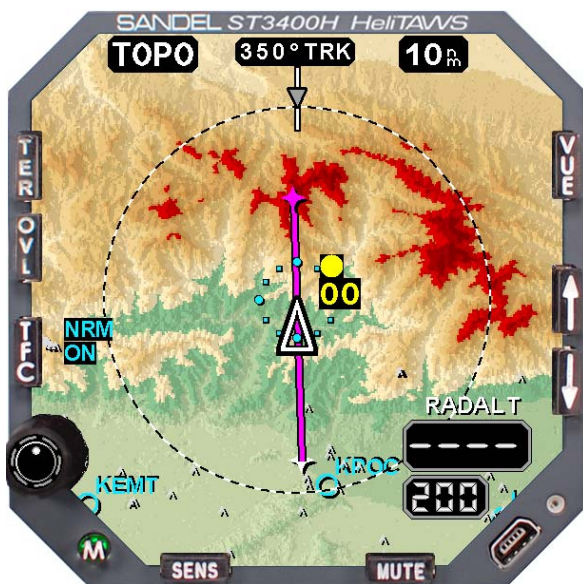


SANDEL®

ST3400H

HeliTAVS™

Helicopter
Terrain Awareness
Warning System



Pilot's Guide

Revision B1

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TABLE OF CONTENTS

1 INTRODUCTION	1-1
1.1 Pilot Information	1-1
1.2 Copyright	1-1
1.3 Revision Notice.....	1-1
1.4 Operational and Legal Issues	1-2
1.5 Trademarks	1-2
1.6 Approvals.....	1-2
1.7 Conventions Used In This Manual.....	1-3
1.8 Effectivity, Revision History And Errata	1-3
2 LIMITATIONS.....	2-1
3 WELCOME TO THE ST3400H HELITAWS.....	3-1
3.1 Description.....	3-1
3.2 What it is	3-1
3.3 What it isn't.....	3-2
3.4 What it does	3-2
3.5 Other Features.....	3-3
4 SYSTEM OVERVIEW	4-1
4.1 “Design Cruise Altitude”	4-1
4.1.1 Sensitivity	4-1
4.2 Off Airport Landings	4-1
4.3 Alerts, Warnings and Cautions	4-1
4.4 TAWS Inhibit.....	4-2
4.5 Display	4-2
4.5.1 Topographic Display	4-2
4.5.2 Relative Altitude Display	4-2
4.5.3 Obstacle Display.....	4-2
4.5.4 Flight Plans.....	4-3
4.5.5 Airports and Runways	4-3
4.5.6 Radar Altimeter Display.....	4-3
4.5.7 Traffic.....	4-3
4.5.8 NVIS.....	4-3
4.6 Sensors	4-4
4.7 Database	4-4
4.7.1 Coverage area of the database	4-4
4.7.2 Database updates	4-4
5 TERRAIN DISPLAY AND OPERATION.....	5-1
5.1 Control Overview.....	5-1
5.2 Display Overview	5-2
5.3 Splash Screen	5-3
5.4 Initial Bootup Display.....	5-3

5.5	No-Sensor Display	5-4
5.6	FULL / ARC	5-5
5.7	REL/TOPO	5-6
5.7.1	TOPO DETAILS	5-6
5.7.2	REL DETAILS	5-6
5.8	REL Color Banding	5-7
5.9	Display Orientation	5-7
5.10	Display Range	5-9
5.11	Overlay	5-10
5.12	Heading Pointer	5-11
5.13	Sensitivity	5-12
5.14	Off Airport Mode	5-13
5.15	Mute	5-14
5.16	Brightness	5-15
5.17	Flight Plan	5-16
6	TERRAIN AND OBSTACLE ALERTING	6-1
6.1	Alert Generation	6-1
6.2	Alert Display	6-3
6.3	External Annunciation	6-3
6.4	Responding to an Alert	6-3
6.5	Alert Circle	6-4
6.5.1	Terrain	6-4
6.5.2	Obstacles	6-4
6.6	Obstacle Symbolology	6-5
6.6.1	Obstacles in TOPO Display	6-5
6.6.2	Obstacles in REL Display	6-7
6.7	TAWS Inhibit - FLTA	6-8
6.8	Simultaneous TAWS and TFC Alerts	6-8
7	GPWS ALERTING	7-1
7.1	Mode 1 – Excessive Rate of Descent	7-1
7.2	Mode 2 – Not Implemented	7-1
7.3	Mode 3 – Descent after Takeoff	7-1
7.4	Mode 4 – Landing Gear	7-2
7.5	Mode 5 – Glideslope	7-2
7.6	Mode 6 – Altitude Callouts	7-2
7.7	TAWS INH - GPWS	7-3
8	RADAR ALTIMETER FUNCTIONS	8-1
9	TRAFFIC FUNCTION	9-1
9.1	Traffic Display	9-1
9.2	TFC Button	9-1
9.3	Traffic Processor Altitude Mode	9-2
9.4	TFC Range Ring	9-2

9.5	Symbology	9-3
9.6	Altitude Tags.....	9-4
9.6.1	Relative.....	9-4
9.6.2	Traffic Absolute Altitude	9-4
9.6.3	Traffic Alert Priority.....	9-4
10	PILOT MENU	10-1
10.1	GS INHIBIT.....	10-1
10.2	TAWS INH.....	10-2
10.3	TEST.....	10-3
10.4	TCAS TEST.....	10-4
10.5	Traffic System Altitude Mode	10-5
10.6	Brightness	10-6
10.7	System Status	10-6
10.7.1	Equipment List	10-7
11	EXTERNAL SWITCH AND ANNUNCIATORS	11-1
12	ON SCREEN ANNUNCIATIONS	12-1
13	HTAWS SYSTEM LEVEL ERROR DISPLAY	13-1
14	TROUBLESHOOTING	14-1
14.1	Nuisance Alerts.....	14-1
14.2	Flight Data	14-1
14.3	Gray Terrain Cells.....	14-1
15	SPECIFICATIONS.....	15-1
16	ACRONYMS.....	16-1
17	JEPPESEN TERMS AND CONDITIONS	17-1

TABLE OF FIGURES

Figure 5-1 ST3400H Physical Features.....	5-1
Figure 5-2 Display Overview TOPO/FULL.....	5-2
Figure 5-3 Startup Screen.....	5-3
Figure 5-4 Initial Display	5-4
Figure 5-5 FULL and ARC Views	5-5
Figure 5-6 REL and TOPO Displays.....	5-6
Figure 5-7 REL Display Color Banding relative to aircraft altitude	5-7
Figure 5-8 Display Orientation.....	5-8
Figure 5-9 Display Ranging	5-9
Figure 5-10 Overlay Button	5-10
Figure 5-11 Heading Pointer – FULL View.....	5-11
Figure 5-12 Heading Pointer – ARC View	5-11
Figure 5-13 Alert Sensitivity Selection	5-12
Figure 5-14 Off-Airport Mode Selection.....	5-13
Figure 5-15 MUTE Button Highlighting.....	5-14
Figure 5-16 MUTE Annunciator.....	5-14
Figure 5-17 Brightness	5-15
Figure 5-18 Flight Plan Line	5-16
Figure 6-1 “CAUTION TERRAIN” Annunciation.....	6-1
Figure 6-2 Terrain Alert Flying Toward Obstacle – Level Flight	6-2
Figure 6-3 Terrain Alert Flying Toward Obstacle – Descending Flight ..	6-2
Figure 6-4 “WARNING TERRAIN” Annunciation.....	6-3
Figure 6-5 Obstacle Alert on a tall tower	6-5
Figure 6-6 Obstacle Symbols	6-5
Figure 6-7 Obstacles in TOPO Display.....	6-6
Figure 6-8 Minimized Obstacles in TOPO Display	6-6
Figure 6-9 Obstacles in REL Display.....	6-7
Figure 6-10 Obstacles in REL Display.....	6-7
Figure 6-11 Display During TAWS Alerts.....	6-8
Figure 7-1 GPWS Mode 1 Alerts	7-1
Figure 7-2 GPWS Mode 3 Alert.....	7-1
Figure 7-3 GPWS Mode 4 Alert.....	7-2
Figure 7-4 GPWS Mode 5 Alert.....	7-2
Figure 7-5 TAWS INHIBIT	7-3
Figure 8-1 Radar Altimeter Functions.....	8-1
Figure 9-1 ST3400 Traffic Overlay.....	9-1
Figure 10-1 Pilot Menu	10-1
Figure 10-2 GS INHIBIT	10-1
Figure 10-3 TAWS INHIBIT	10-2
Figure 10-4 TEST.....	10-3
Figure 10-5 TCAS Test.....	10-4
Figure 10-6 Traffic System Altitude Mode	10-5

Figure 10-7 Dimmer Mode..... 10-6

Figure 10-8 System Status..... 10-6

Figure 12-1 On-Screen Annunciation 12-1

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1 INTRODUCTION

1.1 Pilot Information

Publication Date 21-OCT-2010

This guide provides information on the use and operation of the ST3400H HeliTaws.

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 Sandel Avionics, Inc.

1.2 Copyright

Copyright 2010 Sandel Avionics, Inc.

May be covered by one or more of the following US and foreign patents, including US patent nos. 6,259,378, 6,489,916, 6,670,288, 6,507,288, 6,750,788, 6,972,695, 7,187,304. Australia Patent No. 750,651. China Patent No. 1211639C. Israel Patent Nos. 135,174, 153,460, and 155,983.

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1.3 Revision Notice

The “Effectivity, Errata, and Revision History” allow the use of this Pilot Guide with a specific software release. The “Effectivity, Errata, and Revision History” specifically lists the software to which this Pilot’s Guide applies and corrects any errors or omissions in this revision of the Pilot’s Guide. Document number 82046-PG-ERR, Effectivity, Errata, and Revision History” can be found on page 1-3 of this Pilot’s Guide.

1.4 Operational and Legal Issues

The information displayed on the ST3400H is generated by external equipment. It is the pilot's responsibility to ensure the correct configuration and use of the external equipment. The ST3400H is subject to all legal and operational limitations of the equipment supplying data to it. Always refer to your approved Rotorcraft 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 ST3400H may vary depending on the presence or absence of equipment.

