# DPE and CFI Avionics Guide

G1000NXI

GARMIN.
AVIATION TRAINING

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# INTRODUCTION

When the original G1000 was introduced in 2004, it offered the potential to bring a higher level of safety to general aviation (GA). Much of this potential has been realized through the training efforts and dedication of Designated Pilot Examiners (DPE), Certified Flight Instructors (CFI), and Certified Flight Instructors - Instrument (CFII). The purpose of this updated document remains the same as the original, to provide G1000 NXi system familiarization and an overview of potential G1000 NXi failure modes and sample system operation/failure mode scenarios that correspond to flight training requirements. The goal is that this information will assist DPEs and instructors to prepare pilots for checkrides with greater system understanding for simulating realistic failures and teach appropriate failure response plans. Although this document has been updated for the G1000 NXi, many of its principles and methods of instruction remain relevant for training the original G1000 system.

This document serves as supplemental training material to the Garmin Pilot's Guide, the aircraft manufacturers (OEM) Aircraft Flight Manual (AFM) and Federal Aviation Administration (FAA) authoritative documents and regulations. The best practices discussed in this document are superseded by the aircraft manufacturer's recommendations and FAA-approved documentation for each aircraft model. This document provides a quick reference to Line Replaceable Unit (LRU) operation, failure modes, and best practices on how to simulate emergency situations. All recommendations of operation are subject to aircraft manufacturer's guidance and should be practiced under safe conditions with a flight instructor or a knowledgeable and proficient safety pilot.

# G1000 NXi SYSTEM OVERVIEW

The basic G1000 NXi system architecture is similar across many aircraft models. However, the location of the actual components of the system, the location and grouping of the circuit breakers, and the engine instrumentation presentations vary between aircraft. Therefore, it is important to review the aircraft manufacturer documentation for each aircraft model.

Figure 1 is a sample system diagram that shows the typical LRUs in a single engine piston aircraft. Please consult the Pilots Guide for your specific airframe to see all that apply to the aircraft.

