SANDEL®

ST3400

TAWS/RMI

with Traffic Capability

Pilot's Guide

PILOT INFORMATION

Publication Date: February, 2004

This guide provides information on the use and operation of the ST3400 Class A TAWS/RMI and the ST3400 Class B TAWS/RMI.

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.

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Sandel Avionics, Inc.
2401 Dogwood Way
Vista, CA 92081

Tel: (760) 727-4900
Fax: (760) 727-4899
www.sandel.com

REVISION NOTICE

The "Effectivity and Errata" page specifically lists the software to which this Pilot's Guide applies, corrects any errors or omissions in this revision of the Pilot's Guide, and will be reprinted at the time of any new software revisions to approve use of this manual with the revised software.

OPERATIONAL AND LEGAL ISSUES

Please keep in mind that information displayed on the ST3400 is generated by external instruments. It is the pilot's responsibility to ensure the correct configuration and utilization of these external devices. The ST3400 is subject to all legal and operational limitations of the devices supplying it data. 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 ST3400 may vary depending on the presence or absence of equipment.

APPROVALS

The ST3400 TAWS/RMI meets FAA (Federal Aviation Administration) Class A TAWS equipment standards and Class B equipment standards for GA (General Aviation) and commercial air carriers.

The ST3400 is approved by the FAA under the following TSO (Technical Standard Orders):

TAWS/GPWS Functions:
TSO-C151B: TAWS (Terrain Awareness and Warning System)

Multipurpose Displays:
TSO-C113: AMED (Airborne Multipurpose Electronic Displays)

The following certification levels also apply to this product:

Environmental Certification Level:	DO-160-D
Software Certification Level:	DO-178-B level C
Jeppesen Database:	DO-200-A

Installation of the ST3400 TAWS/RMI in a type-certificated aircraft must be performed in accordance with the Sandel Avionics ST3400 TAWS/RMI Installation Manual.

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 …"

In some cases, the text may describe a two (or more)-button action, for example, "…press and hold the [TERR] [VUE] selection buttons to …". This means that the buttons are to be pressed simultaneously.

In some cases, the text will describe a two-button sequence, for example, "…press the [TERR] >[VUE] selection buttons to …". This means that the buttons are to be pressed consecutively.

This manual uses terms, which should be familiar to aviation-minded readers, such as "selected radial" and "magnetic heading". Terms, which are specific to the ST3400, are listed in the glossary, for example "Current Display Indicator".

Revision History

Revision	Date	Comments
F	2/17/04	A/R 675 Revised for software v3.00 Illustrations revised throughout Pilot's Guide Page 9: Added traffic to description of the ST3400 Page 12: Added additional functions to Mode 5 and Mode 6 GPWS Alerts Page 15: Added text to description of Predictive Altitude Display. Page 16: Added paragraph on Traffic and TCAS. Page 23: Added TFC button to table. Page 24: Added note on traffic. Page 27: Added GS OVRD, FLAP OVRD and GPWS FAIL. Page 37: New chapter on Traffic Operations. Page 52: Added TFC OVRD. Page 55: Added TFC OVRD. Removed TERR. Page 56: Added TCAS FAIL Page 59: Removed LAMP MAINTNCE advisory message. Page 61: Removed illustration. Page 65: Added GS INH, FLAPS INH, GPWS FAIL. Removed illustration. Page 74: Added RTCA, TAS, TCAS I, and TCAS II to list.
E	07/29/03	A/R 638 Revised for software v2.02. Improved description of TAWS INH during alerts Page 25: Added note on flight plan display with Bendix/King GPS receivers. Page 26: Added new map ranges for FULL and ARC map views. Page 27: Modified section on Ground Operations Page 40: Added '(minimum 5 nm)' in second paragraph. Page 46: Modified section on Flaps Override. Page 48: Modified Invalid/Failed Equipment table. Page 52: Added new advisory messages: 'CONFIG MODULE ERR 'LOCAL CFG CRC' 'REMOTE CFG CRC' Added comments to error table
D	02/20/03	Revised for software v2.00 Added GPS altitude and OAT info. Mode 3 refs to NCAT removed. Changed description of suppression during ground OPS. Changed description of color bands TAWS INH description ground ops note
C	06/14/02	Revised for software v1.04
B	05/19/02	Revised for software v1.03
A	04/10/02	Initial release

Approvals

Prepared By: _____ Date 2-17-04
Gerald J. Block, Director of Engineering

Reviewed By: _____ Date 2-17-04
Murray Kerslake, QA

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CHAPTER 1. WELCOME TO THE ST3400 TAWS/RMI

What is the ST3400

The ST3400 is a multi-function display with a self-contained TAWS (Terrain Awareness Warning System) system. It includes a TAWS computer, graphics symbol generator and an integrated full-color screen, built within a standard 3-inch instrument chassis. It includes bearing-pointer features to directly replace an existing mechanical RMI (Radio Magnetic Indicator), and has the optional capability 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.

The ST3400 is a situational awareness tool and an alerting and warning device. It is not intended to be used for primary navigation of the aircraft. 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.

Runway Awareness, Virtual Approach Path, Safe Operating Area, and Predictive Altitude are smart and exclusive Sandel features that provide the pilot with fast access to usable information, maximizing relevant data and reducing nuisance alerts. Pilot workload in interacting with the system during normal flight is minimal. In PRED (Predictive) mode, the ST3400 can show only terrain that represents a potential threat during an emergency climb in an easily interpreted format.

The ST3400 includes a built-in caution and warning system providing annunciation and aural alerts. Provision is made for all the traditional/standard Ground Proximity Warning System (GPWS) alerts, new enhanced terrain alerts, and various advisories. All of the alerts are automatically displayed. The unit supports optional external caution and warning annunciators.

An internal recorder automatically records a minimum of the last ten 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.

The ST3400 TAWS/RMI 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.

Class A and Class B

Various ST3400 models may be installed as "Class A" systems or as "Class B" systems.

A Class A system requires airdata and radar altitude as system inputs and provides the full complement of GPWS, FLTA and PDA alerting (see following sections for a description). At the time of publication, a Class A installation requires an STC and Class A is required for certain larger classes of aircraft.

Class B installations, required for some smaller aircraft, have the same FLTA and PDA capability but are not required to have the full complement of GPWS alerts. However, some ST3400 models support enhanced Class A alerting features even when installed on a Class B basis. One advantage of Class B installations is that they may be installed as follow-on installations without an STC.

The ST3400 supports the use of GPS altitude without airdata using approved receivers; these represent the easiest installations and contain all of the system features except some GPWS alerting modes.

If both GPS altitude and airdata are available in the aircraft, then both can be supplied to the ST3400 for redundancy. GPS altitude will be used as the primary source of altitude for TAWS alerts. Airdata will be used as the primary source of altitude for GPWS alerts.

See your Airplane Flight Manual Supplement for the details of the specific installation in your aircraft. When installed as Class B, consult your flight manual supplement to determine what particular alerting modes your ST3400 does or does not support.

Class B Without Radar Altitude and/or Airdata

In this POH, there are references to radar altitude, barometric altitude and other airdata. If your aircraft is not so equipped, the ST3400 will substitute GPS altitude and Height Above Terrain Cell from its database when possible to supply the maximum alerting capability. The general descriptions of ST3400 functions will remain the same.

Alerts and Advisories

The ST3400 annunciates alerts for the following table of conditions, and provides alert messages to the airplane audio system. Optional external annunciators are also supported for these conditions. There are six traditional/standard GPWS modes. One mode is based on downward deviation from the ILS glideslope. The other five are based on altitude above the terrain directly beneath the aircraft. The altitude clearance is measured by radar altitude and/or by barometric altitude compared with the terrain height below the airplane.

There are two terrain modes that determine safe proximity to terrain based on location to a suitable airport (PDA) and the distance to and closure to the terrain based on the airplane flight path (FLTA). In common usage these two *terrain* database modes are generically called "TAWS modes" in distinction to the "GPWS modes" because they rely on the terrain database whereas the classic GPWS modes do not.

GPWS ALERTS

ERD Mode 1 (Excessive Rate of Descent)
Uses a combination of barometric altitude and radar altitude, alerts excessive barometric rate of descent when close to the ground. When radar altitude is not available, the calculated height above terrain from the terrain database is substituted.

ECRT Mode 2 (Excessive Closure Rate to Terrain)
Alerts on high rates of change of radar altitude when close to the ground. (Radar Altitude equipped aircraft only)

ALAT Mode 3 (Altitude Loss After Takeoff or Missed Approach)
Uses radar altitude and barometric altitude to detect accumulated altitude loss after take off or a missed approach. The height above takeoff altitude is used. The takeoff alert is disabled after climbing 770' above takeoff elevation; the go-around alert is disabled when reaching 1000' radar altitude (radar altitude equipped aircraft only).

FITNL Mode 4 (Flight Into Terrain Not in Landing Configuration)
Uses radar altitude to detect too low an altitude without gear and/or flaps in landing configuration. (Radar Altitude equipped aircraft only)

EDGSD Mode 5 (Excessive Downward Glideslope Deviation)
When in landing configuration, provides an alert in the event of an excessive downward deviation from an ILS Glideslope when

below 950' radar altitude. In a Class B installation without radar altitude, the calculated height above terrain from the terrain database is substituted. Note: In your installations, Mode 5 may automatically inhibited when flying a back course approach through interconnection to the HSI or Flight Control System.

VC Mode 6 (Altitude Callout). Provides a voice callout "Five Hundred" when the aircraft descends through 500 feet radar altitude with the gear down. In a Class B installation without radar altimeter, this callout will occur 500 feet above the runway elevation using aircraft altitude compared to the nearest runway touchdown zone elevation.

