

400W / 500W Series



Garmin Optional Displays
Pilot's Guide Addendum For:

- GDL 69/69A XM Satellite Datalink
- GTX 330/330D TIS
- Garmin TAWS (GPS 500W & GNS 530W)



This Pilot's Guide Addendum is written for:

- Garmin GPS 400W, GNC 420W/420AW, and GNS 430W/430AW Main System Software Version 2.00
- Garmin GPS 500W & GNS 530W/530AW Main System Software Version 2.00
- GTX 330/330D Main Software Version 4.05
- GDL 69/69A Main Software Version 3.02

Some differences in operation may be observed when comparing the information in this manual to earlier or later software versions.
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The screen display examples shown in this addendum are taken from the GNS 430W and GNS 530W. TIS and Weather Data Link Display Interface functionality is the same for the 400W and 500W Series Units. TIS Traffic Display and Weather Data Link are available only when the 400W/500W units are configured with the GTX 330 Mode S Transponder and GDL 69/69A Data Link Transceiver, respectively.





WARNING: Terrain data is obtained from third party sources. Garmin is not able to independently verify the accuracy of this data which should be used only as an aid for situational awareness. Terrain data must not be used as the sole basis for decisions or maneuvers to avoid terrain or obstacles. Terrain data must not be used for navigation.



CAUTION: Use the 400W/500W Series Units at your own risk. To reduce the risk of unsafe operation, carefully review and understand all aspects of the Owner's Manual and the Flight Manual Supplement, and thoroughly practice basic operation prior to actual use.



CAUTION: The Global Positioning System is operated by the United States government, which is solely responsible for its accuracy and maintenance. The system is subject to changes which could affect the accuracy and performance of all GPS equipment. Although Garmin 400W/500W Series Units are precision electronic NAVigation AIDS (NAVAID), any NAVAID can be misused or misinterpreted and therefore become unsafe.



CAUTION: Use the Weather Data Link Interface, TIS, TAWS, and TERRAIN at your own risk. To reduce the risk of unsafe operation, thoroughly practice basic operation prior to actual use. When in actual use, carefully compare indications from the Garmin unit to all available navigation sources, including the information from other NAVAIDS, visual sightings, charts, etc. For safety, always resolve any discrepancies before continuing navigation. The GPS altitude format calculated by the Garmin 400W/500W Series units is geometric height above mean sea level and could vary significantly from altitude displayed by pressure altimeters in aircraft. Never use GPS altitude to determine aircraft altitude.



CAUTION: The Jeppesen database incorporated in the Garmin 400W/500W Series Units must be updated regularly in order to ensure that its information is current. Updates are released every 28 days. A database information packet is included in your Garmin 400W/500W Series Unit package. Pilots using an out-of-date database do so entirely at their own risk.



CAUTION: The Weather Data Link, TIS, TAWS, and TERRAIN information contained in this Pilot's Guide Addendum is not intended to replace the documentation that is supplied with the applicable Garmin 400W/500W Series Unit and the GTX 330 Transponder. The user must know how to operate the 400W/500W Series Unit and be knowledgeable of the information in the 400W/500W Pilot's Guide.



TIS CAUTION: TIS is *NOT* intended to be used as a collision avoidance system and does not relieve pilot responsibility to "see and avoid" other aircraft. TIS should not be used for avoidance maneuvers during IMC or other times when there is no visual contact with the intruder aircraft. TIS is intended only to assist in visual acquisition of other aircraft in VMC. Avoidance maneuvers are not recommended, nor authorized, as a direct result of a TIS intruder display or TIS alert.

While TIS is a useful aid to visual traffic avoidance, it has some system limitations that must be fully understood to ensure proper use. Many of these limitations are inherent in secondary radar surveillance. In other words, the information provided by TIS will be no better than that provided to ATC.



CAUTION: Garmin would like to remind pilots flying with GDL 69/69A-equipped aircraft that TFRs are only advisory and are not a replacement for a thorough preflight briefing on TFR times and locations. Always confirm TFR data through official sources and contact your Flight Service Station for interpretation of TFR data.

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Part One: Traffic Information Service (TIS) Interface

Section 1: TIS Operation and Symbology

TIS Operation



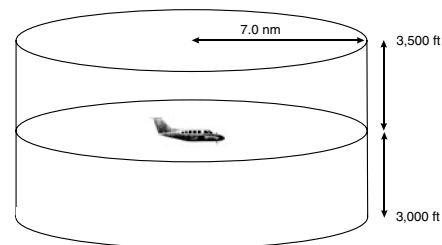
NOTE: Part One of this Addendum assumes the user has experience operating the 400W/500W Series units and the Garmin GTX 330 Transponder.

The Traffic Information Service (TIS) provides a graphic display of traffic advisory information in the cockpit for non-TCAS (Traffic alert and Collision Avoidance System) equipped aircraft. TIS is a ground-based service providing relative location of all ATCRBS (Air Traffic Control Radar Beacon System) Mode A and Mode C transponder-equipped aircraft within a specified service volume. The TIS ground sensor uses real-time track reports to generate traffic notification. TIS Traffic display is available to aircraft equipped with a Mode S Data Link such as the Garmin GTX 330 Transponder. TIS Traffic from a GTX 330 Transponder can then be displayed on a Garmin 400W/500W Series unit. Surveillance data includes all transponder-equipped aircraft within the coverage volume. Aircraft without an operating transponder are invisible to TIS. TIS displays up to eight traffic targets within seven nautical miles horizontally from 3000 feet below to 3500 feet above the requesting aircraft.

The TIS is a ground-based service that displays nearby aircraft on your 400W/500W-series display. For the TIS feature to inform you of a nearby aircraft's presence, several conditions must be met:

- Your aircraft must be equipped with a Mode S data link transponder, such as the GTX 330.
- You must be within range of a Mode S radar that provides the TIS service. Not all Mode S ground radars provide TIS service.
- The “intruder” aircraft must be equipped with a transponder, and that transponder must be turned on. Aircraft that are not equipped with operating transponders will not be visible to the Mode S surveillance radar.
- The “intruder” aircraft must be within the TIS coverage volume for your aircraft. TIS displays up to eight traffic targets within seven nautical miles horizontally from the requesting aircraft, and from 3,000 feet below to 3,500 feet above the requesting aircraft.
- Both your aircraft and the intruder aircraft must be visible to the Mode S surveillance radar on the ground.

Always remember that TIS cannot alert you to the presence of aircraft that are not equipped with transponders, nor can it alert you to aircraft that may be nearby, but obscured from the ground surveillance radar by intervening terrain.



TIS Coverage Volume (not to scale)

How TIS differs from TCAS

The main difference between TIS and TCAS is the source of surveillance data. TCAS uses an airborne interrogator with a one-second update rate, while TIS uses the terminal Mode S ground interrogator and its Data Link to provide about a five-second update rate. The range accuracy of TIS and TCAS is similar.

TIS Limitations



NOTE: *This section on TIS Limitations is not comprehensive. Garmin recommends the user review the TIS Limitations section of the Aeronautical Information Manual, Section 1-3-5.*

TIS is NOT intended to be used as a collision avoidance system and does not relieve the pilot of responsibility to “see and avoid” other aircraft. TIS should not be used for avoidance maneuvers during IMC or other times when there is no visual contact with the intruder aircraft. TIS is intended only to assist in visual acquisition of other aircraft in VMC. No recommended avoidance maneuvers are provided for, nor authorized, as a direct result of a TIS intruder display or TIS advisory.

While TIS is a useful aid to visual traffic avoidance, it has some system limitations that must be fully understood to ensure proper use. Many of these limitations are inherent in secondary radar surveillance. In other words, the information provided by TIS will be no better than that provided to ATC. TIS will only display aircraft with operating transponders installed.

TIS relies on surveillance of the Mode S radar, which is a “secondary surveillance” radar similar to the ATCRBS. TIS operation may be intermittent during turns or other maneuvering. TIS is dependent on two-way, “line-of-sight” communication between the aircraft and the Mode S radar. Whenever the structure

of the client aircraft comes between the transponder antenna (usually located on the underside of the aircraft) and the ground-based radar antenna, the signal may be temporarily interrupted. Other limitations and anomalies associated with TIS are described in the AIM, Section 1-3-5.



Garmin is not responsible for Mode S geographical coverage. Operation of the ground stations is the responsibility of the FAA. Refer to the Aeronautical Information Manual for a Terminal Mode S Radar Site Map covering the U.S.



NOTE: *TIS will be unavailable at low altitudes in many areas of the U.S., particularly in mountainous regions. Also, when flying near the “floor” of radar coverage in a particular area, intruders below the client aircraft may not be detected by TIS.*

TIS information is collected one radar scan prior to the scan during which the uplink occurs. Therefore, the surveillance information is approximately five seconds old. In order to present the intruders in a “real time” position, the TIS ground station uses a “predictive algorithm” in its tracking software. This algorithm uses track history data to extrapolate intruders to their expected positions consistent with the time of display in the cockpit. Occasionally, aircraft maneuvering will cause this algorithm to induce errors in the 400W/500W display. These errors primarily affect relative bearing information and traffic target track vector (it will lag); intruder distance and altitude will remain relatively accurate and may be used to assist in “see

and avoid.” Some of the more common examples of these errors follow:

- When client or intruder aircraft maneuvers excessively or abruptly, the tracking algorithm may report incorrect horizontal position until the maneuvering aircraft stabilizes.
- When a rapidly closing intruder is on a course that crosses the client aircraft course at a shallow angle (either overtaking or head on) and either aircraft abruptly changes course within $\frac{1}{4}$ NM, TIS may display the intruder on the opposite side of the client than it actually is.

These are relatively rare occurrences and will be corrected in a few radar scans once the course has stabilized.

Improving TIS




Users of TIS can render valuable assistance in the correction of malfunctions by reporting their observations of undesirable performance. Reporters should identify the time of observation, location, type and identity of aircraft, and describe the condition observed; the type of transponder processor and software in use can also be useful information. Since TIS performance is monitored by maintenance personnel other than ATC, it is suggested that malfunctions be reported in the following ways:

- By telephone to the nearest Flight Service Station (FSS) facility.
- By FAA Form 8000-7, Safety Improvement Report, a postage-paid card designed for this purpose. These cards may be obtained at FAA FSSs, General Aviation District Offices, Flight Standards District Offices, and General Aviation Fixed Based Operations.

