

## GDL 88

ADS-B Transceiver

Pilot's Guide



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This manual reflects the operation of System Software version 2.00, or later. Some differences in operation may be observed when comparing the information in this manual to later software versions.

Garmin International, Inc., 1200 East 151st Street, Olathe, KS 66062, U.S.A.

Tel: 913/397.8200

Fax: 913/397.8282

Garmin AT, Inc., 2345 Turner Road SE, Salem, OR 97302, U.S.A.

Tel: 503/391.3411

Fax 503/364.2138

Garmin (Europe) Ltd., Liberty House, Bulls Copse Road, Hounslow Business Park, Southampton, SO40 9LR, U.K.

Tel. +44 (0) 23 8052 4000

Fax +44 (0) 23 8052 4004

Garmin Corporation, No. 68, Zhangshu 2nd Road, Xizhi Dist., New Taipei City 221, Taiwan

Tel: 886/02.2642.9199

Fax: 886/02.2642.9099

Garmin Singapore Pte. Ltd., 46 East Coast Road, #05-06 Eastgate, Singapore 428766

Tel : (65) 63480378

Fax : ( 65 ) 63480278

At Garmin, we value your opinion.

Please send questions or comments about Garmin aviation products to [Avionics@garmin.com](mailto:Avionics@garmin.com).

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[Techpubs.Salem@Garmin.com](mailto:Techpubs.Salem@Garmin.com)

[www.garmin.com](http://www.garmin.com)

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**WARNING:** For safety reasons, GDL 88 operational procedures must be learned on the ground.

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**WARNING:** This unit provides the ability to receive weather information through external sources. Use weather data only as an aid to situational awareness. Such weather information is merely supplemental and advisory in nature and is not intended to be relied upon as safety-critical information in connection with any aviation, vehicle, or marine usage. The user should always exercise caution and common sense when confronted with severe weather conditions.

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**WARNING:** Do not use data link weather information for maneuvering in, near, or around areas of hazardous weather. Information contained within data link weather products may not accurately depict current weather conditions.

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**WARNING:** Traffic information is provided as an aid in visually acquiring traffic. Pilots must maneuver the aircraft based only upon ATC guidance or positive visual acquisition of conflicting traffic.

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**CAUTION:** The Garmin GDL 88 does not contain any user-serviceable parts. Repairs should only be made by an authorized Garmin service center. Unauthorized repairs or modifications could void both the warranty and the pilot's authority to operate this device under FAA/FCC regulations.

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**NOTE:** All visual depictions contained within this document, including images of the GDL 88 and the bezel, displays, and screens of other products are subject to change and may not reflect the most current software or hardware. Depictions of equipment may differ slightly from the actual equipment.

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**NOTE:** This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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**NOTE:** This product, its packaging, and its components contain chemicals known to the State of California to cause cancer, birth defects, or reproductive harm. This notice is being provided in accordance with California's Proposition 65. If you have any questions or would like additional information, please refer to our web site at [www.garmin.com/prop65](http://www.garmin.com/prop65).

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**NOTE:** *This device complies with Part 15 of the FCC limits for Class B digital devices. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Furthermore, there is no guarantee that interference will not occur in a particular installation.*

*If this equipment does cause harmful interference, the user is encouraged to try to correct the interference by relocating the equipment or connecting the equipment to a different circuit than the affected equipment. Consult an authorized dealer or other qualified avionics technician for additional help if these remedies do not correct the problem.*

*Operation of this device is subject to the following conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.*

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<b>Record of Revisions</b>			
<b>Part Number</b>	<b>Revision</b>	<b>Date</b>	<b>Description</b>
190-01122-03	A	10/19/12	Initial release
	B	04/12/13	Prepared document for print production.
	C	06/19/13	Revised NEXRAD description.

To obtain accessories for your unit, please contact your Garmin dealer.

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Registration ensures that you will be notified of product updates and new products and provides lost or stolen unit tracking. Please, have the serial number of your unit handy, connect to our web site ([www.garmin.com](http://www.garmin.com) or <https://fly.garmin.com/fly-garmin>) and look for our Product Registration link on the Home page.

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# 1 INTRODUCTION

The GDL 88 is a remotely mounted ADS-B transceiver. There are four models of the GDL 88(D). Models with a single bottom mounted UAT antenna meet TSO C154c Class A1S and are available with or without an internal GPS/SBAS receiver. Models with one top mounted and one bottom mounted antenna meet TSO C154c Class A1H and are also available with or without an internal GPS/SBAS receiver.

## 1.1 GDL 88(D) System Functions

The GDL 88 performs the following functions:

- UAT transmission (978 MHz)

The GDL 88 transmits ADS-B Out data on the 978 MHz (UAT) frequency to be received by other aircraft, vehicles, and ATC for situational awareness and traffic management.

- UAT reception (ADS-B, ADS-R, TIS-B, and FIS-B) on 978 MHz

The GDL 88 receives ADS-B data transmitted on the UAT link from other aircraft, vehicles, and ground stations to present a traffic situational awareness display for use by the flight crew. In addition, the GDL 88 receives FIS-B data on the UAT link to provide the flight crew with graphical and textual weather products.

- Mode-S Extended Squitter reception on 1090 MHz

The GDL 88 receives ADS-B data transmitted by aircraft on the 1090 MHz link to provide a comprehensive situational awareness traffic display for use by the flight crew.

- Correlation of traffic reports from multiple traffic sources, including no heading source installations

The GDL 88 is capable of interfacing with TCAD/TAS/TCAS I systems to create and present a “fused” situational awareness display to the flight crew.

- Output of ADS-B and TAS/TCAS I traffic data to an external display

The GDL 88 is capable of providing a situational awareness traffic display on compatible displays.

- Output of FIS-B weather data to an external display

The GDL 88 is capable of providing various textual and graphical weather

products for display on compatible displays.

- Traffic alerting

The GDL 88 provides aural and visual cues of impending traffic conflicts, to include directional aural (“Traffic, Traffic, Two O’clock, Two Miles, Low”).

- Single point of entry for transponder squawk code, IDENT, and emergency status

## 1.2 GDL 88 Part Numbers

Part Number	Description
010-00859-30	GDL 88
010-00860-30	GDL 88, Internal WAAS with install kit
010-00861-30	GDL 88 Diversity with install kit
010-00862-30	GDL 88 Diversity, Internal WAAS with install kit

**Table 1-1 GDL 88 Configurations**

## 2 ADS-B SYSTEM OVERVIEW

ADS-B is a core technology in the FAA Next Gen air traffic control system and is comprised of three segments: ADS-B (Broadcast), ADS-R (Rebroadcast), and TIS-B.

Nearly 400 ADS-B ground stations were completed and operational by mid-2012, with most of the rest — totaling more than 700 planned stations — expected to be operational by early 2014. The graphic below illustrates where ADS-B is currently operational. In the areas highlighted in blue, you can already start taking advantage of ADS-B’s datalink traffic and subscription-free weather services if you’re equipped with an ADS-B “In” solution.



