# 400/500 Series Garmin Display Interfaces

Pilot's Guide Addendum

- GDL 49 Weather Datalink
- GTX 330/330D TIS Interface
- Garmin TERRAIN Interface
- Garmin TAWS Interface (GPS 500 & GNS 530)

This Pilot's Guide Addendum is written for:

- Garmin GPS 400, GNC 420/420A, and GNS 430/430A Main System Software Version 5.10
- Garmin GPS 500 & GNS 530/530A Main System Software Version 5.01
- GTX 330/330D Main Software Version 3.06
- GDL 49 Main Software Version 2.03

Some differences in operation may be observed when comparing the information in this manual to earlier or later software versions

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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 400/500 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 400/500 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, and TAWS/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 400/500 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 for vertical navigation.

CAUTION: The Jeppesen database incorporated in the Garmin 400/500 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 400/500 Series Unit package. Pilots using an out-of-date database do so entirely at their own risk.

CAUTION: The Weather Data Link, TIS, and TAWS/TERRAIN information contained in this Pilot's Guide Addendum is not intended to replace the documentation that is supplied with the applicable Garmin 400/500 Series Unit, the GDL 49, and the GTX 330 Transponder. The user must know how to operate the 400/500 Series Unit and be knowledgeable of the information in the 400/500 Pilot's Guide.

*TIS CAUTION:*

*TIS is <u>NOT</u> intended to be used as a collision avoidance system and does not relieve the 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.*

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**PART TWO — WEATHER DATA LINK INTERFACE**

*The screen display examples shown in this addendum are taken from the GNS 430 and GNS 530. TIS and Weather Data Link Display Interface functionality is the same for the 400 and 500 Series Units. TIS Traffic Display and Weather Data Link are available only when the 400/500 units are configured with the GTX 330 Mode S Transponder and GDL 49 Data Link Satellite Transceiver, respectively.*

*Garmin TERRAIN is offered as a standard feature for 400/500 Series units equipped with software version 5.10 or above, along with corresponding hardware updates.*

*Garmin TAWS is offered as an option for GPS 500 and GNS 530 units. Differences between TAWS and TERRAIN are outlined in Part Three of this manual.*

*TAWS/TERRAIN CAUTION:*

*Garmin TERRAIN is <u>NOT</u> intended to be used as a primary reference for terrain avoidance and does not relieve the pilot responsibility to be aware of surroundings during flight. TERRAIN is to be used only as an aid for terrain avoidance and is not certified for use in applications requiring a terrain awareness system. Only Garmin TAWS is certified according to TSO-C151b as a Class B terrain awareness system.*

# 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 400/500 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 equipped aircraft.  TIS is a ground-based service providing relative location of all ATCRBS 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 400/500 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 7 nautical miles horizontally from 3000 feet below to 3500 feet above the requesting aircraft.
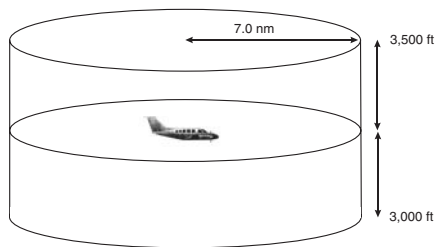


TIS Coverage Volume (not to scale)

*How TCAS differs from TIS*—*the main difference between TIS and TCAS is the source of surveillance data. TCAS uses an airborne interrogator with a half-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.*

*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 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 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" communications 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.

TIS information is collected one radar scan prior to the scan during which the uplink occurs. Therefore, the surveillance information is approximately 5 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 400/500 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 ¼ 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.*

*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 rather 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.*

*The TIS audio alert is generated whenever the number of Traffic Advisories on the 400/500 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.*

## TIS Symbology

TIS traffic is displayed on the 400/500 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 Advisory (TA)—This symbol is generated when traffic meets the advisory criteria described on page 9.

Own Aircraft

Traffic Ground Track is indicated on the 400/500 display by a "target track vector", a short line displayed in 45-degree increments.  This vector shows the flight direction of the traffic.
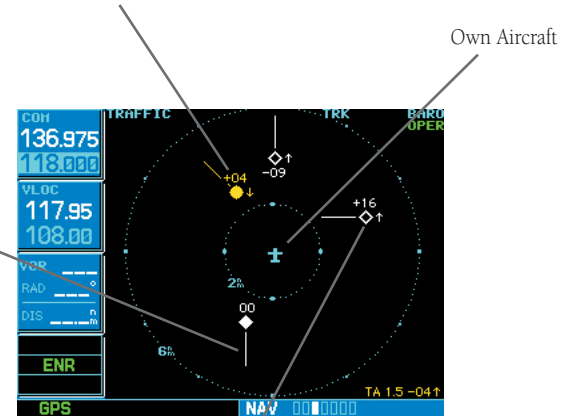
'Other' Traffic—This symbol represents traffic detected within the selected display range that does not generate a TA.

## Section 2:  Control and Display

### TIS Traffic Display Status and Pilot Response

- STBY — When the 400/500 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 400/500 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). After another 6 seconds, if data is still not received, the traffic is removed from the display. The pilot should be aware that the quality of displayed traffic is reduced in this condition.

- TRFC CST — The 'TRFC CST' (traffic coasting) banner located above the AGE timer indicates that displayed traffic is held even though the data is stale. The pilot should be aware that the quality of displayed traffic is reduced in this condition.

- TRFC RMVD — The 'TRFC RMVD' banner indicates that traffic has been removed from the display due to the age of the data being too old to "coast" (for the time period of 12-60 seconds from the last receipt of a TIS message). The pilot should be aware that traffic may be present but not shown.

- UNAVAIL — When a 60 second period elapses with no data, TIS is considered to be unavailable. This state is indicated by the text 'UNAVAILABLE' (500 Series) and 'UNAVAIL' (400 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, 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.

- 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 installer for corrective action.

- FAILED — 'FAILED' is displayed when the GTX 330 has indicated it has failed. The pilot should see the installer for corrective action.



*Traffic Age Indication showing "traffic coasting".*



*Traffic Page displaying 'TRFC RMVD' banner.*

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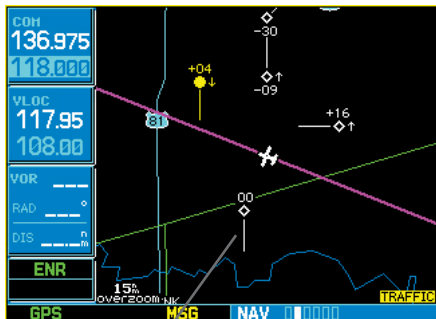
*Traffic Target Track Vector.*



*Traffic Warning Window*

### Traffic Ground Track

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

### Traffic Warning Window

When the unit is on any page (other than the NAV Traffic Page) 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**.

> 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 400/500 Series unit pages, the Traffic Page and the Map Page. The 500 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:**

1.  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.

### 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 (400 Series) or four (500 Series) data fields on the right side of the Map Page.

#### 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 (400 Series) or four (500 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.

*The Map Page displaying traffic.*
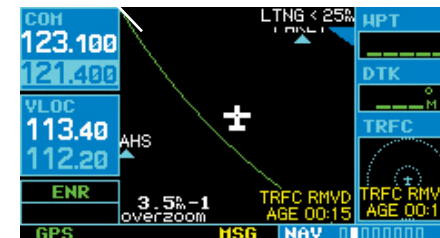


*Thumbnail Traffic displayed on the GNS 430.*
***NOTE:*** *The thumbnail will display traffic coasting 'TRFC CST' or traffic removed 'TRFC RMVD' in the lower right when TIS messages have been missed.*

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

### 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.

### 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 sidebar). The user should not start evasive maneuvers using information from the 400/500 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.*



Intruder Aircraft

0.5 nm   + 500 ft

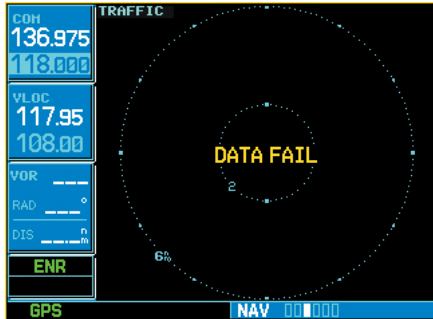This area within 34 seconds   - 500 ft
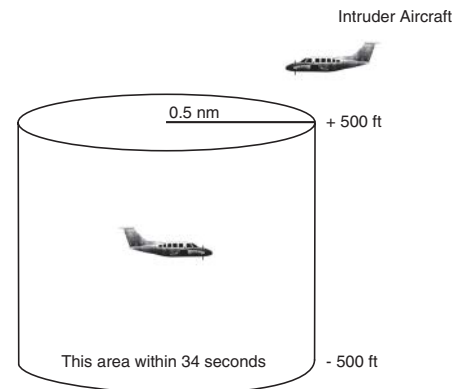
**Conditions for Traffic Advisories**

*The following condition causes TIS to display a Traffic Advisory (TA) on the 400/500 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 ft) your course within 34 seconds.*

*'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.*

## 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.

## 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 400/500 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 page 5 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 400/500 Series unit displays 'STBY'. As described previously, both the standby and operating modes can be manually overridden by the display controls.