TIS Symbolology

TIS traffic is displayed on the 400W/500W Series unit according to TCAS symbology, graphically displayed on a dedicated graphical page (Traffic Page; see below), and on the moving Map Page. A Traffic Advisory (TA) symbol appears as a solid yellow circle (or half circle on the outer range ring if the traffic is outside the range of the dedicated Traffic Page). All other traffic is displayed as a hollow white diamond. Altitude deviation from own aircraft altitude is displayed above the target symbol if traffic is above own aircraft altitude, and below the symbol if they are

below own aircraft altitude. Altitude trend is displayed as an up arrow (> +500 ft/min), down arrow (< -500 ft/min), or no symbol if less than 500 ft/min rate in either direction.

-  • Traffic Advisories (TA)—Yellow
-  • Proximity Advisories (PA)—White
-  • Other—White



The TIS audio alert is generated from the GTX 330 whenever the number of Traffic Advisories on the 400W/500W display increases from one scan to the next. Limiting Traffic Advisories only reduces the “nuisance” alerting due to proximate aircraft. For example, when the first Traffic Advisories appears on the TIS display, the user is alerted audibly. So long as a single aircraft remains on the TIS display, no further audio alert is generated. If a second (or more) aircraft appears on the display, a new audio alert is sounded.

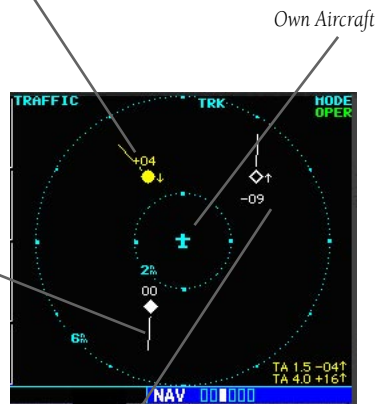
If the number of Traffic Advisories on the TIS display decreases and then increases, a new audio alert is sounded. The TIS audio alert is also generated whenever TIS service becomes unavailable. The volume, pitch, and duration of the audio alert (including the choice between a male or female voice) is configured during installation.

The following TIS audio alerts are available:

- “Traffic” —TIS traffic alert is received.
- “Traffic Not Available” — TIS service is not available or out of range.

Traffic Advisory (TA)—This symbol is generated when traffic meets the advisory criteria described in TIS Operational Procedures.

Traffic Ground Track is indicated on the 400W/500W display by a “target track vector”, a short line displayed in 45-degree increments. This vector shows the flight direction of the traffic.



“Other” Traffic—This symbol represents traffic detected within the selected display range that does not generate a TA.

Section 2: Control and Display

TIS Traffic Display Status and Pilot Response

- STBY — When the 400W/500W displays STBY in the upper right hand corner of the display the TIS system is in standby mode and cannot display traffic data.
- OPER — When the 400W/500W displays OPER in the upper right hand corner of the display the TIS system is in operational mode and available to display traffic on the Traffic or Map Page.
- AGE — If traffic data is not refreshed within 6 seconds, an age indicator (e.g., “AGE 00:06”) is displayed in the lower right corner of the display (when displaying traffic). The pilot should be aware that the quality of displayed traffic is reduced in this condition.
- TRFC CST — If data is still not received between six and twelve seconds, the “TRFC CST” (traffic coasting) banner located above the AGE timer will indicate that displayed traffic is held even though the data is not current. The pilot should be aware that the quality of displayed traffic is reduced in this condition.



Traffic Age Indication showing “traffic coasting”.

- TRFC RMVD — If data is still not received after twelve seconds, the “TRFC RMVD” banner will indicate that traffic has been removed from the

display due to the age of the data being too old to “coast” (for the time period after 12 seconds from the last receipt of a TIS message). The pilot should be aware that traffic may be present but not shown.



Traffic Page displaying “TRFC RMVD” banner.

- UNAVAIL — After a 60 second period elapses with no data, TIS is considered to be unavailable. This state is indicated by the text “UNAVAIL”. The pilot should be aware that “UNAVAIL” could indicate a TIS coverage limitation due to a line-of-sight situation, a low altitude condition, no TIS service, or a result of flying directly over the radar site providing coverage (cone of silence).
- NO DATA — “NO DATA” is displayed when no data is being received from the GTX 330. The pilot should be aware that this status may be a normal mode of operation in a dual transponder installation where the GTX 330 with TIS is not the selected transponder. The GTX 330 may not be powered on.
- DATA FAIL — “DATA FAIL” is displayed when data is being received from GTX 330, but there was a failure detected in the data stream. The pilot should see the dealer for corrective action.
- FAILED — “FAILED” is displayed when the GTX 330 has indicated it has failed. The pilot should see the dealer for corrective action.

Traffic Ground Track

Traffic ground track is indicated in the 400W/500W display by a “target track vector”, a short line displayed in 45-degree increments, **extending in the direction of target movement**.



Traffic Target Track Vector.

Traffic Warning Window

When the unit is on any page (other than the NAV Traffic Page or when a TAWS/Terrain, or Dead Reckoning pop-up is displayed) and a traffic threat is imminent, the Traffic Warning Window is displayed. The Traffic Warning Window shows a small thumbnail map which can take the user to the Traffic Page by pressing **ENT**, or go back to the previous page by pressing **CLR**.



Traffic Warning Window



NOTE: The Traffic Warning Window is disabled when the aircraft ground speed is less than 30 knots or when an approach is active.

Traffic Page

TIS Traffic data is displayed on two 400W/500W Series unit pages, the Traffic Page and the Map Page. The 500W Series unit can also be configured to display a traffic thumbnail window below the VLOC frequency window. Unlike other forms of traffic, TIS traffic does not require heading data to be valid on the map. The only difference between TIS and other traffic data occurs on the Traffic Page. If heading is available, then the traffic data is compensated and displayed as heading-up. If it's not available, the Traffic Page is a track-up display. It is labeled on the upper portion of the Traffic Page.

Traffic Page Display Range

Various display ranges can be selected for optimal display of TIS traffic information.

To change the display range on the Traffic Page:

Press **RNG** to zoom through the range selections which are: 12/6 NM, 6/2 NM, and 2 NM.

Map Page

TIS traffic is displayed on the Map Page in addition to the Traffic Page.



The Map Page displaying traffic.

Configuring TIS Traffic Data on the Map Page

To configure TIS traffic on the Map Page:

1. Turn the **small right** knob to select the Map Page.
2. Press the **MENU** key.
Turn the **small right** knob to select "Setup Map?"
3. The flashing cursor highlights the GROUP field.
Turn the **small right** knob to select "Traffic" and press **ENT**.
4. Turn the **large right** knob to select the desired Traffic Mode option. Turn the **small right** knob to select the desired option and press **ENT**. Repeat the step for Traffic Symbol and Traffic Label.
5. Press **CLR** to return the Map Page.



The traffic mode selection menu allows the user to choose from the following:

- All trfc - All traffic is displayed on the Map Page.
- TA/PA - Only traffic advisories and proximity advisories are displayed on the Map Page.

- TA only - Only traffic advisories are displayed on the Map Page.

From the Map Page you can display traffic in a thumbnail format in any of the top three (400W Series) or four (500W Series) data fields on the right side of the Map Page.



Thumbnail Traffic displayed on the GNS 430W. NOTE: The thumbnail will display traffic coasting "TRFC CST" or traffic removed "TRFC RMVD" in the lower right when TIS messages have been missed.

To display Thumbnail Traffic on the Map Page:

1. Turn the **small right** knob to select the Map Page.
2. Press the **MENU** key and display the Page Menu.
3. Turn the **small right** knob to select "Change Fields?" and press **ENT**.
4. Select one of the top three (400W Series) or four (500W Series) configurable fields. Select 'TRFC' from the Select Field Type List and press **ENT**. Note that the thumbnail range defaults to 6 NM and cannot be changed.

Highlighting TIS Traffic Using Map Page Panning

Another Map Page feature is panning, which allows you to move the map beyond its current limits without adjusting the map scale. When you select the panning function — by pressing the **small right** knob — a target pointer will flash on the map display. A window also appears at the top of the map display showing the latitude/longitude position of the pointer, plus the bearing and distance to the pointer from your present position.



Displaying traffic range and altitude separation using the Map Panning feature.

To activate the panning feature and pan the map display:

1. Press the **small right** knob to activate the panning target pointer.
2. Turn the **small right** knob to move up (turn clockwise) or down (counterclockwise).
3. Turn the **large right** knob to move right (turn clockwise) or left (counterclockwise).
4. To cancel the panning function and return to your present position, press the **small right** knob.

When the target pointer is placed on traffic, the traffic range and altitude separation are displayed.

Section 3: TIS Operational Procedures

Introduction

TIS warns the user with voice and visual traffic advisories whenever it predicts an intruder to be a threat (see illustration). Voice and visual data is sent from the GTX 330. The user should not start evasive maneuvers using information from the 400W/500W display or on a traffic advisory only. The display and advisories are intended only for assistance in visually locating the traffic, due to the lack in resolution and coordination ability. The flight crew should attempt to visually acquire the intruder aircraft and maintain a safe separation in accordance with the regulatory requirements and good operating practice. If the flight crew cannot visually acquire the aircraft, they should contact ATC to obtain any information that may assist concerning the intruder aircraft. Based on the above procedures, minor adjustment to the vertical flight path consistent with air traffic requirements are not considered evasive maneuvers.

Power-Up Test

The TIS interface performs an automatic test during power-up.

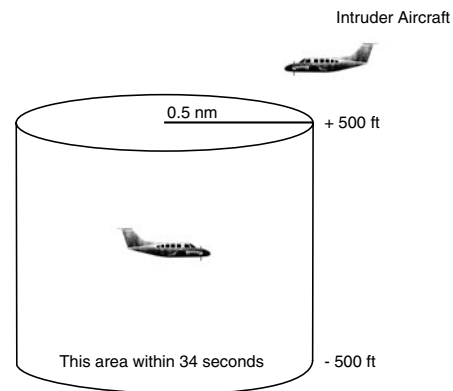
- If the system passes the power-up test, the Standby Screen appears on the Traffic Page.
- If the system passes the power-up test and the aircraft is airborne (as determined by system configuration at the time of installation, see your installer for detailed criteria information), traffic is displayable on the Traffic Page in operating mode.
- If the system fails the power-up test, the “NO DATA”, “DATA FAIL”, or “FAILED” message is displayed. See your installer for corrective action if the “DATA FAIL”, or “FAILED” message

is displayed. The “FAILED” message indicates the GTX 330 has failed. The “DATA FAIL” message indicates data is being received from the GTX 330 but a failure was detected in the data stream. The “NO DATA” message indicates that data is not being received from the GTX 330.



