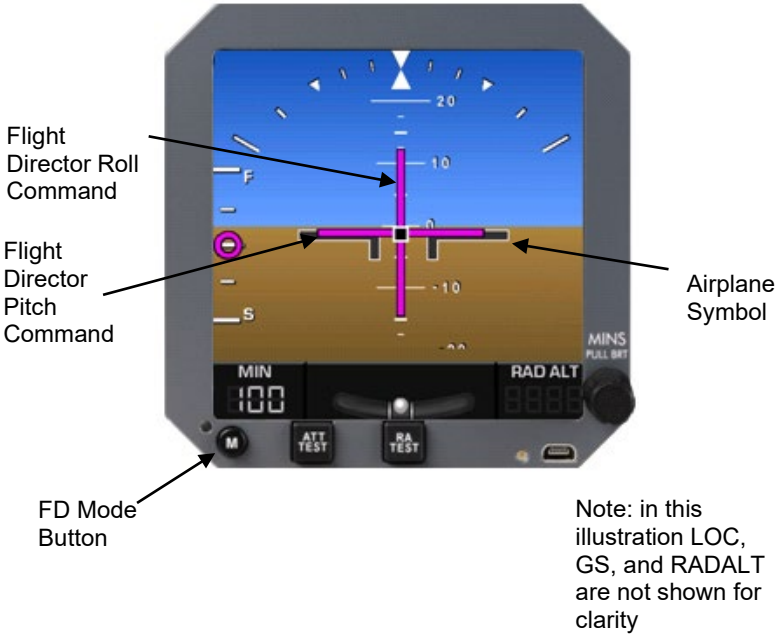


Figure 2-4 SA4550 Dual Cue FD Differences

The following describes each control.

CONTROL FEATURE	
	
FUNCTION	**OPERATION**
DC Power LED: Indicates the presence of DC power.	Indicator only. No pilot interaction required.
FD Mode Select: Toggles between the Single Cue and Dual Cue Flight Director Mode. (If enabled during installation)	Depress button to alternate Flight Director presentation.

CONTROL FEATURE	
	
FUNCTION	**OPERATION**
Attitude Test: Performs display self-test. Perform this test prior to each flight. NOTE: ATT TEST may also operate the APFD self-test which will cause the on-screen annunciators to illuminate.	Depress [ATT TEST] button and observe display. A successful display test will cause the display to indicate a 10° roll to the left, a 10° pitch up and full right deflection of the slip skid ball indicator. The red ATTITUDE flag will display with the words "Att Test" directly below. The words RED, GREEN, and BLUE will display in their respective colors. The display will go blank after [ATT TEST] button is held for 5 seconds. If the display does not test properly or if any of the colors are visibly incorrect do not fly aircraft using the SA4550. Maintenance is required.

Figure 2-5 ATT Test

CONTROL FEATURE	
	
FUNCTION	**OPERATION**
Radar Altimeter Test: Used to test radar altimeter system. *If a radar altimeter system is not installed or remote test function is not enabled, the message "Function Not Installed" will appear when [RA TEST] is pressed.*	Depress [RA TEST] button and observe radar altimeter display for proper indications. See AFM for proper radar altimeter test display indications. For installations using a digital 429 radar altimeter, the text "RAD ALT" in the radar altimeter window of the display will be replaced with "RA TEST" in amber while the system is under test.
CONTROL FEATURE	
	
FUNCTION	**OPERATION**
Mini-USB Port: Used for updating internal software.	Maintenance function only.

<table>
<tr><th colspan="2">CONTROL FEATURE</th></tr>
<tr><td colspan="2"> 

MINS / DISPLAY BRIGHTNESS CONTROL KNOB</td></tr>
<tr><th>FUNCTION</th><th>OPERATION</th></tr>
<tr><td>MINS:
(IN) Used for setting a minimum radar altitude in the MIN window.