**Figure 2-1 ADS-B Ground Stations (mid-2012) - FAA Illustration**

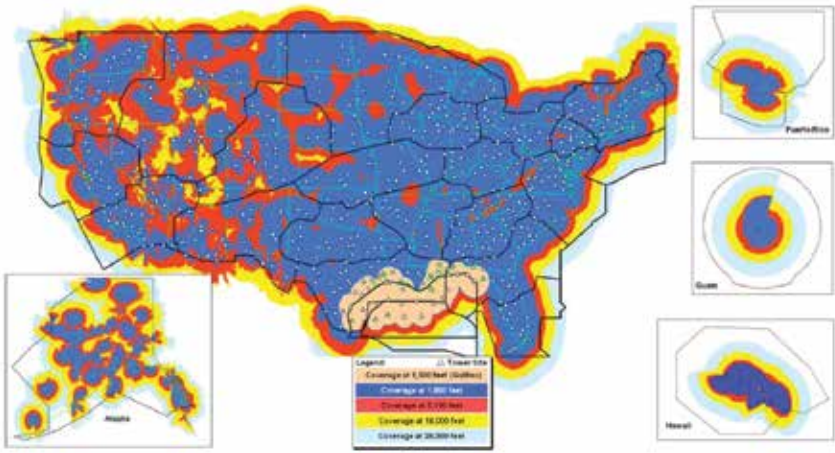
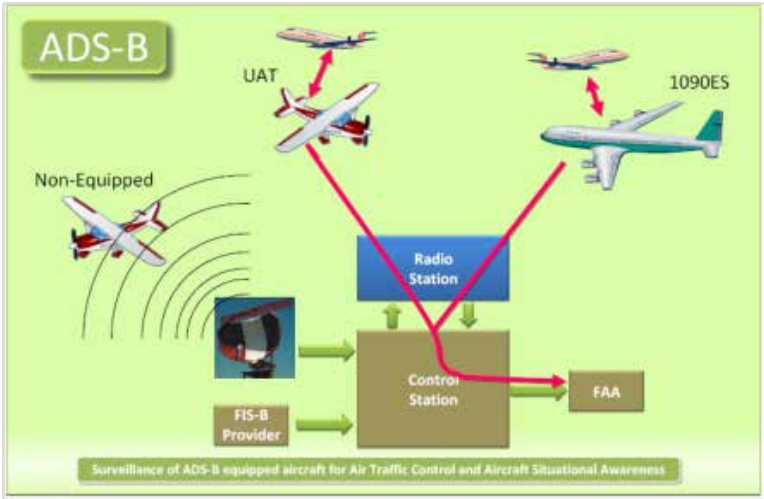


Figure 2-2 ADS-B Coverage vs Altitude (Planned for 2014) - FAA Illustration

## 2.1 ADS-B - Broadcast (ADS-B)

ADS-B is the automatic broadcast of position reports by aircraft, surface vehicles, and transmitters on fixed objects. These broadcasts contain much more data than just a simple position report, they include: identity (Flight ID, Call Sign, Tail Number, ICAO registration number, etc), ground track, ground speed, pressure altitude, indications of multitude capabilities, and emergency status. This list of data is non-inclusive of other data fields and bits used for various other functions.



**Figure 2-3 ADS-B Operation - FAA Illustration**

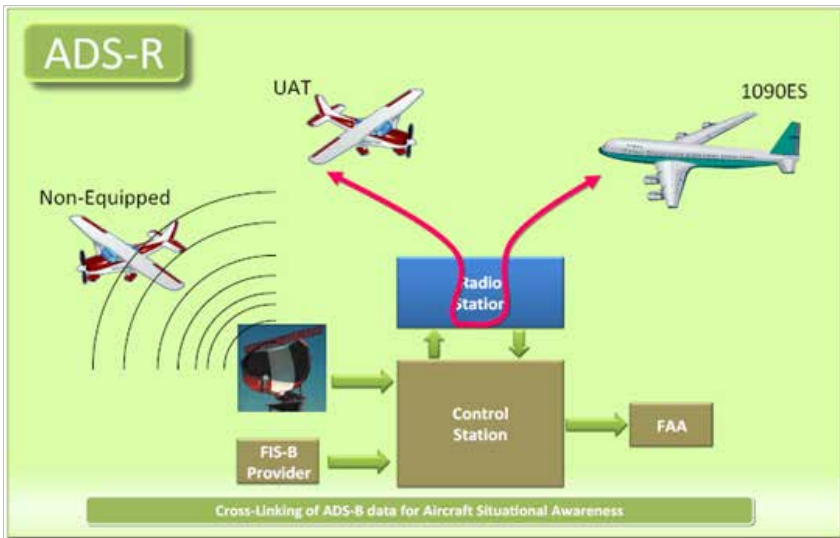
Garmin display units have the capability to show the status of the ground station services being received. Examples for the GTN and GNS products are shown below. See the display device Pilot Guide for the symbology used on that display.

Unit	Symbol	Description
GNS		Within coverage of a TIS-B ground station when connected to a GDL 88.
GNS		Not within coverage of a TIS-B ground station when connected to a GDL 88.
GNS		GDL 88 does not have a valid track or heading and cannot place ADS targets on the display.
GTN		Within coverage of a TIS-B ground station when connected to a GDL 88.
GTN		Not within coverage of a TIS-B ground station when connected to a GDL 88

**Table 2-1 Map TIS-B Availability Symbols**

## 2.2 Automatic Dependent Surveillance – Rebroadcast (ADS-R)

Because it is not required that ADS-B In capable aircraft be able to receive ADS-B data on both the 1090 MHz and 978 MHz data links, a means to get data from one data link to the other is required. ADS-R is the rebroadcast of ADS-B data by FAA ground stations and provides this service by taking data from one link and rebroadcasting it on the other. For example, two aircraft are in the service volume for a ground station, and one transmitting on 1090 MHz and the other 978 MHz, the ground station will retransmit the data from each aircraft on the other link to ensure the two aircraft can “hear” each other.



**Figure 2-4 ADS-R Operation - FAA Illustration**

The GDL 88(D) is capable of receiving ADS-B traffic reports directly on a 1090 MHz data link in addition to traffic reports and FIS-B weather uplinks on the 978 MHz data link. This allows the GDL 88 to directly receive all ADS-B position reports from aircraft in the vicinity guaranteeing the most complete traffic picture is available to the flight crew without relying on being within ground station coverage and ADS-R to provide this complete picture.

## 2.3 Traffic Information Service - Broadcast (TIS-B)

TIS-B provides the bridge between the current, radar based, ATC system and the future ADS-B based system. When an ADS-B In or Out capable aircraft is within the service volume of an FAA ADS-B ground station, the ground station will begin to broadcast a portion of the ATC radar picture to the aircraft. This aircraft is then included in the list of aircraft that is being provided TIS-B service and is then considered a “TIS-B participant.”