Please keep in mind that it is required by Federal Aviation Regulations to have on board current charts appropriate to the flight. The moving map on the ST3400H does not fulfill this requirement. Current internal databases are not required but are recommended. The internal databases supply supplemental data only (such as nearest airports and obstacles). Flight plan waypoints are supplied to the ST3400H by the associated approved GPS receiver.

Supplemental data is intended for positional awareness only.

1.5 Trademarks

Sandel, the Sandel Logo, HeliTaws, and the HeliTaws Logo are trademarks of Sandel Avionics, Inc.

1.6 Approvals

The FAA has approved the ST3400H under the following TSOs:

- TSO-C194: Helicopter Terrain Awareness and Warning System (HTAWS)
- TSO-C87: Airborne Low-Range Radio Altimeter
- TSO-C113: Airborne Multipurpose Electronic Displays
- TSO-C118: Traffic Alert and Collision Avoidance System (TCAS) Airborne Equipment, TCAS I

The following certifications also apply to this product:

- Environmental Certification Level: RTCA/DO-160F
- Software Certification: RTCA/DO-178B Level C
- Complex Logic: RTCA/DO-254 Level C

Installation of the ST3400H in a type-certificated rotorcraft must be performed in accordance with the Sandel ST3400H Installation Manual, document number 82046-IM applicable revision.

1.7 Conventions Used In This Manual

The name of a button is placed within square brackets when the button is described in text. For example, “...press the [VUE] selection button to ...”

This manual uses terms, which should be familiar to aviation-minded readers, such as “Radar Altitude” and “Magnetic Heading”. Terms, which are specific to the ST3400H, will be placed in the glossary.

1.8 Effectivity, Revision History And Errata

Date: 21-OCT-2010

Applies to: ST3400H Software Version 1.01

ST3400H Pilot’s Guide 82046-PG, Revision B1

With the exception of the superseding information contained in this section, operation of the ST3400H is as described in the ST3400H Pilot’s Guide referenced above.

Revision History		
Revision	Date	Comments
B1	22-OCT-2010	A/R 1147 Updated Section 17 Jeppesen Terms and Conditions
B	10-SEP-2010	Revised for S/W Version 1.01
A	06-AUG-2010	Initial Release

No errata applicable to this release

2 LIMITATIONS

The ST3400H is an alerting system. It is intended for use in rotorcraft for all phases of flight in VMC and in IMC while operating under instrument flight rules (IFR).

Due to data limitations it is NOT guaranteed that every actual terrain or obstacle conflict will produce an alert, and alerts generated may NOT guarantee successful recovery due to factors such as pilot response, aircraft performance and database limitations. No standardized recovery technique is defined as recovery maneuvers may vary.

The ST3400H Terrain and Obstacle displays shall NOT be used for navigation.

The course line and present aircraft position shall NOT be used for approach and departure navigation.

The Obstacle Database does not include power lines.

Low Sensitivity or Off Airport Modes must not be selected when operating under IMC conditions except as required when performing offshore platform IMC Approach Procedures or other Special Procedures.

The ST3400H must utilize FAA approved software version 1.01 or later FAA approved version.

The “CRC Self Test Failed” message must not appear on power-up if flight operations are predicated on the use of the ST3400H.

The ST3400H Pilots Guide, SPN 82046-PG (applicable revision) must be immediately available to the flight crew.

Data loading and maintenance mode operation are prohibited during normal flight operation.

Note: The Terrain and Obstacle Displays are intended to serve as a terrain and awareness tool only. The Display and database may not provide the accuracy or fidelity on which to base navigation decisions and plan routes to avoid terrain or obstacles.

3 WELCOME TO THE ST3400H HELITAWS

3.1 Description

Sandel HeliTaws is a self-contained Helicopter Terrain Awareness Warning System and which both meets the FAA C194 requirements and exceeds these requirements with additional display and protection modes and features. It includes an advanced HTAWS computer, a GPWS computer, graphics symbol generator and Sandel's high brightness display engine built within a standard 3-inch instrument chassis. It includes Radar Altimeter features and can be used to directly replace an existing Radar Altimeter indicator. It has the optional capabilities of acting as a primary or secondary traffic indicator, showing traffic either in standard TCAS format or overlaid on terrain when connected to an external traffic detection system.

Terrain protection is enabled during all airborne phases of flight - Departure, Enroute, Terminal, and Approach and in any selected display mode.

Pilot selection of low-sensitivity and off-airport operational modes, allows nuisance-free protection in very demanding missions.

The terrain display features a new plan-view 3D shaded format with industry leading terrain resolution, providing an unmatched understanding of the terrain surrounding the helicopter and its contours.

3.2 What it is

The ST3400H is a situational awareness tool and an alerting and warning device. It is designed to reduce the incidence of CFIT accidents by providing increased situational awareness of the surrounding terrain and obstacles, both in VMC and in IMC under Instrument Flight Rules.

The unit supports optional external caution and warning annunciators and optional external mounted momentary switches to control certain functions such as alert muting and modes.

The ST3400H uses Sandel's patented rear-projection display technology. This technology allows the displayed image to extend to the edges of the instrument's bezel. Therefore, even though the Sandel display is in a 3-inch form factor, its image is approximately the size of a 4" primary display.

3.3 What it isn't

The ST3400H is not the pilot. Remember: it is a tool, and it isn't perfect. Neither the terrain data nor the obstacle data on which alerting is based is guaranteed to be 100% accurate, nor are the sensors feeding the system. There is no substitution for good judgment by the pilot. The pilot should always exercise prudent caution, with or without the ST3400H.

Again, it is NOT designed for navigation.

3.4 What it does

During normal flight operations the system remains essentially silent. It uses GPS, Radar Altitude, barometric altitude, and other relevant data in combination with its internal database information to provide the pilot with a full-time terrain display. The look-ahead function compares the aircraft flight path to terrain and obstacle database information and distance to known runways and landing zones.

A built-in caution and warning system provides visual annunciation and aural alerts. Provided are downward-looking Ground Proximity Warning System (GPWS) alerts, Forward Looking Terrain Alerts (FLTA), and various advisories.

FLTA provides predictive "look ahead" warnings by comparing its internal terrain and obstacle database to position information provided by the GPS receiver.

The internal terrain and obstacle database provides the basis to detect terrain or obstacle conflicts. This is accomplished using the aircraft position, phase of flight, vertical speed, ground track, and ground speed relative to the terrain database image.

Through sophisticated look-ahead algorithms, alerts are generated if terrain or an obstacle conflict with the flight path of the aircraft. This potential conflict area projects forward of the aircraft. During enroute operations, a Caution Alert typically occurs approximately 20 seconds ahead of the collision conflict. A caution will turn into a warning if evasive action is not taken after approximately 10 seconds of Caution.

During other operations the alert times may be shorter but Cautions are always designed to occur prior to Warnings. A Warning does not indicate a higher severity of threat, but simply that immediate action must be taken.

The Topographic (TOPO) and Relative Altitude (REL) display modes provide the pilot with fast access to visual information to maximizing the pilot's understanding of the relationship between the aircraft and the

ground. An image of the surrounding terrain is represented in color. Terrain and Obstacles can be displayed along the forward path or completely around the aircraft, at distances up to 20nm.

An internal data recorder automatically records a minimum of the last twenty hours of flight data. Oldest data is automatically overwritten with most recent data. This data can be used by Sandel Customer Support to analyze recent alert activity.

3.5 Other Features

Display of Radar Altitude is provided along with a MINS setter.

Display of Traffic from an external traffic processor is provided.

4 SYSTEM OVERVIEW

4.1 “Design Cruise Altitude”

The ST3400H introduces the concept of “Design Cruise Altitude”. This is the nominal cruise altitude at which the ST3400H is designed to give nuisance-free alerts with a black (no terrain showing) relative altitude display.

4.1.1 Sensitivity

To facilitate low altitude operations unique to helicopters, the ST3400H supports two pilot selectable alert sensitivity modes: Normal Sensitivity and Low Sensitivity.

In NORM Sensitivity the Design Cruise Altitude is 500’ AGL. In LOW Sensitivity, the Design Cruise Altitude is 300’ AGL - allowing standard operations closer to the ground.

In addition to changing the alerting criteria, the selected Sensitivity adjusts the relative altitude display colors to provide a black display screen at the design cruise altitude to prevent color flooding.

4.2 Off Airport Landings

In addition, an Off Airport Mode is pilot selectable which operates at either Sensitivity.

Alerts are normally automatically suppressed during the landing phase at an airport or helipad. OFF-APT mode further suppresses alerts for landing at random non-airport locations, such as for EMS operations. When this mode has been selected, no further pilot action is required and no nuisance alerts will be generated when landing anywhere. Normal alerting criteria are automatically established when not landing or in cruise flight.

4.3 Alerts, Warnings and Cautions

An Alert is defined as either a Caution or Warning, generated by the GPWS computer or the FLTA computer. A Caution is defined as an alert which indicates that pilot action will be needed *shortly*; a Warning alert indicates that pilot action is required *immediately*.

If any alert occurs, the alert text is shown at the bottom of the screen and an audible alert message will occur on the cockpit audio system. The REL

(relative altitude) terrain display is automatically selected at an appropriate range to put the alerting terrain on-screen.

Pilots should train to react properly to all alerts, cautions and warnings, just as one would train to react to any other potential or actual emergency situation.

Pilot reactions to alerts and warnings differ according to weather conditions, visibility, types of warning, phase of flight and aircraft performance considerations. Pilots should be thoroughly familiar with FAA, company, or other approved operational procedures as required by their aircraft and type of operation.

The ST3400H is not the pilot nor is it a substitute for the pilot's judgment; it is a display and computer. However, because it is designed to only alert when the aircraft is outside normal flight envelopes in relation to terrain, we recommend that all alerts should result in immediate and appropriate action by the pilot. A Warning should *always* result in an evasive maneuver.

4.4 TAWS Inhibit

A pilot selectable TAWS INH function allows the Pilot to disable all alerts. When selected, all FLTA and GPWS alerts are inhibited, and the terrain is removed from the screen. All altitude Callouts will still be enabled.

4.5 Display

4.5.1 Topographic Display

A Pilot Selectable TOPO (Topographic) view shows all terrain, in sectional-chart colors. Terrain and Obstacles are shown RED when above the aircraft altitude.

4.5.2 Relative Altitude Display

A Pilot Selectable REL view shows only proximate terrain and obstacles.