NOTE: “NO DATA” may be a normal mode of operation in a dual transponder installation where the GTX 330 with TIS is not the selected transponder.

- UNAVAIL — When a 60 second period elapses with no data, TIS is considered to be unavailable. This state is indicated by the text “UNAVAILABLE” (500W Series) and “UNAVAIL” (400W Series). The pilot should be aware that “UNAVAIL” could indicate a TIS coverage limitation due to a line-of-sight situation, a low altitude condition, no TIS service, or a result of flying directly over the radar site providing coverage (cone of silence).



Conditions for Traffic Advisories

The following condition causes TIS to display a Traffic Advisory (TA) on the 400W/500W Series unit:

- **The intruder aircraft approaches your aircraft on a course that will intercept (defined by a 0.5 NM horizontal radius and a relative altitude of ± 500 feet) your course within 34 seconds.**

Manual Override

The user can manually switch between standby (STBY) and operating (OPER) mode of operation to manually override automatic operation.

To place the display into operating mode from the standby mode (to display TIS traffic):

1. Turn the cursor on and highlight "STBY".
2. Turn the **small right** knob to select "OPER?".
3. Press **ENT** to confirm.

To place the display into standby mode from operating mode (to stop displaying TIS traffic):

1. Turn the cursor on and highlight "OPER".
2. Turn the **small right** knob to select "STBY?".
3. Press **ENT** to confirm.



"DATA FAIL" Message



The 'NO DATA' message indicates that data is not being received from the GTX 330.

NOTE: This may be a normal mode of operation in a dual transponder installation where the GTX 330 with TIS is not the selected transponder.

Flight Procedures

Once the aircraft is airborne (determined by system configuration at the time of installation) the system switches from standby mode to operating mode. The 400W/500W Series unit displays OPER in the upper right hand corner of the display and begins to display traffic on the Traffic or Map Page.

The TIS Traffic Advisory (TA) should alert the crew to use additional vigilance to identify the intruding aircraft. Any time the traffic symbol becomes a yellow circle or a voice warning is announced, conduct a visual search for the intruder. If successful, maintain visual contact to ensure safe operation. See Section 2: Control and Display for a description of pilot responses to TIS display messages.

After Landing

Once the aircraft is "groundborne" (determined by system configuration at the time of installation) the system switches from operating mode to standby mode. The 400W/500W Series unit displays "STBY". As described previously, both the standby and operating modes can be manually overridden by the display controls.

Part Two: XM Radio

Section 1: Introduction

Overview

The GDL 69™ is a remote sensor that receives broadcast weather data from a data service of XM Satellite Radio, Inc. The GDL 69A™ is similar to the GDL 69, but also receives audio entertainment broadcasts from another service of XM Satellite Radio. The 400W and 500W series units serve as the display and control head for your remotely mounted GDL 69/69A satellite radio.

Before the GDL 69/69A can be used, the unit must be activated by XM Satellite Radio with a service subscription through XM Satellite Radio. Please note that the GDL 69 is a weather data link. The GDL 69A is a weather data link and audio receiver. The data link service and the audio entertainment services must be activated separately.

Your GDL 69 or GDL 69A is shipped with one or two radio hardware identifications, respectively. These IDs serve as identification codes for your XM-equipped GDL 69/69A and are needed in the activation process. The ID(s) is (are) attached to the Activation Instructions and printed on a label on the back of the unit. The IDs can also be retrieved through your unit in the XM Information page of the Aux function. Contact your dealer or customer service if you are unable to locate the radio hardware IDs.

Weather and/or audio data from your GDL 69/69A are provided by XM Satellite Radio, a company separate and independent from Garmin Corporation. Have your radio hardware IDs ready before contacting XM Satellite Radio. During the process, you can select services for subscription. Keep in mind that the GDL 69 has no audio capability, audio services will not

be available with the unit.

Follow the *GDL 69/69A XM Satellite Radio Activation Instructions (190-00355-04)* enclosed with your GDL 69/69A unit to activate the XM products.

XM Radio Pages

To reach the XM pages:

1. From any page, press and hold **CLR** to select the Default NAV Page. (You may skip this step if you are already viewing any of the main pages.)
2. Turn the **large right** knob to select the AUX page group. "AUX" appears in the lower right corner of the screen.
3. Turn the **small right** knob to select the XM Audio, XM Information, or XM WX Timestamps pages.

XM Weather page is displayed in the NAV page group. The XM Audio function pages are displayed in the AUX page group.

XM NAV Pages

When a GDL 69 or GDL 69A is installed, the following XM-related pages appear in the NAV group of pages:

- Map Page. The Map page (the second page in the NAV page group) becomes capable of displaying weather data and the boundaries of areas with Temporary Flight Restrictions (TFRs).
- XM Weather Page. The XM Weather page is inserted as the third page of the NAV page group, immediately after the Map page. This page is like the map page, but can show either NEXRAD weather data or colored flags showing which airports have METARs (current weather observations—Meteorological Aerodrome Reports).

XM WPT Pages

When a GDL 69 or GDL 69A is installed, two XM-related pages are added to “airport” pages in the WPT page group:

- **Textual METAR Page.** The Textual METAR page shows the text of the most recent METAR (Meteorological Aerodrome Report) that has been received for an airport.
- **TAF Page.** The TAF page shows the text of the most recent TAF (Terminal Aerodrome Forecast) that has been received for an airport.

XM AUX Pages

When a GDL 69 or GDL 69A is installed, the following XM pages appear in the AUX group of pages:

- **XM Audio Page** (GDL 69A only). See Section 4 below for a description of this page.
- **XM Information Page.** This page contains information that you will use when activating your XM satellite radio subscription. It also reports the GDL 69/69A’s software version number.
- **XM Weather Timestamps Page.** This page shows timestamp data for the most recently received XM weather data.

Section 2: XM Weather

The XM Weather Function is capable of displaying graphical weather information through the XM Satellite Radio Service when activated in the optional installation of the GDL 69/69A. Nexrad graphic weather and METARs symbols are displayed on the NAV pages. The types of products available depend on the subscription service with XM Satellite Radio.

Once you have activated an aviation weather service from XM Satellite Radio, the 400W/500W series unit can display the following aviation-related data:

- **NEXRAD Weather.** An indication of the intensity of weather radar echoes from the National Weather Service’s network of NEXRAD (NEXt generation RADAr) sites can be shown on the XM Weather Page and can optionally be overlaid on the Map page. (Both these pages are in the NAV page group.)
- **Radar Coverage.** Whenever NEXRAD radar echoes are shown, a cross-hatch pattern indicates the limits of NEXRAD radar coverage. The cross-hatched area shows where NEXRAD information is unavailable.
- **Meteorological Aerodrome Reports (METARs).** When a GDL 69/69A is installed, a “Textual METAR” page is inserted among the airport pages of the WPT page group. On this page you can see the most recent METAR for that airport, as downloaded from XM Satellite Radio.
- **Textual METARs.** When you zoom in to show the airport symbol associated with the colored flag for a graphical METAR, and move the Map Pointer to highlight that airport, you can then press ENT to see the Textual METAR page for that airport. The Textual METAR page is one of the airport pages of the WPT page group.

- **Graphical METARs.** The MX Weather page (in the NAV page group) can show colored flags to indicate the level of current weather conditions at those airports for which textual METAR reports are available. The flags are color-coded to indicate the severity of the current weather at the airport: cyan for VFR conditions, green for Marginal VFR conditions, yellow for IFR conditions, or magenta of Low IFR conditions.
- **TAFs.** A TAF (Terminal Aerodrome Forecast) page is added among the airport pages of the WPT page group. The TAF page differs from the Textual METAR page in that it describes forecast future weather conditions rather than current conditions.
- **TFRs.** The boundaries of areas with Temporary Flight Restrictions are outlined in yellow on the Map and XM Weather pages of the NAV page group. In the 500W-series, TFR boundaries are also shown on the NAV main page. You can obtain more information about a TFR by bringing up the map cursor, moving the map cursor to within the yellow outlined area, and pressing the **ENT** key.

XM Nexrad Weather

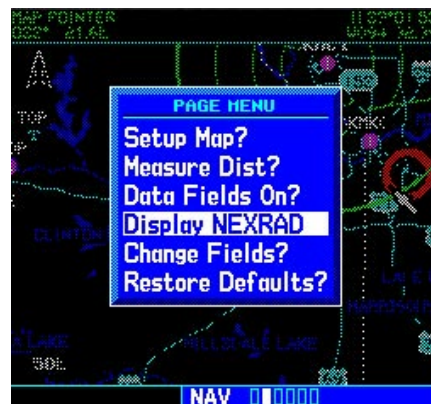
The National Weather Service's network of WSR-88D Doppler weather surveillance radars—also called NEXRAD, for Next Generation Radar—has greatly improved the detection of meteorological events such as thunderstorms, tornados, and hurricanes. An extensive network of NEXRAD weather radars provides almost complete coverage of the continental United States, Alaska, and Hawaii. The unobstructed range of each NEXRAD is up to 250 nautical miles.

When enabled, composite data from all the NEXRAD radar sites in the United States is shown. This data is composed of the maximum reflectivity

from the individual radar sweeps. The display is color-coded to indicate the weather level severity. Information about which sites are operational or off-line is also available.

To display NEXRAD weather on the Map page:

1. With the Map page (the second page of the NAV page group) displayed, press the **MENU** key. The Page Menu for the Map page appears.
2. Turn the **large right** knob to highlight "Display NEXRAD," and then press **ENT**. (If "Hide NEXRAD" appears, NEXRAD radar data is already enabled; just press **MENU** again to exit the Page Menu.)