# PART TWO:
# WEATHER DATA LINK INTERFACE

## Section 1:  Introduction

The Garmin 400/500 Series units provide the display interface and control for satellite up-linked textual and graphical weather on a request/reply basis. Transmissions are made using bursts of compressed data at a rate of 4800 bps.

Functions provided by the Data Link system include:

- Request for and display of NEXRAD radar imagery.

- Request for and display of text-based METAR data.

- Request for and display of a compressed form of METAR data that allows icon representations at reporting stations on a moving map indicating visibility, ceiling, etc.

- Position tracking services are provided through periodic position report transmissions from the 400/500 Series unit.

## Weather Products

The following weather products are available for display on the 400/500 Series unit via the Data Link interface:

- NEXRAD Data

- Graphical METAR Data

- Text-based METAR Data

- Graphical Temperature/Dewpoint Data

- Graphical Wind Data

*How it Works:*

*NEXRAD and METAR data is collected by the National Weather Service and disseminated to Meteorlogix™, a weather information provider. This data is then delivered to Echo Flight (a delivery systems provider) via geostationary satellite to a weather server in the Echo Flight Message System. The system immediately makes the data available to Echo Flight users.*

*With the weather data always readily available on the system, an incoming customer request is filled, logged, and turned around for delivery via ORBCOMM in less than five seconds (ORBCOMM is a provider of global messaging services using a constellation of 26 low-Earth orbiting satellites).*

*The weather data is then forwarded to ORBCOMM where the ORBCOMM Message Switch (OMS) relays the message to the appropriate Ground-Earth station (GES) for delivery to the satellite. The message is relayed from the satellite to the Garmin GDL 49 Data Link Transceiver aboard the aircraft. Once the GDL 49 receives the message, it is displayed on the 400/500 Series unit.*

*CAUTION: NEXRAD weather data is to be used for long-range planning purposes only. Due to inherent delays and relative age of the data that can be experienced, NEXRAD weather data cannot be used for short-range avoidance of weather.*

## Section 2:  NEXRAD Overview

### NEXRAD Description

WSR-88D weather surveillance radar or NEXRAD (NEXt generation RADar) is a Doppler radar system that has greatly improved the detection of meteorological events such as thunderstorms, tornadoes, and hurricanes. An extensive network of NEXRAD stations provides almost complete radar coverage of the continental United States, Alaska, and Hawaii. The range of each NEXRAD is 124 nautical miles.

### NEXRAD Abnormalities

There are possible abnormalities regarding displayed NEXRAD images.  Some, but not all, of those include:
- Ground Clutter
- Strobes 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

### 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.
- Depending on the amount and complexity of the weather data being received, the resolution of the displayed NEXRAD data may be anywhere from 2-12 km. Therefore, when zoomed in on the display, each square block is 2-12 kilometers in square diameter. The intensity level reflected by the square will be the highest level sampled within the 2-12 kilometer area.

### 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. Precipitation intensity is displayed on the 400/500 Series units using colors represented by the dBz values listed in Appendix C.

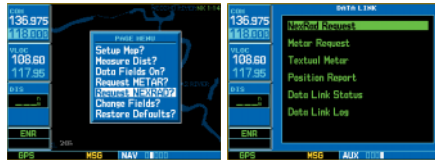*The information presented in this Pilot's Guide regarding NEXRAD is not meant to be comprehensive. The NOAA website contains complete and detailed information regarding NEXRAD weather radar operation and theory. You can visit them at www.noaa.gov.*
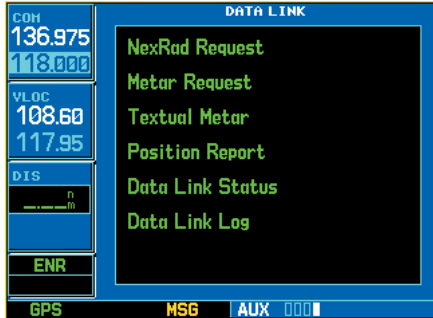
*The Data Link Page is the main page of the Weather Data Link interface.*



Map Page          Data Link Page

*NEXRAD data can be requested from the Map Page or the Data Link Page.*

# Section 3:  NEXRAD Operation

NOTE:  This Weather Data Link information assumes the user has knowledge of the Takeoff Tour in the 400/500 Series Pilot's Guide concerning Page Groups, Page Selection, Key and Knob Functions, and Data Entry.

## Requesting NEXRAD Data

NEXRAD data can be requested from the Data Link Page or the Map Page.

### To request NEXRAD data from the Data Link Page:

1.  Select the Data Link Page. When the 400/500 Series unit is configured for the Data Link interface, the Data Link Page is the fourth page in AUX Page Group.

2.  Press **CRSR**. 'NexRAD REQUEST' is highlighted.

3.  Press **ENT**. The NEXRAD REQUEST Page (see page 14) is displayed containing the following fields:

**Center —** this field allows you to specify reference points for the request. Up to five reference points are available:

- Current Position — Request NEXRAD data from your current position.
- Look Ahead — Request NEXRAD data ahead of (along) your current route.
- From ID — Request NEXRAD data from a specific waypoint identifier. If 'From ID' is selected for the reference point for the request, the 'WPT' field is displayed. This field is used to enter a waypoint identifier as the reference point for the request.
- From Lat/Lon — Request NEXRAD data from a specific latitude and longitude. This is only selectable when requesting from the map. The 'Position' field displays the position of the map cursor and cannot be edited.
    - From Flight Plan — Request NEXRAD data from one of the waypoints on the active flight plan. This is only selectable when an active 'Flight Plan' has been selected. The 'Flight Plan' field is used to select which waypoint in your active flight plan to use as the reference point for the request.

**Radius —** This field selects a request radius from 50 to 250 nautical miles from the selected position.

**Position —** 'Current Posn'-Position is current, 'Look Ahead'-Position is look ahead position, and 'From Lat/Lon'-Position is Map Cursor position.

**Auto Request —** This field is used to set the time interval for the system to automatically send a NEXRAD data request. The time options are OFF, 10 min, 15 min, 20 min, 30 min, 45 min, and 1 hour. When an auto request time is selected, the first request will be sent after the specified time has elapsed from when the field was set (as opposed to immediately sending a request).

**Manual Send? —** This field is used to send out a current single request for NEXRAD Data.

1. Select the desired field and enter the appropriate data.
2. Select 'Manual Send?' or 'Auto Request' and press **ENT.** The request has been sent. Note that selecting 'Auto Request' and pressing **ENT** will not send the request until after the auto time period.
3. To exit from the NEXRAD Request Page, press **CRSR**. The Data Link Page is displayed.

### To request NEXRAD data from the Map Page:

1. Select the Map Page.
2. Press **MENU**. The Map Page Options Menu is displayed.
3. Select 'Request NEXRAD?' and press **ENT**. The NEXRAD Request Page is displayed defaulting to the following fields:

   - Center — This field specifies the reference point for your request; defaults to your current position or map cursor position.

   - Radius — this field selects a request radius from 50 to 250 nautical miles from the selected position.

   - Position — This field displays the selected (current or map) position and is not user selectable.

   - Manual Send? — This field is used to send out a current single request for NEXRAD Data.

4. Change field, and/or enter a radius, if desired.
5. Select 'Manual Send?' and press **ENT**. Once the request has been sent, the statement 'MSG Queued' is momentarily displayed.
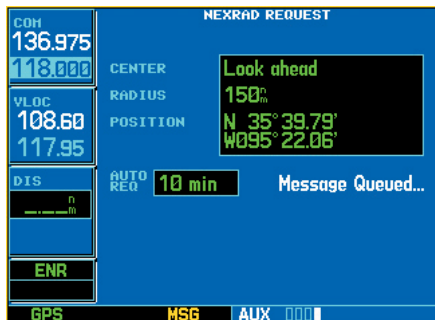6. To exit from the NEXRAD Request Page, press **CRSR**. The Map Page is displayed.
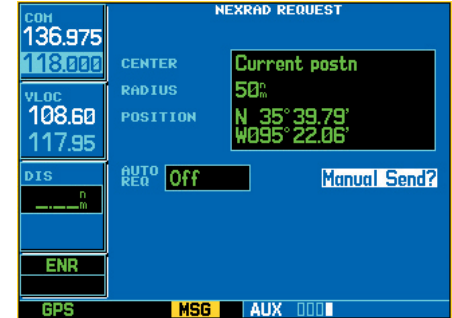
*The NEXRAD Request Page.*
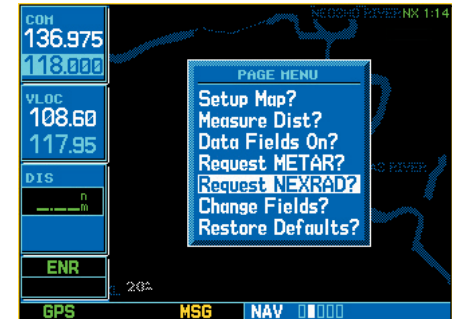


*Requesting NEXRAD data from the Map Page.*

*Once a request has been manually sent, the words 'Message Queued' are momentarily displayed.*



*The NAV Weather Page.*

### Data Received Message

When the request has been answered, the message annunciator (MSG) will flash to alert you to one of the following messages depending on the type of data received:

- New NEXRAD Received
- New Graphic METAR Received
- New Text METAR Received

### Displaying NEXRAD Data on the NAV Weather Page

#### To select the Weather Page from the Data Link Page:

1. Turn the **large right knob** and move through the Page Groups until the Nav Page Group is selected.
2. Turn the **small right knob** until the Weather Page is selected. When the 400/500 Series unit is configured with the Data Link interface, the Weather Page is the third page in the NAV Page Group (it is the fourth page if a traffic sensor is also configured).