4.5.3 Obstacle Display

The ST3400H displays obstacles above 50' AGL using the standard obstacle symbol. Obstacles above 500' are displayed using the tall tower symbol (see section on obstacle display).

4.5.4 Flight Plans

The ST3400H overlays the GPS/FMS flight plan over any terrain view, if a flight plan is available from the GPS /FMS.

NOTE: The flight plan overlay is for position awareness only and the information in the flight plan has absolutely no effect or control over alerting. For this reason, alerting works identically whether the aircraft is on-flight plan or off-flight plan – without pilot intervention.

NOTE: Display of DME arcs, Holding Patterns, and Procedure Turns is not currently supported in the ST3400H with S/W version 1.01. These flight plan segments will be supported in a future software release.

4.5.5 Airports and Runways

For reference, airports are displayed with runways greater than 2500 feet within 20nm of the aircraft position. In lower zoom ranges, the airport runways and runway numbers are depicted on-screen.

4.5.6 Radar Altimeter Display

The ST3400H can function as an optional primary or secondary Radar Altimeter indicator when interfaced to a compatible Radar Altimeter system. Digital RADALT (Radar Altitude) and a MINS setting window are provided.

Radar Altitude will not be displayed when a Radar Altimeter is not installed; however the MINS display is always present and may be used by the pilot as a reference number.

4.5.7 Traffic

The ST3400H can optionally display nearby transponder equipped aircraft when interfaced with compatible TAS, TCAS. Standard TCAS symbology is used to display the relative location and altitude of traffic. The traffic information is displayed overlaid on terrain.

Note: If the ST3400H is interfaced to TCAS, the TCAS processor itself generates the alerts and these are only displayed on the ST3400H.

4.5.8 NVIS

For missions requiring the use of night vision goggles, certain ST3400H models are equipped with Sandel's proprietary on-demand Class-B NVIS capability. Unlike aftermarket NVIS modifications, Sandel's unique NVIS feature employs no external filters and does not degrade its brightness or daylight characteristics when NVIS is OFF.

NVIS is activated through the use of an external switch or push button. Refer to the Rotorcraft Flight Manual Supplement for your specific ST3400H installation for details on NVIS operation.

4.6 Sensors

Sensor data is the input data fed to the ST3400H that comes from external sources. There are no sensors inside the ST3400H. Data is derived from the following sensors:

- GPS Position
- FMS Flight Plan
- Compass system (AHRS, DG) (optional)
- Radar Altimeter (optional)
- Traffic Computer (optional)
- Airdata Computer (optional)

Heading data from an AHRS or compass system is used to provide terrain display while hovering.

4.7 Database

Databases are supplied by Jeppesen. See Chapter 17 for Terms and Conditions regarding the use of the databases contained within the ST3400H.

4.7.1 Coverage area of the database

The internal database of the ST3400H includes terrain, charted man-made obstacles above 50' AGL, and airports with runways greater than 2500 feet in length. Obstacles are shown, processed and alerted discretely from the terrain.

The terrain and airport database coverage is provided by geographical area. Coverage is limited to those areas between 70°N and 70°S latitude. Obstacle data is included for most countries. Please contact Sandel for the most current coverage information.

Note: There is no guarantee that every obstacle is charted or that every charted obstacle is in the obstacle database.

4.7.2 Database updates

Updates are uploaded into the ST3400H through a USB port located on the front right corner of the display bezel.

5 TERRAIN DISPLAY AND OPERATION

The following section describes the appearance of the ST3400H display and identifies each functional element.

5.1 Control Overview

The ST3400H physical layout consists of a display screen, 9 backlit buttons, one push-pull rotary knob, and one USB connector.

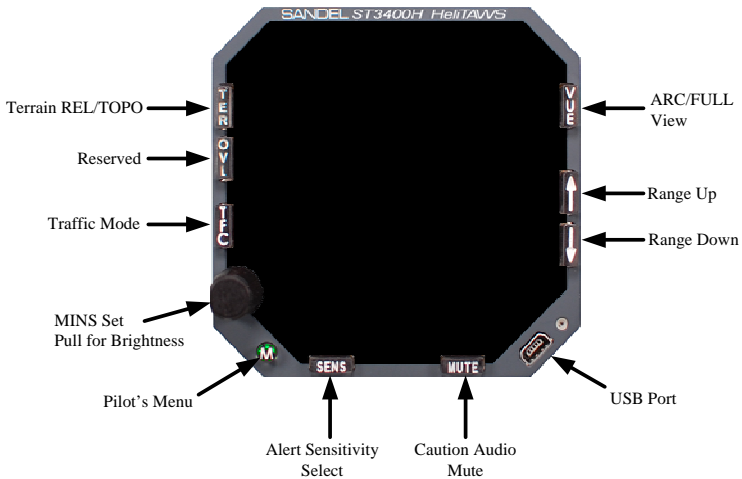


Figure 5-1 ST3400H Physical Features

5.2 Display Overview

The display is composed of underlying terrain, with symbol and text overlays.

The display is geometrically referenced to the tip of the symbolic aircraft

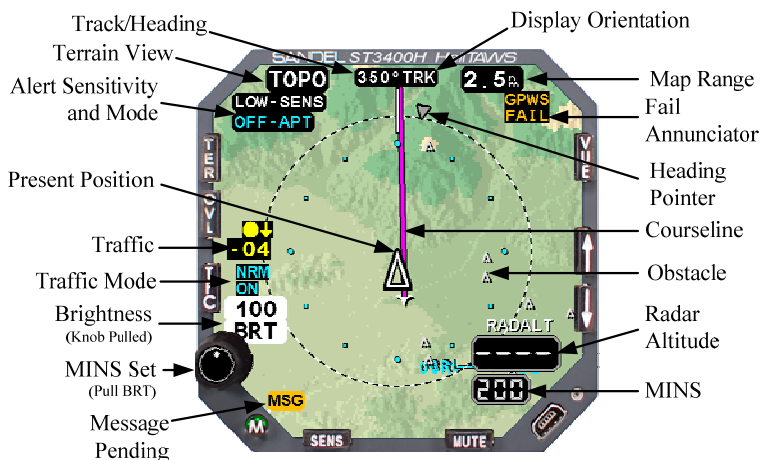


Figure 5-2 Display Overview TOPO/FULL

5.3 Splash Screen

At power-up there is no splash screen shown. The M button will light at night brightness level when power is applied, and the display will be blank for approximately 25 seconds.

5.4 Initial Bootup Display

After approximately 25 seconds after initial power-up, a short introduction screen will be displayed which includes software and database versions.



Figure 5-3 Startup Screen

5.5 No-Sensor Display

After the power up display is removed, the operating screen will likely show sensors in the failed state until they become available:

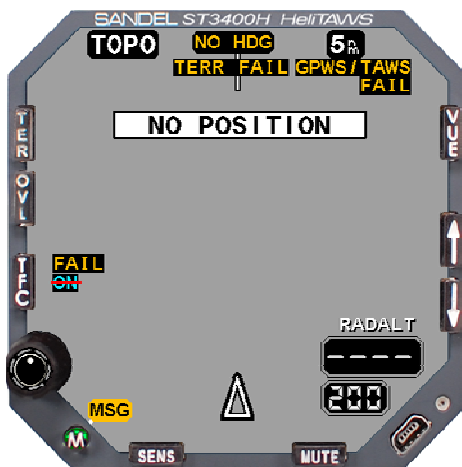


Figure 5-4 Initial Display

As soon as sensor availability is established the terrain will immediately build on the screen and normal operation will start.

5.6 FULL / ARC

Press [VUE] to switch between 360-degree and 70-degree ARC views.

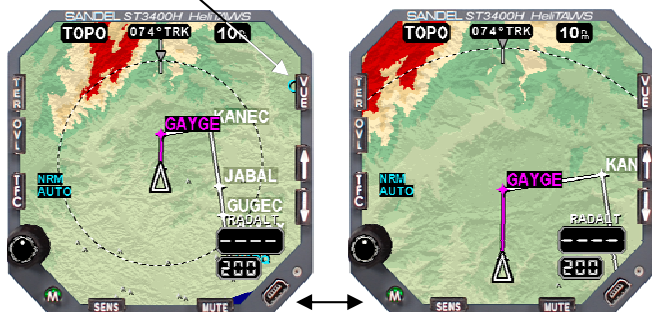


Figure 5-5 FULL and ARC Views

This action only affects the screen display – it has no effect on alerting. The ARC view maximizes the display of the ground track ahead of the aircraft and provides the greatest amount of screen area for map data.

5.7 REL/TOPO

Pressing the TER button will change the display from REL to TOPO. The current mode is annunciated at the top of the display.

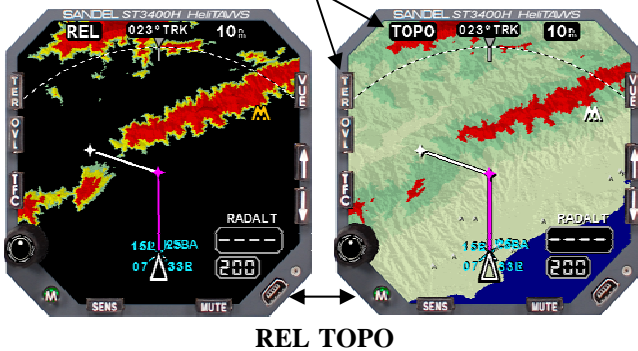


Figure 5-6 REL and TOPO Displays

NOTE: Selecting REL/TOPO has no affect on alerting.

5.7.1 TOPO DETAILS

TOPO shows all the terrain in sectional chart colors in shaded relief.

Any terrain that is above the current altitude overlays in RED. Terrain more than 1000' above the aircraft altitude is overlaid in shaded red.

Ocean is shown in blue. Other water is shown only by its elevation color coding.

5.7.2 REL DETAILS

On the Relative Altitude display, only proximate terrain is shown.

Terrain with adequate terrain clearance is black (i.e. not shown). Terrain progressively closer to the aircraft altitude is shown in green, then yellow, and finally red.

On an approach to the airport, the yellow/green bands will shrink as the aircraft gets closer to the runway. Within 1nm of the airport and when on the ground, green and yellow are suppressed. Red is then used to depict terrain above the aircraft.

NOTE: If an alert occurs while in TOPO, the display mode will change to REL, in ARC view, at an appropriate range to put the terrain conflict on the screen.

