National Transportation Safety Board
Office of Research and Engineering
Washington, DC 20594

CEN22FA424

# GPS AND TRANSPONDER DEVICES

Specialist's Factual Report

December 2, 2022

## A. ACCIDENT

| | |
|---|---|
| Location: | Longmont, CO |
| Date: | September 17, 2022 |
| Time: | 08:53 mountain daylight time (MDT) |
| Aircraft: | Cessna 172S, N2117Y |
| | Sonex Aircraft Xenos, N255BF |

## B. GPS AND TRANSPONDER DEVICES GROUP

| | |
|---|---|
| Group Chair | Sean Payne<br>Sr. Engineer<br>National Transportation Safety Board (NTSB) |
| Group Member | Tom Jacky<br>Aerospace Engineer<br>NTSB |
| Group Member | Gregg Nesemeier<br>Manager, AIR-622 Communications, Surveillance & Traffic<br>Federal Aviation Administration (FAA) |
| Group Member | Brent R. Elliott<br>Aviation Safety Inspector – AFS-340 GA – Avionics Section<br>FAA |
| Group Member | Paula Gardner<br>Aviation Systems Engineer<br>Garmin |

## C. DETAILS OF THE INVESTIGATION

A global positioning system (GPS) and transponder group was convened on November 21, 2022. The NTSB Vehicle Recorder Division received the following avionics:

| | |
|---|---|
| Recorder Manufacturer/Model: | Garmin GNS-430W |
| Part Number: | 011-01060-00 |
| Recorder Serial Number: | 23432031 |

| | |
|---|---|
| Recorder Manufacturer/Model: | Garmin GTX-330 |
| Part Number: | 011-00455-60 |
| Recorder Serial Number: | 84142720 |

## 1.0 Device Description

### GARMIN GNS-430W

The Garmin Model GNS-430W is a panel-mounted GPS receiver featuring a color liquid crystal (LCD) display and offering navigation and communication data, along with precision and non-precision approach certification in the IFR environment. The unit has a slot for a Jeppesen database (front-loading data card) containing all airports, VORs, NDBs, intersections, Approach, STAR/SIDs and SUA information. A flight plan composed of multiple waypoints, including user-defined waypoints, can be programmed in the unit. However, the unit has no capability of recording and storing position information. Data related to last known communication frequency and navigation frequency settings is stored in non-volatile memory (NVM) and may be read from the front panel display upon power-up.[1] There are no provisions for downloading stored data to a PC. An internal button-battery is used to back-up power to the internal memory and real-time clock during those periods when main power is removed. The manufacturer's data plate indicated the unit was a Technical Standard Order (TSO) TSO-C146a Class 3 and European TSO (ETSO) ETSO-C146 Class 3 compliant device.

### GARMIN GTX-330

The Garmin GTX-330 is a panel mounted Mode S digital transponder with traffic datalink capability and dedicated pushbutton keys for squawk code selection. The device has an optional 1090 MHz ES broadcast mode when connected to a WAAS position source.[2, 3] The manufacturer's data plate indicated the unit was a TSO/ETSO-C112d Level 2ens, Class 1 compliant device.

## 1.1 Data Recovery

### GARMIN GNS-430W

The device was lightly damaged in the event. The only evidence of damage was some broken plastic in the outer case that holds the screen and a missing left cursor knob. The device was installed into a third-party bench top power supply that was designed to operate the device outside of an aircraft's panel. The power supply has two settings, normal mode and simulation mode. Normal mode was used to power the device in the benchtop power supply. Normal mode provides grounding to certain pins that enable factory configuration pages to be accessed, as if the unit was installed in an aircraft. Alternatively, when set to simulation mode, these pins remain ungrounded.

[1] NVM – Semi-conductor memory that does not require power application to retain data
[2] ES – Extended Squitter
[3] WAAS – Wide Area Augmentation System

**Figure 1.** Photo of Garmin GNS-430W, as received.

The following figures are included.

Figure 2 is the device's power splash screen. Nothing anomalous was noted by the group.


**Figure 2.** Photo of Garmin GNS-430W power splash screen.

Figure 3 is the device's database information page. Nothing anomalous was noted by the group.


**Figure 3.** Photo of Garmin GNS-430W database information page.

Figure 4 is satellite status page. On the left, the active and standby communications and navigation frequencies are shown. The active communication frequency was set to 118.825 MHz. The standby communication frequency was set to 122.750 MHz. The active VHF radio navigational communication frequency was set to 108.10 MHz. The standby VHF radio navigational communication frequency was set to 117.05 MHz. The unit displayed a message that stated the unit's terrain test had failed. This is an expected result as the device was not computing a GPS position as the test was conducted indoors and the unit was not connected to a GPS antenna. The unit also failed a GPS integrity test for the same reason.