TIS-B coverage can be made available when the aircraft is within ground station coverage, in Secondary Surveillance Radar coverage, and the other aircraft has to be in secondary surveillance radar coverage and transmitting altitude.

ATC radar tracks for other aircraft within  $\pm 3,500$  feet and 15 NM of the participant will be provided by the ground station, to include altitude, position, ground speed, and ground track. TIS-B data is broadcast once every three to thirteen seconds depending on the characteristics of the radar providing the data to the ground station.

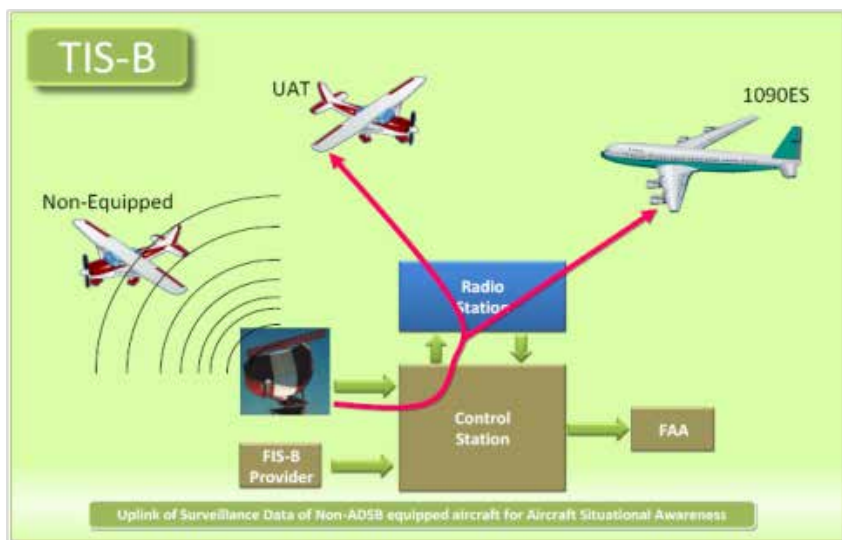


Figure 2-5 TIS-B Operation - FAA Illustration



**NOTE:** Even if the display is showing TIS-B traffic, unless the TIS-B participant indication is present (see Section 2.1), TIS-B services are not being provided specific to your aircraft and the traffic picture may not be complete.

## 2.4 Flight Information Service – Broadcast (FIS-B)

FIS-B is provided on the 978 MHz link only and is broadcast from the FAA ground stations continuously. This service provides multiple weather products for display in the cockpit to be used by the flight crew for situational awareness. These products, update rates, and coverages are specified in the Aeronautical Information Manual section 7-1-11(d)(7). Examples of these products include NEXRAD Precipitation, Graphical TFRs, Graphical AIRMETs/SIGMETs, METARs, TAFs, winds aloft, status of Special Use Airspaces (SUA), and textual NOTAMs.

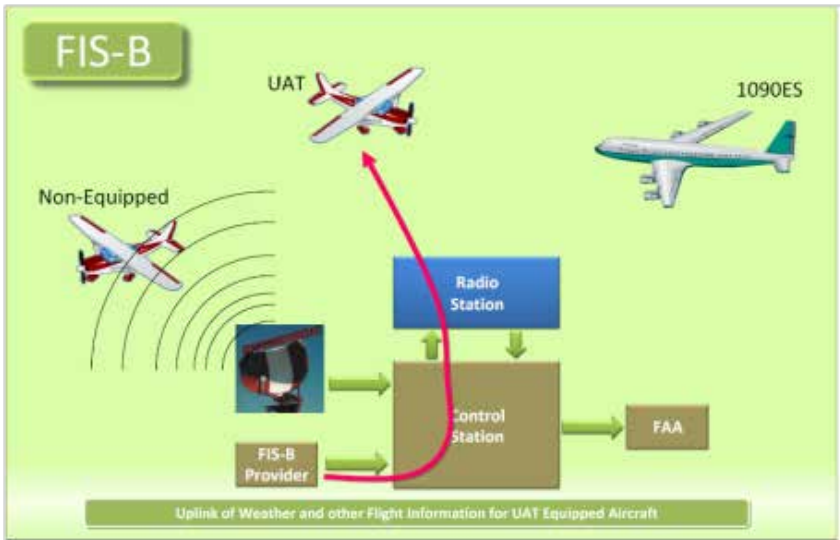


Figure 2-6 FIS-B Operation - FAA Illustration



### 3 GDL 88 ADS-B OUT

ADS-B Out sends information from the aircraft so it can be “seen” by other aircraft using ADS-B In equipment and FAA ground stations. ADS-B Out provides air traffic controllers with real-time position information that is, in most cases, more accurate than the information available with current radar-based systems. With more accurate information, ATC will be able to position and separate aircraft with improved precision and timing.

#### 3.1 GDL 88 ADS-B Out Data

ADS-B Out data is transmitted on the UAT (978 MHz).

- GPS position
- Altitude
- Position Integrity
- Ground Track and/or Heading
- Ground Speed
- Velocity Integrity
- Air/Ground State
- Identifying information (Transponder Squawk Code, Call sign, ICAO Registration Number, Flight ID), integrity, and capability data.

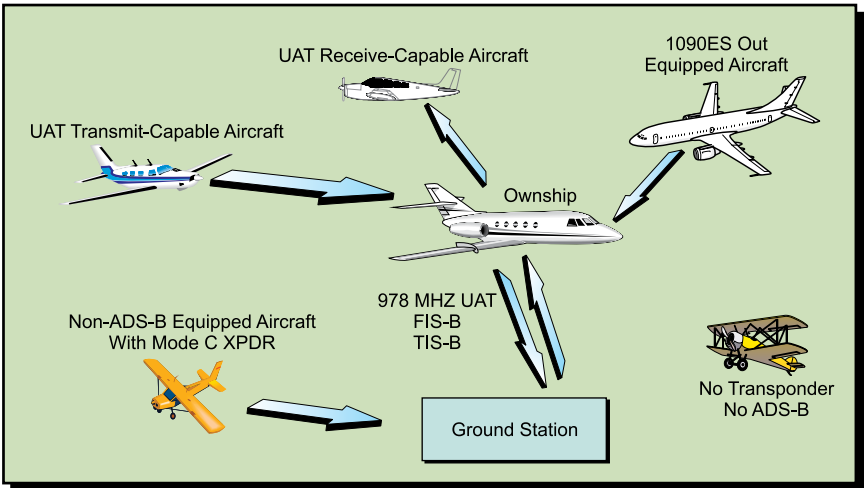


Figure 3-1 GDL 88 ADS-B In and Out

The following table describes the aircraft that will be observed by a GDL 88 equipped aircraft according to the level of equipment installed in the other aircraft.