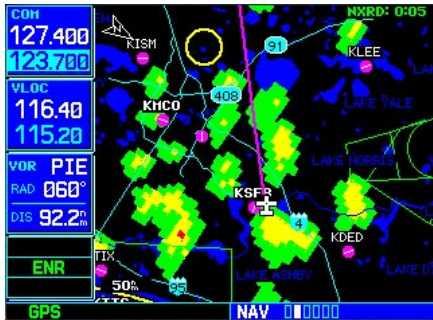


To display NEXRAD weather on the XM Weather page:

1. With the XM Weather page (the third page of the NAV page group) displayed, look at the upper left corner of the page. Under the page title ("XM Weather") either "NEXRAD" or "METAR" appears. If the word is "NEXRAD," do nothing; NEXRAD weather is already being displayed.
2. If the word in the upper left corner of the page

is "METAR" (rather than "NEXRAD"), press the **small right (CRSR)** knob to highlight that word. Then turn the **small right** knob to change "METAR" to "NEXRAD."

3. Press the **small right** knob again to bring down the cursor (that is, to stop the blinking highlighting of "NEXRAD") and retain the selection.



NEXRAD Intensity

Colors are used to identify the different NEXRAD echo intensities (reflectivity) measured in dBZ (decibels of Z). "Reflectivity" is the amount of transmitted power returned to the radar receiver. Reflectivity (designated by the letter Z) covers a wide range of signals (from very weak to very strong). So, a more convenient number for calculations and comparison, a decibel (or logarithmic) scale (dBZ), is used. The dBZ values increase as the strength of the signal returned to the radar increases. There are seven gradations for rain, two gradations for mixed rain and snow, and two gradations for snow.

To display the Nexrad Intensity Legend:

1. While viewing the XM Weather page, press the **MENU** key to display the Page Menu.
2. Turn the **large** or **small** knob to select "Display legend?"



3. Press **ENT** to display the Nexrad Intensity Legend.



4. Turn the **large** or **small** knob to scroll through the full table. Press **CLR** to return to the normal view.

NEXRAD Abnormalities

There are possible abnormalities regarding displayed NEXRAD images. Some, but not all, causes of abnormal displayed information include:

- Ground Clutter
- Strokes and spurious radar data
- Sun strobes, when the radar antenna points directly at the sun
- Military aircraft deploy metallic dust which can cause alterations in radar scans
- Interference from buildings or mountains, which may cause shadows
- Scheduled maintenance may put a radar off-line

NEXRAD Limitations

Certain limitations exist regarding the NEXRAD radar displays. Some, but not all, are listed for the user's awareness:

- NEXRAD base reflectivity does not provide sufficient information to determine cloud layers or precipitation characteristics (hail vs. rain, etc).
- NEXRAD base reflectivity is sampled at the minimum antenna elevation angle. An individual NEXRAD site cannot depict high altitude storms at close ranges, and has no information about storms directly over the site.
- The resolution of displayed NEXRAD data is 2 kilometers. Therefore, when zoomed in on the display, each square block is 2 kilometers. The intensity level reflected by the square will be the highest level sampled within the 2 kilometer square area.

XM Weather METARs

XM Weather METARs (Meteorological Aerodrome Reports) are available on the XM Weather page. When enabled (that is, when "METAR" is shown in the upper left corner of the page rather than "NEXRAD"), airports with METAR information above a certain severity level are marked with colored flags on the display. Refer to the XM Weather legend for a description of the color code. The update rate is every 12 minutes.

To display METARs on the XM Weather page:

1. While viewing the XM Weather page, check the upper left corner to see whether "METAR" or "NEXRAD" is displayed in the upper left corner.
2. If "NEXRAD" (rather than "METAR") is shown,

press the **small right (CRSR)** knob to highlight "NEXRAD". Turn the **small right** knob to change "NEXRAD" to "METAR," and press that **small right** knob again to bring down the cursor (stop the highlighting) and retain the "METAR" selection.

3. Now colored flags will be displayed at those airports that have METARs above a certain severity level. (If there are no colored flags visible, you may have to search a wider area—zoom out with the **RNG** key—before you see some METAR flags.)



To display the METAR Legend:

1. Press the **MENU** key to display the Page Menu.
2. Turn the **large** or **small right** knob to select "Display legend?"
3. Press **ENT** to display the METAR symbols legend. Press the **CLR** key to remove the METAR Symbols legend.



XM Weather METAR Symbols	
VFR - Ceiling > 3000 ft and visibility > 5 statute miles	Cyan
MVFR (Marginal VFR) - Ceiling 1000 to 3000 ft, and/or visibility 3 to 5 statute miles	Green
IFR - Ceiling 500 to 1000 ft, and/or visibility 1 to 3 statute miles	Yellow
LIFR (Low IFR) - Ceiling less than 500 ft and/or visibility less than 1 statute mile	Magenta

Textual METAR Page

When the GDL 69/69A is installed, a Textual METAR page is added among the APT (airport) pages of the WPT page group. This page can be accessed from the XM Weather page as well as from the WPT page group.

To display Textual METARs from the Nav XM Weather page:

1. While viewing the Nav XM Weather page, press the **MENU** key to display the Page Menu.
2. Turn the **large** or **small right** knob to highlight "Show Map Pointer?" and then press **ENT**.



3. Turn the **large** or **small right** knob to move the Map Pointer to highlight an airport with a METAR flag.



4. Press **ENT** to display the METAR text. With "Done?" highlighted, press **ENT** to return to the map view.



To view any airport's Textual METAR page:

1. If not viewing the WPT page group, press **CLR** and turn the **large right** knob to select the WPT page group.
2. Turn the **small right** knob until the Textual METAR page appears.



3. To select another airport, press the **small right (CRSR)** knob to highlight the airport ID (in the "APT" field).
4. Turn the **small** and **large right** knobs to edit the airport identifier for the desired airport. Then, press **ENT** to confirm the airport name.
5. Press the **small right (CRSR)** knob again to remove the cursor (that is, to stop highlighting the APT field).

Textual METAR/TAF Code

The current airport weather reports on the Textual METAR page (and the airport weather forecasts on the TAF page, too) use a rather cryptic format originally devised for teleprinters. You can find information about this format in an FAA publication, Aviation Weather Formats: METAR/TAF, which can be downloaded from the FAA Web site.

You may see the following codes, which differ slightly from the codes described in the FAA publication referenced above, at the start of a METAR on the Textual METAR page:

- SA = METAR — a standard hourly METAR report.
- SP = SPECI — a Special Report inserted between regular hourly METARs to provide late-breaking weather news.

TAF Page

When a GDL 69/69A is installed, the TAF (Terminal Aerodrome Forecast) page is inserted into the WPT page group, immediately after the Textual METAR page.

This page shows a text message giving a weather forecast for a particular airport. The format is similar to that used for METARs, but describes a weather forecast rather than current weather at the particular airport.



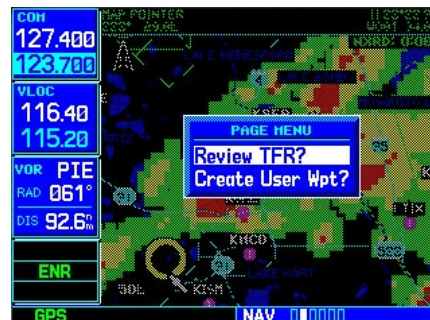
TFR Information

Areas with TFRs (Temporary Flight Restrictions) are shown outlined in yellow on the NAV main page of the 500W-series and on the Map and XM Weather page of both the 400W and 500W-series. More information about Temporary Flight Restrictions can be seen on the TFR Information page, which can be accessed from the Map page or the XM Weather page.

- 1a. With the Map page (the second page of the NAV page group) displayed, press the **small right** knob to bring up the map pointer.
- or
- 1b. With the XM Weather page (the third page of the NAV page group) displayed, press the **MENU** key to bring up the Page Menu. Then, turn the **large right** knob to highlight “Show Map Pointer” and press **ENT** to bring up the map pointer.
2. Turn the **large** and **small right** knobs to move the map pointer to the yellow boundary of a TFR region. When the map pointer is within the TFR region, its boundary will be highlighted with a wider yellow line.



3. Press **ENT**. The first item is the pop-up Page Menu will be “Review TFR?”.



4. Press **ENT** again to see the TFR Information page.



5. Press **ENT** when done viewing the TFR Information page.

The fields of the TFR Information page are as follows:

- **Type.** A brief description of the reason for the temporary flight restriction appears here. Some examples of the text that might appear here are: “Fire,” “Miscellaneous,” “National Security Area,” “Natural Disaster,” and “Sports Event.”
- **Facility/NOTAM.** This field contains a code for the name of the FAA facility that issued the NOTAM (Notice to Airmen) announcing the TFR, followed by the NOTAM number. For instance, “ZSE 6/9507” would mean NOTAM number 6/9507 from the Seattle ARTCC (KZSE).



NOTE: The full text of the NOTAM may be obtained from a local FSS or from the FAA web site, using the contents of this field as a reference to locate the particular NOTAM. However, the information shown on the TFR Information page is sufficient to let you comply with the Temporary Flight Restriction by avoiding the affected area.

- **Active Time.** This field is for the beginning and ending times of the temporary flight restriction. It may be blank, in which case the TFR is active “until further notice.”
- **Vert Limits.** This field gives the upper and lower limits of the airspace to which the TFR applies.

Section 3: XM AUX Pages

When a GDL 69 (or GDL 69A) is installed, two (or three) pages are inserted into the 500W/500W's AUX page group. Here we discuss the two pages that are inserted regardless of whether the XM receiver is a GDL 69 or GDL 69A:

- **XM Information Page.** This page contains information that you will use when activating your XM satellite radio subscription.
- **XM Weather Timestamps Page.** This page shows timestamp data for the most recently received XM weather data.

The other AUX page, which is installed only if the XM receiver is a GDL 69A.

XM Information Page

The XM Information page in the AUX page group is the page you will refer to when activating your subscription to the XM Satellite Radio services.



- **Audio ID.** The Audio ID contains the eight-character identification code of the XM Audio radio built into the GDL 69A. Provide this ID to XM Satellite Radio when activating an XM audio subscription. (In the case of a GDL 69, this field shows eight hyphens instead of an

audio ID, because the GDL 69 is a data-only receiver.)

- **Audio Signal.** The Audio Signal field indicates the signal strength of the GDL 69A's audio signal. (In the case of a GDL 69, this field shows “antenna” rather than a signal strength indication.)
- **Data ID.** The Data ID field contains the eight-character ID code of the XM data radio built into the GDL 69 or GDL 69A. Provide this ID to XM Satellite Radio when activating your XM aviation data subscription.
- **Data Signal.** The Data Signal field displays an indication of the XM data signal strength.
- **Service Class.** Once you have activated your XM Satellite Radio service, the Service Class field will show the XM subscription plan you have purchased. Typical values would be “Aviator LT” or “Aviator.” Currently, the 400W and 500W-series only support a subset of the Aviator LT service from XM Satellite Radio.