Mode 6 Enhanced: On Radar Altitude equipped aircraft, additional voice callouts at 400, 300, 200, 100, 50, 40, 30, 20, and 10 feet of radar altitude may be enabled during installation. Please refer to the AFMS for details on the specific installation in your aircraft. (Radar Altitude equipped aircraft only)

On equipped aircraft, a voice callout of "Minimums, Minimums' can be provided triggered by an external decision-height setter. Please refer to the AFMS for details on the specific installation in your aircraft.
Note: The "Minimums" callout is inhibited for 40 seconds after power-up, and will only occur when the aircraft is airborne.

TAWS ALERTS

FLTA (Forward Looking Terrain Avoidance)
Looks ahead of the aircraft along the lateral and vertical flight path against the terrain database to provide an alert if a potential terrain threat exists.

PDA (Premature Decent Alert)
Uses the vertical and lateral position of the aircraft compared to the proximity of the nearest airport to determine if the aircraft is abnormally below a reasonable altitude.

CHAPTER 2. ST3400 SMART FEATURES

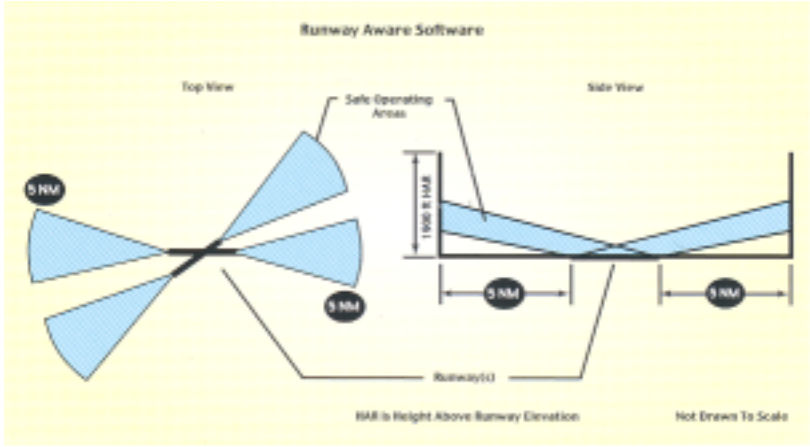
One characteristic of terrain displays is that they become more cluttered as the aircraft approaches the ground, even during a normal approach. This characteristic – more and more detail with more and more colors – may have the unwanted effect of producing less and less information.

The concept of the ST3400 is "don't show everything all the time". Instead, during normal conditions, the ST3400 allows the pilot to select different views of the same terrain information specifically tailored to the pilot's needs and appropriate to emergency conditions. This concept is a very direct way to reduce information overload during normal flight or emergencies and assist the pilot in making the right choices.

Runway Awareness

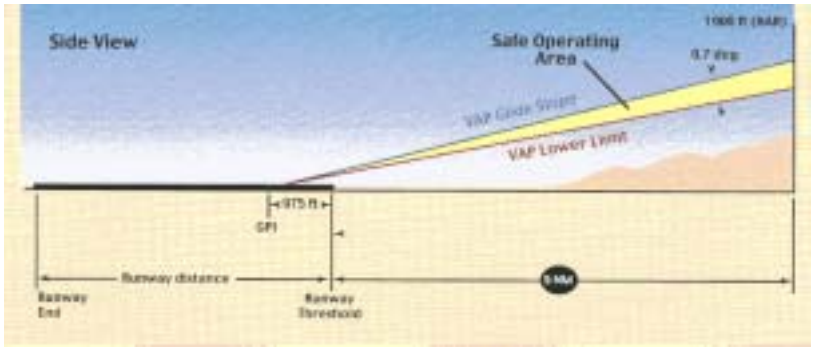
The conventional way to implement Terrain Warning is to use ever rising concentric circles around the ARP (Airport Reference Point) and use these to inhibit terrain alerts. The goal is to reduce nuisance alerts when maneuvering or landing at airports.

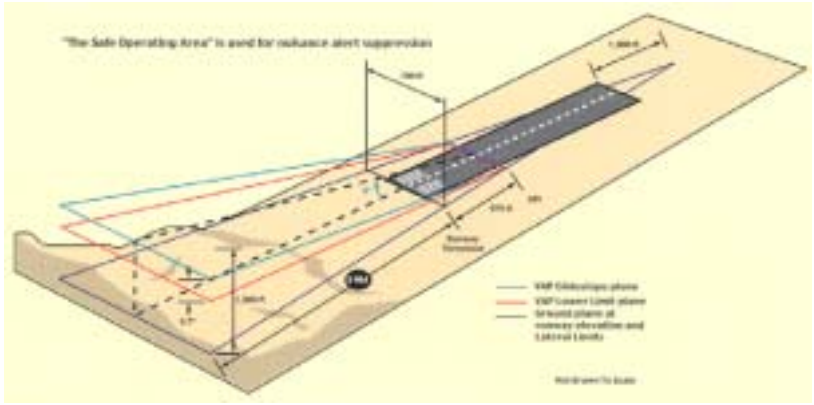
Instead, the ST3400 recognizes each and every runway and tracks the aircraft's approach and landing to the touchdown zone. The ST3400 internal database contains the safe approach path – based on TERPS terrain clearances – to every charted runway, whether it has an instrument approach or not.



Virtual Approach Path | and Safe Operating Area |

The ST3400 uses a VAP (Virtual Approach Path) to produce, internally, a SOA (Safe Operating Area) within which the aircraft will normally fly on approach to the runway. In this way the ST3400 can be actively scanning terrain outside the normal approach path while minimizing false alerts inside the approach path.





Predictive Altitude | Display

The ST3400 implements a new display mode called PRED (Predictive Altitude). It is especially useful in climbs where you want to know what terrain you are actually out-climbing in the current aircraft configuration – and what terrain you are not out-climbing. PRED displays the terrain clearances in relation to the angle of the flight path of the aircraft. In effect, you see what your terrain clearance will be *in the future* instead of the present. This feature can be extremely beneficial in emergency climbs in the vicinity of terrain.

During descents, the predictive altitude display has the benefit of showing, well ahead of time, what terrain you are descending into. This may be valuable when descending into a terminal area prior to landing or at any time during a descent.

Topographic Display

The ST3400 also supports a TOPO (Topographic) view of terrain, in sectional-chart colors. This display is useful to show the terrain situation when at enroute altitudes when the other displays show no information. It can also be a useful clue to turbulence encounters at altitude if the pilot is aware of the wind direction.

Flight Plans

The ST3400 overlays the GPS/FMS flight plan over any terrain view, if a flight plan has previously been entered into the GPS/FMS. The flight plan overlay is for position awareness only and the information in the flight plan is not used in the logic to control alerts or other functions. Because this information is not used for this purpose, the ST3400 logic works equally well during on-flight plan or off-flight plan operations without pilot intervention. The flight plan is not shown when displaying the RMI or the TFC screens.

In installations where the #1 GPS/FMS does not supply flight plan data to the display, the flight plan from the #2 GPS/FMS will automatically be displayed. Please refer to the AFMS for details on the specific installation in your aircraft.

Airports and Runways

The ST3400 shows airports 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. The presence of an airport and/or runway on the display can be used to verify that the airport is contained in the ST3400 database.

Cold Weather Operation

Colder than standard air temperature can cause barometric altimeters to indicate a higher altitude than actual. For installations using corrected barometric altitude (altitude from the altimeter) the ST3400 must be connected to an outside air temperature (OAT) probe to correct the barometric altimeter reading to ensure correct terrain alerts. In installations that use an air data computer to provide altitude information, the ST3400 will add a correction factor to the supplied altitude when the outside air temperature is greater than 20°C below standard temperature. The message "OAT BELOW STANDARD" will be displayed on the ST3400 when correction factors are being applied. Please refer to the AIM for more information on altimeter errors caused by cold weather.

Traffic and TCAS

The ST3400 can display nearby transponder equipped aircraft when interfaced with compatible TAS or TCAS processors. Standard TCAS symbology is used to display the relative location and altitude of traffic. The traffic information can be displayed overlaid on terrain or a dedicated TFC display mode (without terrain) can be viewed. As a display, the ST3400 will operate in accordance with the Pilots Operating Handbook of the installed Traffic Processor as a primary traffic display.

CHAPTER 3. TAWS FUNCTIONAL REQUIREMENTS

The ST3400 can be configured either as a Class A TAWS system or as a Class B TAWS system. An aircraft with radar altimeter may be certified as Class A or as Class B.

Note: It may be easier and less expensive, given the same equipment, to certify an aircraft for Class B. The aircraft may be later promoted to Class A with additional inspections and paperwork and ST3400 upgrade.

CLASS A TAWS FUNCTIONAL REQUIREMENTS	
Mode	**Function**
FLTA	Forward Looking Terrain Avoidance
PDA	Premature Descent Alert
GPWS Mode 1	Excessive Rate of Descent
GPWS Mode 2	Excessive Closure Rate to Terrain
GPWS Mode 3	Altitude Loss After Takeoff or missed approach
GPWS Mode 4	Flight Into Terrain Not in Landing Configuration
GPWS Mode 5	Excessive Downward Deviation from Glide Slope
GPWS Mode 6	Voice callout "Five Hundred" when the aircraft descends through 500 feet radar altitude
Class A TAWS requires a display, which shows the aircraft in relation to the terrain. Satisfied by the ST3400 dedicated display. Class A TAWS requires a radar altimeter and barometric vertical speed and pressure altitude for GPWS functions.	

CLASS B TAWS FUNCTIONAL REQUIREMENTS	
Mode	**Function**
FLTA	Forward Looking Terrain Avoidance
PDA	Premature Descent Alert
GPWS Mode 1	Excessive Rate of Descent
GPWS Mode 3	Altitude Loss After Takeoff
GPWS Mode 6	Voice callout “Five Hundred” when the aircraft descends to 500 feet above the nearest runway elevation
When configured as a Class B TAWS system, the ST3400 exceeds the FAA Class B TAWS requirements. Even in Class B mode without radar altimeter, the ST3400 includes Class A features such as a terrain display and an excessive glide slope deviation alert, when so installed and configured.	