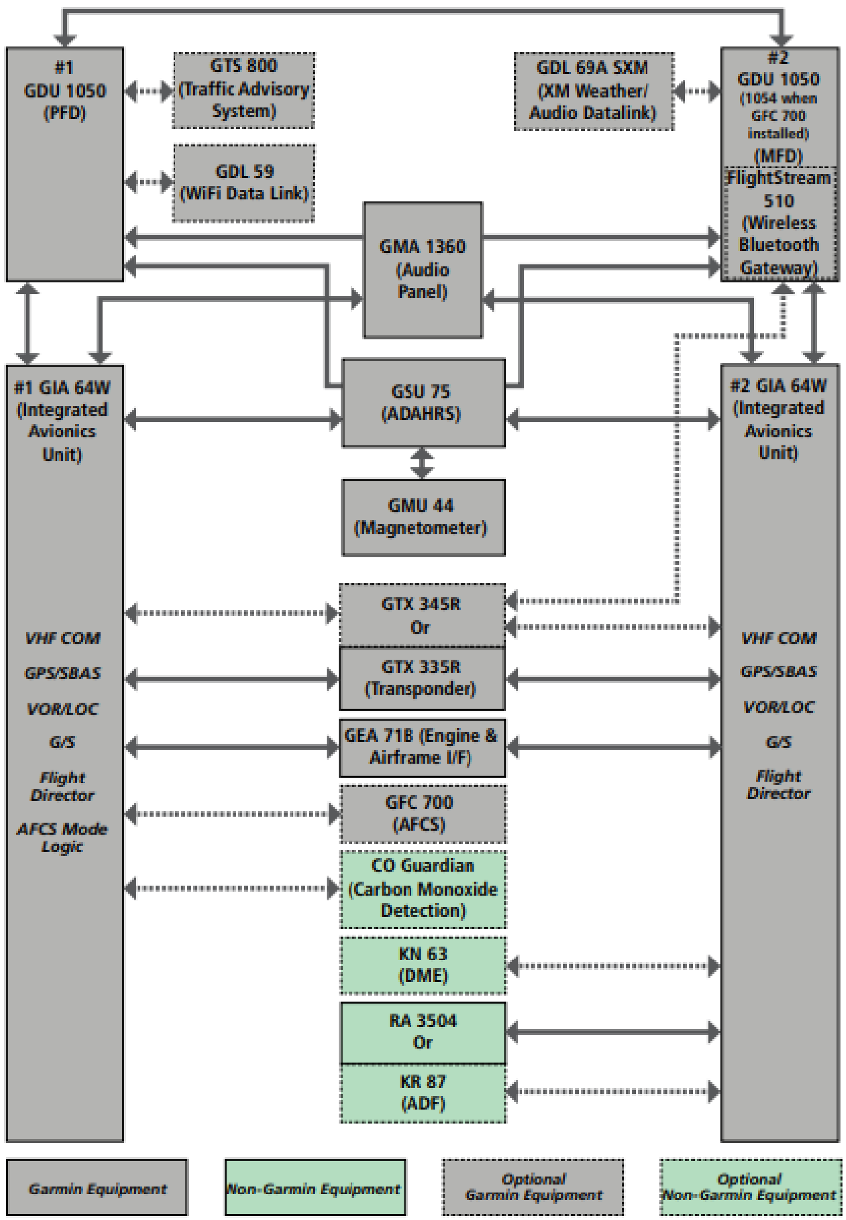


*Figure 1: GIFD System Diagram*

# G1000 NXi SYSTEM COMPONENTS

The main interface for the GIFD system is the Garmin Display Unit (GDU). The GDUs serve as the Primary Flight Display (PFD) and Multi-Function Display (MFD). The PFD consolidates all of the primary flight instruments (traditional "six pack") information into the pilot's primary field of view along with some small inset maps and navigation/surveillance interface. The MFD displays the engine instrumentation, moving map, and detailed displays/articulation of flight related data. The PFD, MFD, and GIA (Integrated avionics) communicate via propriety Ethernet based, high speed digital data bus system. All other LRUs communicate with a variation of RS 232 or ARINC 429 wiring protocols.

Figure 2 shows GDU data sources. This will assist you through the remainder of this guide to show which LRU feeds which corresponding fields on the PFD and MFD.


*Figure 2:GDU Data Sources*

***Note: Figure 2 is shown in Reversionary mode for the purposes of displaying all critical data in the same image. The engine information is normally displayed on the left hand side of the MFD screen during normal operations.***

## *DISPLAY UNITS (GDU-GARMIN DISPLAY UNIT)*

There are various versions of the GDU's. The hardware remains the same but has several minor differences to accommodate aircraft manufacturer requests and specifications. The largest difference exists with GDUs that integrate the bezel mounted mode controller vs those with more limited hard key selections.

### *Failure Modes*

In the unlikely event of a GDU failure the primary flight instruments and Engine Indication System (EIS) will display on the functioning screen. This mode is called "reversionary mode." Reversionary mode may be automatic when the system detects a failure, or it can be manually initiated by the pilot using the red "DISPLAY BACKUP" button. Figure 3 shows the reversionary mode display on the MFD. The pilot should land as soon as practical for service.


*Figure 3. Reversionary Mode on MFD*

## AVIONICS (GIA 64W-GARMIN INTEGRATED AVIONICS)

The Garmin Integrated Avionics (GIA) functions as the main hub for most if the individual LRUs. Air Data, Altitude Heading Reference, transponder, autopilot servos, and Engine Information System feed to the GIA. The GIA also houses the GPS, navigation, communication, and glideslope receivers and synthesis the flight director display. The GIFD has two independent GIA 64W units for redundancy due to the critical nature of its functions.

### Failure Modes

If a single GIA fails one COM/NAV/GPS receiver will no longer display. A red or yellow "X" appears over COM/NAV frequencies to annunciate the failure (Figure 4). The autopilot may no longer be available for use. If both GIA 64W units fail there will be no navigation, communication, or engine monitoring capabilities available. The Air Data Computer (ADC) and Attitude Heading and Reference System (AHRS) information will continue to be fed to the display directly from the ADC and AHRS related LRUs. Figure 5 shows what the screen will look like in reversionary mode with two GIA fails. The pilot should land as soon as possible for service.


*Figure 4: Single GIA Fail (Displayed in reversionary mode)*


*Figure 5: Dual GIA Fail (Displayed in Reversionary Mode*

## AIR DATA, ATTITUDE HEADING AND REFERENCE SYSTEM (GSU 75-GARMIN SENSOR UNIT)

The GSU 75 is a combination of an Air Data Computer (AD) and independent Attitude Heading and Reference System (AHRS). Some G1000 NXi (airframe dependent) systems will have a GDC 74A and GRS 77 that derive the same data using two different LRUs. Whether the aircraft has combined ADAHRS or separate ADC/AHRS, the same data will be presented. The GSU 75 synthesizes air data from the Pitot/Static system and Outside Air Temperature (OAT) probe to provide altitude, airspeed, vertical speed, and OAT information to the LRUs. The GSU 75 also uses solid state sensors and accelerometers to provide pitch, roll, and yaw data to the flight deck. Magnetometer data is feed to the GSU to determine independent heading.