### Customizing NEXRAD Data on the NAV Weather Page

You can customize the NEXRAD data on the NAV Weather Page from the Weather Page Options Menu.

#### To customize the NEXRAD data on the NAV Weather Page:

1. From the Weather Page, press **MENU** to display the NAV Weather Page Options Menu.
2. Select from the following options to customize the NEXRAD data:

    **View 120°? / View 360°?** — There are two viewing options available, each shown relative to the position of the aircraft. When the MENU button is pressed, the alternate selection will be shown. Use this option to switch between a radar-like, 120° display of the data, and the default 360° display.

    **Request New Data?** — This option is a link to either the NEXRAD or METAR Request Pages, depending on which is currently displayed on the Weather Page.

## Displaying NEXRAD Data on the Map Page

When NEXRAD data is received, it is displayed on the Map Page, in addition to the Weather Page and the default NAV Page.

### To select the Map Page from the Data Link Page:

1. Turn the **large right knob** and move through the Page Groups until the Nav Page Group is selected.
2. Turn the **small right knob** until the Map Page is selected.

## Customizing NEXRAD Data on the Map Page

You can customize NEXRAD data on the Map Page by using the Map Page Options Menu.
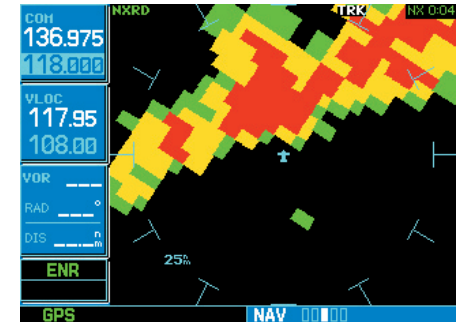
### To customize the Map Page:

1. Go to the Map Page, the second page in the NAV Group.
2. Press **MENU** and select 'Setup Map?' from the page menu.
3. Select 'Weather' from the GROUP field in the Map Setup window.
4. Highlight the NEXRAD SMBL field, and use the **small right knob** to set the desired map range at which to overlay NEXRAD data. The range values are 'Off' to 2000 nm miles. Press **ENT** for the desired range selection. Press **CLR** to go back to the Map Page.
5. Highlight the NEXRAD DENSITY field, use the **small right knob** to set the density desired (i.e., the transparency) of the NEXRAD cells. The density values are LOW-MED-HIGH. Press **ENT** for your selection then **CLR** to go back to the Map Page.

## Displaying NEXRAD Data on the Default NAV Page

When NEXRAD data is received, it is displayed on the default NAV Page, in addition to the Weather Page and the Map Page.

### To select the Default NAV Page from the Data Link Page:

1. Turn the **large right knob** to the left and move through the Page Groups until the Nav Page Group is selected.
2. Turn the **small right knob** to the left until the default NAV Page is selected, OR, press **CLR** and hold for two seconds from any page.

*NEXRAD data displayed on the NAV Weather Page using the 360 degree viewing option.*
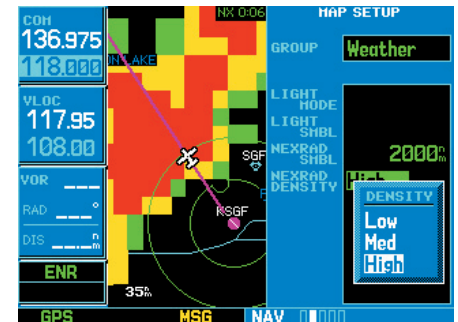


*You can customize NEXRAD data on the Map Page such as selecting the desired display density for NEXRAD cells.*

*NEXRAD data is displayed on the default NAV Page in addition to the NAV Weather Page and the Map Page.*



*You can request NEXRAD data or METAR data from the Airport Location Page.*

## Customizing NEXRAD Data on the Default NAV Page (500 Series Only)

The customized NEXRAD data that was configured on the Map Page appears on the default NAV Page. All other default NAV Page options remain accessible from the default NAV Page.

## Request Shortcuts

You can quickly select the NEXRAD, METAR, or Textual METAR Page for a specific airport from the Airport Location Page.

### To select the Airport Location Page, use one of the following three methods:

1. Use the **inner right knob** and select the Airport Location Page from the WPT Group of pages.

2. On the Map Page, move the map cursor and highlight an on-screen airport. Press **ENT**.

3. On any page that displays an airport identifier, use the cursor and highlight the desired airport identifier. Press **ENT**.

Once the Airport Location Page is displayed, enter the identifier for the desired airport. Press **MENU**. The options menu appears listing the following three options:

- Request NEXRAD?

- Request METAR?

- View Text METAR?

Highlight the desired option and press **ENT**. 'Request NexRAD?' and 'Request METAR?' options select the NEXRAD and METAR Request Pages, respectively. 'View Text METAR?' selects the Textual METAR Page for the desired airport, if textual METAR is available for that airport.

## Data Link Request Log Page

The Data Link Request Log Page is used to display the data that was requested. When a request is received, a check mark is placed in the box.

### Sending Position Reports

The Data Link allows for accurate location tracking of your aircraft by sending your position manually or automatically to the EchoFlight web site (www.EchoFlight.com) for use by third-party EchoFlight customers.

#### To Send Your Position:

1. Select the Data Link Page.

2. Highlight 'Position Report' and press **ENT**. The 'Position Report' Page is displayed with the following six fields:

   - Nearest VOR — Nearest VOR identifier.

   - Distance — The distance from the nearest VOR.

   - Radial — The radial from the nearest VOR.

   - Position — Displays your current position expressed in Latitude and Longitude.

   - Auto Request — This field is used to set the time interval for the system to automatically send your position. The time options are OFF, 10 min, 15 min, 20 min, 30 min, 45 min, and 1 hr. When an auto request time is selected, the first report will be sent after the specified time has elapsed from when the field was set (as opposed to immediately sending a report). Note that in order to take advantage of Echo Flight's Automatic Weather Delivery (AWD) service, the time interval must be set to 15 minutes.

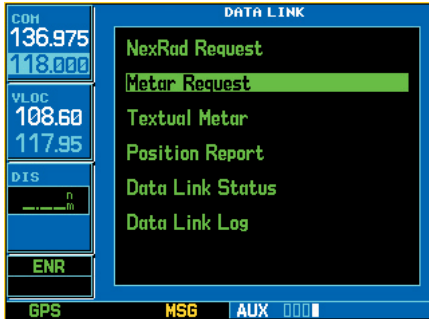   - Manual Send? — This field is used to send out a current single position report.
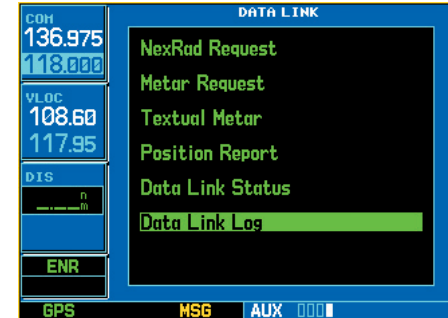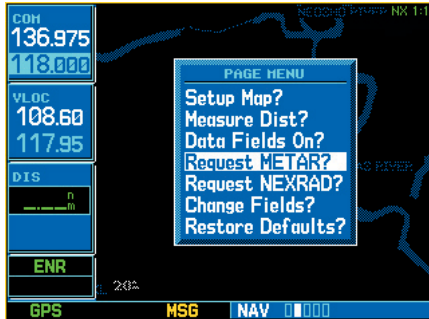
*The Data Link Log Page is selected from the Data Link Page.*
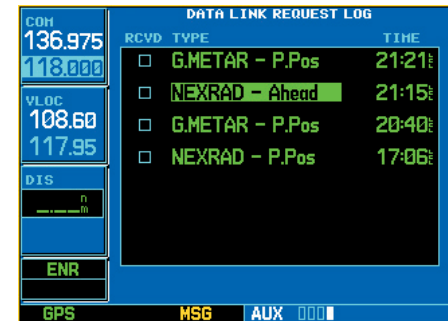


*The Data Link Request Log Page shows the type of data that was requested and the time of the request.*

*METAR data can be requested from the Data Link Page.*



*You can also request METAR data from the Map Page.* **Note: Textual METARS can only be requested by identifier or by flight plan, if the flight plan contains METAR station identifier.**

## Section 4:  METAR Operation

### Requesting Graphical METARS

Graphical METAR Data can be requested from the Data Link Page, Map Page, or Airport Page.

### To request Graphical METARS from the Data Link Page:

1. Select the Data Link Page.

2. Press **CRSR**. Turn the **small right knob** and highlight 'Metar Request'.

3. Press **ENT**. The 'METAR REQUEST' Page is displayed containing the same fields as the NEXRAD Request Page with the exception of the 'FORMAT' field:

   • Format — This field is used to select between requesting the raw METAR text or requesting a graphical summary of several METARS.

