

GARMIN<sup>®</sup>

# GTS 8XX Series

## Pilot's Guide Traffic Advisory System



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## WARNINGS, CAUTIONS, AND NOTES



**WARNING:** *The GTS 8XX Series Traffic Advisory System (TAS and TCAS I) is intended for advisory use only to aid the pilot in visually acquiring traffic. No avoidance maneuvers should be based solely upon TAS traffic information. It is the responsibility of the pilot in command to see and maneuver to avoid traffic.*



**NOTE:** *Pilots should be aware of TAS/TCAS system limitations. TAS/TCAS systems require intruder transponders to respond to system interrogations. If an intruder transponder does not respond to interrogations due to antenna shading or marginal transponder performance, it will not be displayed, or display may be intermittent. Pilots should remain vigilant for traffic at all times when using TAS/TCAS systems for non-transponder equipped airplanes or unresponsive airplanes.*

## TSO COMPLIANCE

GTS Unit	Product Description	Applicable TSO
GTS 800	Low Power TAS	C147, C166a
GTS 820	High Power TAS	C147, C166a
GTS 850	TCAS I	C118, C166a

**Table 1 GTS 8XX Series Family TSO Compliance**

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## PRODUCT DESCRIPTION

The GTS 8XX Series Traffic Advisory System (TAS) and Traffic Collision Avoidance System (TCAS I) uses active interrogations of Mode A/C/S transponders to provide Traffic Advisories to the pilot independent of the air traffic control system. The system also uses passive surveillance by means of an Automatic Dependent Surveillance – Broadcast (ADS-B) receiver which is enabled when installed with an ADS-B link transmit class of equipment.



**Figure 1 GTS 8XX LRU**

The GTS 8XX Series of Traffic Advisory System (TAS) or Traffic Alert and Collision Avoidance System (TCAS I) microprocessor-based sub-systems products consist of the GTS 800, GTS 820 and GTS 850. The GTS 800 TAS product consists of one LRU which has low power (40 Watts) transmit capability, and one GA 58, or other Garmin-approved, directional antenna. The GTS 820 TAS and GTS 850 TCAS I products include one LRU paired with one GPA 65 PA/LNA Amplifier Module, which allows high power (250W) transmit capability, and one GA 58 or other Garmin-approved directional antenna. An optional second antenna may also be installed with these systems. The optional second bottom mounted antenna may be omnidirectional or a Garmin approved directional antenna.

For targets equipped with a 1090 MHz ADS-B transmit class of equipment, the GTS 8XX series combines active (interrogated) and passive (ADS-B) surveillance data to enhance the accuracy of target position on the display. The systems use Garmin's CLEAR CAS™ technology to correlate ADS-B and actively interrogated targets to provide pilots with the most accurate target position. Passive ADS-B surveillance is enabled when the GTS 8XX is installed with an ADS-B transmit class of equipment.

The GTS 8XX Series provides for expanded audio messaging in an ATC-like verbal format: “Traffic. One o’clock. High (or Low or Same Altitude). Two miles.” If surveillance bearing information is not available on the intruder, “Traffic, No Bearing” is called out.

Bearing may be derived from either the top or bottom directional antenna depending upon which antenna hears the response. A directional antenna is used to derive bearing to the intruder aircraft, which is displayed with relative altitude to own aircraft. Top antenna transmitted interrogations are directional, reducing the number of transponders that receive the interrogation thus reducing potential garble on the 1090 MHz band.



**Note:** *GTS 8XX is used throughout this manual to refer to the GTS 800, 820, or 850 products. When a feature is unique to the GTS 800, 820, or 850 it will be specifically referenced as such.*

Product	GTS 800	GTS 820	GTS 850
Traffic Advisory System (TAS)	X	X	
Traffic Alert and Collision Avoidance System (TCAS I)			X
LRU	X	X	X
GPA 65 PA/LNA		X	X
1090 ES ADS-B Receiver	X	X	X
Transmit Power (Watts)	40	250	250
Top-Mounted Garmin-Approved Directional Antenna	X	X	X
Optional Bottom-Mounted Garmin-Approved Directional or Omnidirectional Antenna	X	X	X

**Table 2 GTS 8XX Series Family Product Description**

The GTS 8XX Series does not contain a display, but transmits traffic data to a Garmin or third party multi-function display that is capable of displaying traffic data. More information is located in the installation manual. The GTS 8XX Series supplies data to a traffic display to indicate the presence and location of intruder aircraft. The information provides the crew with the intruder’s range, bearing, and, for altitude reporting intruders, relative altitude and vertical trend. TCAS I symbology as defined in the FAA Advisory Circular entitled “Airworthiness

Approval of Traffic and Collision Avoidance Systems (Active TCAS I)” is utilized to depict traffic information.