### Failure Modes

A failure of the GSU 75 will result in red or yellow "X" annunciation over the indicated airspeed tape, transponder PA, altitude tape, and vertical speed tape as well as the corresponding trend vector data. There will also be a degradation in AHRS display depending on GPS signal available. Figure 6 illustrates a full ADAHRS fail. See Figure 7 for a flow chart of the fail down options depending on what information the system has available. The GIFD uses GPS to aid the AHRS inputs to provide as much data as possible in the event of failures (GPS aiding). The pilot should avoid IMC and land as soon as possible for servicing.

***Note: Pitot icing will exhibit the same indications as analogue instrumentation (airspeed zero, lower than expected airspeed, or airspeed functioning like an altimeter). Pitot hole blockage obstructs the ram air reading but will not cause red or yellow X annunciations. In this case the appropriate action is the application of pitot heat power.***

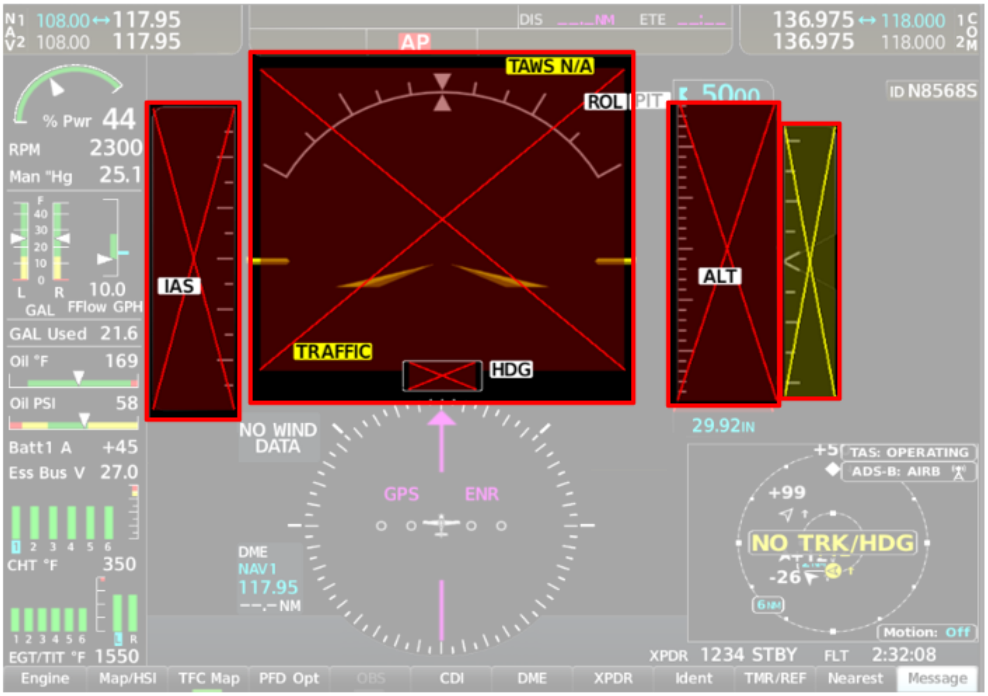


*Figure 6: Full ADAHRS Fail*

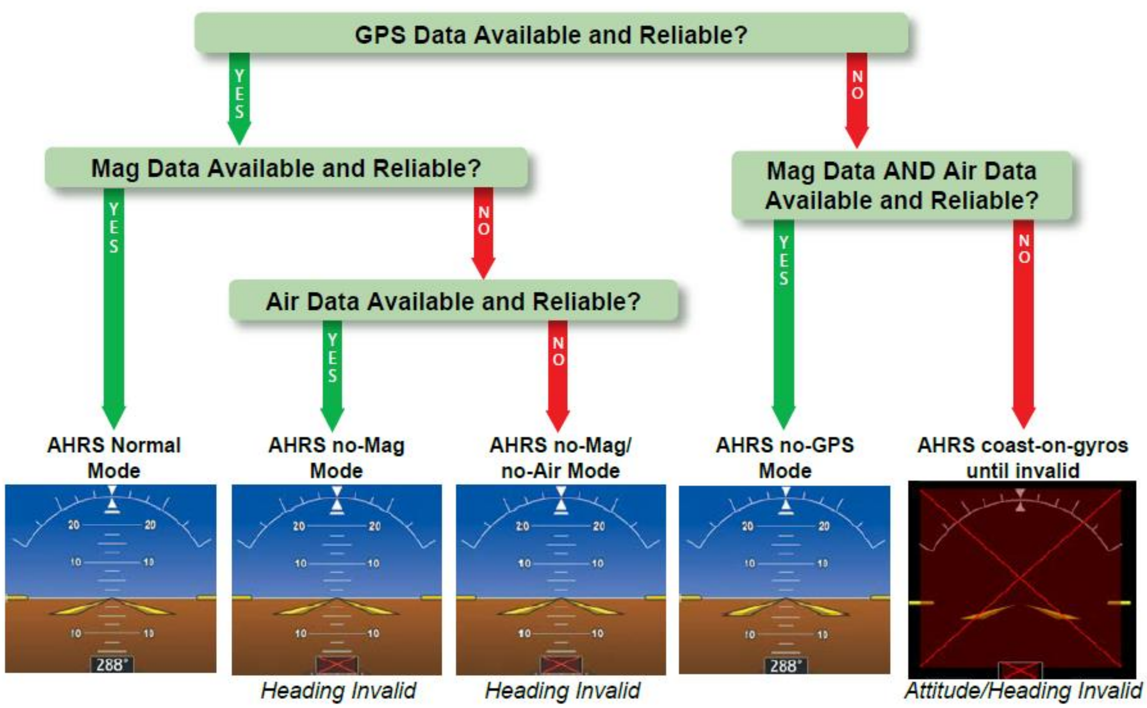


*Figure 7: ADAHRS Fail Down Flow Chart (GPS Aiding)*

## *ENGINE INFORMATION (GEA 71B-GARMIN ENGINE ADAPTER)*

The GEA consolidates data from various measuring devices such as pressure sensors, transducers, temperature sensors, and fuel senders to create the engine data window and engine data page information.

### *Failure Modes*

A GEA failure will result in all fields of the engine window or engine page to be annunciated with a red or yellow X as shown in Figure 8. This is a loss of critical VFR and IFR required instrumentation. The pilot should land as soon as possible for equipment servicing

***Note: Alternator failures would be identified through the GEA. An alternator failure shows as a voltage loss and current discharge, not a red or yellow X annunciation. This is due to the GEA logic to differentiate between an alternator failure and a GIA/GEA failure.***


*Figure 8: GEA Failure*