If [MINS] knob is rotated in an aircraft without a radar altimeter system installed or configured, the message "Function Not Installed" will appear.</td><td>Rotate to set the desired minimum radar altitude in the MIN window:
 

MIN window will not display in aircraft that do not have a radar altimeter system configured for display on the SA4550.</td></tr>
<tr><td>Display Brightness:
(OUT) Used for manually adjusting display brightness</td><td>Pull the knob out and rotate to manually adjust the display brightness. Brightness setting (0-100) will appear on screen when an adjustment is made:
 
</td></tr>
</table>

DISPLAY DESCRIPTION

The display utilizes a standard blue-above-brown attitude depiction to depict Pitch and Roll, as directed by the aircraft Vertical Gyro. The airplane symbol references the aircraft's current attitude.

If tuned, the localizer and glideslope deviations are shown fed from the VHF NAV receiver.

The flight director command bars provide pitch and roll guidance from the flight computer.

A slip/skid indicator is provided operated from an internal accelerometer.

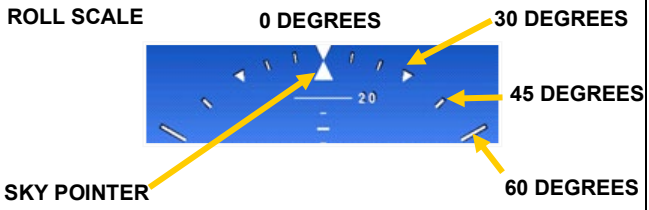
Desired radar altitude minimums can be set in the MIN window and current radar altitude (AGL) is displayed in the RAD ALT window using information from the radar altimeter (if equipped – see AFM).

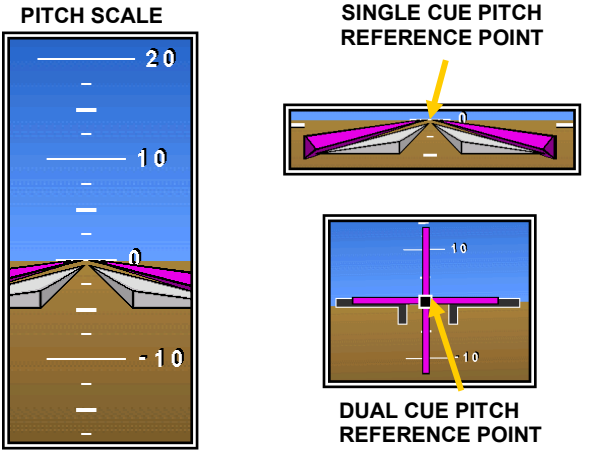
Ref Approach speed deviation is shown using information from the angle of attack system.

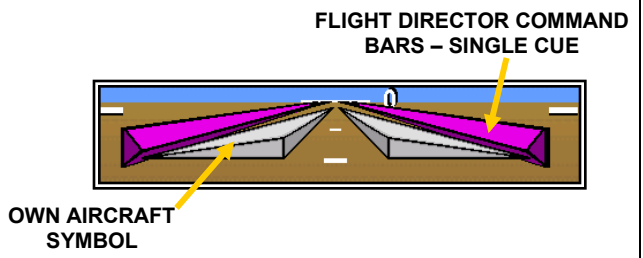
The flight director mode annunciations displayed are dependent on equipment installation – see AFM.

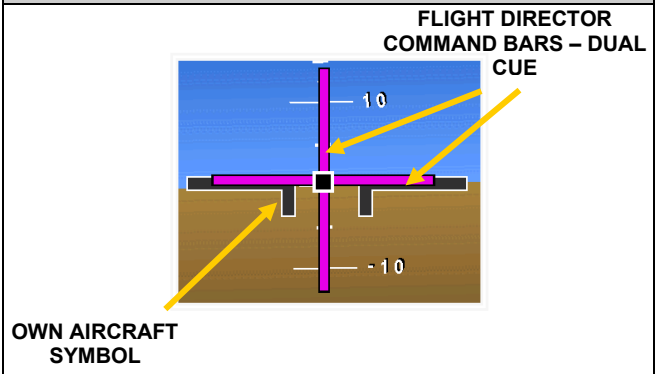
Figure 2-6 SA4550 Primary Attitude Display

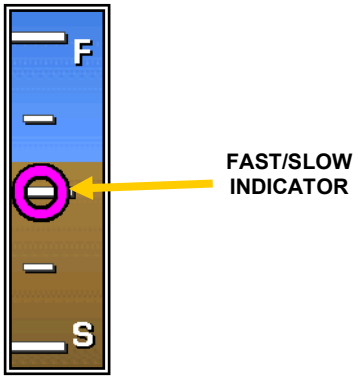
Unit on right is configured without a radar altimeter.