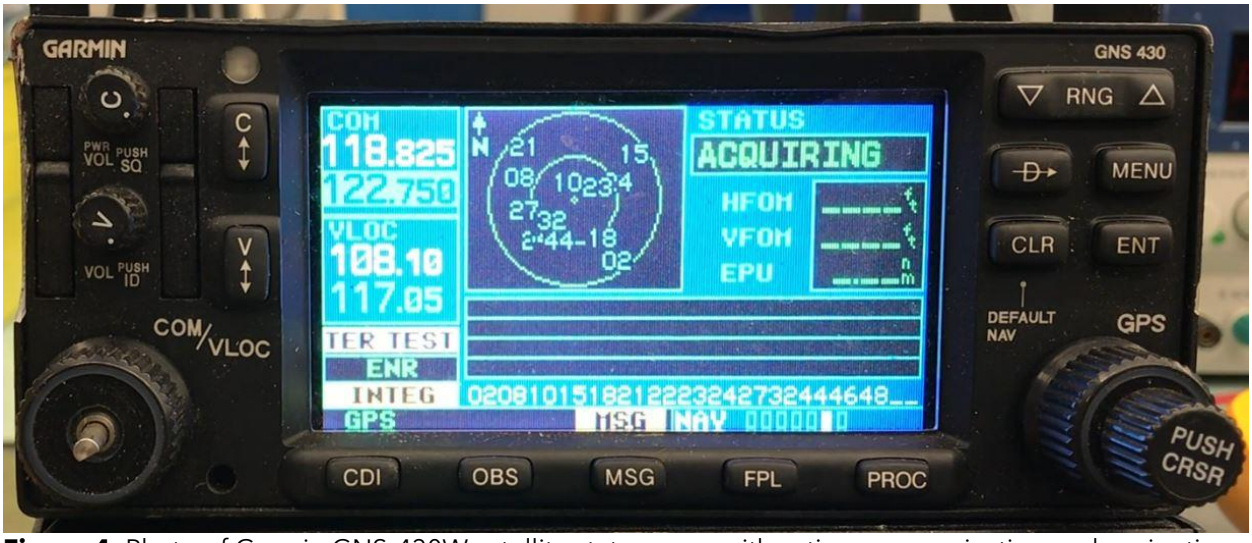


**Figure 4.** Photo of Garmin GNS-430W satellite status page with active communication and navigation frequencies.

Figure 5 is the ARINC 429 configuration page. The unit showed that all ARINC 429 channels were configured to "Off" for input and output data.


**Figure 5.** Photo of Garmin GNS-430W ARINC 429 configuration page.

Figure 6 is the RS-232 configuration page. The unit showed that all RS-232 channels were configured to "Off" for input and output data. This indicates that the unit was not configured to provide any sort of GPS position data for ADS-B to the transponder. The Garmin representative indicated that, with these settings, the transponder would not receive GPS position for ADS-B from the GNS.


**Figure 6.** Photo of Garmin GNS-430W RS-232 configuration page.

The unit was powered down and no further work accomplished on it.

## GARMIN GTX-330

The device was lightly damaged in the event. The device is shown in figure 7. The only evidence of damage was some broken plastic in the left front face of the

display housing. The damage in the left portion of the display housing affected some of the device's buttons. Before powering the device, the extent of the damage to the buttons was unknown. The device appeared otherwise operable.

The device was powered using a wiring diagram supplied by Garmin which can be found in the unit's installation manual. The device powered up normally.

**Figure 7.** Photo of Garmin GTX-330, as received.

By holding the function key and repowering the unit, the unit was booted into configuration mode. The following figures are included. Only configuration pages relevant to the accident investigation are discussed.

Figure 8 shows the unit was initially booted and was in altitude mode "ALT" with a transponder code of "1200."


**Figure 8.** Photo of Garmin GTX-330 when initially booted in the laboratory.

Figure 9 is the ARINC 429 input configuration screen for channels 1 and 2. The configuration shows the unit could accept data on ARINC 429 channel 1 if it were provided input from a GPS source such as the Garmin GNS-430W. The source device, however, would have to be configured to send this data. Recall that figure 5 shows the GNS-430W was not configured to output ARINC 429 data.

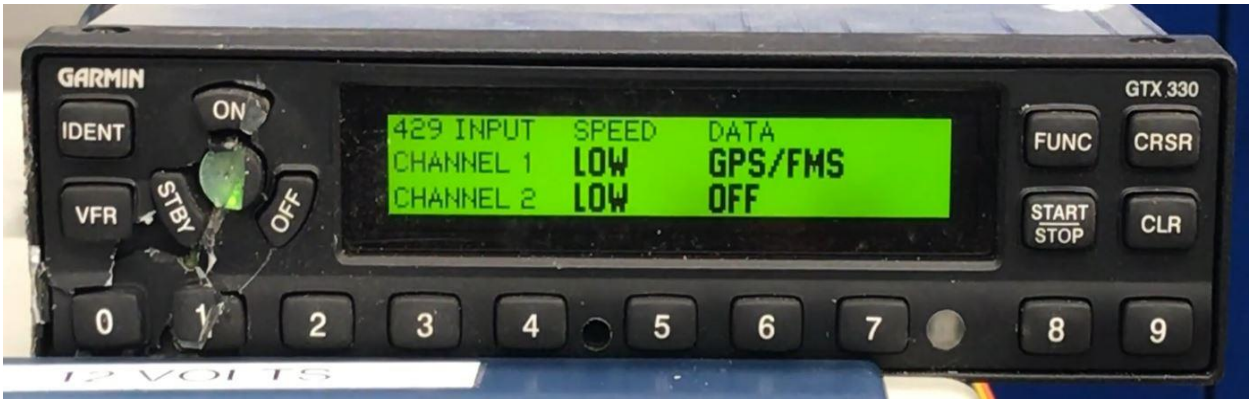


**Figure 9.** Photo of Garmin GTX-330 channel 1 and 2 ARINC-429 Input configuration screen.

Figure 10 is the secondary ARINC 429 configuration screen for channel 3. Channel 3 was set to off.