## *MAGNETOMETER (GMU 44-GARMIN MAGNETOMETER UNIT)*

The GMU uses a local magnetic field to derive the aircraft's independent heading and provides it to the GSU. This heading is used in conjunction with the International Geomagnetic Reference Field (IGRF) database to correct for shifts and variations in the earth's magnetic field based on aircraft location.

### *Failure Modes*

A GMU failure will result in a loss of heading indication at the top of the Heading Situation Indicator (HSI). This will display as a red X to show that the heading is invalid and Synthetic Vision will no longer display (Figure 9). The pilot should reference the magnetic compass and track information generated by the GPS in the track data fields (top of the MFD) and seek servicing for the GMU.


*Figure 9: GMU Failure*

## *AUDIO PANEL (GMA- GARMIN AUDIO PANEL)*

The GMA is a consolidated interface for all audio controls including the communication radio, navigation radio, marker beacons, intercom, music, and passenger address. The GMA is a solid-state controller that also houses the reversionary mode button that manually changes the GDU into reversionary mode in the event of a display failure. The specific GMA version will vary based on airframe.

### *Failure Modes*

A GMA failure will not allow you to control multiple radios simultaneously. The audio panel will drop into "Fail Safe Mode" which allows the pilot to use only the COM 1 transceiver. The pilot should land when practical and seek service to restore full audio control capabilities.

## *TRANSPONDER (GTX 33ES/335R/345R-GARMIN TRANSPONDER)*

The GTX is a mode A, C, S, and Extended Squitter capable transponder that are ADS-B compliant. The GTX transmits current position, altitude, and a squawk code to Air Traffic Control. Only the GTX 345R has an ADS-B In capability to receive FIS-B weather and traffic for display on the G1000 NXi.

### *Failure Modes*

A GTX failure will result in a red or yellow X annunciation over the transponder squawk code window. There may also be an alert message with more detail on the specific failure. The pilot should notify ATC if the transponder is required equipment such as a Class Bravo, Mode C veil, or on an IFR flight plan. Seek servicing before continued flight requiring a functioning transponder.