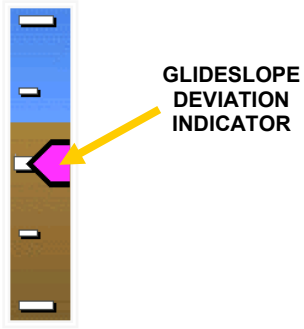
DISPLAY FEATURES	
	
FUNCTION	**OPERATION**
Roll Scale: Indicates aircraft roll attitude in degrees from 0° to 60° left or right of level. Scale is marked at 10°, 20°, 30°, 45°, and 60° increments. **Sky Pointer:** Moves in accordance with the aircraft roll attitude. Always points up.	Utilize normally.

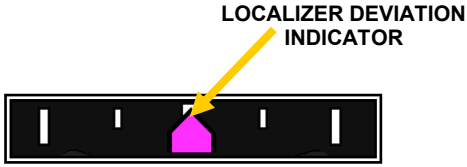
DISPLAY FEATURES	
	
FUNCTION	**OPERATION**
Pitch Scale: Indicates aircraft pitch attitude in degrees from 0° to 90° above or below level pitch attitude. Scale is marked in increments of 2.5° with short lines 2.5° and 5° increments and longer lines at 10° increments. There are numerical markings at 10° increments. Pitch attitudes below zero are preceded by a minus sign.	Utilize normally.

DISPLAY FEATURES	
	
FUNCTION	**OPERATION**
Flight Director Command Bars (Single Cue): Supplies combined pitch/roll guidance from the flight computer. **Own Aircraft Symbol (Single Cue):** Represents the aircraft pitch and roll attitude relative to the pitch scale and sky/ground.	Fly the aircraft to center the own-aircraft symbol into the command bars.

DISPLAY FEATURES	
	
FUNCTION	**OPERATION**
Flight Director Command Bars (Dual Cue): Supplies split pitch/roll guidance from the flight computer. **Own Aircraft Symbol (Dual Cue):** Represents the aircraft pitch and roll attitude relative to the pitch scale and sky/ground.	Fly the aircraft to center the cross-pointer on the nose of the symbolic aircraft. Note: The split-cue presentation can provide guidance in one direction without the other. For instance, if Alt Hold is selected on the flight computer without a lateral mode, vertical guidance is presented without lateral guidance.

DISPLAY FEATURES	
	
FUNCTION	**OPERATION**
Fast/Slow Indicator: (if equipped) is driven by the angle of attack system and displays the aircraft speed relative to the optimum approach speed.	If the aircraft speed is too fast the magenta index circle will move toward the "F" on the scale. An appropriate speed decrease should be made. If the aircraft speed is too slow, the magenta index circle will move toward the "S" on the scale. An appropriate speed increase should be made. The indications on the Fast/Slow indicator are secondary and should be crosschecked with airspeed.

DISPLAY FEATURES	
	
FUNCTION	**OPERATION**
Glideslope Deviation Indicator: Indicates the deviation of the ILS glideslope.	The magenta pointer will move up or down, indicating the direction the aircraft should fly to return to on-course. When VHF NAV is not tuned to ILS, this indicator will not appear.

DISPLAY FEATURES	
	
FUNCTION	**OPERATION**
Localizer Deviation Indicator: Indicates the deviation of the aircraft with respect to the localizer.	The magenta pointer will move left or right, indicating the direction the aircraft should fly to stay on course. When VHF NAV is not tuned to ILS, this indicator will not appear. NOTE: This is a *standard localizer* and is *not* an expanded-scale localizer.