Other Aircraft Equipage	Viewable by GDL 88 Equipped Aircraft
1090ES Out Equipped	Yes
UAT Receive Only Capable	No
UAT Transmit Equipped	Yes
No Transponder, No ADS-B	No
Non ADS-B Equipped, but with Mode C or S Transponder	Yes (see Note)

**Table 3-1 Aircraft Available for Viewing by an ADS-B Equipped Ownship**



**NOTE:** *Only when in ADS-B ground station coverage and when the other aircraft is in ATC radar coverage.*

## 3.2 Self-Interrogation

For installations with a digital interface between the GDL 88 and the installed transponder, the transponder acts as a single control to enter the transponder squawk code, IDENT, and emergency status.

When a digital interface is not available, the GDL 88 is configured to utilize self-interrogation. The GDL 88 has a small, ultra low power 1030 MHz transmitter integrated into the unit that interrogates the transponder installed in the aircraft. This interrogation looks exactly like the interrogations received from ground based surface search radars and the transponder replies like it is designed to do, to include the squawk code, IDENT status, and emergency status. The GDL 88 receives this reply and sets the corresponding ADS-B Out message values to match the received data.

## 3.3 Pressure Altitude Broadcast Inhibit (PABI)

Much like with Mode C transponders, a method is required to be available to the flight crew to inhibit the transmission of pressure altitude in the ADS-B Out message. This could be used for certain surface operations, in the event of a failure of an altitude source in the ownship, etc. This control may either be integrated into the controlling display or as a stand-alone switch installed in the cockpit.

While conducting operations within airspace requiring ADS-B Out compliant Out transmissions, per 14 CFR 91225, PABI should not be activated unless directed by ATC.

## **3.4 Anonymous Mode**

The GDL 88 provides an Anonymous Mode which broadcasts a randomized ICAO address in the ADS-B Out message. The Anonymous Mode, when armed, will replace the Flight ID with a temporary randomized number for privacy while the position information will still be provided. This randomized address allows the ADS-B Out message to not be tied to a specific aircraft, much like a VFR squawk code of 1200 on a Mode A or Mode C transponder. The mode is armed via a switch in the cockpit or via a control on the display integrated with the GDL 88. When a VFR squawk is present in the transponder and anonymous mode is selected, then the GDL 88 operates in anonymous mode and no identifying information is provided in the ADS-B Out message. This mode will persist until the squawk code is changed or the Anonymous Mode control is turned to the off state.

Anonymous Mode is not available when installed in an aircraft with a Mode S transponder.

## **3.5 Air/Ground Determination**

If a weight on wheels or squat switch is installed, the GDL 88 will use that input to determine air/ground status. If not, then air/ground status is purely based on GPS-derived information.

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## 4 GDL 88 ADS-B IN

The ADS-B In capability allows the GDL 88 to receive data through the UAT (978 MHz) and the 1090 MHz receiver. The UAT receives data directly from another ADS-B transmitting aircraft, ADS-B data from ground stations (ADS-R), TIS-B information from ground stations, and FIS-B data from ground stations. The 1090 MHz receiver receives data directly from another ADS-B transmitting aircraft.

### 4.1 GDL 88 ADS-B In Data

ADS-B In data is received by the UAT (978 MHz) and by the 1090 MHz receiver.

#### UAT Received Data

- ADS-B (Data directly from another transmitting aircraft)
- ADS-R (Rebroadcast of ADS-B data from a ground station)
- TIS-B (Broadcast of secondary surveillance radar (SSR)-derived traffic information from a ground station)
- FIS-B (Broadcast of aviation data from a ground station)

#### 1090 MHz Received Data

- ADS-B (Data directly from another transmitting aircraft)

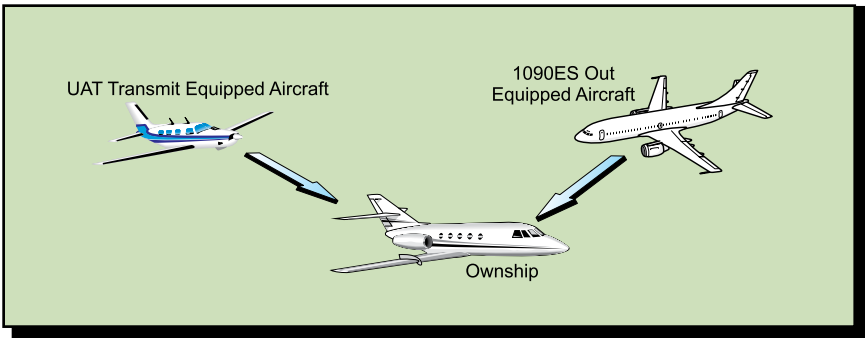


Figure 4-1 GDL 88 Equipped Aircraft Without TCAS Not In Ground Station Coverage

## 4.2 Traffic

The GDL 88 may receive traffic from several sources including external sources (ADS-B, ADS-R, and TIS-B) and onboard sources (TAS/TCAS) and creates a single, fused traffic picture to provide to the flight crew. Using relative altitude, relative bearing, range, directionality, ground track, and other identifying information (ICAO address, flight ID, call sign, tail number), the GDL 88 determines when tracks from multiple sources represent a single traffic target, selects the most accurate position source for the target, and sends the data to the display.




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**NOTE:** *The GDL 88 will observe all ADS-B participants within range. However, due to the nature of TIS-B's service volumes and the incomplete equipage/adoption of ADS-B Out equipment, NOT ALL TRAFFIC WILL BE OBSERVED by the GDL 88. The flight crew must rely on "see and avoid" procedures to detect and avoid traffic. In addition, when operating on the edges of ATC radar coverage or when using an interfaced active traffic system and TAS/TCAS targets are intermittent, it is possible that a single target aircraft may be briefly or periodically depicted as two grouped targets in the same location.*

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### 4.2.1 Traffic Applications – SURF, AIRB, etc

When the GDL 88 is interfaced to a GTN 6XX, GTN 7XX, or other compatible units, a traffic display is available for the flight crew's situational awareness and to enhance the visual acquisition of surrounding traffic. The GNS 400W/500W units do not support all applications, including SURF.

The exact location of the ownship as shown by the ownship symbol on the moving map varies by the display device. For GTN units, the tip of the ownship icon, or where the dot is, identifies the exact location. For GNS units, the exact location of the ownship is the center of the ownship icon where the wings cross the fuselage.

This display is capable of running in two "modes:" Airborne Situational Awareness (AIRB) and Surface Situation Awareness (SURF).

AIRB is in operation in the en route environment, outside of five NM from and 1,500 feet above the nearest airport.

\* Indicates Multiple Targets. Touch the target to show all targets. Then touch next to get info on each of the targets.



**Figure 4-2 AIRB Display with the GTN 7XX**

SURF is in operation within the terminal environment (within five NM and less than 1,500 feet above field elevation). When SURF is running, and the zoom scale on the traffic display is less than two NM, the airport environment (including taxiways and runways) will be displayed in addition to traffic. This is to aid in situational awareness of runway occupancy/availability, etc.