5.8 REL Color Banding

The REL colors graphically show the clearance between the current aircraft altitude and the terrain or obstacles. Colors depend on the selected SENSITIVITY. The following are the color band altitudes during cruise flight.

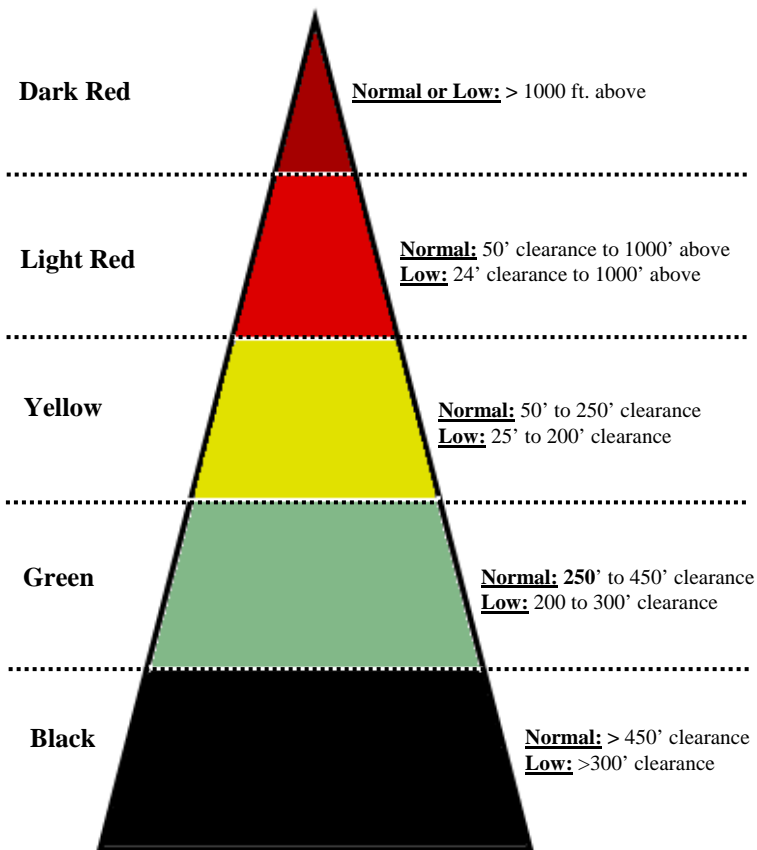


Figure 5-7 REL Display Color Banding relative to aircraft altitude

5.9 Display Orientation

The display orientation (HDG/TRK) is selected automatically and is shown within a box at the top of the display. When displaying TRK the lubber

line shows exactly where the aircraft is going to be on its current ground track.

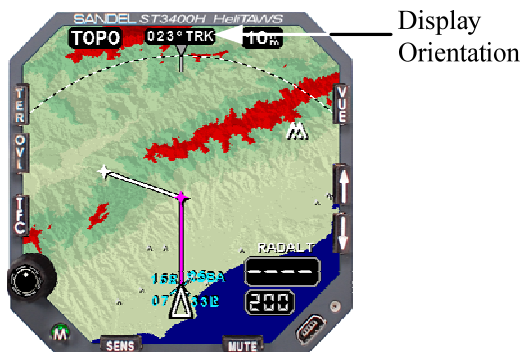


Figure 5-8 Display Orientation

TRK is used above 35Kts ground speed.

HDG is used below 30Kts ground

NOTE: Traffic symbols are always referenced to the nose of the aircraft, even if the display directional source is TRK.

5.10 Display Range

The Display Range is the distance in nautical miles between the tip of the symbolic aircraft and the dashed range ring. Switching between FULL and ARC view maintains the terrain cell size during range changes.

AVAILABLE RANGES	
View	Ranges
FULL	½, 1, 1.5, 2.5, 5, 10
ARC	1, 2, 3, 5, 10, 20

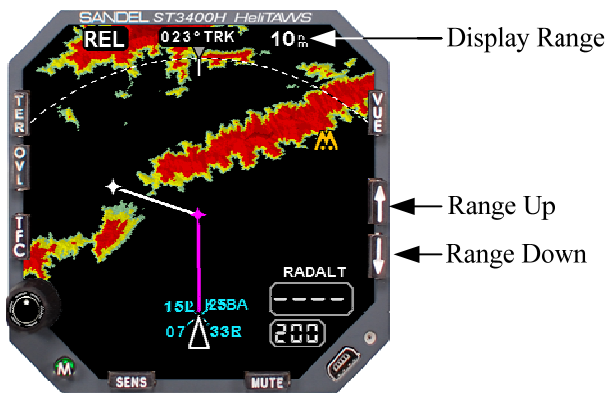


Figure 5-9 Display Ranging

5.11 Overlay

The OVL button is reserved for a future feature. Pressing this button when in the normal display mode (not in the pilot menu) will display the message “NOT IMPLIMENTED”.

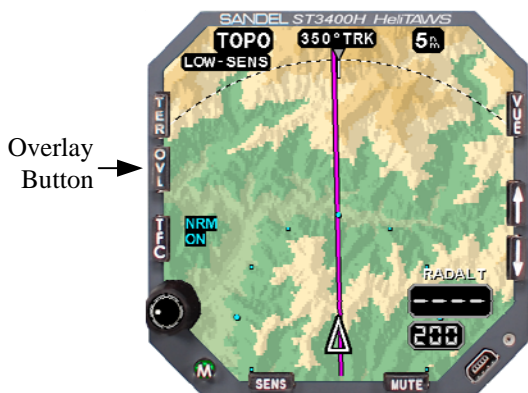


Figure 5-10 Overlay Button

5.12 Heading Pointer

The Heading Pointer is the inverted gray triangle located at the top of the display when in TRK orientation. The Heading Pointer shows the magnetic heading of the aircraft (where it is pointed) and can be used for identifying the crab angle.

In the following illustration the wind is coming from the right and the aircraft is crabbed to the right. Its direction of travel is straight up towards the lubber line.

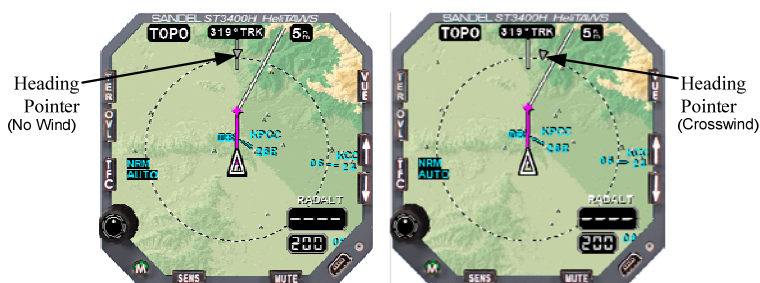


Figure 5-11 Heading Pointer – FULL View



Figure 5-12 Heading Pointer – ARC View

5.13 Sensitivity

Press the SENS button to toggle the Sensitivity between NORM and LOW. NORM has no screen annunciation. LOW displays LOW-SENS as shown in the figure.

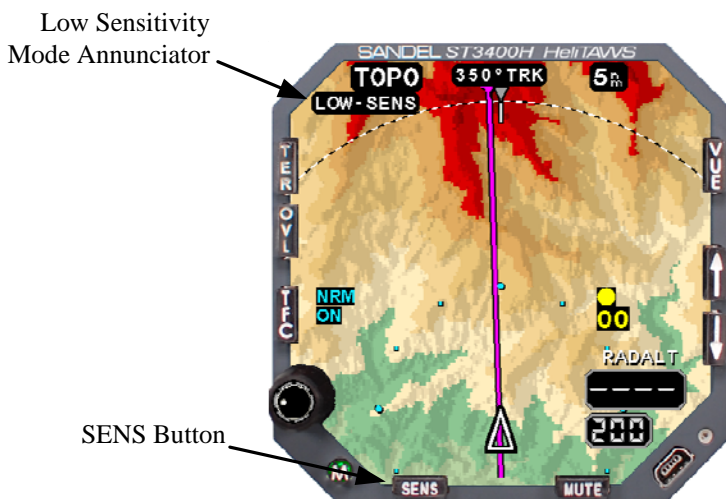


Figure 5-13 Alert Sensitivity Selection

Note: This function may also be accessed by an optional mounted pushbutton.

5.14 Off Airport Mode

HOLD the SENS button to toggle the OFF-APT mode. This annunciates OFF-APT in Cyan.

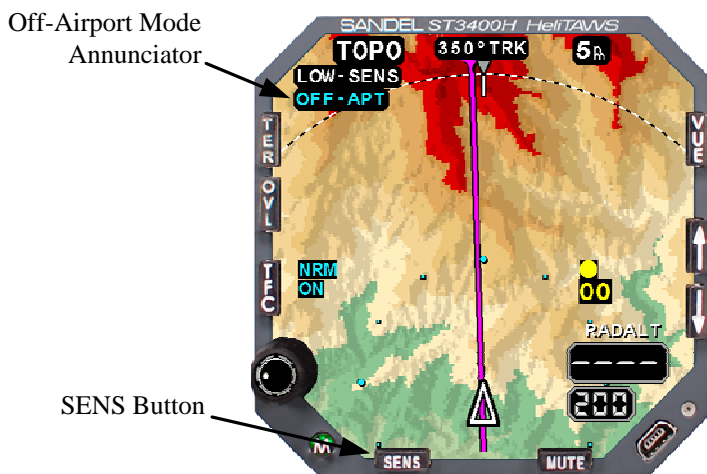


Figure 5-14 Off-Airport Mode Selection

Note: This function may also be accessed by an optional mounted pushbutton.

5.15 Mute

An already occurring CAUTION alert may be muted for 15 seconds by pressing the MUTE button. During Caution alerts the MUTE button will highlight with a white bar as an aid to locating the mute function.

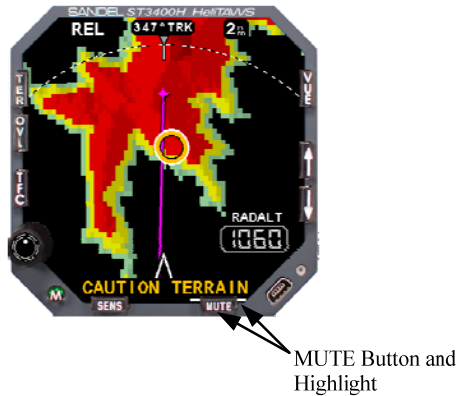


Figure 5-15 MUTE Button Highlighting

Notes:

- In the special case of a GPWS Altitude Loss After Take-off alert (“DON’T SINK”), pressing MUTE will disarm the alert completely until the next takeoff.
- If the MUTE button is pressed when a CAUTION alert is not present, the text “NO ACTION” will display on the screen.
- This function may also be accessed by an optional mounted pushbutton.