4. Enter data into the desired field. Enter 'Auto Request' or 'Manual Send' to send request. Press **CRSR** for sending an auto request. The Data Link Page is displayed.

### To request Graphical or Textual METARS from the Map Page:

1. Select the Map Page.

2. Press **MENU**. The Map Page Options Menu is displayed.

3. Select 'Request METAR' and press **ENT**. The METAR Request Page is displayed containing the following fields:

   • Format — This field allows the user to select between the type of METAR Data displayed, Textual or Graphic.
   • Center — This field selects the request position.
   • Radius — This field selects a request radius from 50 to 250 nautical miles from the request position (graphical requests only).
   • Position — This field will display the request position and is not user selectable.
   • WPT — This field selects a waypoint identifier to use as the center of the request. This is only available if 'From ID' is selected.
   • Flight Plan — This field selects a flight plan waypoint to use as the center of the request. This is only available if 'Flight Plan' is selected.
   • Manual Send? — This field is used to send out a current single request for METAR Data.

4. Enter the type of METAR Data you desire and the desired radius (graphical requests only).

5. Select Manual Send? and press **ENT.** The request has been sent.

Once received, Graphical METAR data is displayed on the NAV Weather Page.

<u>**Displaying Graphical METARS on the NAV Weather Page**</u>

    **To display Graphical METARS on the NAV Weather Page:**

1. Select the NAV Weather Page.

2. Press **CRSR**. The upper left hand corner field flashes.

3. Turn **small right knob** and select 'METAR'.

4. Press **CRSR**.

<u>**Viewing Graphical METAR Data for a Specific Airport from the Map Page**</u>

As a shortcut, Graphical METAR Data can be viewed for a specific airport from the Map Page:

1. Select the Map Page.

2. Move the Map Cursor and highlight a desired airport. Graphical METAR data is displayed for that airport in a thumbnail image.

*Graphical METAR data displayed on the NAV Weather Page.*
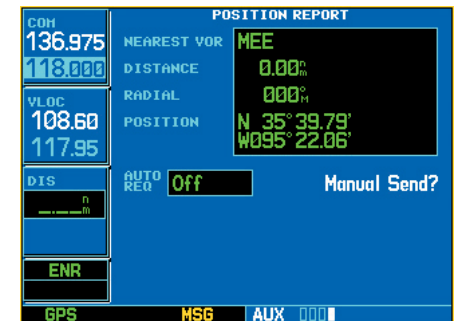


*With the Data Link you can accurately track the location of your aircraft, sending position, heading, ground speed, and altitude to the Echo Flight secure web-site or any Internet-connected E-mail address or pager within minutes.*

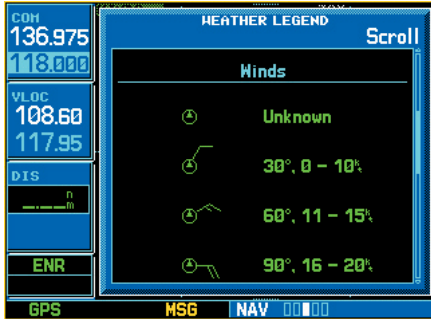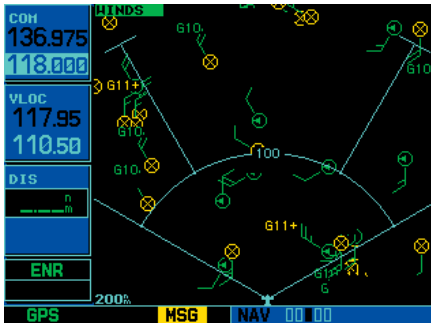*Look at the Weather Legend Page for a description of the Temperature, Dew Point, and Wind symbology.*



*Wind data displayed on the NAV Weather Page.*

## Weather Legend Page

The symbology unique to Graphical METAR, Winds, and Temperature/Dew Point data is displayed on the Weather Legend Page. The Weather Legend Page is accessed from the Weather Page.

### To display the Weather Legend Page:

1. Select the Weather Page.

2. Use the **small right knob** and select METAR, WINDS, or TEMP/DP in the flashing cursor in the upper left hand part of the screen.

3. Press **MENU**. The Weather Page Menu is displayed.

4. Turn the **small right knob,** highlight 'Display Legend', and press ENT. The Weather Legend Page is displayed for the type of data that was selected. Use the **small right knob** and scroll through the various descriptions for the symbols that are shown. Press **CRSR** to return to the Weather Page.

> NOTE:  See Appendix B for a complete description of all METAR symbols.

The following symbology is shown for the various types of data:

**For METAR Data:**
- Age of Data in Minutes
- Ceiling, Visibility, and Precipitation
- Ceiling, Visual Flight Rules
- Precipitation

**For Wind Data:**
- Age of Data in Minutes
- Winds
- Wind Gust

**For Temperature/Dew Point Data:**
- Age of Data in Minutes
- Temperature/Dew Point

## Displaying Textual METARS

Once received, Textual METARS are displayed on the METARS Text Page.

**To select the METARS Text Page:**

1. Select the Data Link Page.

2. Select 'Textual Metar'.

3. Press **ENT**. The Textual METAR Page is displayed for the airport you selected. You can enter a different identifier on the Textual METAR Page.

**To enter an identifier:**

1. Select the Data Link Page. Highlight 'TEXTUAL METAR' and press **ENT**.

2. Turn the **small right knob** and scroll through the list of four letter identifiers.

3. Highlight the desired identifier and press **ENT**.

4. The text box displays the METAR data for the selected identifier.

5. To request an updated graphic or textual METAR for this airport, press the **MENU** key to access the page menu and select 'Request METAR?'.

6. This option will take you to the METAR Request Page. The request option is displayed on the Textual METAR Page.
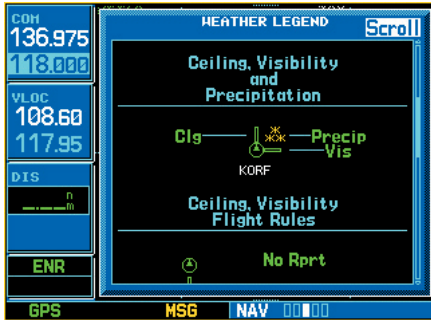
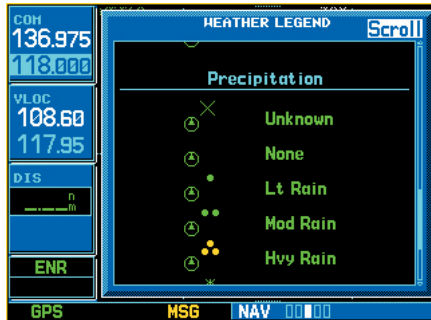*The Textual METAR Page. See Appendix A for a list of common weather forecast abbreviations.*



*Use the small right knob and scroll through the list of identifiers to select the desired one.*

*The Weather Legend Page describes the weather symbology used in the Data Link interface.*



*Precipitation symbology is described on the Weather Legend Page.*

## Section 5:  Temperature, Dewpoints, and Winds

### Displaying Temperature/Dewpoints

Temperature/Dewpoints are displayed on the NAV Weather Page.

**To display Temperature/Dewpoints on the NAV Weather Page:**

1.  Select the NAV Weather Page.
2.  Press **CRSR**. The upper left hand corner data field flashes.
3.  Turn the **small right knob** and select 'TEMP/DP'.
4.  Press **CRSR**. The Temperature/Dewpoints are displayed on the NAV Weather Page.

### Displaying Wind Data

**To display wind data on the NAV Weather Page:**

1.  Select the NAV Weather Page.
2.  Press **CRSR.** The upper left hand corner field flashes.
3.  Turn **small right knob** and select 'WINDS'.
4.  Press **CRSR**.  The wind icons are displayed on the NAV Weather Page.

## Section 6: Troubleshooting

Although it is the responsibility of the facility that installed the GDL 49 to correct any hardware problems, you can perform some quick troubleshooting steps to find the possible cause of a failure.

First, ensure that the owner/operator of the aircraft in which the GDL 49 is installed has subscribed to Echo Flight for a Service Plan, and it has been activated.  Perform a quick check of the circuit breakers to ensure the GDL 49 has power applied.  If a failure still exists, continue to the Data Link Status Page.

The fields on the Data Link Status Page may provide insight to a possible failure.  Information displayed at this page should be noted and provided to the repair station. The Connectivity Message table should also provide a clear indication of the failure if power has been properly applied to all systems. Repair stations are equipped to repair the system, should a hardware failure exist.
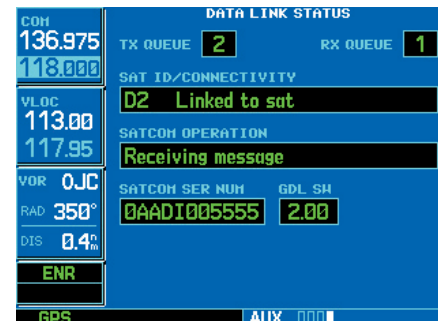
### Monitoring the Data Link

The Data Link Status Page provides an indication of the integrity of the Data Link. The Data Link Page allows you to monitor the system and determine the possible cause of a failure.