**Figure 4-3 SURF Display with the GTN 7XX**

Due to the varying precision of the data that may be received via ADS-B, ADS-R, and TIS-B, all traffic targets may not be depicted on the traffic display. Because higher data precision is required for display in the SURF environment, some targets eligible for AIRB will not be displayed while SURF is active. Individual eligibility for AIRB and SURF is depicted in the selected traffic data on the traffic page of both the GTN 6XX and 7XX.



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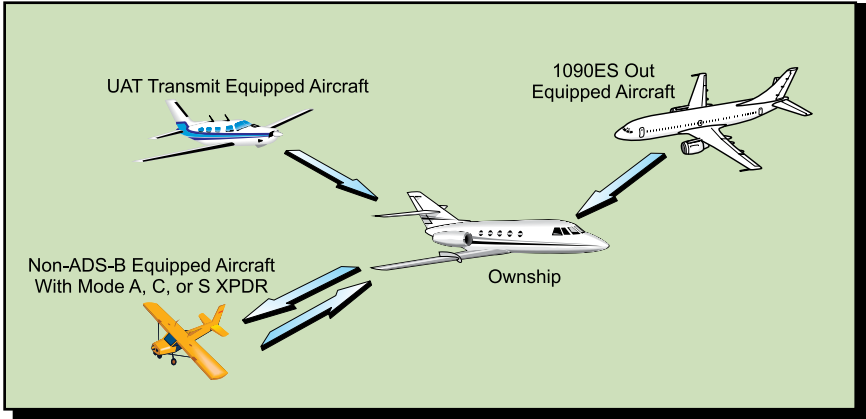
**NOTE:** *Displays not capable of SURF will always run the AIRB application.*

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## 4.2.2 GDL 88 Integration with TCAD/TAS/TCAS I

Installations with the GDL 88 interface to a TAS/TCAS/TCAD traffic system require a display to be installed.



**Figure 4-4 GDL 88 With TCAS Not In Ground Station Coverage**

When an active traffic system is interfaced with a GDL 88, the GDL 88 receives traffic from the active traffic system and attempts to match (or “correlate”) this traffic with ADS-B traffic that the GDL 88 has received and is already tracking. When a correlation is made, the active traffic system or ADS-B target with the most accurate information is displayed to the flight crew. Any active traffic system or ADS-B traffic that is not correlated will also be displayed for the flight crew. The correlation of traffic by the GDL 88 ensures that only the most accurate, and no duplicate, traffic targets are displayed for the flight crew’s situational awareness.

When interfaced to a TAS or TCAS system, traffic alerts are provided as follows:

Traffic Correlated?	TAS/TCAS Alert Active?	CSA Alert Active?	Aural Alert Source	Visual Alert Source
Yes	Yes	N/A	TCAS/TAS	TCAS/TAS
Yes	No	N/A	None	None
No	Yes	Yes	TCAS/TAS (prioritized) GDL 88	TCAS/TAS GDL 88
No	No	Yes	GDL 88	GDL 88

**Table 4-1 TAS/TCAS Traffic Alerts**



**NOTE:** Aural traffic alerts from the GDL 88 are suppressed when below 500 feet Radar Altitude or Height Above Terrain.

When a GDL 88 and TAS/TCAS system are integrated, the GDL 88 controls the mode of the TAS/TCAS system using the air/ground logic in the GDL 88, as well as from the mode controls available on the interfaced display.

### **4.2.3 No-Heading Source Traffic Information**

When a GDL 88 and TAS/TCAS are integrated in an airplane without a heading source, they are subject to certain limitations:

- While on the ground, display of TCAS traffic and ADS-B traffic are mutually exclusive.
- TCAS (heading referenced traffic) and ADS-B traffic are allowed to be displayed on the traffic page concurrently in a Track Up orientation while airborne, but bearing of the TCAS targets relative to ADS-B targets will be skewed by the crab angle of the aircraft.
- Traffic is not displayed on the moving map with ground features depicted. Traffic will always be available for display on the traffic page.

### **4.2.4 Conflict Situational Awareness (CSA)**

Conflict Situational Awareness is an alerting algorithm that provides TCAS-like Traffic Alerts on ADS-B, ADS-R, and TIS-B targets to enhance situational awareness.

The GDL 88 issues an aural alert when a Conflict Situational Awareness (CSA) alert is displayed: “Traffic-<X>O’Clock,<Y>, <Z>” spoken once, (where <X> is the clock position of the intruder, ”,<Y> is the relative position (Above, Below), and <Z> is the range in nautical miles).

As in some TCAS I TA implementations, altitude above terrain is used to adjust the sensitivity of the CSA algorithm to minimize nuisance alerts. Radar Altitude (if available), Height Above Terrain (as provided by a GNS or GTN navigator with a terrain database), and Geodetic Altitude are used to adjust the sensitivity of the CSA algorithm.

Radar Altitude (if available), Height Above Terrain (if available), and Geodetic Altitude are used to adjust the sensitivity of the CSA algorithm, in accordance with the following table:

Radar Altitude (RA) or Height Above Terrain (HAT) (if Available)	GPS Phase of Flight	RA, HAT, and GPS Flight Phase Not Available OR GPS Phase of Flight Not Approach or Terminal	Sensitivity Level	Look-Ahead Time(s)	Vertical Threshold for Alarm (feet)	Minimum Protected Volume (NM)
Up to 1000 (RA or HAT)	Approach	N/A	2	20	850	0.20
1000-2350 (RA or HAT)	Terminal	N/A	3	25	850	0.20
2350-5000 (Geodetic)		Below 5000 (Geodetic)	4	30	850	0.35
5000-10,000 (Geodetic)		5000-10,000 (Geodetic)	5	40	850	0.55
10,000-20,000 (Geodetic)		10,000-20,000 (Geodetic)	6	45	850	0.80
20,000-42,000 (Geodetic)		20,000-42,000 (Geodetic)	7	48	850	1.10
Above 42,000 (Geodetic)		Above 42,000 (Geodetic)	8	48	1200	1.10

**Table 4-2 Traffic Alert Functionality**

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## 5 WEATHER

The Flight Information Services (FIS-B) function is capable of displaying textual and graphic weather information with GDL 88 installations. No subscription for FIS-B services is required with the GDL 88.

The FIS-B Function is based on a ground-to-air data link and requires that the appropriate ground systems are broadcasting weather data and the aircraft is within reception range of the Ground Broadcast Transceiver (GBT).