DISPLAY FEATURES	
	
FUNCTION	**OPERATION**
Slip/Skid Indicator: Shows turn coordination from lateral body acceleration.	Center the ball to produce coordinated flight. This ball is centered if the aircraft is parked level.

DISPLAY FEATURES	
	
FUNCTION	**OPERATION**
Radar Altimeter Display (Feet): Shows current radar altimeter altitude in 5' increments below 200' and 10' increments above 200' when the radar altimeter units setting is set to FEET. Blanks if above the maximum Radar Altitude of 2000' or 2500' depending on the make/model of Radar Altimeter. Shows all dashes if the RA is invalid.	The RAD ALT window will not appear in aircraft that do not have a radar altimeter system configured for display on the SA4550.

DISPLAY FEATURES	
	
FUNCTION	**OPERATION**
Radar Altimeter Display (Meters): Shows current radar altimeter altitude in 1m increments below 60m, 5m increments between 60m and 200m, and 10' increments above 200m when the radar altimeter units setting is set to METERS. Blanks if above the maximum Radar Altitude of 610m or 762m depending on the make/model of Radar Altimeter. Shows all dashes if the RA is invalid.	The RAD ALT window will not appear in aircraft that do not have a radar altimeter system configured for display on the SA4550.

DISPLAY FEATURES	
	
FUNCTION	**OPERATION**
Minimum Radar Altitude Display (Feet): Shows the currently set minimum radar altitude in 10’ increments with a maximum value of 990’ when the radar altimeter units setting is set to FEET. Blanks if the minimum radar altitude is set to 0’. Shows all dashes if the MIN is invalid.	The MIN window will not appear in aircraft that do not have a radar altimeter system configured for display on the SA4550. A Radar Altitude Minimum (MIN) annunciator will be displayed when the radar altitude has reached the minimum radar altitude set in the MIN window.

DISPLAY FEATURES	
	
FUNCTION	**OPERATION**
Minimum Radar Altitude Display (Meters): Shows the currently set minimum radar altitude in 5m increments with a maximum value of 300m when the radar altimeter units setting is set to METERS. Blanks if the minimum radar altitude is set to 0m. Shows all dashes if the MIN is invalid.	The MIN window will not appear in aircraft that do not have a radar altimeter system configured for display on the SA4550. A Radar Altitude Minimum (MIN) annunciator will be displayed when the radar altitude has reached the minimum radar altitude set in the MIN window.

DISPLAY FEATURES	
	
FUNCTION	**OPERATION**
Red Chevrons: Points to the level flight attitude Alerts the pilot that a potentially hazardous nose low pitch attitude exists.	The upward pointing red chevrons appear any time the pitch attitude exceeds -20°. Automatic decluttering of the display will occur prior to this unusual attitude indication. Appropriate unusual attitude recovery techniques should be used when this display appears.

DISPLAY FEATURE	
	
FUNCTION	**OPERATION**
Red Chevrons: Points to the level flight attitude Alerts the pilot that a potentially hazardous nose high pitch attitude exists.	The downward pointing red chevrons appear any time the pitch attitude exceeds +30°. Automatic decluttering of the display will occur prior to this unusual attitude indication. Appropriate unusual attitude recovery techniques should be used when this display appears.

ANNUNCIATOR DESCRIPTION

The SA4550 annunciators appear in fixed locations. Certain locations are shared by difference annunciators which normally will not be on at the same time – for instance VRT and ALT are mutually exclusive.

When a properly equipped aircraft has a GPS WAAS approach selected and is on the approach, one of the following GPS WAAS approach annunciators will display: LP, LPV, L NAV, LVNAV.

When an annunciation changes state, a green highlight box will display around the text for 5-7 seconds

During flight computer self test (or If a malfunction occurs during normal operation) two annunciators which share one location may activate simultaneously. In this case the text message will toggle once a second.