### To view the Data Link Status Page:

1. From the AUX Page Group, select the Data Link Page.

2. Highlight 'Data Link Status' and press **ENT**.

3. The Data Link Status Page is displayed with the following fields:

    • TX Queue — This field shows the number of requests in the GDL 49's transmit queue waiting to be sent to the satellite.

    • RX Queue — This field shows the number of responses in the GDL 49's receive queue waiting to be sent to the 400/500 Series.

    • Sat ID/Connectivity — Shows the current satellite in view and also indicates the status of the current satellite connection.

*The Data Link Status Page*

The following are possible messages that can be displayed in the Sat ID/Connectivity field:

| "Data Link has failed" | There is a disconnect inside the GDL 49. |
|---|---|
| "Searching..." | No satellite is currently in view. |
| "Satellite in view" | Found satellite but have not yet identified it. |
| "Linked to sat" | Can exchange data with the satellite. |
| "_ _ _" | RS-232 communication with the GDL 49 has been lost. |

• SATCOM Operation — This field indicates the current activity being performed by the satellite communicator within the GDL 49.  The following are possible messages that can be displayed, including interpretations of the most common ones:

| "Idle" | Waiting to perform the next task. |
|---|---|
| "Sending message" | Transmitting a message. |
| "Sending request" | Transmitting a request to the satellite. |
| "Receiving message" | Receiving a response from the satellite. |
| "_ _ _" | Unknown task is being performed, or RS-232 communication with the GDL 49 has been lost. |

• SATCOM SER NUM — This field shows the serial number assigned to the GDL 49's internal satellite communicator.

•GDL SW— This field shows the currently installed software version for the GDL 49.

# PART THREE:
# TAWS/TERRAIN INTERFACE

## Section 1: Introduction

### Overview

Garmin's Terrain Awareness Warning System (TAWS) is now an option for the GPS 500 and GNS 530/530A. Garmin TAWS satisfies TSO-C151b Class B requirements for certification. Class B TAWS is required for all Part 91 aircraft operations with 6 or more seats and for Part 135 turbine aircraft operations with 6 to 9 passenger seats (FAR Parts 91.223, 135.154).

Garmin TERRAIN is a non-certified terrain awareness system incorporated into 400/500 Series units as a standard feature. It should be noted that the TERRAIN is only included in 400/500 Series units with main software version 5.10 or above, along with appropriate hardware upgrades. Garmin TERRAIN offers many of the operational characteristics of Garmin TAWS, yet at a lower cost to pilots. Both TAWS and TERRAIN greatly increase situational awareness and aid in reducing accidental Controlled Flight Into Terrain (CFIT).

### Theory of Operation

The Garmin TAWS/TERRAIN system requires the following criteria to operate properly:
 a) The system must have a valid 3D GPS position solution.
 b) The system must have a valid terrain/obstacle database.

### GPS Position/Altitude

Garmin TAWS/TERRAIN uses GPS information provided from the 400/500 Series GPS receiver. The position solution is compared to the terrain and obstacle databases. Garmin TAWS/TERRAIN then portrays a 2D picture of the surrounding terrain relative to the altitude and position of the aircraft. GPS information is also used to calculate and 'predict' the flight path of the aircraft. In this manner, the system can provide early warning of impending dangerous conditions.

### Limitations

It is always the ultimate responsibility of the pilot in command to navigate safely throughout the course of the flight. Garmin TAWS/TERRAIN is designed to be an aid to situational awareness. It is not to be relied upon as a primary source of terrain avoidance.



*Garmin TAWS is optional with GPS 500 and GNS 530 units with main software version 5.01 or above, along with corresponding hardware upgrades.*
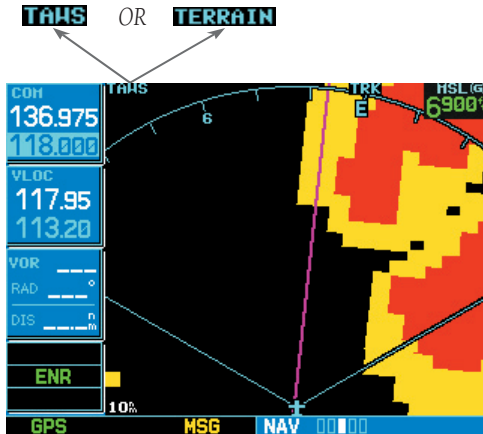


*Garmin 400/500 Series units with main software version 5.10 or above, along with corresponding hardware upgrades, include Garmin TERRAIN as a standard feature.*

*The upper left corner of the TAWS/TERRAIN Page indicates which system is installed and operating.*

## System Functions

Garmin TAWS and TERRAIN share several common operational characteristics. Table 1-1 compares the features and abilities of the two systems:

| Function | TAWS | TERRAIN |
|---|---|---|
| TSO-C151b Class B Certified | Yes | No |
| TAWS/TERRAIN Display<br>*( Shows terrain elevations relative to the aircraft )* | Yes | Yes |
| Visual Alerting<br>*( Includes popup alerting )* | Yes | Yes |
| Aural Alerting | Yes | No |
| External Visual Alerting Capability | Yes | No |
| Reduced Terrain Clearance (RTC) Avoidance<br>*( Forward Looking Terrain Avoidance (FLTA) sub-function )* | Yes | Yes |
| Imminent Terrain Impact (ITI) Avoidance<br>*( Forward Looking Terrain Avoidance (FLTA) sub-function )* | Yes | Yes |
| Premature Descent Alert (PDA) | Yes | Yes |
| Excessive Rates of Descent<br>*( Ground Proximity Warning System (GPWS) Alerting sub-function )* | Yes | No |
| Negative Climb Rate/Altitude Loss After Takeoff<br>*( Ground Proximity Warning System (GPWS) Alerting sub-function )* | Yes | No |
| "Five Hundred" Voice Callout<br>*( Ground Proximity Warning System (GPWS) Alerting sub-function )* | Yes | No |
| Inhibit Capability<br>*( Inhibits FLTA and PDA visual and aural alerting )* | Yes | Yes |
| Manual System Test Capability | Yes | No |
| Worldwide Terrain Database | Yes | Yes |
| Airport Layer Database | Yes | Yes |
| Obstacle Database | Yes | Yes |

*Table 1-1 TAWS/TERRAIN Feature Comparison*

## Section 2:  Basic Operation

### Power Up

During power-up of the 400/500 Series unit, terrain/obstacle database versions are displayed along with a disclaimer to the pilot.  At the same time, the TAWS/TERRAIN system self-test begins.  For TAWS units, an aural message plays upon test completion:
- "***TAWS System Test, OK***", if the system passes the test.
- "***TAWS System Failure***", should the system fail the test.

A failure to pass the test is annunciated for both TAWS and TERRAIN, as shown on page 36.

### Display Page Operation

The display interface for both Garmin TAWS and TERRAIN appears in the NAV Page Group.  To select the TAWS/TERRAIN Page, rotate the **small right knob** until the terrain display appears.  Terrain information, aircraft ground track, and GPS-derived MSL altitude are displayed on the screen.  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.

There are two main display settings from which the pilot can choose:
- •360° View—Bird's eye view from above aircraft depicts surrounding terrain on all sides.
- •120° View—Bird's eye view of terrain ahead of and 60° to either side of the aircraft flight path.
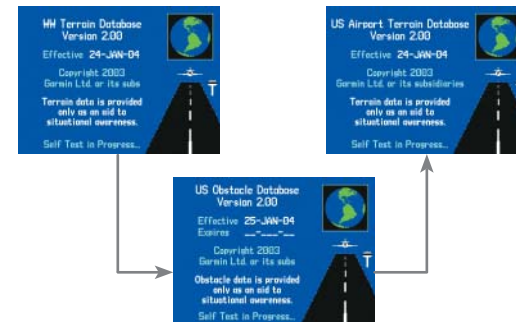
![check] *NOTE:  The TAWS/TERRAIN Page gives a 'Track Up' display orientation, as indicated by the 'TRK' label shown on the display.  This is the only orientation available for the TAWS/TERRAIN Page.*

**To configure the TAWS/TERRAIN display mode for 120° View:**

1.  At the TAWS/TERRAIN Page, press **MENU**.
2.  Select "View 120°?".
3.  Press **ENT**.  The TAWS/TERRAIN Page now displays the 120° view.  To switch back to 360° view, repeat step 1, select "View 360°?", then press **ENT**.
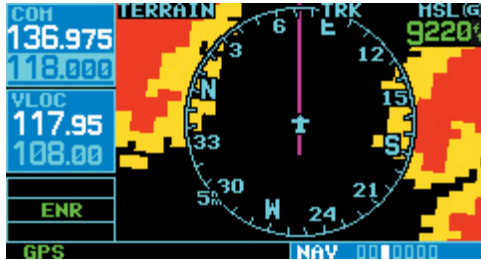
*Upon power-up, the TAWS/TERRAIN database versions are displayed momentarily on three sequential screens. The TAWS/TERRAIN self test then begins.*
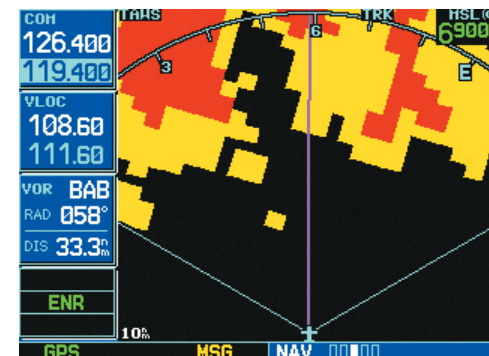


*The Garmin TAWS Display Interface with the 120° View Setting.*

*The 360° View Setting on a 400 Series unit with TERRAIN installed.*



*When the TAWS/TERRAIN system is inhibited, the annunciation 'TER INHB' appears in the lower left of the display.*

The TAWS/TERRAIN Page allows the pilot to zoom in and out of various display ranges, allowing a more thorough view of surrounding area.