Standard Aviator LT	Supported Aviator LT
NEXRAD	Yes
TFRs	Yes
City Forecasts	No
County Warnings	No
Precipitation Type (at surface)	Yes
METARs	Yes
TAFs	Yes

- **GDL 69 Version.** This field shows the version number of the software in your GDL 69 or GDL 69A XM radio receiver.

XM WX Timestamps

The XM WX Timestamps page, like the XM Information page, is added to the 400W/500W's AUX page group when a GDL 69/69A is installed. This page displays date/time stamps showing when the various items of XM weather data were most recently downloaded.



Each of these time stamps is a date-time group in “DDHHMMZ” format, where:

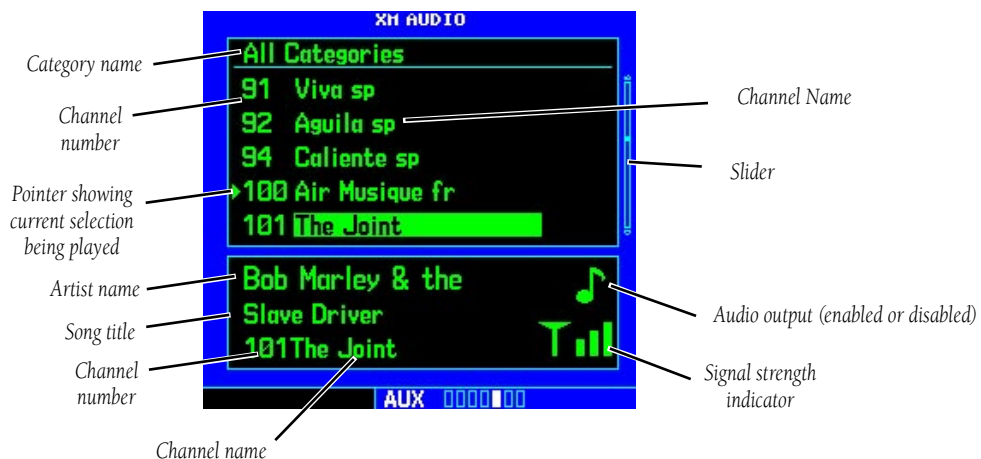
- **DD** is the day of the month
- **HH** is the hour of the day
- **MM** is the minute of the hour
- **Z** is a time zone designator indicating that the date and time are for standard time on the Greenwich meridian: that is, UTC (Coordinated Universal Time).

Section 4: XM Audio

Audio entertainment is available through the XM Satellite Radio Service when activated in the optional installation of the GDL 69A. The 400W and 500W series units serve as the display and control head for your remotely mounted GDL 69A. XM Satellite Radio allows you to enjoy a variety of radio programming over long distances without having to constantly search for new stations. Based on signal from satellites, coverage far exceeds land-based transmissions. When enabled, the XM Satellite Radio audio entertainment is accessible in the AUX function.

The information on the XM Satellite Radio display is composed of four areas: the Active channel, available Channels, Category of the highlighted channel, and the Volume setting. The Active Channel window shows the Channel Name and Number, Artist, Song Title, Category, and provides an indication of signal strength. A bar graph next to the antenna symbol describes the signal strength. Maximum signal strength is shown by three full bars.

The XM Audio page allows you to control the functions of the XM Audio receiver in the GDL 69A, such as, category and channel selection, artist selection, and volume. Pressing the **MENU** key displays the Page Menu selections.



XM Audio Page Description

Selecting categories

1. Press the **small right (CRSR)** knob to highlight the category names. The categories will be listed below in numeric order.
2. Turn the **small right** knob to scroll through the list of categories. Categories are shown in the upper section of the display. The channels for each category are shown in the list below the category title.



3. Press **ENT** to select the highlighted category. The first channel in the selected category will now be highlighted and the current song being played in that channel will be shown in the lower window.



4. Turn the **large right** knob counterclockwise to move the highlight back up to the category name window.

Selecting channels

1. Press the **small right (CRSR)** knob to highlight the category names.
2. Turn the **large right** knob clockwise, or press **ENT**, to move the highlight into the channel selections.
3. Turn the **small right** knob to highlight a channel.
4. Press **ENT** to select the highlighted channel for listening. A triangle will point to the song currently being played.

XM Audio Menu

The XM Audio Menu provides choices for selecting a channel, displaying the channel, artist, or title, enabling audio output, and controlling the volume.

1. While viewing the XM Audio page, press the **MENU** key.



2. Turn the **large** or **small right** knobs to highlight the choices. Press the **ENT** key to make a selection.

Add to Presets List

Up to fifteen channels may be saved as presets to easily return to your favorite channels.

1. While viewing the XM Audio page, selected the desired channel.
2. While the desired channel is highlighted, press the **MENU** key. With "Add to Presets List?" highlighted, press **ENT**.



3. Turn the **large right** knob clockwise to move the highlight into the presets list. Turn the **small right** knob to highlight the position where you want to place the preset.



4. Press **ENT** to replace the previous preset channel with the newly selected channel.



Enter Channel Number

You may directly select a specific channel by using the “Enter Channel Number” item from the Page Menu.

1. While viewing the XM Audio page, press the **MENU** key. Turn the **large right** knob to highlight “Enter Channel Number.”
2. Turn the **large right** knob to move the highlight and the **small right** knob to select a number.



3. Press the **ENT** key to make a selection. The selected channel will now play and is displayed in the window at the bottom of the display.

**Display Channel In List**

Channels can be shown in a list of channels in the middle pane by using the “Display Channel In List” item from the Page Menu.

1. While viewing the XM Audio page, press the **MENU** key. Turn the **large right** knob to highlight “Display Channel In List.”



2. Press the **ENT** key.



Display Artist In List

The name of the artists in the range of displayed channels can be shown in the middle pane by using the “Display Artist In List” item from the Page Menu.

1. While viewing the XM Audio page, press the **MENU** key. Turn the **large right** knob to highlight “Display Artist In List.”



2. Press the **ENT** key.

**Display Title In List**

The Titles of the songs in the range of displayed channels can be shown in the middle pane by using the “Display Title In List” item from the Page Menu.

1. While viewing the XM Audio page, press the **MENU** key. Turn the **large right** knob to highlight “Display Title In List.”



2. Press the **ENT** key.



Enable/Mute Audio Output

The Enable/Mute Audio Output selection of the Page Menu allows you to toggle the audio output On or Off. When Audio Output is muted, a green slash will cross over the music symbol in the song pane.

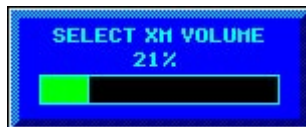
1. While viewing the XM Audio page, press the **MENU** key. Turn the **large right** knob to highlight "Enable Audio Output" or "Disable Audio Output."
2. Press the **ENT** key to perform the highlighted action. Pressing the CLR key toggles the audio output.

Change Volume

The XM Audio volume may be changed in two ways: directly with the **Range** keys or through the Page Menu.



1. While viewing the XM Audio page, press the **MENU** key. Turn the **large right** knob to highlight "Change Volume."
- 2a. Press the **ENT** key and then turn the **small right** knob to change the volume.



or

- 2b. Press the **Range** keys to adjust the volume.

Part Three: TAWS Interface

Section 1: Introduction

Overview

Garmin's Terrain Awareness Warning System (TAWS) is an optional feature (500W-series only) to increase situational awareness and aid in reducing controlled flight into terrain (CFIT). Garmin TAWS satisfies TSO-C151b Class B requirements for certification. Class B TAWS is required for all Part 91 turbine aircraft operations with six or more passenger seats and for Part 135 turbine aircraft operations with six to nine passenger seats (FAR Parts 91.223, 135.154).



Garmin TAWS satisfies TSO-C151b Class B requirements for certification

Operating Criteria

Garmin TAWS requires the following to operate properly:

- The system must have a valid 3D GPS position solution
- The system must have a valid terrain/obstacle database

GPS Position and GPS-MSL Altitude

Garmin TAWS uses information provided from the 500W Series GPS receiver to provide a horizontal position and altitude. GPS altitude is derived from satellite measurements. GPS altitude is converted to a Mean Sea Level (MSL)-based altitude (GPS-MSL Altitude) and is used to determine TAWS alerts. GPS-MSL Altitude accuracy is affected by factors such as satellite geometry, but is not subject to variations in pressure and temperature that normally affect pressure altitude devices. GPS-MSL Altitude does not require local altimeter settings to determine MSL Altitude. Therefore, GPS altitude provides a highly accurate and reliable MSL altitude source to calculate terrain and obstacle alerts.

TAWS Alerting using the GPS Position/GPS-MSL Altitude

Garmin TAWS utilizes terrain and obstacle databases that are referenced to Mean Sea Level (MSL). Using the GPS Position and GPS-MSL Altitude, Garmin TAWS portrays a 2D picture of the surrounding terrain and obstacles relative to the position and altitude of the aircraft. Furthermore, the GPS Position and GPS-MSL Altitude are used to calculate and “predict” the aircraft’s flight path in relation to the surrounding terrain and obstacles. In this manner, the Garmin TAWS system can provide advanced alerts of predicted dangerous terrain conditions. Detailed alert modes are described further in Part Three, Section 3.

Baro-Corrected Altitude versus GPS-MSL Altitude

Baro-Corrected Altitude (or Indicated Altitude) is derived by adjusting the altimeter setting for the local atmospheric conditions. The most accurate Baro-Corrected Altitude can be achieved by frequently updating the altimeter setting to the nearest reporting station along the flight path. However, because actual

atmosphere conditions seldom match the standard conditions defined by the International Standard Atmosphere model (where pressure, temperature, and lapse rates have fixed values), it is common for the Baro-Corrected Altitude (as read from the altimeter) to differ from the GPS-MSL Altitude.

Premature Descent Alerting (PDA) using GPS-MSL Altitude

The Premature Descent Alert (PDA) is announced when the aircraft is significantly below the recommended minimum altitude for an approach. The aircraft's GPS-MSL altitude is compared to a calculated Above-Ground-Level (AGL) altitude along the estimated path to the airport. When the aircraft descends below the calculated minimum altitude for the estimated path, the PDA alert is announced.