TAWS Required Equipment

The ST3400 uses the following equipment to meet TAWS Class A and Class B requirements.

ST3400 TAWS EQUIPMENT REQUIREMENTS		
Equipment	**Class A**	**Class B**
Terrain Display	Integrated	Integrated
Radar Altimeter	Required	Optional
GPS or FMS System	Required	Required
Heading System	Required	Required
Audio Panel	Required	Required
Air Data Computer	Required	Required if GPS altitude is not available
Remote Annunciators	Optional in single pilot aircraft: required in two-crew aircraft	Optional
Flap Position	Required	Required only if fixed-gear or installed with radar altimeter
Gear Position	Required	Recommended
ILS Receiver	Required	Recommended
NAV	Optional (for RMI)	Optional (for RMI)
ADF	Optional (for RMI)	Optional (for RMI)

What aircraft are required to install TAWS equipment

The FAA has mandated that all U.S. registered turbine powered aircraft that have six or more passenger seats be equipped with a TAWS no later than March 29, 2005.

Depending on the number of seats and the type of operation, the TAWS requirement will be for a Class A system or a Class B system.

FAA TAWS REQUIREMENT BY TYPE OF OPERATION		
Class	**Type of Operation**	**Number of Passenger Seats**
Class A	FAR Part 121	ALL
Class A	FAR Part 135	10 or more
Class B	FAR Part 135	6-9
Class B	FAR Part 91	6 or more

Why are there two different classes of TAWS

The Class B TAWS system was intended to allow smaller aircraft to meet the TAWS minimum safety requirements at a lower cost, by eliminating the requirements for a terrain display, radar altimeter, and airdata.

An ST3400 Class B TAWS system exceeds FAA Class B TAWS requirements. Some ST3400 Class B models may include all Class A features when so installed.

The ST3400 RMI Function

The ST3400 RMI function is provided to allow the ST3400 function as the primary RMI by replacing an existing installed electromechanical RMI. The Sandel RMI displays aircraft heading information on a calibrated compass card read against a fixed lubber line.

Bearing is provided to both a primary pointer and a secondary pointer, each of which is read against the compass card.

Each pointer may be switched independently to any installed navigation source, which may be a VOR, ADF, or the GPS/FMS waypoint. The ability to assign the GPS/FMS to a bearing pointer is unique to the ST3400 RMI.

If the navigation source has an invalid state available, the associated bearing pointer will be removed completely from the display instead of being parked at 90° as is common in mechanical RMIs.

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CHAPTER 4. SYSTEM OVERVIEW

How does it work

In addition to the six GPWS alerts, the ST3400 provides predictive "look ahead" warnings by comparing its internal terrain and obstacle database to position information provided by the GPS or FMS navigator.

The internal terrain and obstacle database provides the basis to look ahead of the aircraft and detect terrain or obstacle conflicts. This is accomplished based on aircraft position, phase of flight, flight path angle, track, and speed relative to the terrain database image forward of the aircraft.

Through sophisticated look-ahead algorithms, alerts are generated if terrain or an obstacle conflict with the flight path angle of the aircraft. This potential conflict area projects forward and to the side of the aircraft. During enroute operations, a caution typically occurs approximately 60 seconds ahead of the terrain conflict. A caution will turn into a warning if evasive action is not taken. During other operations the alert times are shorter but cautions are always designed to occur prior to warnings. A warning does not indicate a higher severity of threat, but simply that less time exists for evasive action.

Topographic (TOPO) and Predictive Altitude (PRED) features provide the pilot with fast access to new types of useful information maximizing the pilot's understanding of the relationship between the aircraft and the ground in different flight situations. An image of the surrounding terrain is represented in various colors. Terrain (inclusive of obstacles) forward, behind and to the side of the aircraft is displayed.

Understanding Alerts, Warnings and Cautions

If any terrain alert occurs, the TAWS 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 screen is automatically selected at an appropriate range to put the alerting terrain on-screen. This action occurs on any alert, including GPWS. If the pilot has previously selected TAWS INH, GPWS alerts are still enabled but no terrain will be shown.

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

Pilot reactions to alerts and warnings differ according to weather conditions, visibility, type 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 ST3400 is not the pilot or 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. Please see the section on Cautions and Warnings.

Note: If the ST3400 is interfaced to TCAS, the TCAS processor itself generates the alerts and these are only displayed on the ST3400.

Coverage area of the database

The internal database of the ST3400 includes terrain, charted man-made obstacles, and airports with runways greater than 2500 feet in length. Obstacles are not shown discretely, but are included in the terrain cell height. This means, for instance, that flat terrain with a charted broadcast antenna may show the terrain cell containing the antenna as yellow when all the surrounding terrain shows as green.

The terrain and airport database coverage is provided by geographical area. Coverage is currently limited to those areas between 70ºN and 70ºS 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.

Database updates

Updates to the coverage area database can be obtained on CD-ROM or downloaded from the Sandel web site. They are used in conjunction with a Sandel Data Loader program that runs on a laptop computer. The terrain data is downloaded from the PC into the ST3400 through a USB port located on the front right corner of the ST3400.

The coverage area database can be updated during normal maintenance to the aircraft.

Note: The Sandel Data Loader program is compatible with Windows 98, 2000 and XP operating systems.

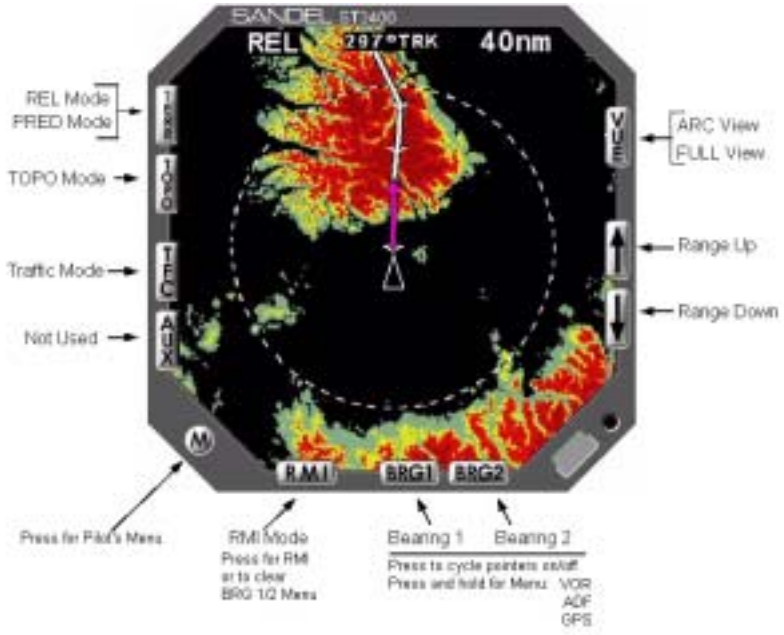
CHAPTER 5. OPERATIONAL OVERVIEW

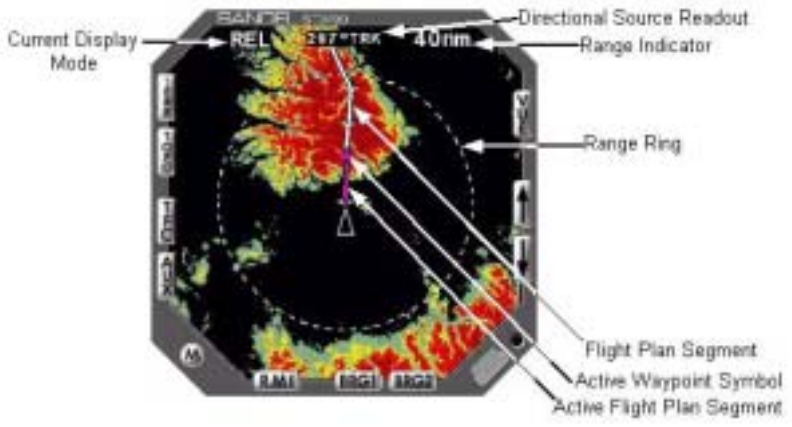
During normal flight, terrain information and the active flight plan from the GPS/FMS are presented on a full-color display.

Use [TOPO] or [TERR] Display Selection buttons to select the display that is appropriate for current flight operations.

Use the Range Up/Down buttons to increase or decrease the range.

Use the view button to select a 360° FULL view or a 70° ARC view. The distance to display ratio is maintained when toggling between FULL and ARC.





DISPLAY SELECTION BUTTONS		
Button	**View**	**Description**
TERR	RELative Altitude	Color coded above/below aircraft current altitude; flight plan displayed. This selection pops-up from any other selection in the event of a terrain alert.
	PREDictive Altitude	Color coded above/below aircraft flight path angle (predicted altitude)
TOPO	TOPOgraphic	Topographic view of the terrain without regard to aircraft altitude; flight plan displayed.
TFC	Traffic	Traffic is displayed. No terrain or flight plan is displayed.
RMI	RMI	Compass rose is displayed, no terrain or flight plan is displayed
VUE	FULL	360-degree view
	ARC	70-degree view (not available for TFC)
		Size of terrain cells is maintained when toggling between FULL view and ARC

♣#		Press to increase the range in REL, PRED, TOPO or TFC view
♦#		Press to decrease the range in REL, PRED, TOPO or TFCview
M	MENU	Press to display the Pilot's Menu

Current Display Mode

This indication in the upper left corner identifies the current display mode: PRED, REL, TOPO, TFC, or RMI. Flashes for 5 seconds whenever it changes to REL or PRED mode.

Flight Plan

Each flight plan segment of the GPS/FMS flight plan consists of a line between consecutive waypoints. The active flight plan segment is colored magenta and the rest of the flight plan is colored white. When the RMI bearing pointer is selected to GPS, the bearing pointer will be point to the direction of the next waypoint on the magenta segment.

Note: When Bendix/King GPS receivers are in OBS mode, no course line will be shown on the ST3400 display.