The products are transmitted from the UAT (978 MHz) ground stations on a regular basis, in accordance with the following table:

Weather Product	Expiration Time (Minutes)	Transmission Interval (Minutes)	Update Interval (Minutes)
CONUS NEXRAD	60	15	15
Regional NEXRAD	30	2.5	5
AIRMETs	60	5	As Available (Typically 20 minutes)
SIGMETs	60	5	As Available (Typically 20 minutes), then at 15 minute intervals for 1 hour
METARs	90	5	1 minute (where available), As Available otherwise (Typically ≤ 20 minutes)
Winds and Temperatures Aloft	90 or at the end of the valid period	10	12 hours
Pilot Weather Report (PIREP) (Blue - Regular, Yellow - Urgent)	90	10	As available (Typically 20 minutes)
TAFs	60	10	8 hours
NOTAMs	60	10	As available (Typically 20 minutes)

**Table 5-1 FIS-B Weather Products and Aging**



**WARNING:** Do not use the indicated data link weather product age to determine the age of the weather information shown by the data link weather product. Due to time delays inherent in gathering and processing weather data for data link transmission, the weather information shown by the data link weather product may be significantly older than the indicated weather product age.

## 5.1 FIS-B NEXRAD

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 unobstructed range of each NEXRAD is 124 nautical miles.

The FIS-B Function is a graphic weather display capable of displaying graphical weather information on UAT equipped installations. Graphical data is overlaid on the map indicating the rainfall detected by ground based radar for a specific area. Colors are used to identify the different NEXRAD echo intensities (reflectivity) measured in dBZ (decibels of Z). “Reflectivity” (designated by the letter Z) is the amount of transmitted power returned to the radar receiver. The dBZ values increase as returned signal strength increases. Precipitation intensity is displayed using colors corresponding to the dBZ values. An example of how precipitation data is color coded follows:

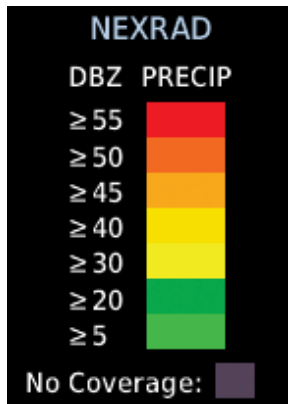


Figure 5-1 Sample FIS-B Weather Precipitation Legend



---

**NOTE:** *FIS-B NEXRAD does not differentiate between frozen and liquid precipitation. The FIS-B NEXRAD intensity colors (as shown below) may differ from the intensity colors from other providers.*

---

### 5.1.1 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 strokes, 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

### 5.1.2 NEXRAD Limitations

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

- The (high resolution) Regional NEXRAD “pixels” are 1.5 minutes (1.5 nautical miles = 2.78 km) wide by 1 minute (1 nautical miles = 1.852 km) tall. The (medium resolution – 5 times larger than high resolution) CONUS NEXRAD “pixels” are 7.5 minutes (7.5 nautical miles = 13.89 km) wide by 5 minutes (5 nautical miles = 9.26 km) wide. Above 60 degrees of latitude the block widths double to 3 minutes/nautical miles for Regional (no CONUS above 60 degrees).

### 5.1.3 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.

### 5.1.4 NEXRAD

When enabled, NEXRAD weather information is shown. Mosaic data from all of the NEXRAD radar sites in the United States is shown. This data is composed of the maximum reflectivity from the individual radar sweeps (i.e. composite reflectivity). The display of the information is color-coded to indicate the weather level severity. FIS-B NEXRAD does not differentiate between frozen and liquid precipitation. Refer to the previously shown legend for a description of the color code.

The NEXRAD option has selections of Regional, CONUS, or Combined NEXRAD (only available with GTN units). CONUS NEXRAD includes a composite of available NEXRAD radar imagery across the 48 states. Regional NEXRAD is a composite of available NEXRAD radar imagery in a local area, showing a more detailed image than CONUS NEXRAD.

FIS-B weather data reception requires line-of-site communication between the receiver and the ADS-B ground station. Incomplete Regional and/or CONUS NEXRAD imagery displayed on the MAP and FIS-B Weather Pages of the affected products is an indicator of poor FIS-B reception. Examples below display areas where FIS-B data is degraded due to poor reception:





GNS



GTN

**Figure 5-2 Examples of Areas Where FIS-B Reception Is Unavailable**

**Affected Areas**

Any area in the continental United States (CONUS) or Alaska where the distance from ADS-B ground stations or the combined effect of distance and low altitude is sufficiently great to cause poor reception. A good source of information for ground station coverage can be found at <http://www.faa.gov/nextgen/flashmap/>

Reception will improve in some affected areas as the FAA completes the NextGen ADS-B ground station infrastructure. However, due to line-of-sight broadcast characteristics, operators with properly installed and functioning equipment may still receive incomplete FIS-B data when signal reception is limited by the distance from ground stations combined with a low altitude.

**Continental US NEXRAD (CONUS)**

The Display CONUS NEXRAD selection shows NEXRAD radar information for the entire continental United States. CONUS NEXRAD data is updated every 15 minutes. The resolution of displayed CONUS NEXRAD data is approximately 10 kilometers (5.4 NM). The intensity level reflected by the pixel will be the highest level sampled within the area covered by each pixel.

**Regional NEXRAD**

The Regional NEXRAD selection shows regional NEXRAD radar information within 250 miles of the aircraft location. Regional NEXRAD data is updated every 5 minutes (10 minutes for clear air mode).

## Combined NEXRAD

Regional NEXRAD data within 500 NM of the aircraft location and CONUS NEXRAD data everywhere else. The two types of NEXRAD are separated by a white stippled border. This boundary is updated whenever new Regional or CONUS NEXRAD data is received.

## 5.2 FIS-B TFRs






Temporary Flight Restrictions (TFRs) provide detailed information for local short term restrictions. The update rate is approximately every 20 minutes.



**NOTE:** *Some TFRs may not be shown or information may be incomplete. The presented TFR information is only advisory in nature. Check official sources, such as from preflight planning or Flight Service Station to determine more complete TFR information.*

## 5.3 FIS-B METARs

When enabled, graphic METARs (METeorological Aviation Reports) are shown as colored flags at airports that provide METAR reports. Press the **METARs** key to enable or disable METARs. Refer to the Legend for a description of the color code. The update rate is every five minutes.

METAR Symbol	Description
	VFR (ceiling greater than 3000 ft. AGL and visibility greater than five miles)
	Marginal VFR (ceiling 1000–3000 ft. AGL and/or visibility three to five miles)
	IFR (ceiling 500 to below 1000 ft. AGL and/or visibility one mile to less than three miles)
	Low IFR (ceiling below 500 ft. AGL or visibility less than one mile)
	Unknown

**Table 5-2 METAR Symbols**

## **5.4 FIS-B PIREPs**

Pilot Weather Reports (PIREPs) provide timely weather information. When significant weather conditions are reported or forecast, Air Traffic Control (ATC) facilities are required to solicit PIREPs. A PIREP may contain non-forecast adverse weather conditions, such as low in-flight visibility, icing conditions, wind shear, and turbulence. PIREPs are issued as either Routine (UA) or Urgent (UUA). The update rate is approximately every 20 minutes.