## *AUTOPILOT (GFC 700-GARMIN FLIGHT CONTROL AND GSA 81-GARMIN SERVO ADAPTERS)*

The GFC 700 is the aircraft autopilot system. Most systems consist of a three (3) servo configuration that control pitch, roll, and pitch trim. The GFC 700, mode controller (airframe dependent), and accompanying GSA 81 servos can control the aircraft through many phases of flight.

### *Failure Modes*

All autopilot or servo failures will be annunciated as part of the Automatic Flight Control System (AFCS) alerting above the attitude indication on the PFD. Please reference your AFM for specific airframe guidance. These messages will be displayed in white text with a red background when attempting to engage the autopilot. Please see the AFCS Annunciations and Alerts section of the Pilot's Guide for a full list of autopilot alerts that pertain to your aircraft. Regardless of the autopilot failure mode, the pilot should consider disengaging the autopilot to manually fly the aircraft. Seek autopilot servicing before continued use.

# RECOMMENDATION FOR FAILURE SIMULATION: INSTRUMENT TRAINING AND CHECKRIDE

The following recommendations are provided as an option for use in the Instrument Check ride pursuant to FAA-S-ACS-8B, Section VII, Task D *Approach with Loss of Primary Flight Instrument Indicators.*

***Note: The recommendations provided are generalized and may not apply specifically to your airframe. Please consult with the manufacturer Aircraft Flight Manual and OEM documentation for specific guidance. OEM guidance supersedes this document.***

## *Method 1: Sticky Note (PREFERRED-Single Failure)*

Sticky notes with light adhesives are the most effective form of training individual LRU failures. The DPE/CFI can cover whatever source of information desired for a simulated failure. For example, to fail AHRS cover the attitude indicator. It may be helpful to turn off Synthetic Vision for attitude related failures.

***Note: Do not use additional adhesives to hold sticky notes in place. Use of additional adhesives such as index tape, super glue, or tacky glue may cause damage to the GDU.***

## *Method 2: Dimming the Display (PREFERRED-Display Failure)*

Dimming the display is the preferred method for simulating display failures with the GIFD system. The display dimming method decreases the chances of damaging the system or hardware that is possible with pulling the circuit breakers. When dimming the display, the screen will decrease visibility uniformly.

Dimming the displays:

1. Press the MENU key on PFD (no other data windows active)
2. Turn the large FMS knob to select "PFD DSPL"
3. Turn the small FMS knob to select "Manual" and press ENT
4. Turn the small FMS knob counterclockwise to decrease display brightness

| Failure to Simulate | Examiner/CFI Action | Applicant/Student Action |
|---|---|---|
| Complete PFD Failure | Dim PFD | Manually select reversionary mode and control the aircraft via the MFD. |
| Loss of MFD | Dim MFD | Manually select reversionary mode and control aircraft (with EIS) via the PFD. |

Returning displays to brightness

1. Press the Display Backup button on GMA (if not already in reversionary mode)
2. Press the MENU key on MFD (now presenting as reversionary PFD; no other data windows active)
3. Turn the large FMS knob to select "PFD DSPL"
4. Turn the small FMS knob to select "Auto" and press ENT
5. De-select the Display Backup button on GMA

## *Method 3: Pulling Select Circuit Breakers (USE CAUTION)*

Pulling select Circuit Breakers (CB) can be an effective means of training or examining pilot skills since it closely replicates what would be experienced in the event of an LRU failure. However, one should use caution when using this method as it may affect the integrity of the hardware and is generally not recommended by most manufacturers

***CAUTION: Most OEMs do not recommend the use of pulling circuit breakers for regular failure training as this may weaken the operation of the circuit breaker or have other consequences for the functioning of other systems. Please consult with your OEM for usage recommendations to limit wear or service a replacement.***

| Failure to Simulate | Examiner/CFI Actions | Applicant/Student Actions |
|---|---|---|
| Loss of AHRS and ADC or ADAHRS (loss of all primary flight instruments) | Pull AHRS and ADC or ADAHRS circuit breakers | Identify the failure. Control the aircraft via the backup instruments |
| Loss of AHRS (loss of attitude and heading) | Pull AHRS circuit breaker (for aircraft without GSU 75) | Identify the failure. Control the aircraft via the backup instruments |
| Loss of ADC (loss of airspeed, altitude, and vertical speed) | Pull ADC circuit breaker (for aircraft without GSU 75) | Identify the failure. Control the aircraft via the backup instruments |
| PFD Display failure | Pull PFD circuit breaker | Identify the failure. Select Display Backup, control the aircraft via MFD reversionary mode |

***CAUTION: Do NOT use this method in IMC. The methods stated above are actual system failures and may result in unsafe conditions if used in IMC.***