**Figure 10.** Photo of Garmin GTX-330 channel 3 ARINC-429 Input configuration screen.

Figure 11 is the ARINC 429 output configuration screen. Nether channel 1 or channel 2 was configured to output ARINC 429 data.


**Figure 11.** Photo of Garmin GTX-330 channel 1 and 2 ARINC-429 Output configuration screen.

Figure 12 is the RS-232 input and output configuration screen. The configuration shows RS-232 was set to "remote" for channels 1 and channel 2 input. This would allow the GTX-330 to accept RS-232 data from a position source such as the GNS-430W, if the device was so configured. Recall from figure 6 that the GNS-430W was not configured to output RS-232 data.


**Figure 12.** Photo of Garmin GTX-330 channel 3 ARINC-429 Output configuration screen.

Figure 13 is ADS-B configuration page. The unit was set to transmit ADS-B with the value set to "ENABLE." With the unit configured this way, with no position source information, a Garmin representative stated the device would show a "NO ADSB" in the upper left corner of the screen when the unit was set to transmit ADS-B data in "ALT" mode. Note from figure 8, that the transponder was set to "ALT" mode with a transponder code of "1200" when booted in the lab.


**Figure 13.** Photo of Garmin GTX-330 ADS-B transmission configuration screen.

The device was then powered off which subsequently took the device out of configuration mode.

The device was then repowered normally to simulate normal operation. Because the device was previously set to configuration mode, the device now powered in standby mode, which was the expected response. Recall in figure 8 which showed the device initially started in ALT mode, which would have likely been representative of the mode the transponder was in during the time of the accident.

With the device repowered, the device was set to transmit data. Note that a dummy load of 50 ohms had been attached to the signal output port to attenuate any potential signal and to protect the device's internal components. Figure 14 shows the unit operating in "ON" mode. Note that the "ALT" button was broken, so ALT mode could not be selected at this time.


**Figure 14.** Photo of Garmin GTX-330 in "ON" mode.

After approximately 150 seconds, the device then displayed a message "NO ADSB" in the upper left hand of the unit's display. This is the expected response. This condition is shown in figure 15.


**Figure 15.** Photo of Garmin GTX-330 in "ON" mode after approximately 150 seconds now displaying a "NO ADSB" message.

The unit was powered down and no further work accomplished on it.

## 1.2 Discussion

### GARMIN GNS-430W

The device can be configured to transmit WAAS GPS position information to connected devices via either ARINC-429 or RS-232 protocols. In order to do this, the GNS- 430W must be properly connected to the receiving source, in this case, the Garmin GTX-330. Figure 5 shows the ARINC-429 output source was set to off. Additionally, figure 6 shows the RS-232 outputs were set to "off" for all channels. The device was not configured to provide position data to the connected device.

### GARMIN GTX-330

The Garmin GTX-330 can be configured to receive WAAS GPS data from an approved and compatible WAAS device. The GTX-330 must be properly connected to the WAAS GPS source, in this case, the Garmin GNS-430W. Figures 9 and 10 show the ARINC-429 input configuration for the GTX-330. Channel 1 was set to "GPS/FMS", channel 2 was set to "off" and channel 3 was set to "off." Figure 12 shows the RS-232 input configuration screen. Both channel 1 and channel 2 were set to "remote" which indicated they could receive a remote WAAS GPS source via RS-232. Recall that in figure 6, the RS-232 output configuration from the GNS-430 was set to "off."

The GTX-330 was then powered on the bench and put into transmission mode. After approximately 150 seconds, the device displayed a "NO ADSB" message.

In summary, the Garmin GTX-330 was set to receive an ARINC 429 GPS/FMS input on channel 1 and a remote RS-232 input on channels 1 and 2, however, a review of the GNS-430W ARINC 429 and RS-232 output configuration showed these output channels were set to "off." When powered, the device displayed a "NO ADSB" message on the display screen.

This report does not discuss the wiring configuration of the GTX-330 or the GNS-430W of the accident aircraft.

Additionally, a GoPro device was recovered from the accident aircraft (Sonex Aircraft Xenos, N255BF). The transponder and instrument panel were visible in the recordings from the GoPro on flights previous to the accident. The accident flight was not captured by the device. For information about these recordings, reference the Onboard Image Recorder Specialist's Factual report, which can be found in the public docket for this accident.

Submitted by:

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