WARNINGS cannot be muted.

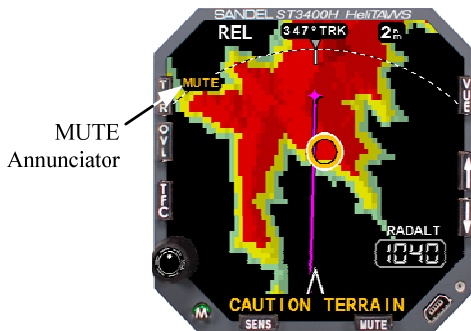


Figure 5-16 MUTE Annunciator

5.16 Brightness

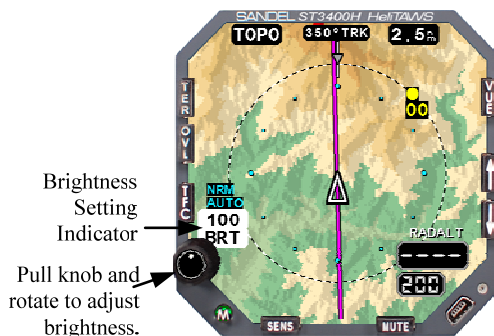


Figure 5-17 Brightness

Pull the knob and turn to adjust the brightness.

The brightness is shown above the knob as a number from 0-100. 100 is full brightness.

5.17 Flight Plan

If the FMS supplies a flight plan, each flight plan segment is displayed. The active flight plan segment is colored magenta and the balance of the flight plan segments are colored white.

NOTE: Display of DME arcs, Holding Patterns, and Procedure Turns is not currently supported in the ST3400H with S/W version 1.01. These flight plan segments will be supported in a future software release.

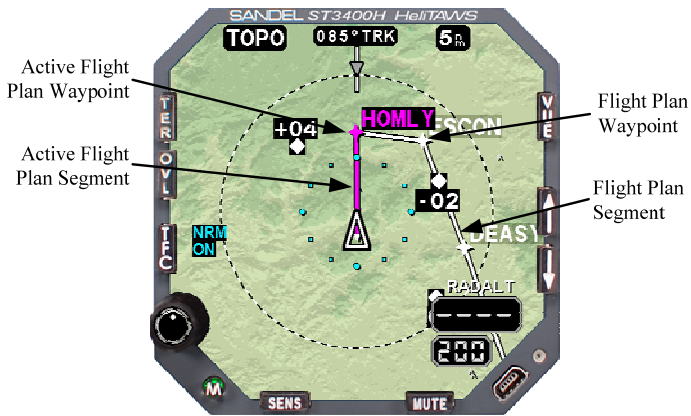


Figure 5-18 Flight Plan Line

6 TERRAIN AND OBSTACLE ALERTING

6.1 Alert Generation

FLTA is an acronym for Forward Looking Terrain Alerting. The FLTA Alerting Area is an area mostly in front of and to both sides of the aircraft.

Through sophisticated look-ahead algorithms, alerts are generated if terrain or an obstacle conflict with the path of the aircraft.

Position and altitude of the aircraft are computed along the projected flight path twice per second. The projected position is based on current aircraft location and the aircraft's ground speed. The projected altitude is based on current aircraft altitude and the aircraft's vertical speed. The aircraft's projected position and each terrain cell and obstacle elevations are then compared to check for conflicts.

During enroute operations, a caution alert typically occurs approximately 20 seconds ahead of the terrain or obstacle conflict. A caution alert will turn into a warning alert if evasive action is not taken approximately 10 seconds ahead of the conflict.

The alert in question will be the closest cell or obstacle in which a threat is detected.



Figure 6-1 “CAUTION TERRAIN” Annunciation

Cautions are always designed to occur prior to warnings during steady-state flight. There are exceptions such as initiating turns into terrain or initiating a descent when close to terrain. Under these conditions a Warning may be received without a Caution.

In some cases, a terrain alert may be issued while flying toward an obstacle. This will occur when terrain beneath the obstacle is within the terrain alerting buffer. Terrain alerts always take precedence over obstacle alerts. If an obstacle is within the alerting area it will show on the display.

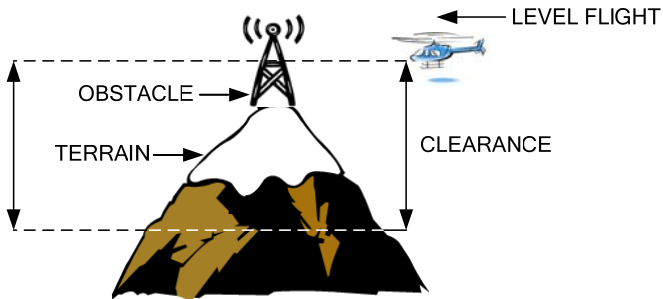


Figure 6-2 Terrain Alert Flying Toward Obstacle – Level Flight

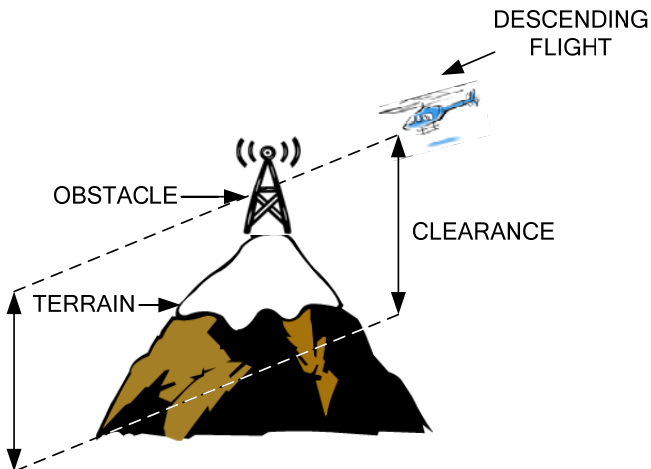


Figure 6-3 Terrain Alert Flying Toward Obstacle – Descending Flight

6.2 Alert Display

When an alert occurs, REL is automatically selected, in ARC view, at an appropriate range to put the conflict on the screen. After the alert occurs the pilot may select other display modes (such as TOPO) and/or other ranges if desired.

The terrain display shows all terrain – not only that which represents actual conflicts. For instance if two cells are threats simultaneously, both cells will be visible on the ST3400H but only the closest one will be circled. There may be other areas of conflict!

In Figure 6-1 note the alert is on a green cell and in Figure 6-4, the alert is on a yellow cell. Both represent terrain below the aircraft. This is occurring because the aircraft is descending, but the cell is still below the aircraft's *current* altitude. In REL display any color cell may produce an alert, depending on the descent rate. In level flight only yellow or red cells will produce an alert.

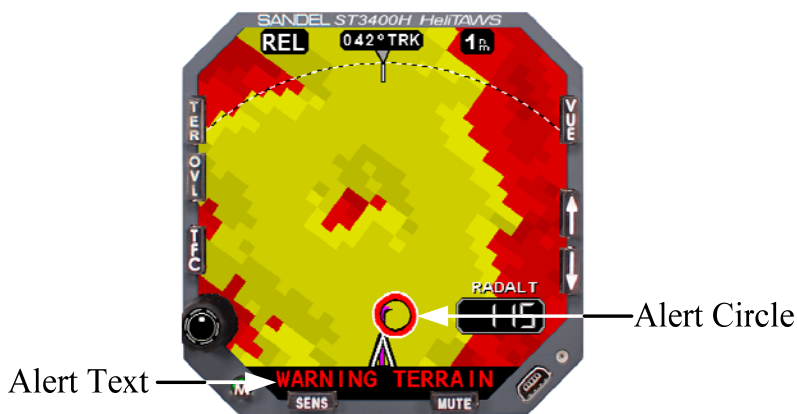


Figure 6-4 “WARNING TERRAIN” Annunciation

6.3 External Annunciation

If optional external annunciators are installed, they will display simultaneously with the on-screen annunciations in Amber or Red.

6.4 Responding to an Alert

Every alert should be considered valid and requires appropriate action.

- An AMBER CAUTION annunciation and requires *immediate pilot attention*.
- A RED WARNING annunciation and requires *immediate aggressive pilot action*.

Pilot reactions to alerts and warnings differ according to weather conditions, visibility, type of warnings, phase of flight, and aircraft performance considerations. Pilots should be thoroughly familiar with FAA, company, or other approved operational procedures as required by their aircraft and type of operation.

Pilots should train to react properly to all alerts, cautions and warnings, just as one would train to react to any other emergency situation.

6.5 Alert Circle

6.5.1 Terrain

The Alert Area Indicator Circle shows the general location of the current alert for FLTA alerts. Do not assume the terrain or obstacle threat is in the exact center of the circle. Also, remember the circle only represents the closest threat. Other threats may exist farther away, or to the side, but will not be circled. Since the exact location of the terrain is subject to uncertainties and tolerances, the terrain or obstacle threat may be anywhere inside the circle.

6.5.2 Obstacles

For obstacle alerts, the size of the Alert Circle displayed on the ST3400H depends on the ‘horizontal extent’ of the obstacle. This includes both the radius of the obstacle and the survey uncertainty of the obstacle as listed in the database. Tall obstacles are assumed to have guy wires and will have a radius equal to their height. This means the horizontal extent can be quite large for tall obstacles – for instance, more than half a mile in diameter for a 2000’ tower..

An alert is generated to the obstacle horizontal extent, which may be larger than the obstacle icon on the screen. If you see a tall tower symbol the circle is a minimum of 1000’ in diameter.

When an alert is generated, the alert caution/warning circle will be *the full diameter of the horizontal extent*. Stay completely out of the circle as you will likely not be able to see guy wires if they are present.

It is possible that a tall obstacle, while not precisely in the aircraft’s flight path, will generate an alert with an alert circle that *will then be in the aircraft’s flight path* unless corrective action is taken. See

Figure 6-5.