### To change the display range for the TAWS/TERRAIN display:

1. Press up/down on **RNG** to zoom through the range selections: 1 nm, 2 nm, 5 nm, 10 nm, 25 nm, 50 nm, 100 nm.

Aviation data such as airports, VORs, and other navaids can be turned on or off at the TAWS/TERRAIN Page.

### To show/hide aviation data:

1. Press **MENU**.

2. Select "Show (or Hide) Aviation Data" and press **ENT**.  Note that **CLR** may also be used to toggle aviation data on or off.



#### Inhibit Mode

Both TAWS and TERRAIN provide 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/TERRAIN system and always remember to enable the system when appropriate.  Only the PDA and FLTA alerts are disabled in the inhibit mode. See Sections 3 and 4 for more information on alerts.

### To Inhibit TAWS/TERRAIN:

1. At the TAWS/TERRAIN Page, press **MENU**.

2. "Inhibit Terrain?" is selected by default.

3. Press **ENT**.  The TAWS/TERRAIN system is now inhibited.



### To Enable TAWS/TERRAIN:

1. At the TAWS/TERRAIN Page, press **MENU**.

2. "Enable Terrain?" is selected by default.

3. Press **ENT**.  The TAWS/TERRAIN system is now functional again.

## TAWS/TERRAIN Symbols

The following symbols are used to represent obstacles on display zoom ranges up to 10 nm:



*Unlighted Obstacles <1000' AGL*　*Lighted Obstacles <1000' AGL*　*Unlighted Obstacles >1000' AGL*　*Lighted Obstacles >1000' AGL*　*Potential Impact Points*

## Color Interpretation

Garmin TAWS/TERRAIN uses black, yellow, and red to depict terrain information relative to aircraft altitude (Figure 2-1). 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.

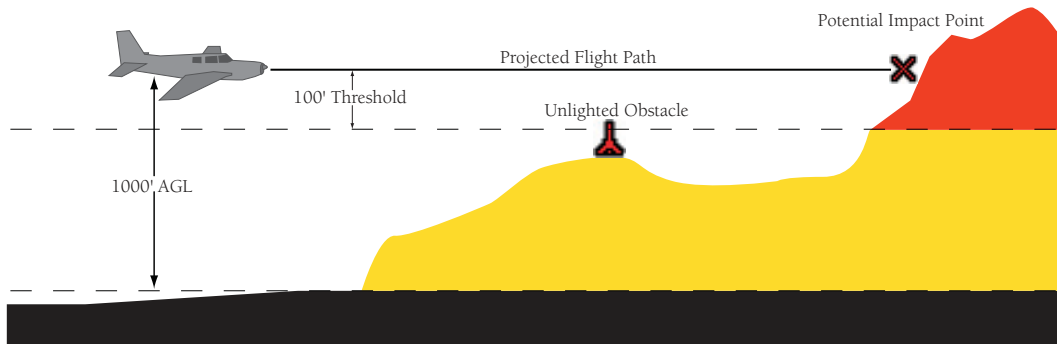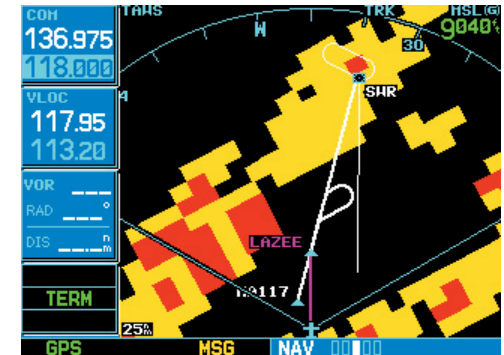| Color | Terrain/Obstacle Location | Alert Level | Suggested Aircrew Response |
|---|---|---|---|
| Red | Terrain/Obstacle is within 100' or above aircraft altitude. | WARNING | Initiate climb and/or turn away from terrain/obstacle. |
| Yellow | Terrain/Obstacle is within 1000' of aircraft altitude. | CAUTION | Be aware of surroundings. Be prepared to take action. |
| Black | Terrain/Obstacle is more than 1000' below aircraft altitude. | NO DANGER | No action required. |

*Table 2-1: TAWS / TERRAIN Color Symbology*



*Active Flight Plan approach information as displayed on the TAWS/TERRAIN Page.*



*Figure 2-1: Terrain Altitude / Color Correlation*

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*TAWS/TERRAIN database versions may be viewed by going to AUX Page 2, selecting "Terrain Database Versions", and pressing the ENT key.*

## General Database Information

Garmin TAWS/TERRAIN 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 information displayed should never be construed to be all-inclusive.  Pilots must familiarize themselves with the appropriate sectional charts for safe flight.

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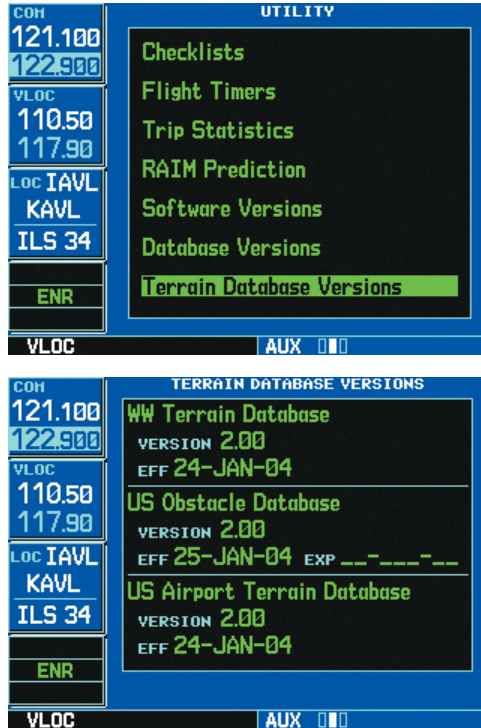
## Database Versions

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/TERRAIN system fails the self-test and issues the TAWS/TERRAIN system failure message (see page 36).

## 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.  Updated terrain data cards may be obtained from the Garmin website or by calling Garmin at one of the numbers listed in the front of this document.

### To update your terrain/obstacle databases:

1. Acquire a new terrain data card from Garmin.
2. Turn off the power to the 400/500 Series unit.
3. Remove the old terrain data card from and insert the new card into the right-most slot of the 400/500 Series unit.
4. Turn on the 400/500 Series unit and verify that the TAWS/TERRAIN 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.

*Worldwide (WW):*
Latitudes:  S60 to N75
Longitudes: W180 to E180

*Americas (AME):*
Latitudes:  S60 to N75
Longitudes: W180 to W30

*Atlantic (ATL):*
Latitudes:  S60 to N75
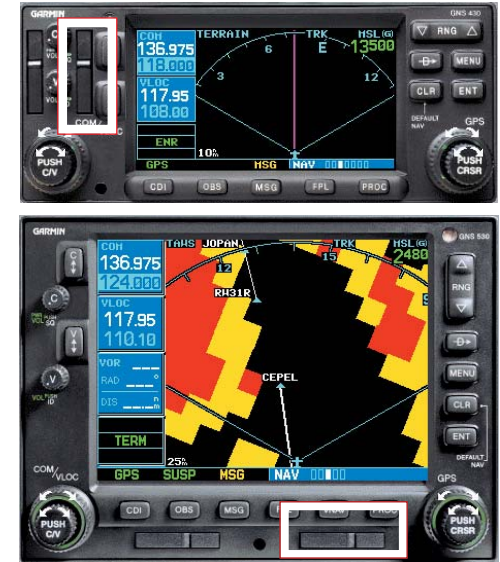Longitudes: W30 to E90

*Pacific (PAC):*
Latitudes:  S60 to N75
Longitudes: E60 to E180

*United States (US):*
Limited to the United States plus some areas of Canada, Mexico, Caribbean, and the Pacific.

*The terrain/obstacle database card should only be inserted into the right-most slot for 400/500 Series units.*

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# Section 3:  TAWS/TERRAIN Alerts

## Basic Alert Interface

Alerts are issued when flight conditions meet parameters that are set within TAWS/TERRAIN software algorithms.   TAWS/TERRAIN alerts typically employ either a CAUTION or a WARNING alert severity level, or both.  When an alert is issued, visual annunciations are displayed to the pilot.  Annunciations appear in a dedicated field in the lower left corner of the display.  Annunciations are color-coded according to severity levels as described on page 31.