Lubber Line and Directional Source Readout

The lubber line is the direction reference for the compass card in RMI mode. It is shown as an inverted solid triangle stationary at the top of the display; the compass rose/arc rotates when the aircraft's track changes

The directional source (HDG/TRK) for all modes is shown within a box at the top of the display and flashes for 5 seconds whenever it should change between heading and track. Terrain views are based on TRK (where you are going) and RMI is based on HDG (where you are pointed).

Note: Traffic is <u>always</u> referenced to the nose of the aircraft, even when terrain data is referenced to TRK.

DIRECTIONAL SOURCE READOUT	
Display Indicator	**Description**
TRK	Aircraft's magnetic track. When TRK is not available, as when stationary on the ramp, changes to HDG.
HDG	Aircraft's magnetic heading. Displayed when aircraft's track is not available or in RMI mode.
NO DIR	Displayed when both aircraft track and aircraft heading are not available or invalid.

DIRECTIONAL SOURCE READOUT AND DISPLAY ORIENTATION			
Input Data		**Readout**	**Display Orientation**
TRK	**HDG**		
No	No	NO DIR	No Display
Yes	No	TRK	Trk, unsmoothed
Yes	Yes	TRK	Trk, smoothed
TRK = Magnetic ground track HDG = Magnetic heading			

Range Ring

The Range Ring displays the current terrain or TFC range in NM (Nautical Miles). The Range Ring is a full circle in the FULL view mode and a 70° arc in the ARC view mode. Switching between FULL and ARC view maintains the terrain cells the same size during range changes. Range is not displayed in the RMI display mode.

Press the [♣] button to increase the current range.

Press the [♦] button to decrease the current range.

RANGE RING	
View	**Ranges (Terrain)**
FULL	1, 1.5, 2.5, 5, 10, 20, 40
ARC	2, 3, 5, 10, 20, 40, 80 (not available for TFC)

The TFC display maintains its own range memory. Thus when switching between terrain and TFC, two different ranges may be pre-selected. The maximum range for TFC is dictated by the type of equipment installed; it may be less than 40 miles. ARC mode is not available on the TFC screen.

Display During Alerts

Unless TAWS INH has been selected, if an alert occurs the REL terrain view is displayed in ARC view at an appropriate range to put the terrain conflict on the screen.

If TAWS INH has been previously selected, classic GPWS alerts are still enabled but terrain is not shown and is replaced by a yellow 'X' in the REL and PRED display modes.

External Switch/Annunciators

External Switch/Annunciators may be installed, if required or desired.

The supported external annunciators are CAUT, WARN and GPWS FAIL. The support external switch/annunciators are TAWS INH, GS OVRD and FLAP OVRD.

CAUT illuminates simultaneously whenever an amber caution is present on the ST3400 display.

WARN illuminates simultaneously whenever a red warning is present on the ST3400 display.

GPWS FAIL illuminates whenever the GPWS FAIL indication is shown on the ST3400 display.

TAWS INH illuminates whenever TAWS INH is shown on the ST3400 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. (Expect this condition on initial power-up while the terrain database is being initialized.)

GS OVRD illuminates whenever GS OVRD is shown on the ST3400 display.

FLAP OVRD illuminates whenever FLAP OVRD is shown on the ST3400 display.

Pressing *external* TAWS INH, GS OVRD, or FLAP OVRD has the same function as the Pilot's Menu TAWS INH, GS OVRD, or FLAP OVRD, respectively.

Note: External annunciators for CAUT and WARN are only required for a two pilot aircraft equipped with a single ST3400. Please refer to the AFMS for details on the specific installation in your aircraft.

Terrain Display During Ground Operations

When connected to Bendix/King and Universal GPS/FMS receivers, the ST3400 will not display terrain data until the aircraft starts taxiing. This prevents the display from showing terrain data when these receivers are in self-test mode, which is not indicated in the receiver data stream.

CHAPTER 6. TERR SELECTION BUTTON

The TERRain button toggles the display between RELative altitude mode, which color-codes terrain above and below the current aircraft altitude, and PREDictive altitude mode, which color-codes based on the aircraft's future altitude.

Press the [TERR] button to display the REL view of terrain.

Press again to display the PRED view of terrain.

When in REL or PRED view, the [VUE] button to toggles the display between FULL view and ARC view.

Bearing pointer indications may be overlaid on the terrain display with the BRG1 or BRG2 buttons.

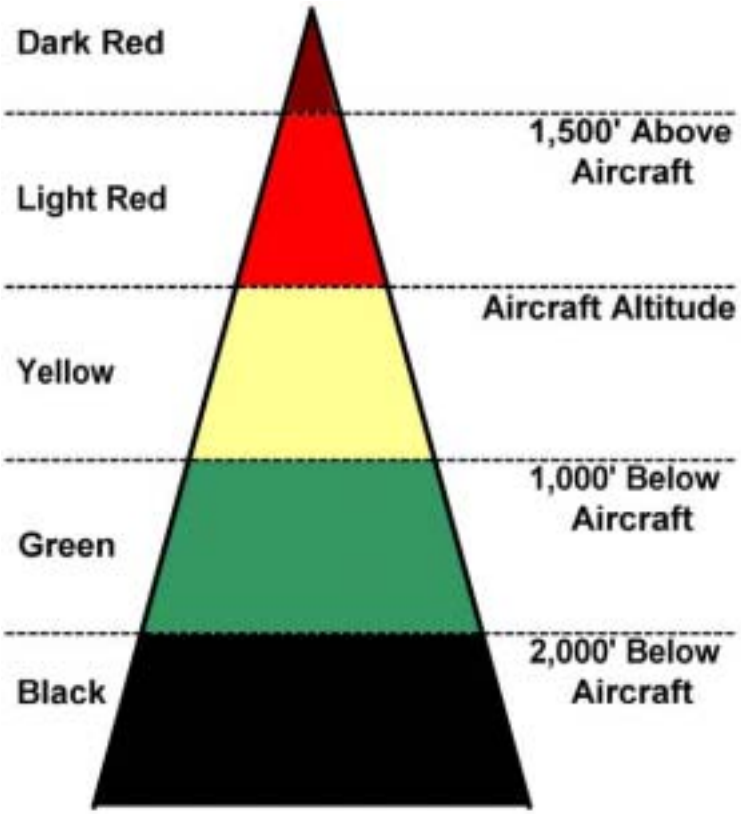
Color Zones for RELative and PREDicted Altitude Displays

On the RELative and PREDicted altitude displays, terrain that is farthest below the aircraft altitude is shown in black. Terrain closer to the aircraft altitude is shown in green. Terrain even closer to the aircraft altitude is shown in yellow. Terrain above the aircraft altitude is shown in light red. Terrain way above the aircraft altitude is shown in dark red.

On an approach to the airport, the color bands become compressed; in effect the yellow/green bands shrink as the aircraft gets closer to the runway. Within 1nm of the airport (during flight) and when on the ground, green and yellow are suppressed. Red is used to depict terrain above the aircraft.

During enroute flight (not on approach to a runway or airport) the nominal color coding is:

Dark Red:	Greater than 1500' **above** the aircraft
Light Red:	Within 100' of the aircraft to 1500' **above** the aircraft
Yellow:	Between 1000' and 100' separation below the aircraft
Green:	Between 2000' and 1000' separation below the aircraft
Black:	Greater than 2000' separation below the aircraft

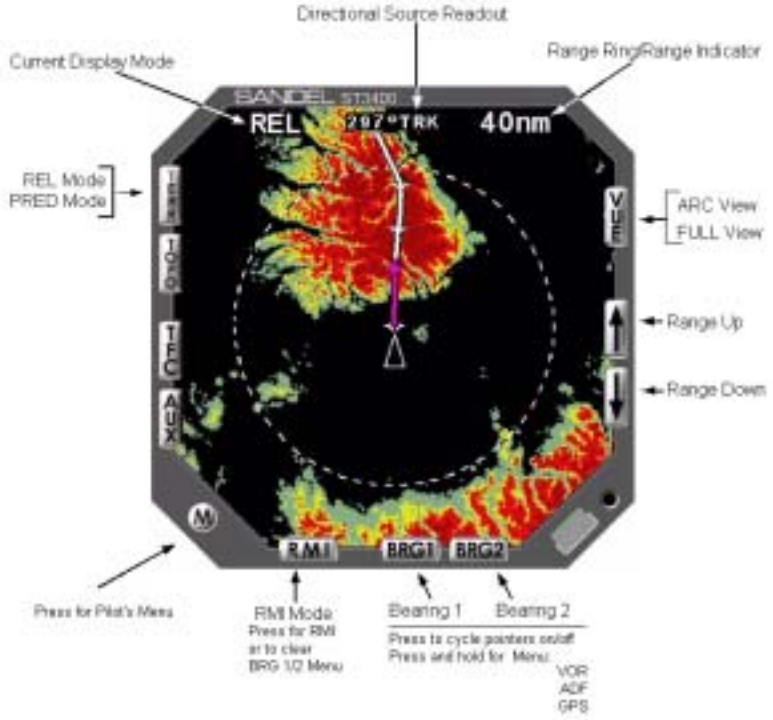


REL (Relative Altitude) Display

The REL (Relative Altitude) display mode shows the terrain above and below the aircraft's current altitude, regardless of climb or descent rates. It is most useful to answer the question of what is "above" and what is "below"; and also, what is "somewhat" below.

During an alert this display will be automatically selected and shown in ARC view unless the pilot has previously selected TAWS INH.

The display mode may be overridden by the pilot after the automatic switching occurs.