## Compatible Display Units

The following table lists compatible display units. As products may continually be added to the list of compatible display units, always refer to the GTS 8XX Installation Manual for a complete list. Some displays may require the purchase and installation of additional modules and/or software to support traffic displays. Check with your installer to ensure an existing display supports traffic prior to installation.

Manufacturer	Model
Garmin	GMX 200/MX20
Garmin	GNS 400/500 Series
Garmin	GNS 400W/500W Series
Garmin	GNS 480
Garmin	GDU 620
Avidyne	EX500 (MFD Only)
Honeywell	Bendix/King KMD 550/850
Sandel	SN3500/SN4500

**Table 3 GTS 8XX Series Compatible Display Units**



## **GTS 800**

The GTS 800 is a TAS system that can track up to 45 Mode A/C/S targets, and display up to 30 intruder threats at a time, depending on the display being utilized. Offering 40 watts of transmit power, a  $\pm 10,000$  foot vertical separation maximum, and an active interrogation range of up to 12 NM in the forward direction, the GTS 800 system will interface with a variety of compatible system displays in the cockpit.

## **GTS 820**

The GTS 820 is a TAS system that can track up to 45 intruding aircraft equipped with Mode A/C transponders, and up to 30 intruders equipped with Mode S transponders. A GTS 820 TAS has an active surveillance range of up to 40 NM in the forward direction, dependent upon interference limiting techniques based on the number of TCAS II interrogators in the area. Interrogation power and range in the left, right, and aft quadrants is reduced in a manner similar to TCAS II systems. It includes a GPA 65 PA/LNA Module that is remotely installed near the top directional antenna to boost the interrogation range.

## **GTS 850**

The GTS 850 is a fully compliant TCAS I certified system. Operational capabilities are similar for airborne traffic surveillance for both the GTS 820 and GTS 850 systems.

## **Antennas**

### **General Antenna Information**

A top-mounted directional antenna is used to derive bearing to the intruder aircraft. Top antenna transmitted interrogations are directional, reducing the number of transponders that receive the interrogation thus reducing potential garble on the 1090 MHz band.

Optional bottom monopole or directional antenna transmit interrogations are omnidirectional. Intruder bearing can be determined from the top directional antenna or an optional bottom directional antenna for retractable gear aircraft.

## **GTS 8XX Series Antenna Configurations**

- Top only directional antenna.
- Top directional with bottom monopole antennas (recommended for fixed gear aircraft) provides improved intruder visibility. The type of antenna used will be primarily limited by the amount of space available on the bottom of the airplane. Any aircraft that can utilize the directional antenna on the bottom would benefit from its use.
- Top directional with bottom directional antennas (recommended for retractable gear aircraft) provides benefit of intruder bearing visibility for targets that are shaded from the top directional antenna.

### **GA 58 Directional Antenna**

The GA 58 directional four element antenna is included with the basic GTS system to provide altitude, distance, and bearing of threat aircraft. A single antenna installation uses top-mounted placement. A second GA 58 may be bottom-mounted to optimize coverage.



**Figure 2 GA 58 Directional Antenna**

### **Bottom Mounted Directional Antenna (optional)**

A directional antenna may be used as an additional antenna for bottom-mounting to reduce shading and provide altitude and distance of threat aircraft. Interrogations from the bottom directional antenna are transmitted in an omnidirectional pattern, but it still allows bearing determination from replies received on the bottom antenna.

## Bottom Mounted Monopole Antenna (optional)

The addition of an optional bottom-mounted monopole antenna will improve visibility of intruder aircraft by reducing shading and providing altitude and distance of threat aircraft. Bearing cannot be determined from replies received on a bottom-mounted monopole antenna.