Pop-up terrain alerts can also appear during an alert, but **only when the TAWS/TERRAIN Page is not currently displayed**.  When a pop-up alert appears on the display, the pilot has two options:

**To acknowledge the Pop-up Alert and return to the currently viewed page:**

1. Press the **CLR** button.

**To acknowledge the Pop-up Alert and quickly access the TAWS/TERRAIN Page:**
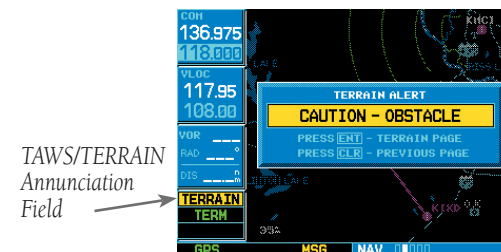
1. Press the **ENT** button.

> ✓ *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, please see page 41.*

## TAWS/TERRAIN Shared Alerts

There are four shared alerts that are used both by TAWS and TERRAIN:
• TAWS/TERRAIN Failure Alert
• TAWS/TERRAIN Not Available Alert
• Forward Looking Terrain Avoidance Alert (FLTA)
• Premature Descent Alert (PDA)

*TAWS/TERRAIN Annunciation Field*

*A dedicated annunciation field appears in the lower left corner of the display for both TAWS and TERRAIN.*



*Pop-up terrain alerts are displayed only when the TAWS/TERRAIN Page is not being viewed.  Pop-up terrain alerts do not appear on the TAWS/TERRAIN Page.*

*The TAWS/TERRAIN Page shows that the system has failed.*

### TAWS/TERRAIN Failure Alert

The TAWS/TERRAIN system continually monitors several system-critical items, such as database validity, hardware status, and GPS status.  Should the system detect a failure, one of the following messages is issued:



*For Garmin TAWS*          *For Garmin TERRAIN*

The TAWS/TERRAIN Page displays "TERRAIN FAILED" in yellow.  For TAWS units, the aural message "**TAWS System Failure**" is issued along with the "TER FAIL" annunciation.

### TAWS/TERRAIN Not Available Alert

Garmin TAWS/TERRAIN requires a 3D GPS navigation solution along with specific vertical accuracy minimums.  Should the navigation solution become degraded, if the terrain/obstacle database is not available, or if the aircraft is out of the database coverage area, the annunciation 'TER N/A' is given in the annunciation window.  The following text is displayed on the TAWS/TERRAIN Page:



*For Garmin TAWS*          *For Garmin TERRAIN*

For TAWS units, the aural message "**Terrain Not Available**" is issued along with the 'TER N/A' annunciation.

## Forward Looking Terrain Avoidance

The Forward Looking Terrain Avoidance alert, or FLTA, is used by TAWS/TERRAIN and is composed of two sub-functions:

*Reduced Required Terrain Clearance (RTC) Avoidance* — Provides alerts when the aircraft flight path is above terrain, yet is projected to come within minimum clearance values outlined in Table 3-1.  When an RTC alert is issued, a potential impact point (see page 31) is displayed on the TAWS/TERRAIN Page.

*Imminent Terrain Impact (ITI) Avoidance* — Provides alerts when the aircraft is below the elevation of a terrain cell in the aircraft's projected path.  ITI alerts are accompanied by a potential impact point displayed on the TAWS/TERRAIN Page.  The alert is given when the projected vertical flight path is calculated to come within minimum clearance altitudes in the following table.

| Phase of Flight | Level Flight | Descending |
|---|---|---|
| Enroute | 700 ft. | 500 ft. |
| Terminal | 350 ft. | 300 ft. |
| Approach | 150 ft. | 100 ft. |
| Departure | 100 ft. | 100 ft. |

*Table 3-1: 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' AGL while within 0.5 nm of the approach runway or is below 125' AGL while within 1 nm of the runway.

### RTC/ITI Severity Levels



*CAUTION—Estimated potential impact in approximately 60 seconds after pop-up alert and annunciation. For TAWS, RTC/ITI caution alerts are accompanied by the aural message "**Caution Terrain; Caution Terrain**" OR "**Terrain Ahead; Terrain Ahead**".*



*WARNING—Estimated potential impact in approximately 30 seconds after pop-up alert and annunciation. For TAWS, 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**".*

## PDA Severity Levels



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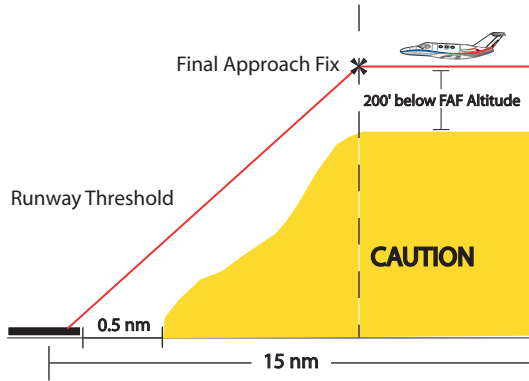


Figure 3-1: Example of Non-Precision Approach PDA alert threshold.  The threshold for the descent is computed by algorithms based on varying flight conditions.

## Premature Descent Alerting (PDA)

Garmin TAWS/TERRAIN issues a Premature Descent alert when the system detects that the aircraft is significantly below the normal approach path to a runway.  The PDA alert mode is functional only during descent to land.  There are three different scenarios to consider with PDA:

•No Approach Loaded—PDA alerting begins when the aircraft is within 15 nm of the destination airport and ends when the aircraft is either 0.5 nm from the runway threshold OR is at an altitude of 125' AGL while within 1 nm of the threshold.  During the final descent, algorithms will set a threshold for alerting based on speed, distance, and other parameters.

•Non-Precision Approach Loaded—PDA alerting begins when FAF is the active waypoint AND the aircraft is within 15 nm of the destination airport. Again, algorithms are used to set a threshold for alerting based upon various parameters (Figure 3-1).  PDA alerting ends at 0.5 nm from the runway threshold OR at an altitude of 125' AGL while within 1 nm of the threshold.

•ILS Approach Loaded—PDA alerting begins when FAF is the active waypoint AND the aircraft is within 15 nm of the destination airport.  Once the aircraft intercepts the glideslope, PDA will alert the pilot if the aircraft descends 0.7 degrees below the glideslope (Figure 3-2).  PDA alerting ends 0.5 nm from the runway threshold OR at an altitude of 125' AGL while within 1 nm of the threshold.
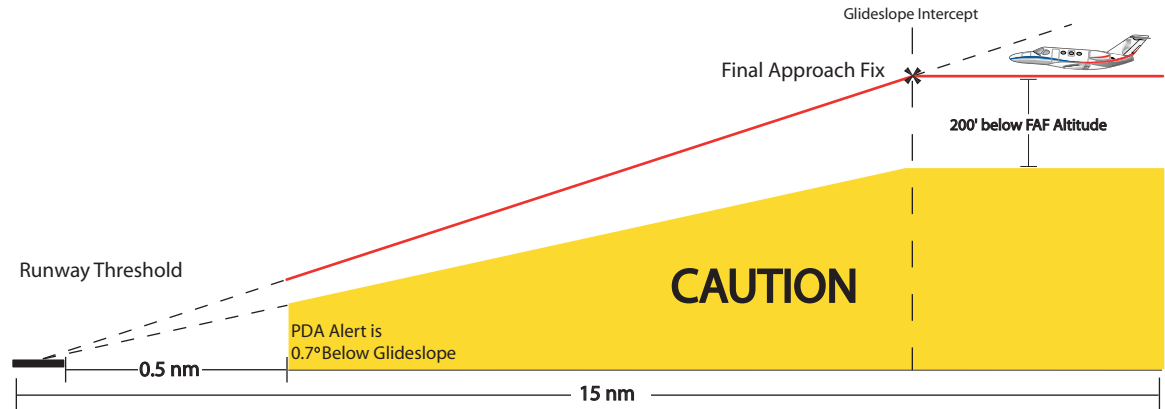


Figure 3-2: Example of PDA alert threshold for ILS approach

## Section 4:  TAWS ONLY Alerts

### Introduction

This section focuses on the TAWS interface and the special functions which set it apart from the non-certified TERRAIN system.  The following features are required to meet Class B requirements for a TAWS system per TSO-C151b.  TAWS provides aural (audio) voice alerts along with regular display annunciations.   As each alert type is discussed, the accompanying aural alerts are addressed as well.