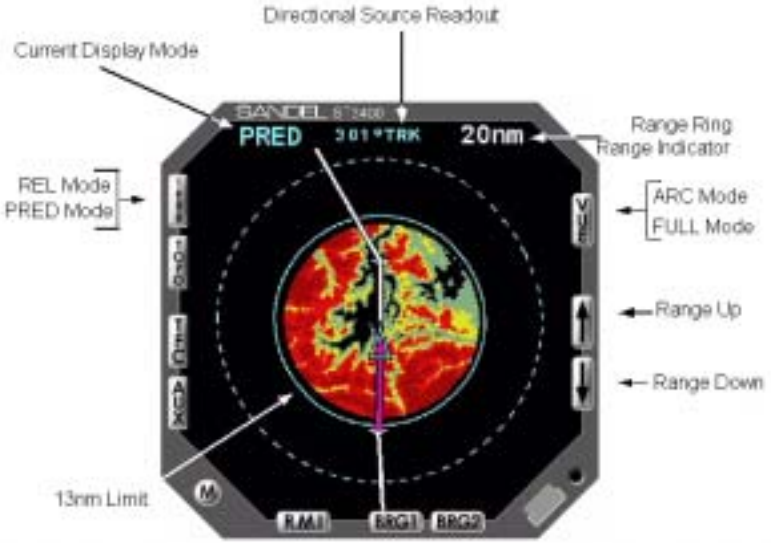


PRED (Predictive Altitude) Display

The Predictive Altitude Display Area is a circular conic up to 13 nm in radius within which the future altitude of the aircraft (based on current conditions) is compared to the terrain heights and then color coded. In FULL display mode, the terrain behind the aircraft will be shown as if the airplane were to have turned in that direction at the current climb or descent profile.

The 13nm limit is shown by a solid cyan circle. No terrain at all will show beyond this 13nm limit in PRED display mode.

PRED is useful when used in climbs and descents by visually presenting the terrain situation farther into the future than FLTA alert itself. This provides the pilot a means to avoid alerts before they occur. In a climb, PRED will clearly show the terrain the aircraft is out-climbing in its current configuration. This feature can give useful information during an engine-failure scenario in a terrain-rich environment. The pilot should be aware that PRED shows this information in regard to the current climb rate. Therefore if the aircraft climb rate is degrading the display will show a more optimistic view than it will show once the steady-state climb rate is finally achieved.



In PRED mode a red cell will always produce an FLTA alert when close enough to and on the aircraft's flight path. A yellow cell *may* produce an alert if it meets the alerting criteria; the alerting criteria are lower than the color coding criteria by a few hundred feet. For this reason not every cell colored "yellow" will produce an alert. A green or black cell will never cause an alert.

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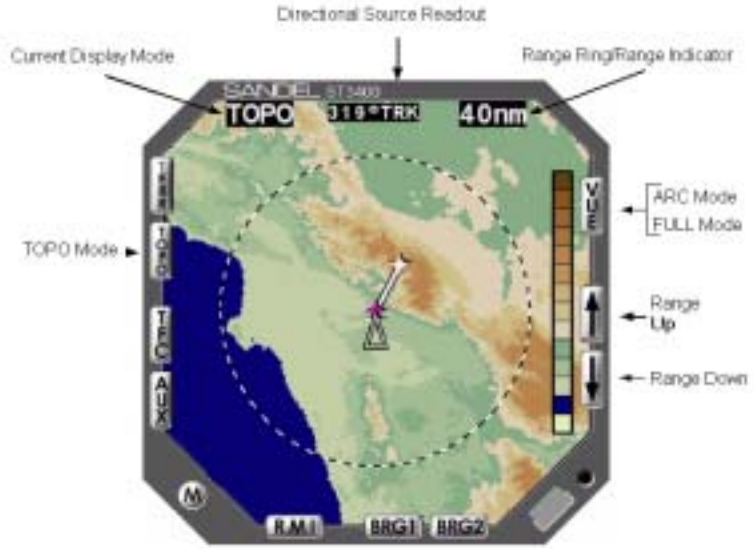
CHAPTER 7. TOPO SELECTION BUTTON

The [TOPO] selection button is used to display a topographical view of the terrain in sectional chart colors. A color scale guide is provided on the right side of the display as a helpful on-screen guide to relative color coding.

Ocean is shown as a special blue color. Other water topology is not shown uniquely in blue; it is shown only by its elevation using the normal color coding.

A flight plan is always displayed if received from GPS/FMS and the bearing pointers will display if selected using the BRG1 or BRG2 buttons.

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 as long as the pilot has not previously selected TAWS INH.



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CHAPTER 8. TRAFFIC SELECTION BUTTON

The [TFC] selection button is used to display traffic data from nearby transponder equipped aircraft when the ST3400 is interfaced with a compatible TAS or TCAS processor. Please refer to the Pilot's Guide for the specific traffic system installed in the aircraft for a complete description of the capabilities.

Traffic Symbology

The ST3400 uses standard RTCA symbology to represent traffic.

	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
	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.
	No Bearing / No Altitude Traffic Advisory	TA with no bearing and no altitude information available.
	No Bearing Traffic Advisory	TA with no bearing information available.

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

-02 ↑	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.
+05 ↓	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.

Standard Traffic Display

The traffic display mode is accessed by pressing the [TFC] button. If there is a Traffic Advisory alert and the aircraft is not on the ground, then the traffic display mode will be automatically selected.

Note: The traffic alert and its audio is provided by the TAS or TCAS system, not the ST3400.

Current Display Mode

The current display mode will indicate TFC while in the traffic display mode.

TCAS Status

The status of the TCAS system will be shown underneath the Current Display Mode:

TA/RA	Both Traffic Advisories and Resolution Advisories from a TCAS II system are available (Future implementation)
TA ONLY	Only Traffic Advisories are available
TCAS TEST	TCAS is currently in Test mode
TCAS OFF TCAS STBY	TCAS is currently in Standby mode
TCAS FAIL	TCAS data communication is not present
TD FAIL	Traffic data has not been updated for two seconds or more

Altitude Display Mode

The currently selected altitude display mode will be displayed underneath the TCAS Status indicator.

NML	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 NML is not annunciated (blank) when operating in normal altitude display mode. Please refer to the AFMS for details on the specific installation in your aircraft.

Altitude Mode Select

With some TCAS equipment without a remote control panel, the ST3400 VUE button is used to toggle the altitude display modes. The currently selected altitude mode will be shown next to the VUE button. Please refer to the AFMS for details on the specific installation in your aircraft.

Absolute Altitude

The current absolute altitude to the nearest 100 feet from the TCAS processor is displayed during Test mode. Some TCAS equipment also has the capability to show absolute altitudes in-flight by pressing a button on the TCAS control panel. The altitude will be tagged MSL if the data is in barometric altitude; otherwise (or above 18000 feet) pressure altitude is shown and tagged FL.

Range Ring/Range Indicator

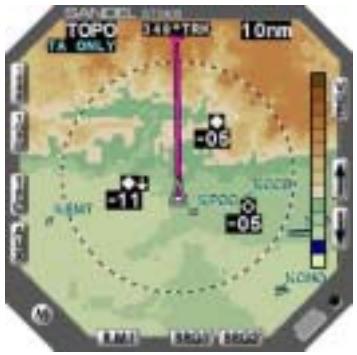
The Range Ring is a full circle in TFC mode. The available ranges are TCAS processor dependent, and are typically 3, 5, 10, 20 and 40nm.

Note: The o'clock position tic marks from the inner range ring are repeated on the outer range ring for reference.

Inner 2nm Range Ring

The 2nm range is shown as a dotted range ring and is always displayed regardless of the range setting of the Outer Range Ring. The 12, 3, 6, and 9 o'clock positions are bolded.

Traffic Overlay with Terrain

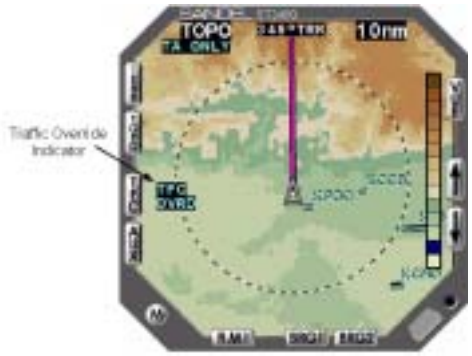


Traffic will be overlaid on terrain when in REL, PRED, and TOPO display modes. The same symbology is used as when the TFC display mode is chosen. *Traffic is always shown relative to the nose of the aircraft – where you would see it if you looked out the window.*

Traffic Override

To suppress the traffic overlay on top of Terrain, the Traffic Override function can be toggled on/off by pressing and holding the [TFC] button for a one second. This function is also available through the Pilot's Menu. Traffic Override will be annunciated next to the [TFC] button as shown below. All traffic will be removed from the Terrain displays.

Note: Traffic Override suppresses display but does not suppress traffic alerts. If there is a TA alert the display will automatically switch to the TFC display mode.

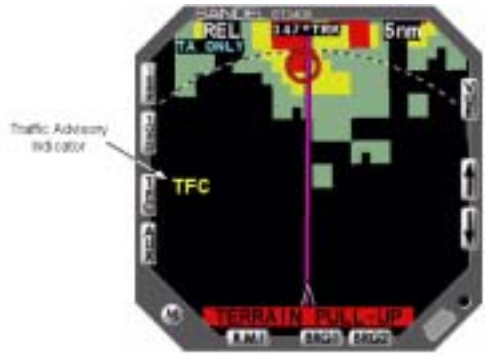


Traffic Advisory Indicator

When a TA is present, the TFC display is automatically popped-up. The pilot can return to any other display mode by pressing the appropriate button such as TOPO. The continued presence of the TA is indicated by a TFC label next to the TFC button on the selected display. This label will change to 'TFC OFSCRN' if the traffic is outside the selected map range. In the example shown below, the TFC alert is on-screen.

GPWS/TAWS Alerts and Traffic

In the case of simultaneous GPWS/TAWS and TCAS alerts, precedence is given to the GPWS/TAWS alerts. The display will not switch to TFC mode during a GPWS/TAWS alert. Traffic symbols are removed from the display although the Traffic Advisory Indicator will be shown if a TA is simultaneously present.