Figure 3 Bottom-Mounted Monopole Antenna

## GPA 65 PA / LNA Module (GTS 820 & 850 only)

The GPA 65 is a combined Power Amplifier and Low Noise Amplifier module used in the higher power GTS 820 and 850.



Figure 4 GPA 65 PA/LNA Module

## **OPERATION**

### **GTS 8XX Series Traffic**

The Garmin GTS 8XX Series unit is a Traffic Advisory System (TAS - GTS 800 and GTS 820) or Traffic Alert and Collision Avoidance System (TCAS I - GTS 850). The GTS 8XX Series enhances flight crew situational awareness by displaying traffic information for transponder-equipped aircraft. The GTS 8XX Series also provides visual and aural traffic alerts including voice announcements to assist in visually acquiring traffic. The GTS 800 and GTS 820 are TAS systems, the GTS 850 is a TSO-approved TCAS I system. The GTS 8XX uses active interrogations of Mode A/C/S transponders to provide Traffic Advisories.

### **Theory of Operation**





When the GTS 8XX Series is in Operating Mode, the unit interrogates the transponders of intruding aircraft while monitoring transponder replies. The GTS 8XX Series uses this information to derive the distance, relative bearing, and if reported, the altitude and vertical trend for each aircraft within its surveillance range. The GTS 8XX Series then calculates a closure rate to each intruder based on the projected Closest Point of Approach (CPA). If the closure rate meets the threat criteria for a Traffic Advisory (TA), visual and aural alerting is provided.

### **TAS/TCAS Surveillance Volume**

The GTS 8XX Series surveillance system monitors the airspace within  $\pm 10,000$  feet of own altitude. Under ideal conditions, the unit scans transponder traffic up to 40 NM (GTS 820 and GTS 850) or 12 NM (GTS 800) in the forward direction using top and bottom-mounted antennas similar to TCAS II systems. In areas of greater transponder traffic density or when TCAS II systems are detected, the GTS 820 and GTS 850 systems automatically reduce interrogation transmitter power (and therefore range) in order to limit potential interference from frequency congestion. The GTS 800's range is 12 NM in the forward direction and the maximum interrogation transmitter power remains constant. There is also a minimum alerting threshold for range to allow alerting in situations where traffic is slowly converging. Alerting may be caused by closure rate or minimum distance to the intruder.

## TAS/TCAS Symbology

The GTS 8XX Series supports displays that depict intruding traffic using the symbols shown in the following table. Refer to the documentation for the specific display to confirm the supported symbology. Symbol colors may vary depending on the display product.

TAS Symbol	Description
	Non-Threat Traffic (intruder is beyond 6 NM and greater than 1200 feet vertical separation)
	Proximity Advisory (PA) (intruder is within 6 NM and less than 1200 feet vertical separation)
	Traffic Advisory (TA) (closing rate, distance, and vertical separation meet TA criteria)
	Traffic Advisory Off Scale

**Table 4 TAS Intruder Symbol Description**

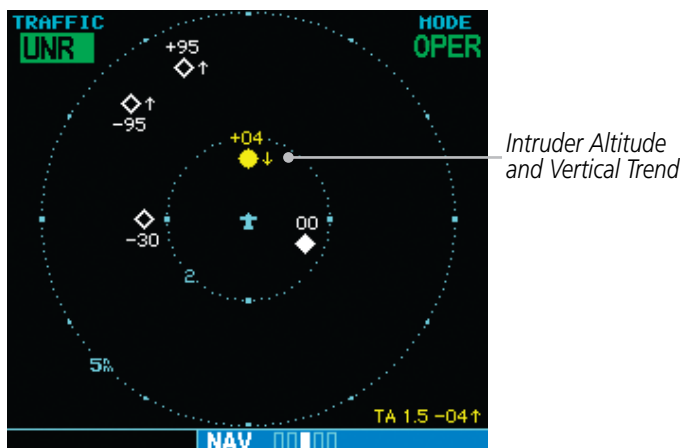
A Traffic Advisory (TA), displayed as a yellow circle, alerts the crew to a potentially hazardous intruding aircraft if the closing rate, distance, and vertical separation meet TA criteria. A Traffic Advisory that is beyond the selected display range is indicated by a half TA symbol at the edge of the screen at the relative bearing of the intruder.