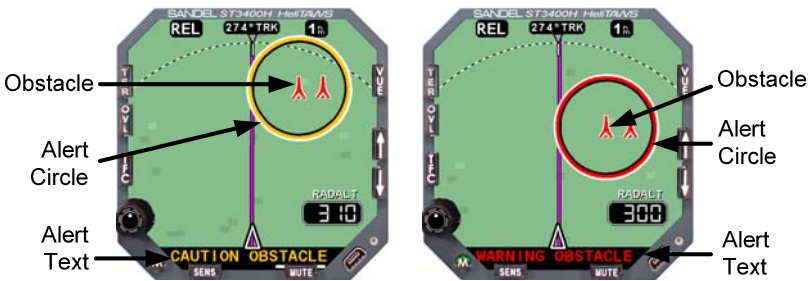


Figure 6-5 Obstacle Alert on a tall tower

6.6 Obstacle Symbolology

Obstacles are depicted by two symbols. These symbols will be sized according to the relative height below the helicopter and the distance. There is no difference in meaning between the same symbol depicted at different sizes. Coloring of obstacles is in accordance with the REL Color Chart in Figure 5-7 with the exception that there is only one RED color band (i.e. red means above, there is no dark red).






Obstacle Symbols	
Obstacles 500' AGL and taller:	 
Obstacles less than 500' AGL	  

Figure 6-6 Obstacle Symbols

6.6.1 Obstacles in TOPO Display

In REL, only obstacles in the REL color bands are shown. In TOPO, *all* obstacles in the database are depicted, adding those obstacles to the

display that are below the REL GRN color band. Any obstacles above the current helicopter altitude are shown in red. All other obstacles are shown sized and highlighted to indicate their proximity to the helicopter. Note that obstacles far from the helicopter are shown very small - for situational reference / planning only. These will drop out of view in REL mode.



Figure 6-7 Obstacles in TOPO Display



Figure 6-8 Minimized Obstacles in TOPO Display

Figure 6-8 is the same depiction as Figure 6-7 except with the helicopter at a higher altitude. Note that all the obstacle symbols, including the 'tall tower' symbol are now minimized.

6.6.2 Obstacles in REL Display

The following figures show the same situation as Figure 6-7 after pressing the TER button. REL mode only obstacles near the helicopter altitude where RED/YEL/GRN color coding is enforced. The obstacles below the 'green' altitude drop out of the display completely.



Figure 6-9 Obstacles in REL Display



Figure 6-10 Obstacles in REL Display

Figure 6-10 is the same as Figure 6-9 except with the helicopter at a higher altitude. There are no obstacles near the helicopter altitude so nothing is shown.

6.7 TAWS Inhibit - FLTA

FLTA alerts can be inhibited by pressing TAWS INH in the Pilot's Menu (or if installed, holding the external mounted MUTE pushbutton for 2 seconds). This feature may be used for:

- Abnormal failure of GPS/FMS resulting in erroneous data. A conventional (flagged) GPS/FMS failure will automatically fail alerts and the terrain display.
- To stop alerts occurring because of unusual VFR mission requirements.
- A perceived nuisance alert, or an alert expected but not received, should be brought to the attention of Sandel Avionics for analysis.

Be aware that the TAWS INH function cancels all alerts - FLTA and GPWS. Altitude Callouts remains active, and terrain is removed from the screen.

6.8 Simultaneous TAWS and TFC Alerts

If a TAWS alert occurs Traffic will be removed from the display.

If a traffic alert is also present during the terrain alert, a yellow or red "TFC" annunciator appears next to the TFC button. If it is desired to simultaneously view the traffic in this situation, pressing the TFC button will restore the TFC targets.

After the terrain alert ceases, the traffic display will always be restored automatically and the prior terrain display mode will be restored after a 5 second delay.

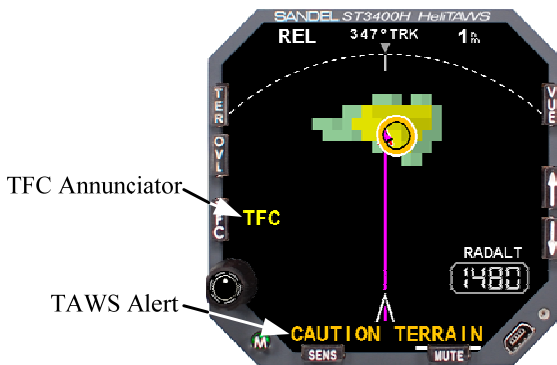


Figure 6-11 Display During TAWS Alerts

7 GPWS ALERTING

The ST3400H contains a Ground Proximity Warning System separate from the FLTA alert system. The GPWS is a downward looking alert capability which generally uses the radar altimeter as an alerting source.

The GPWS alerts could be considered as a backup system if FLTA was not available (such as if GPS position was unavailable) or the helicopter was hovering.

NOTE: GPWS alerting, with the exception of Mode 5 Glideslope, is not operational without a Radar Altimeter installed.

7.1 Mode 1 – Excessive Rate of Descent

A “SINK RATE” Caution Alert is generated when the aircraft height above terrain is below 500’ AGL and is accompanied by a high rate of descent. If the descent is not arrested a “PULL UP” Warning Alert is generated.

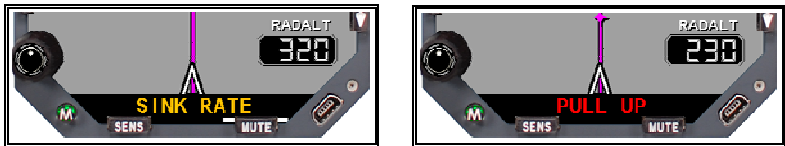


Figure 7-1 GPWS Mode 1 Alerts

7.2 Mode 2 – Not Implemented

This “Terrain Closure Rate” alert is a fixed-wing mode and not supported in Helicopter TAWS.

7.3 Mode 3 – Descent after Takeoff

A “DON’T SINK” Caution Alert is generated if the aircraft climbs past and then descends below 95’ while in the Normal Sensitivity mode (75’ if operating in the Low Sensitivity mode) immediately after take-off. This alert may be cancelled by pressing MUTE.



Figure 7-2 GPWS Mode 3 Alert

7.4 Mode 4 – Landing Gear

For retractable gear aircraft - A “TOO LOW GEAR” Caution Alert is generated if the aircraft descends below 125’ while in the Normal Sensitivity mode (or below 50’ while in the Low Sensitivity mode) and the landing gear is not down.



Figure 7-3 GPWS Mode 4 Alert

7.5 Mode 5 – Glideslope

A “GLIDESLOPE” Caution Alert is generated if the aircraft descends below the glideslope when the aircraft is 400’ AGL or lower while in the Normal Sensitivity mode (200’ or lower while in the Low Sensitivity mode) while on an ILS approach.



Figure 7-4 GPWS Mode 5 Alert

7.6 Mode 6 – Altitude Callouts

When a Radar Altimeter is installed, an altitude callout is generated any time the aircraft descends below 300’ while in the Normal Sensitivity mode (100’ while in the Low Sensitivity mode). Additional callouts are configurable for 200’, 100’, 50’, 40’, 30’, 20’, and 10’.

7.7 TAWS INH - GPWS

GPWS alerting, can be inhibited with the TAWS INH function. The TAWS INH function *also* cancels all FLTA alerts.

When TAWS INH is active, Callouts remains active.

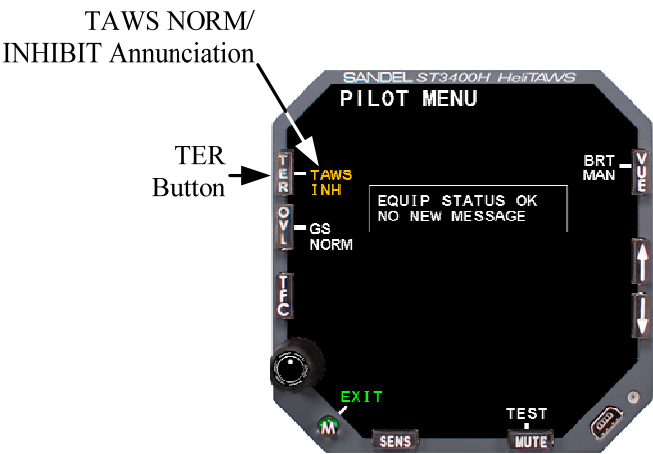


Figure 7-5 TAWS INHIBIT

8 RADAR ALTIMETER FUNCTIONS

The ST3400H functions as a Radar Altimeter indicator when interfaced to a compatible Radar Altimeter system. A Radar Altitude display and a MINS setting window are provided.

The Radar Altitude will not be displayed if a Radar Altimeter is not installed. However the MINS setting window is retained and may be used by the pilot as a reference number.

Radar altitude displays in 5' increments below 200'; 10' increments below 1000'; and 20' increments below 2000'

The knob adjusts the MINS setting by rotating clockwise or counterclockwise, as needed.

When the aircraft Radar Altitude descends below the MINS setting, the MINS annunciator will flash and an audible MINS callout will occur.



Figure 8-1 Radar Altimeter Functions

Note: The MINS function is disabled when the helicopter is on the ground.

9 TRAFFIC FUNCTION

9.1 Traffic Display

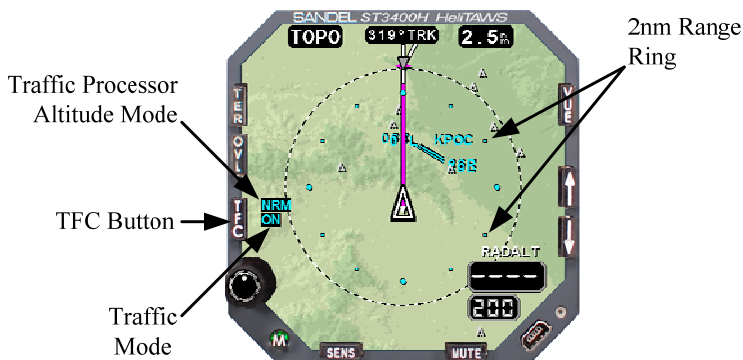


Figure 9-1 ST3400 Traffic Overlay

Traffic will be overlaid on terrain when in REL and TOPO display views. The traffic is always shown relative to the nose of the aircraft – where you would see it if you looked out the window.