CHAPTER 9. RMI SELECTION BUTTON

In the RMI mode, the compass rose is displayed in a 360° full view with aircraft symbol at the center. The RMI is always displayed HDG-up, which differs from the terrain views which are TRK-up. As a reminder to this change in directional reference "HDG" will flash whenever it changes from TRK to HDG or vice-versa.

No terrain or flight plan is displayed in RMI mode.

Compass Rose

The RMI display shows a traditional 360 degree compass rose. A symbol in the center represents the aircraft's current position. The compass card display rotates in relation to changes in the heading.

Bearing Pointers

The RMI display can show two independent bearing pointers - primary and secondary. Each pointer is fed from an individually selected navigation receiver source.

The primary pointer is displayed as a single needle. The secondary pointer is displayed as a double needle. The head of each bearing pointer indicates the bearing **to** the navigation source and the tail of each pointer indicates the bearing **from** the navigation source.

BRG Pointer No 1. The single needle pointer displays bearing to the current selected navigation source. Press [BRG 1] to turn BRG1 on/off. HOLD [BRG 1] to activate the selection menu. Bearing source selection includes all installed navigation receivers. To exit the menu, press [MENU OFF] softkey.

BRG Pointer No 2. The double needle pointer displays bearing to the current selected navigation source. Press [BRG 2] to turn BRG2 on/off. HOLD [BRG 2] to activate the selection menu. Bearing source selection includes all installed navigation receivers. To exit the menu, press [MENU OFF] softkey.

The color of each bearing pointer, and its associated numeric display, provide the following color-coding when on-side:

ADF: Magenta
GPS: Cyan
VOR: Green

The color of each bearing pointer, and its associated numeric display, is *yellow* for any cross-side source.

The digital numeric bearing to the navigation source of the bearing pointer is displayed at the bottom of the screen. When the data is invalid "---" is displayed and the associated bearing pointer is removed from the screen. The selected bearing pointer name is displayed above the numeric bearing display.

Note. Certain ADF receivers may not supply an "invalid" signal. In these cases, the receiver will "park" the needle, usually 90∀to the right of the lubber line, when no signal is being received. See the Pilot's Guide for your navigation receiver to determine its capability during "No-signal" operation.

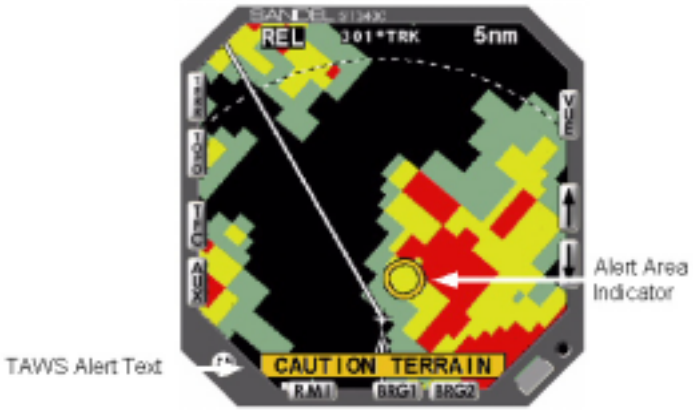
CHAPTER 10. TERRAIN ALERTS

The FLTA Alert Area is an internal computation that covers an area mostly in front of and somewhat to the side of the aircraft.

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

Range and altitude of the aircraft are computed along the projected flight path at one-second intervals. The projected range 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. Within the Alert Area the aircraft's projected flight path and each terrain cell's elevation are compared to check for terrain threats. This area of potential conflict projects forward and to the sides of the aircraft. In turning flight, the covered alert area grows in the direction of the turn.

During enroute operations, a caution typically occurs approximately 60 seconds ahead of the terrain conflict. A caution will turn into a warning if evasive action is not taken. An audible and visual alert will be produced at the closest cell in which a threat is detected.



An AMBER annunciator indicates CAUTION

Cautions are always designed to occur prior to warnings during steady-state flight. There are exceptions such as during turning flights into terrain or when there are significant changes in vertical speed when close to terrain. Under these conditions a Warning may be received without a Caution.

When an alert first occurs, REL is automatically displayed, in ARC view, at an appropriate range (minimum of 5 nm) to put the terrain conflict on the screen as long as the pilot has not previously selected TAWS INH. After the alert occurs the pilot may select other display modes (such as PRED) and/or other ranges.

The terrain display always 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 ST3400 *but only the closest one will be circled*. There may be other areas of conflict!

In the illustration below notice that the alert is on a green cell. This is occurring because the aircraft is descending yet the cell is still well below the aircraft's current altitude. In REL display any color cell may produce an alert. In the PRED display only YEL or RED cells may produce alerts.

A RED annunciator indicates a WARNING

Responding to an Alert

Every alert should be considered valid and requires appropriate action.

An AMBER annunciator indicates CAUTION and requires immediate pilot attention.

A RED annunciator indicates a WARNING and requires immediate aggressive pilot action.

Pilot reactions to alerts and warnings differ according to weather conditions, visibility, type 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

Pilots should train to react properly to all alerts, cautions and warnings, just as one would train to react to an aircraft stall, engine failure or any other emergency situation.

RESPONDING TO AN ALERT		
Text / Alert	**Source**	**Pilot Action**
Caution Terrain (FLTA caution)	FLTA	If level, apply power, establish a climb attitude, and climb out of the alert. Check position on terrain display. If descending, apply power and level off. If caution continues, apply power and establish a climb attitude.
Don't Sink (GPWS caution)	ALAT	Immediately level wings, apply full power, and establish a climb attitude.
Five Hundred	Callout	500' AGL or above runway
Glide Slope (GPWS caution)	EDGSD	Arrest descent rate and rejoin the glide slope.
Pull Up (GPWS warning)	ERD ECRTNL ECRTL	Disengage autopilot/immediately level wings. Apply full power, establish a climb attitude. Continue maneuver until alert ceases or terrain clearance is assured.
Sink Rate (GPWS caution)	ERD	Arrest sink rate and fly out of the alert area

Terrain Pull Up (FLTA warning)	FLTA	Disengage autopilot/immediately level wings. Apply full power, establish a climb attitude. Continue maneuver until alert ceases or terrain clearance is assured.
Terrain, Terrain (GPWS warning)	ECRTNL ECRTL	Apply power, level wings, and establish a climb attitude.
Too Low Flaps (GPWS caution)	FITNLB	Select landing flaps
Too Low Gear (GPWS caution)	FITNLA	If conditions permit, extend the landing gear. Otherwise, execute go around.
Too Low Terrain (caution)	FITNLC PDA	Immediately arrest sink rate and fly out of the alert area

Alert Circle

The Alert Area Indicator circle shows the location of the current alert for FLTA alerts. No circle is shown for GPWS or PDA alerts. Do not assume the terrain threat is in the exact center of the circle. Also, remember the circle only represents the *closest* threat. Other real or potential threats may exist but *will not* be circled.

Since the exact location of the aircraft and the exact location of the terrain is subject to uncertainties and tolerances, the terrain threat may be *anywhere* inside the circle.

The visual alert annunciation is displayed at the bottom of the screen and a simultaneous non-mutable audible alert will occur on the cockpit audio system.

Warnings are shown in red, and Cautions are shown in amber. If external annunciators are installed, they will display simultaneously with the on-screen annunciations.

TAWS Inhibit

FLTA and PDA alerting, can be inhibited using the Pilot's Menu TAWS INHIBIT (or if installed the external TAWS INH pushbutton). This function also inhibits REL and PRED displays. This is used for three distinct purposes:

a) Abnormal failure of FMS resulting in erroneous data. A conventional (flagged) FMS failure will automatically fail alerts and the terrain display. *

b) If a TAWS alert is previously determined to be erroneous and is repetitive at a specific location, to eliminate the alert. A perceived nuisance alert should be brought to the attention of Sandel for analysis.

c) To perform an off-airport or a landing at an airport that is not in the ST3400 database. The presence/absence of an airport in the database can be visually confirmed by looking at the ST3400 screen in any terrain view. If the airport does not show as a circle with identifier (or runways at lower ranges) within 20nm then it is not in the database. If the airport is absent, you can expect to receive more than one type of terrain alert on the descent to the airport within 1000'-1500' AGL. The Alert Inhibit function provides the ability to cancel these alerts.

Be aware that the TAWS INH function cancels all FLTA and PDA alerts but does not cancel basic GPWS alerting modes 1-6. By regulation, there is no provision to disable GPWS modes except by pulling the TAWS CB.

* Note: If it is desired to fail the Taws Alerts and remove the on-screen "X", operate TAWS INH and place the ST3400 in RMI mode.

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CHAPTER 11. PILOT'S MENU

Press the [M] "Menu" button to access the Pilot's Menu.

MSG softkey

[MSG] softkey brings up the MSG screen to show system messages and equipment status.

TEST softkey

[TEST] performs the following functions:

Tests external annunciator lamps, if installed.

Tests on-screen annunciation of WARNING followed by CAUTION.

Tests audio system with WARNING followed by CAUTION audio.

GLIDESLOPE OVERRIDE softkey

[GLIDESLOPE] softkey controls GPWS Mode 5 glide slope alerts NORM or OVERRIDE (disabled). Allows disabling glide slope alerting. Can be used to disable the glide slope warning during VFR conditions or when flying a back-course approach to an ILS. Note: This annunciation is shown only as a result of selection of the GS OVRD function, not from automatic disable from the HSI back-course output, if installed.

FLAPS OVERRIDE softkey

[FLAPS] softkey controls GPWS Mode 4 FITNL alert NORM or OVERRIDE. OVERRIDE forces the internal flap sensor to the DOWN state regardless of the current flap position. Use when a no-flaps landing is desired to inhibit the flaps alerts at 200'. Setting the FLAPS setting to OVERRIDE will also suppress GPWS Mode 3 "Don't Sink" alerts.

TFC OVERRIDE softkey

[TFC] softkey controls availability of traffic overlay over the REL, PRED and TOPO terrain displays. This has exactly the same function as holding the TFC button for one second while displaying any terrain view.