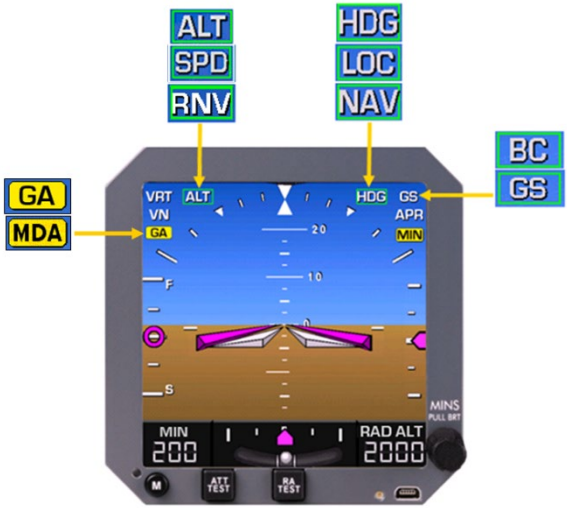


Figure 2-7 Annunciator Locations

ANNUNCIATORS	DESCRIPTION (See Aircraft Flight Manual for Operational Details)
	**Go Around** Go Around mode has been selected.
	**Radar Altitude Minimums** Radar altitude has reached the desired minimum radar altitude set in the MIN window.
	**Minimum Descent Altitude** Aircraft altitude has reached the desired minimum descent altitude set externally (with an altitude alerter).
	**APFD Altitude Hold Mode** Altitude Hold mode is engaged.
	**APFD Vertical NAV Mode** Vertical NAV mode is engaged.

ANNUNCIATORS	DESCRIPTION (See Flight Manual for Operational Details)
	**APFD Vertical Speed Mode** Vertical speed mode is engaged or Altitude capture has occurred.
	**APFD Approach Mode** Appears when VOR or LOC approach capture occurs.
	**APFD Heading Mode** Heading mode is engaged.
	**APFD NAV Mode** VOR/GPS/RNAV track mode is engaged.
	**APFD Localizer Mode** Localizer capture has occurred.

ANNUNCIATORS	DESCRIPTION (See Flight Manual for Operational Details)
	**APFD Glideslope** Glideslope capture has occurred.
	**APFD Back Course** Appears when Back Course Localizer capture occurs.
	**APFD Speed Mode** Airspeed Hold mode is engaged.
	**APFD RNAV Mode** RNAV mode is engaged.

FLAGS	DESCRIPTION
	**Attitude Failure / Message Flag** Appears when the attitude is invalid. Gyro Flag indicates VG is inoperative. ATT TEST indicates the ATT TEST button is depressed. ATT FAIL indicates an internal failure has been detected and attitude may be suspect and should be cross-checked.
	**Flight Director Computer Flag** Appears when there is a flag from the flight director computer. Any time the flight director system is flagged, the command bars will be removed from the display. Reference to primary data should be made.

FLAGS	DESCRIPTION
	**Localizer Flag** Appears when localizer is tuned but not valid.
	**Glideslope Failure Flag** Appears when glideslope is tuned but not valid.
	**Fast/Slow Flag** Appears when angle of attack computer is invalid.
	**Function Not Installed Flag** Appears when an attempt is made to perform a function that is not installed or enabled.

ERROR INDICATIONS	DESCRIPTION
	**CRC Error** Do not fly using SA4550 for attitude reference. The internal program code CRC self-check has failed. Maintenance is required.
	**Fatal Error** Indicates an internal non-recoverable error. The SA4550 is not usable for flight. Maintenance is required.