## **5.5 FIS-B Winds and Temperatures Aloft**

Winds and Temperatures Aloft data shows the forecast wind speed, direction, and Temperature at selected altitudes. Altitudes can be selected in increments from the 1,000 feet up to 53,000 feet. The update rate is every 12 hours.

## **5.6 SIGMETs and AIRMETs**

SIGMETs (SIGnificant METeological Information) and AIRMETs (AIRmen's METeological Information) are broadcast for potentially hazardous weather considered of importance to aircraft. The update rate is approximately every 20 minutes.

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## 6 INSTALLATION CONFIGURATIONS

### 6.1 Possible Installation Configurations

#### 6.1.1 GDL 88 with ADS-B Out Transmission Enabled

The GDL 88 can provide for both the ADS-B Out and ADS-B In functionality. In this case, the GDL 88 transmits ADS-B messages on 978 MHz and receives ADS-B, ADS-R, TIS-B, and FIS-B services on the 1090 and 978 MHz links using its dual link receive capabilities. This installation is limited by FAR 91.227 to use below FL180.

#### 6.1.2 GDL 88 with ADS-B Out Transmission Disabled

With ADS-B Out transmission disabled, the GDL 88 can provide for only ADS-B In functionality. In this case, the GDL 88 receives ADS-B, ADS-R, TIS-B, and FIS-B services on the 1090 and 978 MHz links using its dual link receive capabilities. In order for the ADS-B Out mandate to be met, another LRU, Such as a Garmin GTX 330ES transponder, must be installed that complies with the ADS-B Out mandate on either the 978 MHz or 1090 MHz link. For aircraft operated above FL180, a 1090 MHz ADS-B Out compliant LRU will be required.

#### 6.1.3 GDL 88 Only – No Display

In a minimal installation, the GDL 88 provides the required ADS-B Out functionality with a standalone set of annunciators and control switches installed in the cockpit. When a GDL 88 is installed without interface to an external display, some ADS-B In functionality is still retained. A traffic annunciation light is installed in the cockpit for CSA alerts and aural alerts are provided for these threat aircraft, to include directionality from the ownship and range.

## **6.2 Interfaces**

### **6.2.1 Audio Panel**

Traffic alert audio output is interfaced to a required audio panel with a compatible unswitched unmuted audio input.

### **6.2.2 Altitude Source**

The GDL 88 requires the use of an ownship pressure altitude for transmission of required ADS-B Out data values and to calculate the vertical separation and vertical closure from target aircraft.

### **6.2.3 Heading Source (optional)**

The GDL 88 can optionally use heading for the purpose of correlating ADS-B traffic and traffic received from the external traffic system. HSDB and ARINC 429 digital heading is provided to the GDL 88 from any compatible magnetic heading source. Multiple heading sources may be connected to the GDL 88.

### **6.2.4 GPS Position Source**

The GDL 88 uses the ownship GPS position for creation of the ADS-B Out messages as well as the receipt and tracking of ADS-B In targets. The GDL 88 without the internal GPS WAAS requires at least one compatible GPS position source be installed, while the GDL 88 with the internal GPS WAAS engine may optionally be interfaced with compatible sources.

### **6.2.5 Radar Altimeter (Optional)**

The GDL 88 can optionally be interfaced with a radar altimeter to drive the sensitivity level of the Conflict Situational Awareness (CSA) application.

### **6.2.6 Traffic Mute (Optional)**

The GDL 88 can optionally interface with a pilot controlled switch to acknowledge an active Conflict Situational Awareness (CSA) alert and mute the associated aural alert. This momentary switch only mutes the current CSAs and does not act as an inhibit for future CSA aural annunciations.

## 7 GLOSSARY

ADS-B	Automatic Dependent Surveillance Broadcast. Automatic Dependent Surveillance–Broadcast (ADS–B) equipment is an advanced surveillance technology that combines an aircraft’s positioning source, aircraft avionics, and a ground infrastructure to create an accurate surveillance interface between aircraft and ATC.
ADS-B In	ADS–B In refers to an appropriately equipped aircraft’s ability to receive and display another aircraft’s ADS–B Out information as well as the ADS–B In services provided by ground systems, including Automatic Dependent Surveillance–Rebroadcast (ADS–R), Traffic Information Service–Broadcast (TIS–B), and, if so equipped, Flight Information Service–Broadcast (FIS–B).
ADS-B Out	ADS–B Out provides air traffic controllers and other aircraft with real-time position information that is, in most cases, more accurate than the information available with current radar-based systems. With more accurate information, ATC will be able to position and separate aircraft with improved precision and timing.
ADS-R	ADS Rebroadcast. ADS–R collects traffic information from each broadcast link and rebroadcasts it to ADS–B In equipped operators on the other broadcast link.
AIRB	Airborne Situational Awareness. An ADS-B In application that provides the ADS-B and external traffic system targets on a display to be used by the flight crew for situational awareness.
Anonymous Mode	The Anonymous Mode, when armed, will replace the Flight ID with a temporary randomized number for privacy while the position information will still be provided.
CSA	Conflict Situational Awareness. A traffic alerting feature to increase flight crew situational awareness of traffic situations that could lead to a hazardous condition in the near term.
Extended Squitter	With Extended Squitter capabilities, position, velocity, and heading information are automatically transmitted by the 1090 transponder to other aircraft and ground stations.

---

FIS-B	Flight Information Services-Broadcast. FIS-B is a graphic weather display capable of displaying graphical weather information on UAT equipped installations. FIS-B is available free to any operator with the ability to receive and display the data that is broadcast on the Universal Access Transceiver (UAT) or the 978 MHz link.
Ground Clutter	A form of radar signal interference that occurs when fixed objects close to the transmitter—such as buildings, trees, or terrain (hills, ocean swells and waves)—obstruct a radar beam and produce echoes.
GPS	Global Positioning System. A space-based Navigation system providing accurate position, velocity and time information. This instrumentation will be certified as primary navigation.
HAT	Height Above Terrain
HSDB	Garmin's proprietary High Speed Data Bus.
ICAO	International Civil Aviation Organization.
PABI	Pressure Altitude Broadcast Inhibit.
SBAS	Satellite-Based Augmentation System.
STC	Supplementary Type Certificate
SURF	Surface Situation Awareness. An ADS-B In application that provides the ADS-B and external traffic system targets on a display to be used by the flight crew for situational awareness.
TA	Traffic Advisory.
TAS	Traffic Advisory System.
TCAD	Traffic Collision Avoidance Device.