TAWS INHIBIT softkey

[TAWS INH] softkey provides access to the TAWS INHIBIT function NORM or INHIBIT. In the INHIBIT state, the TAWS alerts and PRED and REL displays are disabled but the GPWS alerts and TOPO display remain active. During ground operations, the PRED and REL displays are enabled even when TAWS INHIBIT is enabled. This allows terrain above the aircraft to be shown before takeoff. To totally disable the terrain display, press TAWS INHIBIT then press RMI.

MANUAL BRIGHTNESS softkeys

[xxx] The brightness level of the display is controlled manually by the pilot using the [♣] and [♦] buttons. The level can be set between 0 and 100. Each time the ST3400 is powered on, the brightness level is reset back to 100 (maximum brightness).

MSG Display

Whenever a system message exists on the MSG screen the normal operating display will show MSG in reverse video next to the [**M**] button. Press the [**M**] for the pilot's menu, and then press the [**MSG**] softkey.

The Equipment Status display lists current equipment status (valid/invalid or no data).

To exit, press [**MSG**] to return to the Pilot's Menu or press the [**EXIT**] softkey to return directly to normal operation.

INVALID/FAILED EQUIPMENT LIST	
Input	**Description**
ADC1	Air Data Computer or OAT probe input
ADC2	Air Data Computer or OAT probe input
ADF1	Automatic Direction Finder Receiver
ADF2	Automatic Direction Finder Receiver
AP	Autopilot engaged input inop (ARINC 429 only)
TAWS INH	Taws Inhibit input inop (ARINC 429 only)
FLPS	Flaps input inop (ARINC 429 only)
FMS1	GPS/Flight Management System input
FMS2	GPS/Flight Management System input
GEAR	Landing Gear inop (ARINC 429 only)
GS1	Glide slope Receiver
GS2	Glide slope Receiver
HDG1	Heading System, AHRS or Directional Gyro
HDG2	Heading System, AHRS or Directional Gyro
NAV1	NAV Receiver: Composite input that contains VOR and localizer signals
NAV2	NAV Receiver: Composite input that contains VOR and localizer signals
RA1	Radio Altimeter
TEST	External Self Test (ARINC 429 only)
WPR	Windshield Wiper Note: This is an external input that raises the ST3400 audio level.

On Screen Annunciation

When an input is either not available (no information is being received), invalid (information is being received but data is not valid), or any other failure condition, a message will be displayed.

Below is an illustration of the REL display with the following annunciations:

GS OVRD: Glide Slope Override active. No glide slope alerts will occur.

FLPS OVRD: Flaps Override active. The system treats the flaps as if they are in the landing configuration (down) regardless of their true position.

TFC OVRD: Traffic Override active. Traffic symbols will not be shown on the REL, PRED, and TOPO displays.

TAWS INH: Taws Inhibit active. All FLTA and PDA alerts are completely suppressed. GPWS alerts are still active. PRED and REL displays are disabled except during ground operations. A yellow 'X' is shown instead of terrain information

GPWS FAIL: One or more GPWS modes are unavailable due to failed equipment, typically radar altimeter failure. The failed equipment will show on the MSG screen

MSG: A message is waiting on the MSG screen.

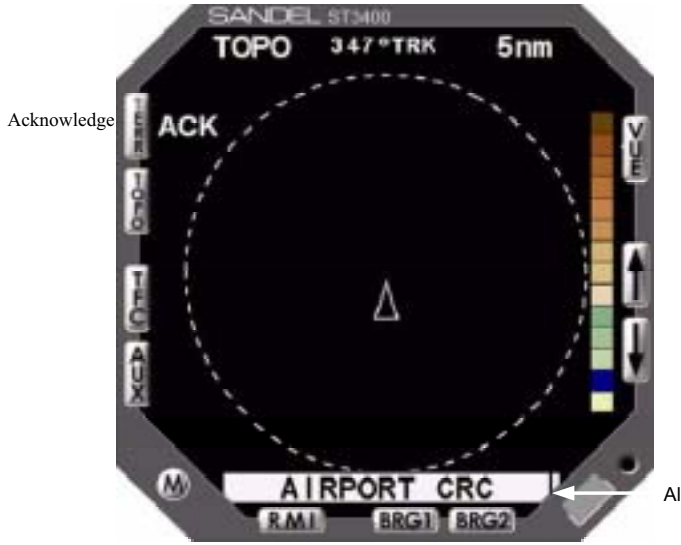
TAWS FAIL: (Shown below in TOPO mode). FLTA and PDA alerts and display are disabled due to lack of required data.

TCAS FAIL: Display of traffic is disabled due to lack of data communication from the TCAS processor.

System Self-Tests requiring Pilot Acknowledgement

In the event of certain equipment failures or the loss of specific required information a pilot advisory is displayed and a flashing "ACK" identifier is displayed next to the terrain button.

Press the [TERR] button to acknowledge the advisory. The advisory is displayed until acknowledged or until the advisory expires.



These messages are displayed during Pilot's Menu test:

ALERT TEST	
Text Message	**Type**
TEST WARNING	Warning
TEST CAUTION	Caution

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 power 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 and/or RMI 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 airworth
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)
OAT BELOW STANDRD	Outside air temperature >20\°C below standard	Pilot advisory

ADVISORY MESSAGES		
Text Message	**Description**	**Comment**
FAN RPM	Fan Failure	May induce an overtemp warning. Report to Maintenance
LAMP VOLTAGE	Lamp Voltage Failed	May induce a lamp failulre. Report to Maintenance

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CHAPTER 12. TAWS SYSTEM 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.

When the display shows a "RESET" identifier, use the [RMI] button to reset the system.

SYSTEM ERROR DISPLAY	
Button	**Description**
Reset	Resets the TAWS system when the System Error display is shown with a "RESET" identifier above the RMI button.

SYSTEM ERROR MESSAGES	
Text Message	**Description**
MEM_DRAM_A	DRAM memory failure

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CHAPTER 13. TROUBLESHOOTING

Bearing Pointers Not Displayed

If the input signal is degraded or lost for a minimum of 5 seconds, the input source is considered invalid and the bearing pointer is removed from the display.

The bearing pointer is redisplayed when the input source becomes valid again for a minimum of 1.5 seconds, or immediately when the input source provides a valid indication.

Nuisance Alerts

If an alert is previously determined to be erroneous, and is repetitive at a specific location, the alerting function can be inhibited.

A perceived nuisance alert should be brought to the attention of Sandel.

The ST3400 has an internal recorder that automatically records a minimum of ten 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.

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.

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APPENDIX A. OPTIONAL EQUIPMENT

Switch/Annunciator Option

Remote switch/annunciators may be installed, if desired or required. These can be comprised of:

[TAWS INH]	pushbutton/annunciator (amber)
[GS INH]	pushbutton/annunciator (amber)
[FLAPS INH]	pushbutton/annunciator (amber)
[CAUT/WARN]	split annunciator that has CAUT (amber) and WARN (red).
[GPWS FAIL]	annunciator (amber)

External switch/annunciators are only required for a two pilot cockpit when a single ST3400 is installed.

Please refer to the AFMS for details on the specific installation in your aircraft.

Back Course Inhibit

If available, the ST3400 may be optionally wired to the HSI or Flight Control System such that when the course pointer is upside down (as during a back-course approach) or when BC is selected on the flight control system GPWS Mode 5 (Glideslope alerting) is inhibited automatically.

Please refer to the AFMS for details on the specific installation in your aircraft.

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GLOSSARY

Active Course Segment	The course line segment between the last waypoint passed and the active waypoint in a flight plan.
Active Waypoint	The next waypoint in a flight plan.
Alert	A visual or aural stimulus presented to attract attention and convey information regarding system status or condition.
Aural Alert	A discrete tone or verbal statement used to annunciate a condition, situation, or event.
Caution Alert	An alert requiring immediate crew awareness. Subsequent corrective action will normally be necessary.
Controlled Flight Into Terrain (CFIT)	An accident or incident in which an aircraft, under the full control of the pilot, is flown into terrain, obstacles, or water.
Course Segment	A portion of a flight plan between two waypoints.
Cross-Side	Equipment associated with the position opposite the installed pilot or copilot position.
Decision Height	The height, in feet, above the highest runway threshold elevation in the touchdown zone to which landing (using a glide slope) is permitted providing the required visual reference is in sight, and the aircraft is in a position to descend for a normal landing.
Disabled Capability	Equipment capability that is operational but disabled (by the pilot or otherwise).
Enabled Capability	Equipment capability that is operational and not disabled.
Failure	The inability of the equipment or any sub-part of that equipment to perform within specified limits.
False Alert	An inappropriate alert that occurs as a result of a failure within the TAWS system or when the design alerting thresholds of the TAWS system is not exceeded.

Hazard	A hazard is a state or set of conditions that together with other conditions in the environment could lead to an accident.
Heading	A fixed line on the RMI compass card
INH	Inhibit; as in TAWS INH
Lubber Line	A fixed line on the Terrain display that is aligned with the magnetic ground track of the aircraft when "TRK" is displayed and aligned with the longitudinal axis of the aircraft when "HDG" is displayed.
Lateral Flight Path	Horizontal component of a flight path.
Level Flight	Flight operations where vertical speed is less than 500 feet per minute.
Minimum Descent Altitude	The lowest altitude, specified in feet above MSL, to which landing (not using a glide slope) is permitted providing the runway environment is in sight, and the aircraft is in a position to descend for a normal landing.
Missed Approach	An aborted approach resulting in an immediate climb and/or turn followed by a route directly to a missed approach point.
Nuisance Alert	An inappropriate alert, occurring during normal safe procedures.
On-Side	Equipment associated with the same position as the installed pilot or copilot position.
OVRD	Override; as in GPWS Glide Slope Override
PDA	Premature Descent Alert. This alert occurs if the aircraft is below a normal altitude as it approaches within 15nm of an airport.
Search Area	An area of airspace around the aircraft's current and projected path that is used to define an FLTA alert condition.
Selectable Items	Modifiable values, multiple-choice listings displayed on multiple lines, and requests that an operator may select.