Limitations



NOTE: *The data contained in the TAWS databases comes from government agencies. Garmin accurately processes and cross-validates the data, but cannot guarantee the accuracy and completeness of the data.*

TAWS displays terrain and obstructions relative to the altitude of the aircraft. The displayed alerts and warnings are advisory in nature only. Individual obstructions may be shown if available in the database. However, all obstructions may not be available in the database and data may be inaccurate. Never use this information for navigation or to maneuver to avoid obstacles.

Terrain information is based on terrain elevation data contained in a database that may contain inaccuracies. Terrain information should be used as an aid to situational awareness. Never use it for navigation or to maneuver to avoid terrain.

TAWS uses terrain and obstacle information supplied by government sources. The data undergoes verification by Garmin to confirm accuracy of the content, per TSO-C151b. However, the displayed information should never be understood as being all-inclusive.

Section 2: TAWS Operation

TAWS (Terrain Awareness and Warning System) is an optional feature to increase situational awareness and aid in reducing controlled flight into terrain (CFIT). TAWS satisfies TSO-C151b Class B requirements for certification. Class B TAWS is required for all Part 91 aircraft operations with six or more passenger seats and for Part 135 turbine aircraft operations with six to nine passenger seats (FAR Parts 91.223, 135.154).

TAWS provides visual and aural annunciations when terrain and obstacles are within the given altitude threshold from the aircraft.

Requirements

TAWS requires the following to operate properly:

- The system must have a valid 3-D GPS position solution.
- The system must have a valid terrain/obstacle/airport terrain database.

Limitations



NOTE: *The data contained in the TAWS databases comes from government agencies. Garmin accurately processes and cross-validates the data but cannot guarantee the accuracy and completeness of the data.*

TAWS displays terrain and obstructions relative to the altitude of the aircraft. The displayed alerts and warnings are advisory in nature only. Individual obstructions may be shown if available in the database. However, all obstructions may not be available in the database and data may be inaccurate. Never use this information for navigation or to maneuver to avoid obstacles.

Terrain information is based on terrain elevation

information in a database that may contain inaccuracies. Terrain information should be used as an aid to situational awareness. Never use it for navigation or to maneuver to avoid terrain.

TAWS uses terrain and obstacle information supplied by government sources. The data undergoes verification by Garmin to confirm accuracy of the content, per TSO-C151b. However, the displayed information should never be understood as being all-inclusive.

TAWS Alerting Using the GPS Position/GPS-MSL Altitude

TAWS uses information provided from the GPS receiver to provide a horizontal position and altitude. GPS altitude is derived from satellite measurements. GPS altitude is converted to a mean sea level (MSL)-based altitude (GPS-MSL altitude) and is used to determine TAWS alerts. GPS-MSL altitude accuracy is affected by factors such as satellite geometry, but it is not subject to variations in pressure and temperature that normally affect pressure altitude devices. GPS-MSL altitude does not require local altimeter settings to determine MSL altitude. Therefore, GPS altitude provides a highly accurate and reliable MSL altitude source to calculate terrain and obstacle alerts.

Baro-Corrected Altitude Versus GPS-MSL Altitude

Baro-corrected altitude (or indicated altitude) is derived by adjusting the altimeter setting for local atmospheric conditions. The most accurate baro-corrected altitude can be achieved by frequently updating the altimeter setting to the nearest reporting station along the flight path. However, because actual atmosphere conditions seldom match the standard conditions defined by the International Standard Atmosphere (ISA) model (where pressure, temperature, and

lapse rates have fixed values), it is common for the baro-corrected altitude (as read from the altimeter) to differ from the GPS-MSL altitude. This variation results in the aircraft's true altitude differing from the baro-corrected altitude.

Power Up

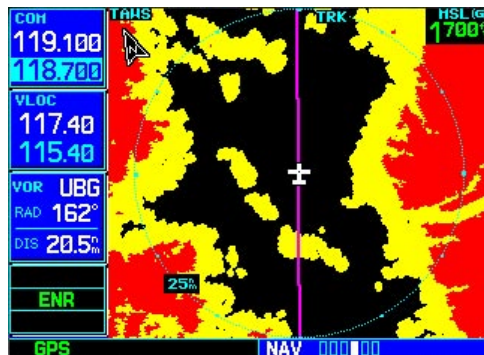
During power-up of the 500W Series unit, the terrain/obstacle database versions are displayed along with a disclaimer to the pilot. At the same time, TAWS self-test begins. TAWS gives the following aural messages upon test completion:

- “**TAWS System Test, OK**”, if the system passes the test
- “**TAWS System Failure**”, if the system fails the test

A test failure is also annunciated for TAWS, as shown in the TAWS Alert Summary table.

TAWS Page

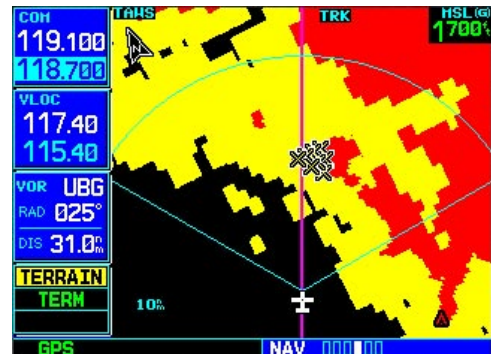
The TAWS Page is in the NAV group of pages (see the 500W Series Pilot's Guide for detailed information regarding page groups and pages).



The TAWS Page

To display the TAWS Page, select the NAV group and turn the **small right** knob until the TAWS Page is displayed. Terrain information, aircraft ground

track, and GPS-derived MSL altitude are displayed on the page. Altitude is shown in increments of 20 feet or in increments of 10 meters, depending on unit configuration. The “G” to right of the MSL altitude display reminds the pilot that altitude is GPS-derived. The TAWS Page has two selectable view settings:



120° Viewing Angle on the TAWS Page

- 360° View—View from above aircraft depicting surrounding terrain on all sides
- 120° View—View of terrain ahead of and 60° to either side of the aircraft flight path



NOTE: The TAWS Page gives a “Track Up” display orientation, as indicated by the “TRK” label shown on the display. This is the only orientation available for the TAWS Page.

To display a 120° view:

1. Select the TAWS Page and press **MENU**. Select “View 120°?”.
2. Press **ENT**. The TAWS Page displays the 120° view. To change to a 360° view, repeat step 1, select “View 360°?”, and press **ENT**.

Seven display ranges are available, allowing for a more complete view of the surrounding area.

To change the display range:

1. Select the TAWS Page and press up or down on the **RNG** key to select the desired range: 1 NM, 2 NM, 5 NM, 10 NM, 25 NM, 50 NM, 100 NM.

Aviation information such as airports, VORs, and other nav aids can be turned on or off on the TAWS Page.

To show or hide aviation information:

1. Press **MENU**.
2. Select "Show (or Hide) Aviation Data?" and press **ENT**. Pressing the **CLR** key when the TAWS Page is displayed can also be used to toggle aviation information on or off.



Aviation Data

Inhibit Mode

TAWS provides an "inhibit mode". This mode is designed to deactivate PDA/FLTA aural and visual alerts when they are deemed unnecessary by the aircrew. Flying VFR into an area where unique terrain exists could cause the system to annunciate a nuisance alert. Pilots should use discretion when inhibiting the TAWS system and always remember to enable the system when appropriate. Only the PDA and FLTA alerts are disabled in the inhibit mode. See section 3 for more information on TAWS alerts.



Inhibiting Terrain

To inhibit PDA and FLTA alerts:

1. Select the TAWS Page and press **MENU**. "Inhibit Terrain?" is selected by default.
2. Press **ENT**. The PDA/FLTA alerts are inhibited. The **TER INHB** annunciation is displayed in the terrain annunciator field whenever terrain is inhibited.

To enable PDA and FLTA alerts:

1. Select the TAWS Page and press **MENU**. "Enable Terrain?" is selected by default.
2. Press **ENT**. The PDA/FLTA alerts are functional again.

External TAWS Inhibit Control

An optional installation is allowed for providing an external TAWS Inhibit switch. Pressing the external TAWS Inhibit switch toggles the TAWS inhibit on and off in the same manner as using the Page Menu selection.

TAWS Manual Test

Garmin TAWS provides a manual test capability which verifies the proper operation of the aural and visual annunciations of the system prior to a flight.



"Test Terrain" selection

To manually test the TAWS system:

1. Select the TAWS Page and press **MENU**.
2. Select the "Test Terrain?" option.
3. Press **ENT** to confirm the selection.

An aural message is played giving the test results:

- "**TAWS System Test, OK**" if the system passes the test
- "**TAWS System Failure**" if the system fail the test



NOTE: TAWS System Testing is disabled when ground speed exceeds 30 knots so as not to impede TAWS alerting.

TAWS Symbols

The symbols depicted below are used to represent obstacles and potential impact points on the TAWS Page. Note that obstacle symbols are shown on display zoom ranges up to 10 NM.

TAWS Alerts

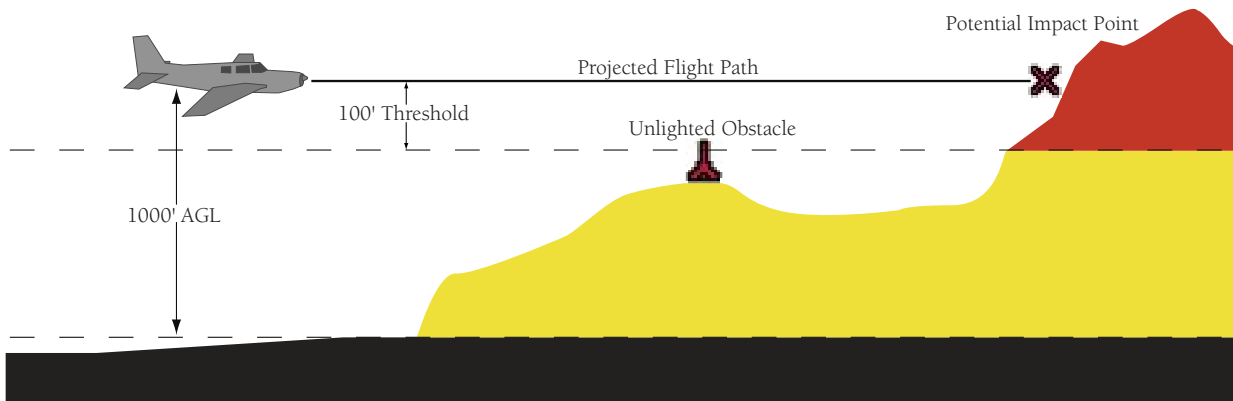
Alerts are issued when flight conditions meet parameters that are set within TAWS software algorithms that detect a potentially hazardous situation. TAWS alerts typically employ either a CAUTION or a WARNING alert severity level, or both. When an alert is issued, visual annunciations are displayed. Aural alerts are simultaneously issued.