### Excessive Descent Rate Alert (EDR)

The purpose of the Excessive Descent Rate alert is to provide suitable alerts when the aircraft is determined to be closing (descending) upon terrain at an excessive speed.  Figure 4-1 shows the parameters for the alert as defined by TSO-C151b.
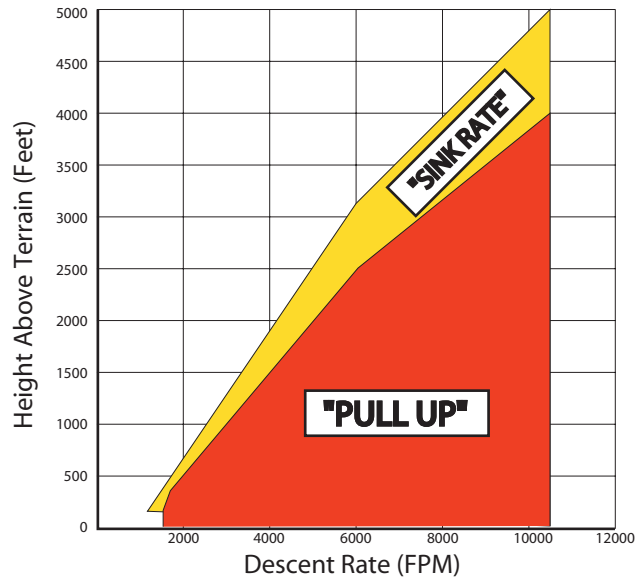


*Figure 4-1: Excessive Descent Rate Graph*

Excessive Descent Rate Severity Levels



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



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

*The 'Don't Sink' pop-up terrain alert accompanies the aural message for the NCR alert.  The aural message "**Don't Sink**" is issued as well.*

### Negative Climb Rate After Takeoff Alert (NCR)

The purpose of the Negative Climb Rate After Takeoff alert 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.
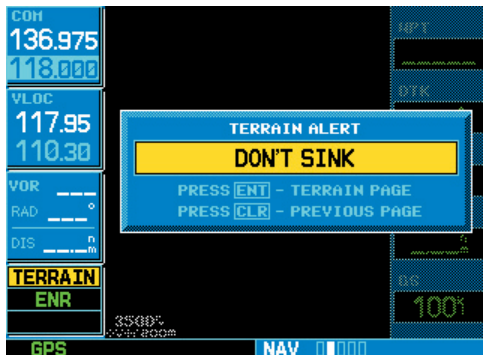
### "Five-Hundred" Aural Alert

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

### Alert Priority and Aural Alert Message Summary

TSO-C151b requires the establishment of an internal priority scheme for alerts.  In this way, the more important alerts will override lesser alerts.  Table 4-1 shows the alert priority level in the Garmin TAWS system and gives a summary of the aural messages.

> *The aural alert voice gender is configurable to be either male or female.  Furthermore, there are different alert text phrases available for several of the alerts, as shown in Table 4-1.  See your Garmin installer for further information on configuring the alert system.*

| Priority | Alert Type | Aural Message |
|:---:|:---:|:---:|
| 1 | Excessive Descent Rate Alert Warning | "Pull Up" |
| 2 | Terrain Awareness Warning: RTC, ITI Alerts | "Terrain, Terrain; Pull-Up, Pull-Up" or "Terrain Ahead, Pull-Up; Terrain Ahead, Pull-Up" |
| 3 | Terrain Awareness Caution: RTC, ITI Alerts | "Caution, Terrain; Caution, Terrain" or "Terrain Ahead; Terrain Ahead" |
| 4 | PDA Caution Alert | "Too Low, Terrain" |
| 5 | Altitude Callout "500" | "Five-hundred" |
| 6 | Excessive Descent Rate Alert Caution | "Sink Rate" |
| 7 | Negative Climb after Takeoff Alert | "Don't Sink" or "Too Low, Terrain" |

*Table 4-1: TAWS Alert Summary*

### TAWS System Test

Garmin TAWS also provides a manual test capability for flight crews.  With this, one can verify proper operation of the aural and visual annunciations of the system prior to a flight.

#### To manually test the TAWS system:

1. At the TAWS Page, 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***", should the system fail the test.



*System test annunciation and message on display.*

*NOTE:  TAWS System Testing is disabled during flight so as not to impede TAWS alerting.*

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## Standard Aviation Forecast Abbreviations

| | |
|---|---|
| CLR – Sky clear | CIG – Ceiling |
| FEW – Few clouds | '+' – (Heavy) |
| BR – Light fog | BLO – Below |
| FZ – Freezing | '/' – (Missing or separator) |
| SCT – Scattered clouds | AFT – After |
| FG – Thick fog | G – Gusts |
| TS – Thunderstorm | OBSCD – Obscured |
| BKN – Broken clouds | SM – Statue Miles |
| DZ – Drizzle | Trrn – Terrain |
| OVC – Overcast clouds | KT – Knots |
| RA – Rain | FM – From |
| VV – Vertical Visibility | SLP – Sea Level Pressure |
| SN – Snow | TEMPO – Occasionally |
| '-' – (Light) | PRESFR – Pressure falling rapidly |
| Axxxx – Altimeter setting (xxxx are numbers) | PRESRR – Pressure rising rapidly |
| Pxxxx – Hourly Precipitation (xxxx are numbers) | |
| RMK – Remarks | |

## METAR Graphics

Shaded Base Symbol—This base symbol is used in all the graphical METAR products (METARs, winds, and temperature – dew points) to indicate the location, source, and age of the data.

> NOTE:  Data older than 2 hours is automatically removed from the METAR display.

*Age of Data*

*Station Identifier*

| 0 — 10 minutes (Green) | 11 — 20 minutes (Green) | 21 — 30 minutes (Green) | 31 — 60 minutes (Green) | 61+ minutes (Yellow) | Unknown (Yellow) |
|---|---|---|---|---|---|

## METARs

*Ceiling*

*Precipitation*

*Visibility*

|  | Light (Green) | Moderate (Green) | Heavy (Yellow) |
|---|---|---|---|
| *No Precipitation* | | | |
| *Rain* | | | |
| *Snow* | | | |
| *Unknown* | | | |

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### Winds

Wind Vector — The wind vector indicates the direction of the surface wind to the nearest 30° increment (e.g. 30°, 60°, 90°, 120°, etc).
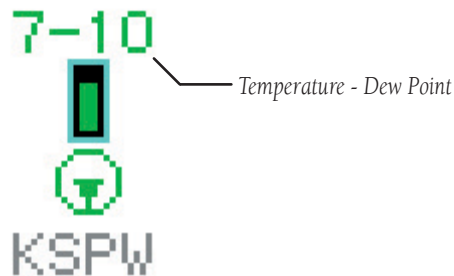
Wind Speed — In general, the sum of the wind barbs is the sustained surface wind speed.

| Wind Speed | | |
|---|---|---|
| (Blank) | | Unkown |
|  | Short Barb | 5 kts |
| | Long Barb | 10 kts |
| | | ≥ 37 kts |

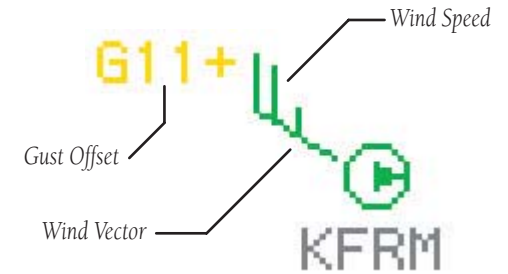| Gust Offset | |
|---|---|
| (Blank) | Gusts are unknown or < 5 kts above sustained wind speed. |
| **G10** (Green) | Wind is gusting 5 — 10 kts more than sustained speed. |
| **G11+** (Yellow) | Wind is gusting 11 kts or more above its sustained speed. |

### Temperature - Dew Points

This symbol displays the difference between the reported temperature and dew point.  Differences are shown in degrees Fahrenheit.


*Temperature - Dew Point*

| Temp - Dew Point Display Ranges | |
|---|---|
| (Blank) | Unknown |
|  | 11°+ (Green) |
|  | 7° — 10° (Green) |
|  | 0° — 6° (Yellow) |



*Wind Speed*

*Gust Offset*

*Wind Vector*

*The symbol above indicates the surface wind at KFRM is coming from a direction of 300° at a speed of 25 knots, gusting to 36 knots or greater.*

*To interpret wind speed, add  the values of each of the wind speed barbs.  In this example, there are two long barbs (10 knots each) and one short barb (5 knots each).  Thus, the total wind speed is 25 knots.  Adding the gust offset to this figure gives winds gusting to 36 knots.*

| Display | dBZ | Rain (inches/hour) | Snow (inches/hour) | Remarks | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Atmos | Cloud | Rain | Snow | Sleet | Hail |
| | <-10 | .00" | .00" | ✓ | | | | | |
| | -10 | .00" | .00" | ✓ | ✓ | | | | |
| | -5 | .00" | trace | ✓ | ✓ | | | | |
| | 0 | .00" | trace - .05" | ✓ | ✓ | | Very Light | | |
| | 5 | .00" | trace - .10" | ✓ | ✓ | | Light | | |
| | 10 | 0" – trace | .10" | ✓ | ✓ | Light | Light | | |
| | 15 | .01" | .1-.2" | | | Light | Light | | |
| | 20 | .02" | .2-.3" | | | Light | Light | | |
| | 25 | .05" | .3-.5" | | | Light | Light – Medium | | |
| | 30 | .09" | .5-.7" | | | Light – Moderate | Moderate | | |
| | 35 | .24" | .7-1.0" | | | Moderate | Heavy | ✓ | |
| | 40 | .48" | 1"+, or sleet | | | Heavy | Heavy | ✓ | |
| | 45 | 1.25" | 1"+, or sleet | | | Heavy | Heavy | ✓ | |
| | 50 | 2.5" | sleet | | | Intense | | ✓ | ✓ |
| | 55 | 5.7" | sleet | | | Extreme | | ✓ | ✓ |
| | 60 | 12.7" | | | | Extreme | | | ✓ |
| | 65 | | | | | Extreme | | | ✓ |
| | 70 | | | | | | | | Large |
| | 75 | | | | | | | | Large |

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