Track	A fixed line on the terrain display that is aligned with the magnetic ground track of the aircraft.
Vertical Speed	The aircraft's rate of climb or descent in feet per minute.
Visual Alert	The display of information to indicate a condition, situation, or event requiring flight crew attention.
Visual Descent Point	A defined point on the final approach course of a non-precision straight-in approach procedure, from which normal descent from the MDA to the runway touchdown point may be commenced, provided the required visual reference is clearly visible to the pilot.
Waypoint	A position on the GPS/FMS flight plan represented on-screen by a "star" symbol.
Warning Alert	An alert for a detected terrain threat that requires immediate crew action.
70° ARC View	A forward-looking 70-degree ARC view that maximizes the display of the ground track ahead of the aircraft where the lubber line is centered in the ARC, and the aircraft's current position, is depicted near the bottom of the display.
360° FULL View	A 360-degree FULL view where the aircraft's current position is depicted at the center of the display.

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AVIONICS ACRONYMS

ACK	Acknowledge
ADC	Air Data Computer
ADF	Automatic Direction Finder
AFM	Airplane Flight Manual
AFMS	Airplane Flight Manual Supplement
AGL	Above Ground Level
AGPWE	Airborne Ground Proximity Warning Equipment
AHRS	Attitude/Heading Reference System
ALAT	Altitude Loss After Takeoff
AMED	Airborne Multipurpose Electronic Displays
AOG	Aircraft On Ground (out of service)
AP	Auto Pilot
APR	Approach phase of flight
ARP	Airport Reference Point
AS	Alerting System
ASL	Above Sea Level
ATC	Air Traffic Control
BIT	Built-In-Test
C	Celsius
CB	Circuit Breaker
CD ROM	Read Only Memory, Compact Disc
CFIT	Controlled Flight Into Terrain
CFM	Cubic Feet per Minute
CM	Configuration Module
CPU	Central Processing Unit

CRC	Cyclic Redundancy Check
DB	Decibels – measure of sound level
DEP	Departure phase of flight
DH	Decision Height (Precision approach)
DME	Distance Measuring Equipment
ECRT	Excessive Closure Rate to Terrain
ECRTL	Excessive Closure Rate to Terrain when Landing
ECRTNL	Excessive Closure Rate to Terrain when Not Landing
EDGSD	Excessive Downward Glide Slope Deviation
EFIS	Electronic Flight Instrument System
EGPWS	Enhanced Ground Proximity Warning System
ENR	Enroute phase of flight
ERD	Excessive Rates of Descent
FAA	Federal Aviation Administration
FAF	Final Approach Fix
FD	Flight Director
FITNL	Flight into Terrain When Not Landing
FLASH	Flash Random Access Memory
FLPS	Flaps
FLTA	Forward Looking Terrain Avoidance
FMS	Flight Management System
FPA	Flight Path Angle
FPM	Feet Per Minute
FTE	Flight Technical Error
GA	General Aviation
GA	Go-Around
GEAR	Landing Gear

GPS	Global Positioning System
GPW	Ground Proximity Warning
GPWS	Ground Proximity Warning System
GS	Glide Slope
HDG	Aircraft's magnetic heading
HMI	Hazardously Misleading Information
Hz	Hertz (cycles per second)
IAVS	Instrument Approach Visual Segment
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INOP	Inoperative
ITI	Imminent Terrain Impact
IVS	Instantaneous Vertical Speed
KTS	Knots
LNAV	Lateral Navigation; also Long Range Navigation
MAP	Missed Approach Point
MDA	Minimum Descent Altitude
MFD	Multi-function Display
MOCA	Minimum Obstruction Clearance Altitude
MSL	Mean Sea Level
MTC	Minimum Terrain Clearance
NAV	NAV Receiver (VOR)
NM	Nautical Miles
OAT	Outside Air Temperature
OBS	Omni Bearing Selector
PDA	Premature Descent Alert

POF	Phase Of Flight
POH	Pilot's Operating Handbook
POST	Power-On Self-Test
PRED	Predictive Altitude Dispaly
RA	Radio Altimeter; also traffic Resolution Advisory
REL	Relative Altitude Display
RMI	Radio Magnetic Indicator
RMS	Root Mean Squared
ROC	Required Obstacle Clearance
RRTC	Reduced Required Terrain Clearance
RTCA	Radio Technical Commission on Aeronautics (rtca.org)
SAT	Static Air Temperature
SDRAM	Synchronous Dynamic Random Access Memory
TACAN	Tactical Air Navigation System
TA	Traffic Advisory
TAS	Traffic Advisory System
TAWS	Terrain Awareness and Warning System
TCAS I	Traffic Alert and Collision Avoidance System which shows proximate traffic and Traffic Alerts
TCAS II	A TCAS-I with the additional feature of a Resolution Advisory VSI display for vertical guidance.
TFC	Traffic
TERPS	U S standard for instrument Terminal Procedures
TOPO	Topographical terrain display
TRK	Aircraft's ground track (usually magnetic)
TRM	Terminal phase of flight
TSO	Technical Standard Order
USB	Universal Serial Bus
VAP	Virtual Approach Path

Vac	Volts AC (alternating current – in aircraft typically 400Hz)
Vdc	Volts DC (direct current)
VDP	Visual Descent Point
VC	Voice Callout
VFR	Visual Flight Rules
VHF	Very High Frequency
VOR	VHF Omnidirectional Radio Range
VORTAC	System with a co-located VOR and a TACAN station
WPR	Windshield Wiper

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LIMITED WARRANTY

Sandel Avionics, Inc. (hereinafter referred to as "Sandel") provides the following limited warranty. If you should have any questions, please contact the avionics shop that sold you the ST3400 or contact Sandel directly.

Conditions of Limited Warranty

The ST3400 is warranted against defects in material and workmanship for a period of three (3) years from date of installation of a Class A version and two (2) years from date of installation of a Class B version. Sandel or an authorized representative will repair such defect or replace the defective unit without charge for parts or labor. Routine maintenance work and the results of normal wear are not covered by this warranty except as noted. During the warranty period, Sandel will replace any individual electronic part, sub-assembly, or finished product judged by Sandel to be defective, without charge for parts. Parts replaced under this portion of the warranty are warranted for the remainder of the original product warranty.

Sandel reserves the right to utilize reconditioned subassemblies as warranty replacements in the repair of the product. In the event Sandel determines that the unit cannot be repaired, Sandel will replace the defective unit with either the same model product or one that is reasonably equivalent. At Sandel's discretion, replacement units or repaired units may include software or hardware updates and revisions that alter some characteristics of the product.

Sandel assumes no responsibility for payment of any repair services performed by third parties including removal of the unit from the aircraft, inspection, packaging, handling, or installation unless such services are authorized in advance and in writing by Sandel.

Sandel reserves the right to make changes, upgrades, and improvements to its products without incurring any obligation to install such changes, upgrades, and improvements in previously manufactured products.

If, during the warranty period, title to the aircraft in which the product is installed is transferred, the remainder of the warranty may be transferred to the new owner by notifying Sandel in writing of the transaction. Such notification must include complete address information for the original owner and the new owner as well as the registration number and serial number of the aircraft and the serial number of the Sandel product.

Please contact Sandel directly if you have any questions regarding the Sandel limited warranty. This limited warranty is applicable only in the fifty states of the USA and the District of Columbia and Canada.

It is not applicable in the possessions or territories of the USA or in any other country. Warranty period for all countries other than the USA and Canada is limited to two (2) years from date of installation. This limited warranty is the only warranty, which Sandel makes with respect to your ST3400. Sandel disclaims all other warranties relating to the product including warranties of merchantability and fitness for a particular use.

In any event, Sandel shall not be liable for any incidental or consequential damages. Some states do not allow the exclusion or limitation of incidental or consequential damages and some states do not allow limitations on how long an implied warranty may last; therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights. You may also have other rights that vary from state to state. In the event any of the provisions of this warranty are found by statute or by applicable administrative or judicial entity to be unenforceable, the remaining provisions shall remain in force.

Sandel Avionics, Inc. - 2401 Dogwood Way - Vista, CA 92081
Tel: (760) 727-4900 - Fax: (760) 727-4899

Owners Responsibilities

Please read the Pilot's Guide of your ST3400 and the equipment to which it is connected. The information provided in your Pilot's Guide covers operation, safety precautions and routine maintenance. This warranty does NOT cover expenses incurred due to a lack of understanding of the functioning of the product when it is operating as designed.

In order for the warranty to be in effect, the owner must complete on-line warranty registration within 90 days from date of installation.

In order for Sandel to provide warranty service, the owner may be required to:

- Supply proof of purchase documents.
- Permit Sandel or an authorized representative to provide the applicable warranty service during normal business hours.
- Retain and provide to Sandel (upon request) any documentation of the installation of the product in your aircraft.
- Provide Sandel with all pertinent information regarding the symptoms, failure, or defect initiating the request for warranty service.

Exclusions

- This warranty does not cover the following:
- Failures that are the result of improper installation, maintenance, or repair.
- Failures that result from neglect, abnormal strain, modification, accidental damage, theft, vandalism, or exposure to extremes in temperature or relative humidity.
- Products whose trademark, name, or identification numbers have been altered or removed.
- Radio frequency interference generated by equipment operated in violation of applicable FCC rules.
- Equipment purchased "As New" from a dealer or distributor not authorized by Sandel.
- Loss of business income during warranty repair process.
- Shipping charges to Sandel and uninstall/reinstall cost of unit to be repaired.

All product or material returned to Sandel must be properly packed and labeled with a Returned Material Authorization (RMA) number. Should proper packing materials not be available, Sandel will provide an approved shipping container on request.