A Proximity Advisory (PA), displayed as a solid white diamond, indicates the intruding aircraft is within  $\pm 1200$  feet and is within a 6 NM range, but is still not considered a TA threat.

A non-threat symbol, shown as an open white diamond, is displayed for all other traffic beyond 6 NM that does not meet the criteria to be a TA or PA.

Relative altitude, when available, is displayed above or below the corresponding intruder symbol in hundreds of feet. When this altitude is above own aircraft, it is preceded by a “+” symbol; a minus sign “-” indicates traffic is below own aircraft.

A vertical trend arrow to the right of the intruder symbol indicates climbing or descending traffic with an upward or downward-pointing arrow respectively.



**Figure 5 Intruder Altitude and Vertical Trend Arrow**

The GTS 8XX Series automatically suppresses the display of altitude-reporting aircraft on the ground under either of the following conditions:

- On-ground aircraft is equipped with a Mode S transponder that reports the on-ground state.
- On-ground aircraft is equipped with a Mode C transponder, and own aircraft's radar altimeter (if installed) is displaying 1700 feet AGL or less.

## GTS 8XX Series Sensitivity Level

The GTS 8XX Series issues Traffic Advisories according to the current Sensitivity Level (SL). To prevent nuisance alerts near airports, the GTS 8XX Series has two sensitivity levels available, Sensitivity Level A (SLA) and Sensitivity Level B (SLB). Refer to Table 5 for Sensitivity Level definitions. SLA is used to reduce sensitivity levels in airport environment and avoid nuisance traffic alerts.

The logic for choosing the sensitivity level is based on aircraft configuration. SLA is determined according the following order:

1. Ownship is below 2,000 feet AGL (if equipped with a radio altimeter)
2. Landing gear is extended (no radio altimeter is installed on retractable gear aircraft)
3. Ground speed is below 120 knots (no radio altimeter installed in a fixed-gear aircraft)

The GTS 8XX Series will remain in SLB at all other times. In the event a fixed-gear aircraft is not equipped with a radio altimeter and ground speed is not available, the GTS 8XX Series will remain in SLB at all times.



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***Note: If the GTS 8XX Series is interfaced to a radio altimeter, or if the gear/wheel is configured as fixed, the system will ignore the GEAR DOWN AND LOCKED discrete input.***

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In both SLA and SLB, audio alerts are suppressed only under the following conditions:

1. If radio altimeter is installed and own altitude is less than 400 feet AGL.
2. If no radio altimeter is installed in a retractable gear aircraft and gear is extended.

## Traffic Advisory (TA) Alerting Conditions

Sensitivity Level	Intruder Altitude Available	TA Alerting Conditions
A	Yes	<p>Intruder closing rate provides less than 20 seconds of vertical and horizontal separation.</p> <p>Or:</p> <p>Intruder closing rate provides less than 20 seconds of horizontal separation and vertical separation is within 600 feet.</p> <p>Or:</p> <p>Intruder range is within 0.2 NM and vertical separation is within 600 feet.</p>
A	No	Intruder closing rate provides less than 15 seconds of separation.
B	Yes	<p>Intruder closing rate provides less than 30 seconds of vertical and horizontal separation.</p> <p>Or:</p> <p>Intruder closing rate provides less than 30 seconds of horizontal separation and vertical separation is within 800 feet.</p> <p>Or:</p> <p>Intruder range is within 0.55 NM and vertical separation is within 800 feet.</p>
B	No	Intruder range is less than 20 seconds.

**Table 5 TA Sensitivity Level and TA Alerting Criteria**



## TAS/TCAS Alerts

When the GTS 8XX Series detects a new TA, the following occur:

- A single “Traffic!” voice alert is generated, followed by additional voice information about the bearing, relative altitude, and approximate distance from the intruder that triggered the TA. The announcement “Traffic! 12 o’clock, high, four miles,” would indicate the traffic is in front of own aircraft, above own altitude, and approximately four nautical miles away.
- A TA is annunciated on the display as a TA symbol or annunciation. Refer to the display pilot’s guide for details.

If the bearing of TA traffic cannot be determined, a yellow text banner will be displayed on the Traffic Page instead of a TA symbol. The text will indicate “TA” followed by the distance, relative altitude, and vertical trend arrow for the TA traffic, if known.