Color Interpretation

Garmin TAWS uses black, yellow, and red to depict terrain information relative to aircraft altitude as shown below. Each color is associated with an alert severity level and a suggested course of action. Color assignments are used by terrain graphics, obstacle symbols, and visual annunciations.

Obstacle Symbol	Unlighted Obstacle		Lighted Obstacle		Potential Impact Points	Terrain Color	Terrain/Obstacle Location	Alert Level
	< 1000 ft AGL	> 1000 ft AGL	< 1000 ft AGL	> 1000 ft AGL				
						Red	Terrain/Obstacle at or within 100 ft below current aircraft altitude	WARNING
						Yellow	Terrain/Obstacle between 100 ft and 1000 ft below current aircraft altitude	CAUTION
						Black	Terrain more than 1000 ft below the aircraft altitude	NO DANGER

TAWS Terrain/Obstacle Colors and Symbology



Terrain Altitude/Color Correlation for Terrain Proximity

General Database Information

Garmin TAWS uses terrain and obstacle information supplied by government sources. The data undergoes verification by Garmin to confirm accuracy of the content, per TSO-C151b. **However, the displayed information should never be understood as being all-inclusive. Pilots must familiarize themselves with the appropriate charts for safe flight.**



NOTE: The data contained in the terrain and obstacle databases comes from government agencies. Garmin accurately processes and cross-validates the data, but cannot guarantee the accuracy and completeness of the data.

The terrain/obstacle databases are contained on a datacard which is inserted in the right-most slot of the 400W/500W Series units.

Database Versions

The version and area of coverage of each terrain/obstacle database is shown on the Terrain Database Versions Page, located in the AUX Page Group. Databases are checked for integrity at power-up. If a database is found to be missing and/or deficient, the TAWS system fails the self-test and displays the TAWS system failure message.



Terrain Database Information

Database Updates

Terrain/obstacle databases are updated periodically with the latest terrain and obstacle data. Visit the Garmin website to check for newer versions of terrain/obstacle databases. Compare database cycle numbers to determine if a newer version is available.

The database update process includes either reprogramming or replacing the database card and inserting the updated card in the right card slot on the unit front panel. The terrain/obstacle database may be downloaded via the internet and the card reprogrammed using a USB programmer available from Garmin. Contact Garmin at 800-800-1020 or at www.garmin.com for more information.

To update your terrain/obstacle databases:

1. Acquire a new terrain data card from Garmin.
2. Turn off the power to the 500W Series unit.
3. Remove the old terrain data card and insert the new card into the right-most slot of the 500W Series unit.
4. Turn on the 500W Series unit and verify that the TAWS system passes self-test.

Terrain/Obstacle Database Areas of Coverage

The following describes the area of coverage available in each database. Regional definitions may change without notice.

The terrain and airport terrain databases include worldwide coverage that includes: Latitudes South 60° to North 75°.

The obstacle database provides coverage for the USA and Europe that includes:

United States: Limited to the United States, some areas of Canada, Mexico, the Caribbean, and the Pacific.

Europe: Limited to Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, and the United Kingdom.



NOTE: *Obstacles 200 feet and higher are included in the Obstacle Database. It is very important to note that not all obstacles are necessarily charted and therefore may not be contained in the Obstacle Database.*

Navigation Database

As explained in the “Premature Descent Alerting (PDA)” section, Garmin TAWS Premature Descent Alerting (PDA) algorithms utilize data contained in the navigation database. ***It is therefore important to also have the latest navigation database installed to ensure correct TAWS alerting.***

TAWS Phase of Flight

The TAWS Phase of Flight definitions are listed below:

En Route Phase - Defined as when the aircraft is more than 15 NM from the destination airport, or when the conditions for Terminal, Approach, and Departure Phases are not met.

Terminal Phase - Defined as when all three of the following conditions are met:

- The aircraft is 15 NM or less from the destination runway.
- The distance to the destination runway threshold is decreasing.
- The aircraft is at or below (lower than) a straight line drawn between the two points specified in the table below (relative to the destination runway).

Distance to Runway	Height above Runway
15 NM	3500 feet
5 NM	1900 feet

Approach Phase - Defined as when all three of the following conditions are met:

- The distance to the destination runway threshold is equal to or less than 5 NM.
- The height above the destination runway threshold elevation is equal to or less than 1000 feet.
- The distance to the destination runway threshold is decreasing.

Departure Phase - Defined as when all five of the following conditions are met:

- It has been determined that the aircraft was previously “on-ground.”
- The aircraft has a vertical velocity greater than zero.
- The aircraft has a ground speed greater than 35 knots.
- The aircraft has an altitude greater than 150 feet AGL and less than 1500 feet AGL.
- The aircraft is within 15 NM of the departure airport.



NOTE: *There are additional factors beyond what is outlined above that may alter the determined TAWS flight phase.*

Nearest Airport Criteria & TAWS Phase of Flight

Changes to the Nearest Airport Criteria Page affects how TAWS performs. The nearest airport list is used to derive the TAWS destination airport when there is no loaded active flight plan or when off the active flight plan or when deviating from the active flight plan (whenever the TAWS algorithms go into estimation mode). In turn, the nearest airport list is used to determine the TAWS phase of flight. The TAWS phase of flight dictates the Required Terrain Clearance (RTC) levels at which Forward Looking Terrain Avoidance (FLTA) alerting occurs. TAWS Premature Descent Alerting (PDA) alerts are also affected by nearest airport list configuration. Airports that are not in the nearest list would not have PDA alerts issued.



Nearest Airport Criteria Page

As an example, if the pilot configures the unit to include only airports with runways 5000 feet or longer, only these are added to the nearest airport list. The TAWS phase of flight is affected in that all airport runways under 5000 feet are NOT included in TAWS calculations. During a cross-country flight with this configuration, only airports runways 5000 feet or greater cause the unit to go into Terminal or Approach Mode from En Route mode. If the pilot makes an emergency landing at an airport that did not show up in the nearest airport list, FLTA alerts would be issued throughout the descent.

TAWS Destination Airport

The TAWS destination airport is considered to be the next airport in the flight plan while adhering to the flight plan path. If no flight plan is entered, or if the aircraft is not adhering to the entered flight plan path, the TAWS destination airport is estimated using the Nearest Airport Criteria as described in the section above.

Section 3: TAWS Alerts

Alerts are issued when flight conditions meet parameters that are set within TAWS software algorithms. TAWS alerts typically employ either a **CAUTION** or a **WARNING** alert severity level, or both. When an alert is issued, visual annunciations are displayed. Aural alerts are simultaneously issued. Annunciations appear in a dedicated field in the lower left corner of the display.

TAWS Annunciation Field



TAWS Annunciation Field

Annunciations are color-coded according to the TAWS Alert Summary table. Pop-up terrain alerts can also appear during an alert, but **only when the TAWS Page is not displayed**. There are two options when an alert is displayed:

To acknowledge the pop-up alert and return to the currently viewed page:

Press the **CLR** button.

To acknowledge the pop-up alert and quickly access the TAWS Page:

Press the **ENT** button.



NOTE: To further capture the attention of the pilot, TAWS issues aural (voice) messages that accompany visual annunciations and pop-up alerts. Some aural messages are configurable during installation of the system. For a summary of aural messages, see the TAWS Alert Summary table in Appendix A.

Forward Looking Terrain Avoidance

The Forward Looking Terrain Avoidance alert, or FLTA, is used by TAWS and is composed of two elements:

Reduced Required Terrain Clearance and Reduced Required Obstacle Clearance

Reduced Required Terrain Clearance (RTC) Avoidance — Reduced Required Terrain Clearance (RTC) and Reduced Required Obstacle Clearance (ROC) alerts are issued when the aircraft flight path is above terrain, yet is projected to come within the minimum clearance values shown below. When an RTC alert is issued, a potential impact point is displayed on the TAWS Page.



TERRAIN

CAUTION—Estimated potential impact in approximately 60 seconds after pop-up alert and annunciation. RTC/ITI caution alerts are accompanied by the aural message "Caution Terrain; Caution Terrain" OR "Terrain Ahead; Terrain Ahead". Similarly, a "Caution Obstacle; Caution Obstacle" or "Obstacle Ahead; Obstacle Ahead" alert is also provided.

Imminent Terrain Impact and Imminent Obstacle Impact

Imminent Terrain Impact (ITI) and Imminent Obstacle Impact (IOI) alerts are issued when the aircraft is below the elevation of a terrain or obstacle cell in the aircraft's projected path. ITI and IOI alerts are accompanied by a potential impact point displayed on the TAWS Page. The alert is annunciated when the projected vertical flight path is calculated to come within minimum clearance altitudes shown below.



PULL UP

WARNING—Estimated potential impact in approximately 30 seconds after pop-up alert and annunciation. RTC/ITI warning alerts are accompanied by the aural message “*Terrain, Terrain; Pull Up, Pull Up*” or “*Terrain Ahead, Pull Up; Terrain Ahead, Pull Up*”. Similarly, a “*Obstacle, Obstacle; Pull Up, Pull Up*” or “*Obstacle Ahead, Pull Up; Obstacle Ahead, Pull Up*” alert is also provided.