Data Color Coding

Color	Data Displayed
BROWN	• Earth (varying shades)
BLUE	• Sky (varying shades)
WHITE	• Angle of bank arc • Pitch tape • Decision Height and Radar Altitude indications • Ball and index lines on Slip/Skid Indicator • Background of Display Brightness Indicator • Glideslope and Localizer deviation scale lines • Text on Flags: ATTITUDE, GS, LOC, SPEED, COMPUTER • Text on the following annunciators: SPD, ALT, VN, VRT, APR, LOC, NAV, HDG, GS, BC

Color	Data Displayed
RED	• Flags: ATTITUDE, GS, LOC, SPEED, COMPUTER • Chevrons • CRC Annunciator
YELLOW	• DH Annunciator, GA Annunciator • Text on GYRO FLAG and ATT FAIL Annunciator
MAGENTA	• Flight Director Command Bars • (Single Cue and Dual Cue) • Fast/Slow Indicator • Glideslope Deviation Indicator • Localizer Deviation Indicator
GRAY	• Aircraft Symbol – Single Cue

Color	Data Displayed
BLACK	• Aircraft Symbol – Dual Cue

CHAPTER 3 TECHNICAL SPECIFICATIONS

TSO Compliance	
TSO	C3d: Turn and Slip Instruments C4c: Bank and Pitch Instruments C34e: ILS Glideslope Receiving Equipment C36e: Airborne ILS Localizer Receiving Equipment C52b: Flight Director Equipment C113: Airborne Multipurpose Electronic Displays
Software Certification	RTCA/DO-178: Attitude Level A; Guidance and Annunciators Level C
Hardware Certification	RTCA/DO-254: Attitude Level A; Guidance and Annunciators Level C
Envir. Category	DO-160E [A2F1Z]BBB[HR]XXXXXXZZAB[ZW][W(D)(W)]M[A3G33]XXAX

Physical Characteristics	
Form Factor	4-ATI (ARINC 408)
Width	3.975 in. (10.1 cm.)
Height	3.975 in. (10.1 cm)
Length	7.57in. (19.22 cm.) overall flush to bezel (SA4550-1XX) 7.82 in. (19.86 cm.) overall flush to bezel (SA4550-0XX, -4XX, -5XX, -6XX, -7XX)
Weight	3.4 lbs. (1.54 kg.)

Operational Characteristics	
Temp/Alt	-20º C to + 70º C 55,000 ft. maximum altitude
Primary Pwr	22 to 33 VDC 1.4 Amperes nominal @ 28 VDC

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CHAPTER 4 GLOSSARY

Decluttering	The SA4550 incorporates an automatic decluttering feature during unusual attitudes when in Flight Mode. The SA4550 utilizes the following parameters in determining when to activate decluttering: 1. +30 Degrees Pitch Attitude (Up) 2. -20 Degrees Pitch Attitude (Down) 3. 65 Degrees Roll Left or Right
Configuration	Inputting specific data for a given sensor or setting equipment emulation.
Fatal Error	Indicates an internal non-recoverable error. The SA4550 is not usable for flight. Maintenance is required.
Flagged	Display of a warning flag to show that an abnormal condition has been detected.
Red Chevrons	Used to identify recovery direction when extreme high or low pitch attitudes are encountered.
Unusual Attitude	Pitch attitude exceeding +30° or -20°. Roll attitude exceeding 65° left or right.

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CHAPTER 5 AVIONICS ACRONYMS/ABBREVIATIONS

AFM	Airplane Flight Manual
ADI	Attitude Director Indicator
AFCS	Automatic Flight Control System
AFMS	Airplane Flight Manual Supplement
AGL	Above Ground Level
ALT	Altitude
AP	Auto Pilot
APFD	Auto Pilot / Flight Director
APR	Approach
ATT	Attitude
BC	Back Course
BIT	Built-In-Test
CRC	Cyclic Redundancy Check
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FD	Flight Director
GA	Go Around
GS	Glide Slope
HDG	Heading
ILS	Instrument Landing System
LED	Light Emitting Diode
LOC	Localizer
MDA	Minimum Descent Altitude

MINS	Radar Altitude Minimums
NAV	Navigation Receiver (VOR)
NVIS	Night Vision
RA	Radar Altitude
RAD ALT	Radar Altimeter
RNAV	Area Navigation
SPD	Speed
TSO	Technical Standard Order
USB	Universal Serial Bus
VHF	Very High Frequency
VN	Vertical Navigation
VRT	Vertical