A TA will be displayed for at least eight seconds, even if the condition(s) that initially triggered the TA are no longer present.

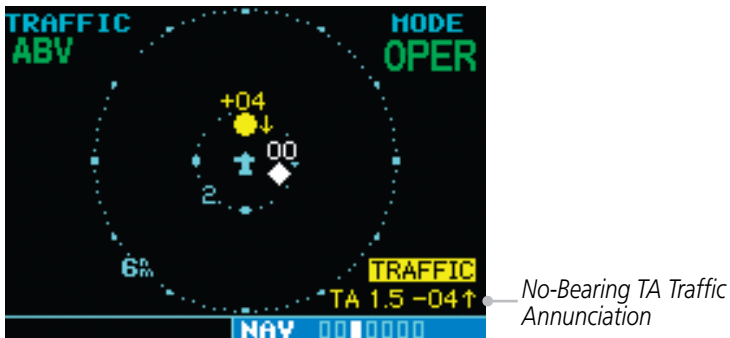


Figure 6 Traffic Annunciation

Bearing	Relative Altitude	Distance
"One o'clock" through "Twelve o'clock" or "No Bearing"	"High", "Low", "Same Altitude" (if within 200 feet of own altitude), or "Altitude not available"	"Less than one mile", "One Mile" through "Ten Miles", or "More than ten miles"

Table 6 TA Descriptive Voice Announcements

## System Test



**NOTE:** GTS 8XX Series traffic surveillance is not available during the system test. Use caution when performing a system test during flight.

The GTS 8XX Series provides a system test mode to verify the TAS system is operating normally. The test takes ten seconds to complete. When the system test is initiated, a test pattern of traffic symbols is displayed on the Traffic Page. If the system test passes, the aural announcement “TAS System Test Passed” is heard, otherwise the system announces “TAS System Test Failed.” For the GTS 850, the aural announcement is “TCAS System Test Passed/Failed.” When the system test is complete, the GTS 8XX Series enters Standby Mode. The system may be installed so that the system test is unavailable during flight.



Figure 7 Self-Test Mode

## Power-Up



**NOTE:** The GTS 8XX Series automatically transitions from **STANDBY** to **OPERATE** mode eight seconds after takeoff. The unit also automatically transitions from **OPERATE** to **STANDBY** mode 24 seconds after landing.

After power-up, the GTS 8XX Series is in Standby Mode. The GTS 8XX Series must be in Operating Mode for traffic to be displayed and for TAs to be issued.

## System Status

The traffic mode is annunciated on the display product. The symbology may vary by display product. See the particular pilot's guide for specific details.

Mode	Traffic Mode Annunciation (Traffic Page)	Traffic Display Enabled Icon (Other Maps)
Self-test Initiated	TEST	
Operating	OPERATING	
Standby	STANDBY (also shown in white in center of page)	
Failed*	FAIL	

Table 7 Example TAS/TCAS Modes

If the traffic unit fails, an annunciation as to the cause of the failure is shown on the display product. During a failure condition, the Operating Mode cannot be selected.

Traffic Map Page Annunciation	Description
NO DATA	Data is not being received from the TAS/TCAS I unit
DATA FAILED	Data is being received from the TAS/TCAS I unit, but the unit is self-reporting a failure
FAILED	Incorrect data format received from the TAS/TCAS I unit

Table 8 TAS/TCAS Failure Annunciations

The annunciations to indicate the status of traffic information appear in a banner on the traffic display. The annunciations may vary by display product. See the particular pilot's guide for specific details.

Traffic Status Banner Annunciation	Description
TA OFF SCALE	A Traffic Advisory is outside the selected display range. Annunciation is removed when traffic comes within the selected display range.
TA X.X ± XX ↓	System cannot determine bearing of Traffic Advisory. Annunciation indicates distance in NM, altitude separation in hundreds of feet, and altitude trend arrow (climbing/ descending).

**Table 8 TAS Traffic Status Annunciations**

## **Q AND A**

### **What are the benefits of ADS-B?**

1090 MHz Extended Squitter ADS-B data contains additional information about a target aircraft including flight ID, latitude, longitude, barometric and geometric altitude, velocity, and direction.