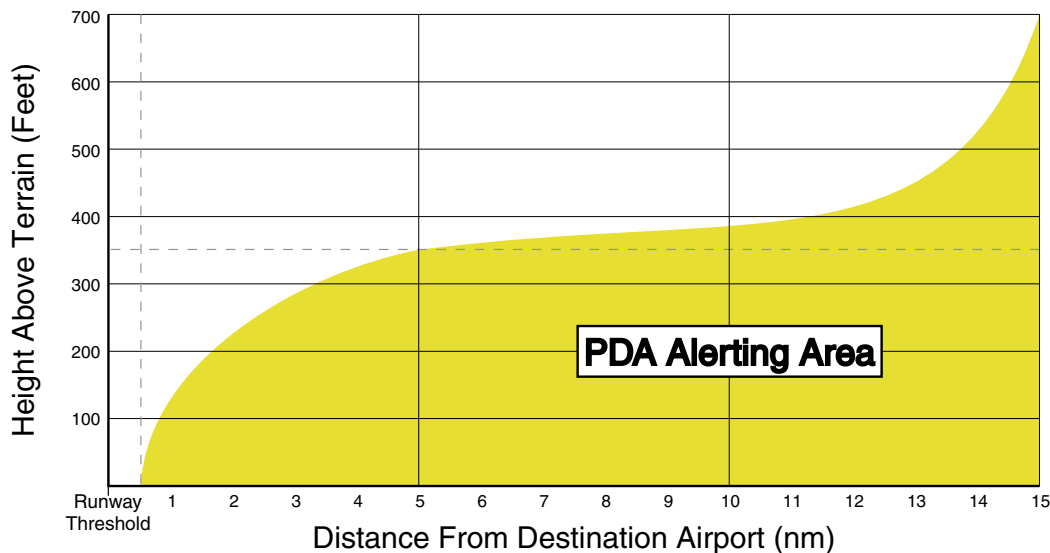
Phase of Flight	Level Flight	Descending
En Route	700 ft.	500 ft.
Terminal	350 ft.	300 ft.
Approach	150 ft.	100 ft.
Departure	100 ft.	100 ft.

Minimum TERRAIN Clearance Values for RTC/ITI Alerts

During the final approach phase of flight, RTC/ITI alerts are automatically inhibited when the aircraft is below 200 feet AGL while within 0.5 NM of the approach runway or is below 125 feet AGL while within 1.0 NM of the runway.

Premature Descent Alerting (PDA)

The TERRAIN system issues a Premature Descent Alert (PDA) when the system detects that the aircraft is significantly below the normal approach path to a runway. PDA begins when the aircraft is within 15 NM of the destination airport. PDA ends when the aircraft is either 0.5 NM from the runway threshold or is below an altitude of 125 feet AGL while within 1.0 NM of the threshold.



PDA Severity Levels

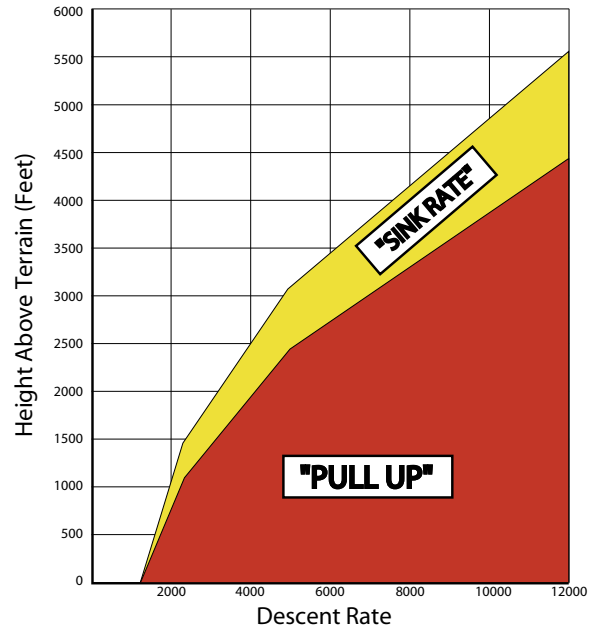


TERRAIN

CAUTION — The above annunciation and pop-up terrain alert are displayed during a PDA alert. For TAWS, the PDA alert is accompanied by the aural message *"Too Low, Terrain"*.

Excessive Descent Rate Alert (EDR)

The purpose of the Excessive Descent Rate alert is to provide suitable notification when the aircraft is determined to be closing (descending) upon terrain at an excessive speed. The parameters for the alert as defined by TSO-C151b are shown in the Descent Rate graph.



Excessive Descent Rate Graph

Excessive Descent Rate Severity Levels



TERRAIN

CAUTION—The annunciation and pop-up terrain alert are accompanied by the aural message *"Sink Rate"*.



PULL UP

WARNING—The annunciation and pop-up terrain alert are accompanied by the aural message “Pull Up”.

Negative Climb Rate After Takeoff Alert (NCR)

The purpose of the Negative Climb Rate After Takeoff alert (also referred to as “Altitude Loss After Takeoff”) is to provide suitable alerts to the pilot when the system determines that the aircraft is losing altitude (closing upon terrain) after takeoff. The aural message “Don’t Sink” is given for NCR alerts, accompanied by an annunciation and a pop-up terrain alert on the display.

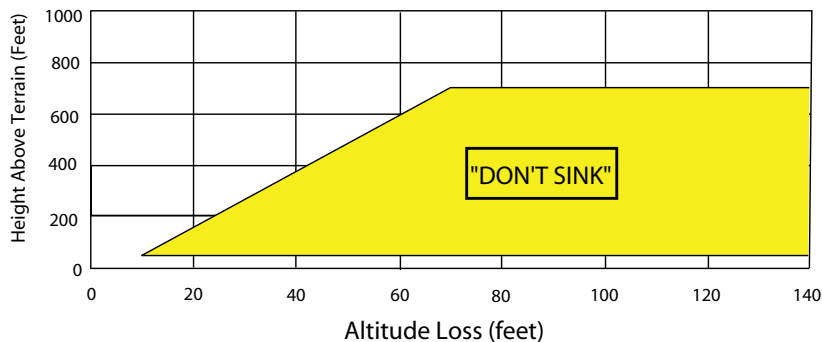


The “Don’t Sink” pop-up terrain alert accompanies the aural message for the NCR alert. The aural message “Don’t Sink” or “Too low, terrain” is issued also.

NCR alerting is only active when departing from an airport and when the following conditions are met:

- The height above the terrain is less than 700 feet
- The distance from the departure airport is 2 NM or less
- The heading change from the heading at the time of departure is less than 110 degrees

The NCR alerting parameters as defined by TSO-C151b are shown in the Negative Climb Rate graph.



Negative Climb Rate (NCR) Graph

“Five-Hundred” Aural Alert

The purpose of the aural alert message “*Five-Hundred*” is to provide an advisory alert to the pilot that the aircraft is five-hundred feet above terrain. When the aircraft descends within 500 feet of terrain, the aural message “*Five-hundred*” is generated. There are no display annunciations or pop-up alerts that accompany the aural message.

TAWS Failure Alert

TAWS continually monitors several system-critical items, such as database validity, hardware status, and GPS status. If the terrain/obstacle database is not available, the aural message “*TAWS System Failure*” is issued along with the “TER FAIL” annunciation.

TAWS Not Available Alert

Garmin TAWS requires a 3-D GPS navigation solution along with specific vertical accuracy minimums. Should the navigation solution become degraded, or if the aircraft is out of the database coverage area, the annunciation “TER N/A” is generated in the annunciation window. When the GPS signal is re-established and the aircraft is within the database coverage area, the “TER N/A” annunciation is removed.

TAWS Alert Summary

The aural alert voice gender is configurable to be either male or female. Also, there are different alert text phrases available for several of the alerts, as shown below. See your Garmin installer for further information on configuring the alert system.

TAWS Alerts Summary

Alert Type	TAWS Page Annunciation	Pop-Up Alert	Aural Message
TAWS System Failure	TER FAIL	None	"TAWS System Failure"
Terrain Inhibited	TER INHB	None	None
Terrain Not Available	TER N/A	None	"Terrain Not Available"
Excessive Descent Rate (EDR) Caution	TERRAIN	SINK RATE	"Sink Rate"
Excessive Descent Rate (EDR) Warning	PULL UP	PULL-UP	"Pull Up"
Required Terrain Clearance (RTC) Caution	TERRAIN	CAUTION - TERRAIN or TERRAIN AHEAD	"Caution, Terrain; Caution, Terrain" or "Terrain Ahead; Terrain Ahead"
Required Terrain Clearance (RTC) Warning	PULL UP	TERRAIN - PULL-UP or TERRAIN AHEAD - PULL-UP	"Terrain, Terrain; Pull Up, Pull Up" or "Terrain Ahead, Pull Up; Terrain Ahead, Pull Up"
Imminent Obstacle Impact (IOI) Caution	TERRAIN	OBSTACLE AHEAD or CAUTION - OBSTACLE	"Obstacle Ahead; Obstacle Ahead" or "Caution, Obstacle; Caution, Obstacle"
Imminent Terrain Impact (ITI) Warning	PULL UP	TERRAIN AHEAD - PULL-UP or TERRAIN - PULL-UP	Terrain Ahead, Pull Up; Terrain Ahead, Pull Up" or "Terrain, Terrain; Pull Up, Pull Up"
Required Obstacle Clearance (ROC) Caution	TERRAIN	CAUTION - OBSTACLE or OBSTACLE AHEAD	"Caution, Obstacle; Caution, Obstacle" or "Obstacle Ahead; Obstacle Ahead"
Required Obstacle Clearance (ROC) Warning	PULL UP	OBSTACLE - PULL-UP or OBSTACLE AHEAD - PULL-UP	"Obstacle, Obstacle; Pull Up, Pull Up" or "Obstacle Ahead, Pull Up; Obstacle Ahead, Pull Up"



NOTE: TAWS Caution Alerts are displayed as constant black text on a yellow background; TAWS Warning Alerts are displayed as constant white text on a red background.

Alert Type	TAWS Page Annunciation	Pop-Up Alert	Aural Message
Imminent Terrain Impact (ITI) Caution	TERRAIN	TERRAIN AHEAD or CAUTION - TERRAIN	"Terrain Ahead; Terrain Ahead" or "Caution, Terrain; Caution, Terrain"
Imminent Obstacle Impact (IOI) Warning	PULL UP	OBSTACLE AHEAD - PULL-UP or OBSTACLE - PULL-UP	"Obstacle Ahead, Pull Up; Obstacle Ahead, Pull Up" or "Obstacle, Obstacle; Pull Up, Pull Up"
Premature Descent Alert (PDA) Caution	TERRAIN	TOO LOW - TERRAIN	"Too Low, Terrain"
Negative Climb Rate (NCR) Caution	TERRAIN	DON'T SINK or TOO LOW - TERRAIN	"Don't Sink" or "Too Low, Terrain"
Altitude Callout "500"	None	None	"Five-Hundred"



NOTE: TAWS Caution Alerts are displayed as constant black text on a yellow background; TAWS Warning Alerts are displayed as constant white text on a red background.

TAWS Alerts Summary (continued)

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