The [TFC] button is used to control the display of traffic data from nearby transponder equipped aircraft when the ST3400H is interfaced with a compatible TAS, TCAS, or ADS-B processor. Please refer to the Pilot's Guide of the specific traffic system installed in the aircraft for a complete description of the capabilities. When a traffic processor is not installed, pressing the TFC button will display a "NOT CONFIGURED" advisory.

9.2 TFC Button

Pressing the TFC button toggles between ON and AUTO modes, annunciated next to the TFC button.

Regardless of the selected mode, traffic alerts will always be shown
ON: Always displays all traffic targets within the selected map range.

AUTO: Traffic will be displayed only when a traffic alert is present (TA's and RA's). When a traffic alert occurs, the map range will auto-scale to an appropriate range to ensure the traffic conflict is shown on the screen. AUTO mode can be useful in busy terminal areas where the

display of traffic all the time may cause the screen to become too cluttered.

Note: The traffic alert and its audio are provided by the TAS or TCAS system, not the ST3400H.

9.3 Traffic Processor Altitude Mode

The traffic processor's altitude display mode will be displayed above the TFC Display Mode indicator.

NRM	Normal altitude display mode. Target aircraft within +/-2,700 ft. of your aircraft are displayed.
ABV	Above altitude display mode. Target aircraft within – 2,700 ft. and +9,000 ft. of your aircraft are displayed.
BLW	Below altitude display mode. Target aircraft within – 9,000 ft. and + 2,700 ft. of your aircraft are displayed.
XTD	Extended altitude display mode. Target aircraft within +/-9,000 ft. of your aircraft are displayed.



Note: With some TCAS equipment NORM is not annunciated. Please refer to the RFMS for details on the specific traffic system installation in your aircraft.




9.4 TFC Range Ring

When traffic is being displayed a dotted 2nm range is shown. The 12, 3, 6, and 9 o'clock positions are bolded.

9.5 Symbology

The ST3400H uses standard RTCA symbology to represent traffic.



Alerting Traffic		
DISPLAY	CONDITION	DESCRIPTION
	Resolution Advisory (RA) (Available with TCAS II Only)	Immediate threat that requires evasive action. Note: Vertical guidance information is NOT shown on the ST3400H display.
	Traffic Advisory (TA)	Traffic within 15-30 seconds of closure, or within 0.20 to 0.55nm and +/-600 to +/-800 ft of your aircraft.
TA 2.0nm	No Bearing / No Altitude Traffic Advisory	TA with no bearing and no altitude information available.
TA 2.0nm / +07↑	No Bearing Traffic Advisory	TA with no bearing information available.

Non-Alerting Traffic		
DISPLAY	CONDITION	DESCRIPTION
	Proximity Advisory	Traffic within 4nm and +/-1,200 ft of your aircraft
	Other Traffic	Traffic not representing an immediate threat
	Out of Range Traffic	Alerts outside of the currently selected display range will be shown as a half symbol against the outer range ring at the corresponding bearing.

9.6 Altitude Tags

9.6.1 Relative

Relative altitude in hundreds of feet and vertical trend information are given for each target aircraft. **Note:** Values greater than 9900 feet are shown as '99'.

	<p>The '-02' indicates the target is 200 feet below your current aircraft altitude. The up arrow indicates the target is climbing at a vertical rate of greater than 500 fpm.</p>
	<p>The '+05' indicates the target is 500 feet above your current aircraft altitude. The down arrow indicates the target is descending at a vertical rate greater than 500 fpm.</p>

9.6.2 Traffic Absolute Altitude

The traffic processor may have an option to change the display of altitude from relative to absolute. This is called 'Flight Level' mode by some manufacturers. When activated, the altitude shown for target aircraft will temporarily be shown in hundreds of feet MSL when below 18,000 feet and as a flight level when above 18,000 feet. The altitude of your aircraft will be shown on the ST3400H display.

9.6.3 Traffic Alert Priority

In the case of simultaneous GPWS/TAWS and TCAS alerts, GPWS/TAWS alerts have a higher alerting priority.

10 PILOT MENU

Press the [M] “Menu” button to access the Pilot Menu.



Figure 10-1 Pilot Menu

10.1 GS INHIBIT

[GS] soft key controls GPWS Mode 5 glide slope alerts NORM or INH (disabled). When in INH the glide slope warning is disabled.

Note: The Mode 5 alert is also automatically disabled when flying a back course approach, if this capability is installed. This condition is not annunciated.

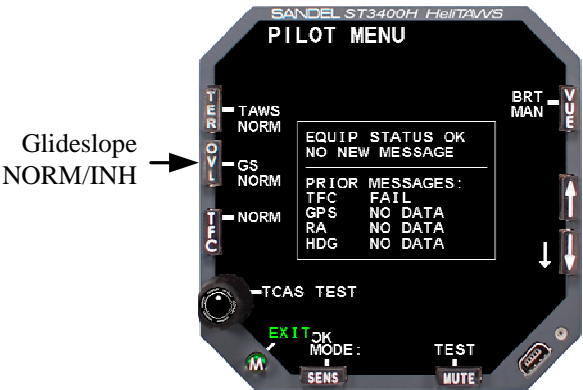


Figure 10-2 GS INHIBIT

10.2 TAWS INH

FLTA and GPWS alerting, can be inhibited by pressing the TAWS NORM/TAWS INH softkey on the Pilot's Menu. This feature can also be operated by holding the external mounted MUTE button for 2 seconds, if installed. When active this function removes terrain from the screen.

This feature is used for:

- Abnormal failure of GPS/FMS resulting in erroneous data. A conventional (flagged) GPS/FMS failure will automatically fail alerts and the terrain display.
- To eliminate nuisance alerts during unusual VFR missions.
- A perceived nuisance alert should be brought to the attention of Sandel Avionics for analysis.

Be aware that the TAWS INH function cancels all FLTA alerts and inhibits GPWS modes 1, 3, 4, and 5. When TAWS INH is active, Altitude Callouts remain active.



Figure 10-3 TAWS INHIBIT

10.3 TEST

The [TEST] softkey performs the following functions.

- Tests external annunciator lamps, if installed.
- Tests on-screen annunciation of CAUTION followed by WARNING.
- Tests audio system with CAUTION followed by WARNING audio.

This test should be performed before each flight.

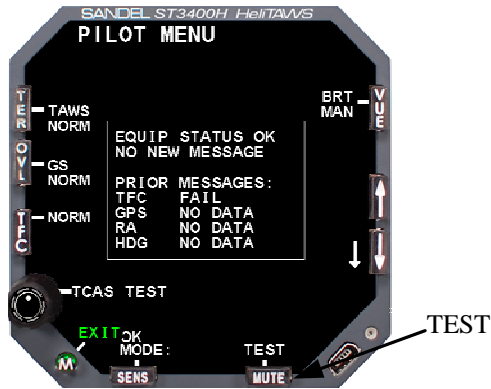


Figure 10-4 TEST

10.4 TCAS TEST

Provides a TCAS TEST output discrete for BFG traffic systems. Press the knob to perform the TCAS TEST. Consult the Rotorcraft Flight Manual Supplement for the ST3400H installation for you aircraft and the traffic system pilot's guide for additional details.

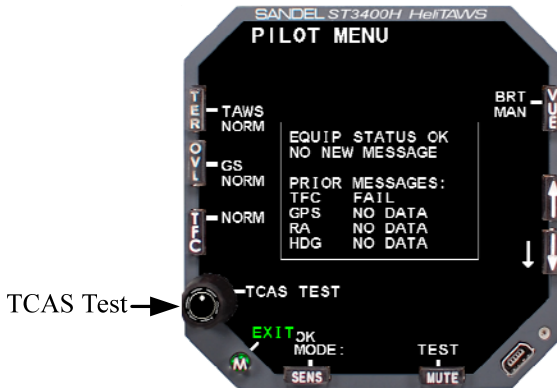


Figure 10-5 TCAS Test

10.5 Traffic System Altitude Mode

The ST3400H supports four altitude filtering modes: NORM (Normal), ABOVE, BELOW, and XTND (Extended). Depending on the model of traffic system interfaced to the ST3400H in your particular installation, these altitude filtering modes may be controllable through this soft key. Descriptions for these modes can be found in Chapter 6 – TRAFFIC DISPLAY. Consult the Rotorcraft Flight Manual Supplement for the ST3400H installation for your aircraft and the traffic system pilot’s guide for additional details.

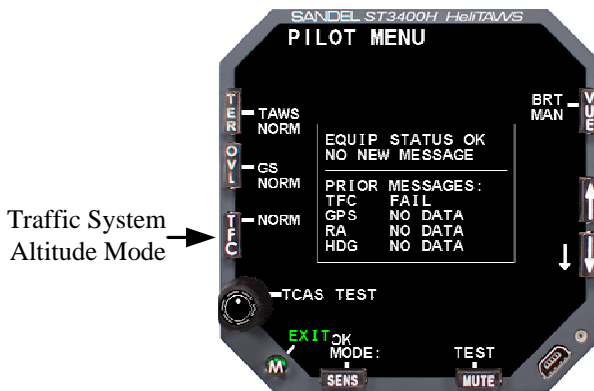


Figure 10-6 Traffic System Altitude Mode

10.6 Brightness

Manual Brightness is the only mode that is currently supported by the ST3400H.

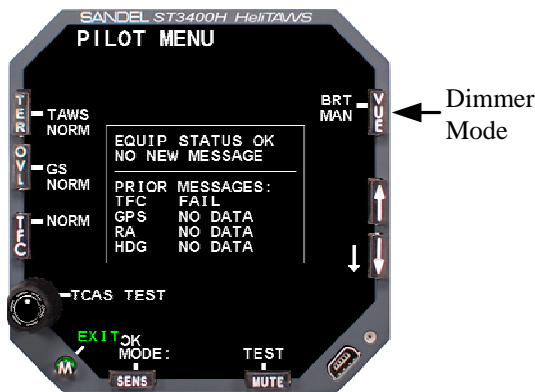


Figure 10-7 Dimmer Mode

10.7 System Status

The System Status box contains a list of failed or inoperative equipment. The UP/DOWN Arrow buttons can be used to scroll through messages.