TCAS	Traffic Collision Avoidance System. An aircraft collision avoidance system designed to reduce the incidence of mid-air collisions between aircraft. It monitors the airspace around an aircraft for other aircraft equipped with a corresponding active transponder, independent of air traffic control, and warns pilots of the presence of other transponder-equipped aircraft which may present a threat of mid-air collision.
TIS-B	Traffic Information Services-Broadcast. TIS-B supplements ADS-B's air-to-air services to provide more situational awareness in the cockpit of all traffic known to the ATC system. The ground TIS-B station transmits surveillance target information on the ADS-B data link for unequipped targets or targets transmitting only on another ADS-B link. TIS-B is a free service available to aircraft operators equipped with ADS-B Out and ADS-B In.
UAT	Universal Access Transceiver. The GDL 88 UAT transmits ADS-B Out data on the 978 MHz (UAT) frequency. The GDL 88 UAT receives ADS-B, ADS-R, TIS-B, and FIS-B on 978 MHz
XPDR	Transponder. The equipment which broadcasts aircraft code, altitude and other information to ground facilities and other aircraft.

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## 8 APPENDIX

### 8.1 Troubleshooting

If efforts to resolve the problem fail, contact your dealer or customer service for technical assistance.

Please have the following information ready:

- System configuration (products, antennas, mounting locations, etc.)
- Model No., part number, and serial number
- Software versions
- Description of the problem
- Efforts made to isolate/solve the problem

Garmin International, Inc.  
Aviation Products Customer Service Department  
1200 East 151st Street  
Olathe, KS 66062-3426 USA  
1-866-739-5687

<https://fly.garmin.com/fly-garmin>

#### External ADS-B Annunciator

When one or more GDL 88 faults are present, the ADS-B annunciator activates one or both of two lights to indicate the presence and type of the highest priority GDL 88 fault present. For example, if both a No Position (priority 2) fault and a Fault (priority 3) are present, the ADS-B annunciator will indicate the presence of a No Position fault.

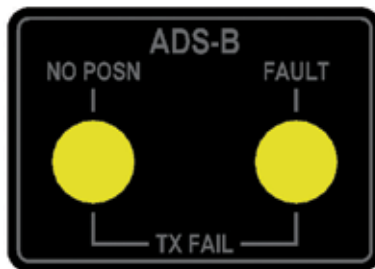


Figure 8-1 GDL 88 Annunciator

Reporting Priority	Fault Type	ADS-B Annunciator Light(s) Activated	Description
1	Transmit Fail	Both	A GDL 88 internal malfunction, antenna malfunction, or incorrect configuration setting prevent transmission.
2	No Position	NO POSN	The GDL 88 is not receiving GPS position.
3	Fault	FAULT	A GDL 88 or external fault prevent proper operation of the GDL 88.
--	No Fault	Neither	No fault present.

**Table 8-1 GDL 88 Fault Types**

## 8.2 Servicing Your Unit

The Garmin GDL 88 has no user-serviceable parts. Should you ever encounter a problem with your unit, take it to an authorized Garmin dealer for repairs, or contact Garmin Product Support at 1-866-739-5687.

The GDL 88 is sealed to protect the unit. Any attempt to open the case to change or modify the unit in any way voids your warranty and may result in permanent damage to the equipment.

## 8.3 Contact Garmin

Contact Garmin if you have any questions while using your GDL 39. In the USA, contact Garmin Product Support by phone: (913) 397-8200 or (866) 739-5687, Monday–Friday, 7 AM–7 PM Central Time; or go to:

<https://fly.garmin.com/fly-garmin/support>.

In Europe, contact Garmin (Europe) Ltd. at +44 (0) 870.8501241 (outside the UK) or 0808 2380000 (within the UK).

## **8.4 Software License Agreement**

BY USING THE GDL 88, YOU AGREE TO BE BOUND BY THE TERMS AND CONDITIONS OF THE FOLLOWING SOFTWARE LICENSE AGREEMENT. PLEASE READ THIS AGREEMENT CAREFULLY.

Garmin grants you a limited license to use the software embedded in this device (the “Software”) in binary executable form in the normal operation of the product. Title, ownership rights, and intellectual property rights in and to the Software remain with Garmin.

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## 8.5 LIMITED WARRANTY

All Garmin avionics products are warranted to be free from defects in materials or workmanship for: two years from the date of purchase for new Remote-Mount and Panel-Mount products; one year from the date of purchase for new portable products and any purchased newly-overhauled products; six months for newly-overhauled products exchanged through a Garmin Authorized Service Center; and 90 days for factory repaired or newly-overhauled products exchanged at Garmin in lieu of repair. Within the applicable period, Garmin will, at its sole option, repair or replace any components that fail in normal use. Such repairs or replacement will be made at no charge to the customer for parts or labor, provided that the customer shall be responsible for any transportation cost. This warranty does not apply to: (i) cosmetic damage, such as scratches, nicks and dents; (ii) consumable parts, such as batteries, unless product damage has occurred due to a defect in materials or workmanship; (iii) damage caused by accident, abuse, misuse, water, flood, fire, or other acts of nature or external causes; (iv) damage caused by service performed by anyone who is not an authorized service provider of Garmin; or (v) damage to a product that has been modified or altered without the written permission of Garmin. In addition, Garmin reserves the right to refuse warranty claims against products or services that are obtained and/or used in contravention of the laws of any country.

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**Online Auction Purchases:** Products purchased through online auctions are not eligible for warranty coverage. Online auction confirmations are not accepted for warranty verification. To obtain warranty service, an original or copy of the sales receipt from the original retailer is required. Garmin will not replace missing components from any package purchased through an online auction.

**International Purchases:** A separate warranty may be provided by international distributors for devices purchased outside the United States depending on the country. If applicable, this warranty is provided by the local in-country distributor and this distributor provides local service for your device. Distributor warranties are only valid in the area of intended distribution. Devices purchased in the United States or Canada must be returned to the Garmin service center in the United Kingdom, the United States, Canada, or Taiwan for service.

To obtain warranty service, contact your local Garmin Authorized Service Center. For assistance in locating a Service Center near you, visit the Garmin web site at <http://www.garmin.com>, <https://fly.garmin.com/fly-garmin>, or contact Garmin Customer Service at 866-739-5687.

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GARMIN International, Inc.

1200 East 151<sup>st</sup> Street, Olathe, Kansas 66062, U.S.A.  
Tel. 913/397.8200 or 866/739.5687 Fax 913/397.8282

Garmin AT, Inc.

2345 Turner Rd., S.E., Salem, Oregon 97302, U.S.A.  
Tel. 503/581.8101 or 800/525.6726 Fax. 503/364.2138

Garmin (Europe) Ltd.

Liberty House, Bulls Copse Road, Hounslow Business Park,  
Southampton, SO40 9LR, U.K.  
Tel. +44 (0) 23 8052 4000 Fax +44 (0) 23 8052 4004

GARMIN Corporation

No. 68, Zhangshu 2<sup>nd</sup> Road, Xizhi Dist., New Taipei City 221, Taiwan  
Tel. 886/2.2642.9199 Fax 886/2.2642.9099

Garmin Singapore Pte. Ltd.

46 East Coast Road  
#05-06 Eastgate  
Singapore 428766  
Tel. (65) 63480378 Fax (65) 63480278

[www.garmin.com](http://www.garmin.com)

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