This provides precise location information about the target aircraft. Targets within the active surveillance range that are correlated with ADS-B data are displayed with much greater accuracy as a result of this.

### **When is ADS-B (passive surveillance) available?**

Passive surveillance functionality is available when the GTS 8XX system is installed with an ADS-B link transmit class of equipment. Target aircraft must be equipped with a 1090 MHz ADS-B transmit class unit to provide ADS-B data for passive surveillance.

### **How do we correlate the ADS-B data with the TAS/TCAS I data?**

The GTS 8XX Series correlates TAS or TCAS I range, altitude, and bearing data with internally received 1090 Extended Squitter ADS-B data when available, using the precision information from ADS-B to determine the location of the target.

The TAS/TCAS I data, either correlated, or uncorrelated if target aircraft is not equipped with an ADS-B transmitter, is sent to a display such as a G600 or G1000 Control/Display Unit, GNS 430, GNS 480, GNS 530, MX 20, GMX 200, or a third-party device.

### **How are active and passive targets displayed?**

For systems that use Garmin's High-Speed Data Bus (HSDB) to communicate data to the display device, correlated targets will be shown with their flight ID. A future update will include the display of track and velocity information, as well as ground targets. Passive surveillance targets outside the active surveillance range will also be displayed with their flight ID.

For systems that use ARINC 429 to communicate data to the display device, ARINC 429 protocol does not exist to distinguish between correlated targets and uncorrelated targets. For this reason only active surveillance correlated and uncorrelated targets will be transmitted to the display device with no distinction between the two, but with enhanced position accuracy derived from the correlated data. Display characteristics that would distinguish the passive (ADS-B) and active targets would require a software update to the display device.

## **What are the ramifications if GPS data is not available?**

Own ship latitude and longitude are not known. Active surveillance still determines target distance, bearing, and altitude (if an altitude reporter). Passive surveillance is disabled if GPS position of own aircraft is not available. TAS/TCAS and traffic alerting remain operational.

## **Is a Mode C or S transponder required for the GTS 8XX Series installation?**

Not for the GTS 800 TAS low power product, but the absence of an ADS-B link transmit class of equipment will disallow the ADS-B receive functionality. ADS-B requires broadcast capability which comes from ADS-B link transmit class of equipment.

The higher power products, GTS 820 TAS and GTS 850 TCAS I, require a Mode S transponder that is capable of obtaining the NTA count (number of TCAS II-equipped aircraft in the active surveillance area). This is due to an interference limiting requirement.

## **Does the GTS 8XX Series require a Garmin Extended Squitter Mode S transponder to support all functions?**

The GTS 800 requires a Garmin Extended Squitter Mode S transponder or other complementary ADS-B link transmit class of equipment for ADS-B operation.

The GTS 820 TAS and GTS 850 TCAS I require a Garmin Extended Squitter Mode S transponder for ADS-B operation.

## **GLOSSARY**

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AGL:	Above Ground level
Active Target:	Any intruder tracked by the appliance using active interrogations
ADS-B:	Automatic Dependent Surveillance – Broadcast
ATCRBS:	Air Traffic Control Radio Beacon Service- A secondary surveillance radar system having ground-based interrogators and airborne transponders capable of operation on Modes A and C
CLEAR CAS:	Correlated Location Enhanced ADS-B Receiver Collision Avoidance System
CPA:	Closest Point Approach
GPS:	Global Positioning System
LRU:	Line Replaceable Unit
MHz:	Mega Hertz
Mode A:	A type of ATCRBS transmission which requests (via Mode A interrogations) or reports (via Mode A replies) aircraft identity information
Mode C:	A type of ATCRBS transmission which requests (via Mode C interrogations) or reports (via Mode C replies) aircraft altitude information
Mode S:	A type of secondary surveillance radar transmission which contains a unique 24-bit discrete address, thus allowing interrogations to be addressed to individual aircraft. Mode S transmissions can be short (56 bits) or long (112 bits), with long transmissions containing a 56-bit “message” field.
NTA:	Number of TCAS equipped targets
NM:	Nautical Mile
PA:	Proximate Advisory
Target:	Any intruder tracked by the appliance
TA:	Traffic Advisory
TAS:	Traffic Advisory System
TCAS:	Traffic Alert and Collision Avoidance System

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