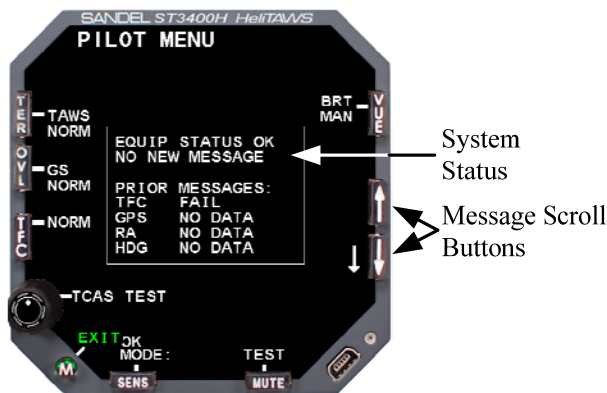


Figure 10-8 System Status

10.7.1 Equipment List

INVALID/FAILED EQUIPMENT LIST	
Input	Description
ADC	Air Data Computer
AP	Autopilot engaged input inop
TAWS INH	Taws Inhibit input inop
FMS	GPS/Flight Management System input
GPS	GPS/Flight Management System input
GEAR	Landing Gear INOP (ARINC 429 only)
GS	Glideslope Receiver
HDG	Heading System, AHRS or Directional Gyro
LOC	Localizer Receiver
RA	Radio Altimeter

11 EXTERNAL SWITCH AND ANNUNCIATORS

External annunciators and switches may be optionally installed.

The supported external annunciators are:

TAWS illuminates in amber whenever an amber caution is present on the ST3400H display.

TAWS illuminates in red whenever a red warning is present on the ST3400H display.

TAWS INH illuminates whenever TAWS INH is present on the ST3400H display. It also illuminates when TAWS alerts are inhibited for any other reason, such as loss of GPS signal, no terrain data, etc. This will correspond with a flagged terrain display.

The supported external switch/ annunciators are:

MUTE illuminates whenever the MUTE is displayed on the ST3400H. Pressing the external MUTE switch has the same function as the front panel MUTE switch. Holding the external MUTE switch for more than 2 seconds has the additional function of selecting the TAWS INH function as if TAWS INH was selected on the pilot's menu.

SENS illuminates whenever LOW SENS is displayed on the ST3400H. Pressing the external SENS switch has the same function as the front panel SENS button, including the HOLD function.

GS INH illuminates when GS INHIBIT is selected. Pressing external GS INH switch has the same function as the pilot's menu GS INHIBIT softkey.

12 ON SCREEN ANNUNCIATIONS

Figure 12-1 (below) is an illustration of the various position and meanings of on-screen annunciations:

GPWS FAIL:	One or more GPWS modes are unavailable due to failed equipment, typically Radar Altimeter failure.
GS INH:	Glide Slope Inhibit active. No glide slope alerts will occur.
MSG:	A message is waiting on the Failed Equipment List.
NO HDG:	Loss of heading information (or no heading system configured) when GPS track is not available.
TAWS FAIL:	FLTA alerts and TOPO and REL displays are disabled due to lack of database or failed database.
TAWS INH:	TAWS Inhibit active. All alerts are suppressed. Terrain is removed from the screen.
TCAS FAIL:	Display of traffic is disabled due to lack of data communication from the TCAS processor.
TERR FAIL:	Loss of terrain data.

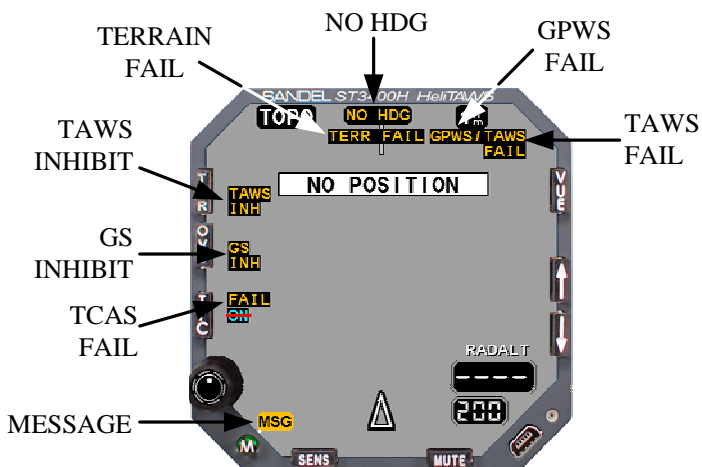


Figure 12-1 On-Screen Annunciation

These messages are displayed during Pilot's Menu test:

ALERT TEST	
Text Message	Type
TEST CAUTION	Caution
TEST WARNING	Warning

ADVISORY MESSAGES REQUIRING ACKNOWLEDGE		
Text Message	Description	Comment
1.5V PWR SUPPLY	1.5 Volt power supply	Report to Maintenance
2.5V PWR SUPPLY	2.5 Volt power supply	Report to Maintenance
3.5V PWR SUPPLY	3.5 Volt power supply	Report to Maintenance
5.0V PWR SUPPLY	5.0 Volt power supply	Report to Maintenance
13.5V PWR SUPPLY	13.5 Volt power supply	Report to Maintenance
15.5V PWR SUPPLY	15.5 Volt power supply	Report to Maintenance
-5.5V PWR SUPPLY	-5 Volt power supply	Report to Maintenance
-15V PWR SUPPLY	-15 Volt power supply	Report to Maintenance
AIRCRAFT POWER	Aircraft power	Check aircraft bus voltage. It is low.
PWR SUPPLY TEMP	Power supply temperature	Pull CB and report to maintenance
OVER TEMP	Over temperature	Pull CB and report to maintenance
400 HZ FAILED	400 Hertz failed	Aircraft inverter failure. May affect HDG operation
400 HZ LOW	400 Hertz low	Aircraft inverter problem
400 HZ HIGH	400 Hertz high	Aircraft inverter problem
PROGRAM CRC	Program cyclic redundancy check invalid	Program code has an error – unit not airworthy
TERRAIN CRC	Terrain data cyclic redundancy check invalid	Terrain data has an error – FLTA not airworthy (use TERR INH)
AIRPORT CRC	Airport data cyclic redundancy check invalid	Airport data has an error - FLTA not airworthy (use TERR INH)
CONFIG MODULE ERR	Configuration module error	Config module does not match configuration. Report to maintenance (may not affect airworthiness)
LOCAL CFG CRC	CRC check invalid for unit's configuration	Internal Configuration data contains an error. May affect airworthiness
REMOTE CFG CRC	CRC check invalid for configuration module	Config Module data contains an error. Does not affect airworthiness

MAP INCOMPATIBLE	Airport database version incompatible	Airport data not usable. FLTA not airworthy (use TERR INH)
TERR INCOMPATIBLE	Terrain database version compatibility failure	Terrain data not usable. FLTA not airworthy (use TERR INH)
MAP&TERR CONFLICT	Map and terrain compatibility failure	FLTA not airworthy (use TERR INH)

ADVISORY MESSAGES		
Text Message	Description	Comment
FAN RPM	Fan Failure	May induce an overtemp warning. Report to Maintenance

13 HTAWS SYSTEM LEVEL ERROR DISPLAY

If the self-test feature detects a system error on power-up, the System Error display is shown with an indication of the cause of the error.

If the cause of the error is an erroneous CRC (Cyclic Redundancy Check) then the expected and calculated CRC is displayed.

If the cause of the error is a failed memory test, the type of memory and the address is displayed.

SYSTEM ERROR MESSAGES	
Text Message	Description
MEM_DRAM_A	DRAM memory failure

14 TROUBLESHOOTING

14.1 Nuisance Alerts

If an alert is previously determined to be erroneous, and is repetitive at a specific location, the alerting function can be inhibited through the use of TAWS INH. A perceived nuisance alert should be brought to the attention of Sandel Avionics.

14.2 Flight Data

The ST3400H has an internal recorder that automatically records a minimum of twenty hours of flight data. (Oldest data is automatically overwritten with most recent data.) This data can be used by Sandel Avionics Customer Support to analyze recent alert activity.

14.3 Gray Terrain Cells

Gray terrain cells will be drawn in cases where terrain data is unavailable. This may also be accompanied by a “TAWS FAIL” message. One example of this is when flying beyond the coverage region of the currently loaded terrain database.

15 SPECIFICATIONS

TSO Compliance	
Technical Standard Order (TSO)	C194: Helicopter Terrain Awareness and Warning System (HTAWS) C87: Airborne Low-Range Radio Altimeter C113: Airborne Multipurpose Electronic Displays C118: Traffic Alert and Collision Avoidance System (TCAS) Airborne Equipment, TCAS 1
Software Certification	RTCA/DO-178B, Level C
Programmable Logic	RTCA/DO-254, Level C
Environmental Category:	[A2F1Z]BBB[UU2]XXXXXXZZAZ[ZW][WW]M[A3G33]XXAX

Physical Dimensions	
Form Factor:	3ATI (ARINC 408)
Width:	3.175 inches
Height:	3.175 inches
Length:	9.5 inches
Weight:	2.7 lbs.

Operational Characteristics	
Temperature/Altitude:	-20° C to + 70° C up to 55,000 ft.
Power Inputs:	22 to 33 VDC 40 watts maximum
400 HZ Reference:	Max 1 ma.

16 ACRONYMS

ACK	Acknowledge
ADS-B	Automatic Dependent Surveillance - Broadcast
AHRS	Attitude/Heading Reference System
BIT	Built-In-Test
CFIT	Controlled Flight Into Terrain
CM	Configuration Module
CRC	Cyclic Redundancy Check
ECRT	Excessive Closure Rate to Terrain
EDGSD	Excessive downward Glideslope Deviation
EMS	Emergency Medical Service
ERD	Excessive Rates of Descent
FAA	Federal Aviation Administration
FITNL	Flight Into Terrain Not in Landing Configuration
FLTA	Forward Looking Terrain Avoidance
FMS	Flight Management System
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
GS	Glide Slope
HDG	Aircraft's magnetic heading
HTAWS	Helicopter Terrain Awareness Warning System
Hz	Hertz (cycles per second)

ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
KTS	Knots
MINS	Minimums
NCAT	Negative Climb after Take-off
NVIS	Night Vision
NM	Nautical Miles
POST	Power-On Self-Test
RA	Resolution Advisory
RFMS	Rotorcraft Flight Manual Supplement
RTCA	Radio Technical Commission on Aeronautics (rtca.org)
TA	Traffic Advisory
TAS	Traffic Advisory System
TFC	Traffic
TRK	Aircraft's ground track (usually magnetic)
TSO	Technical Standard Order
VMC	Visual Meteorological Conditions
USB	Universal Serial Bus

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