

# **G1000™**

*pilot's training guide*  
*instructor's reference*



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## G1000 Integrated Cockpit System

The G1000™ is a completely integrated avionics system designed to fit a broad range of aircraft models. It is an all-glass flight deck that presents flight instrumentation, location, navigation, communication and identification data on large-format, high-resolution displays. The digital data presentation on the G1000 puts all flight-critical information literally at the pilot's fingertips.

### Purpose

In addition to containing the same material as that provided in the G1000 Pilot's Training Guide, this manual also contains all of the answers to each of the ground lesson exercises. Included in the lessons are G1000 PC training device (Simulator) optional practice exercises that should be observed and reviewed by the instructor while they are being completed by the student. These exercises can also be used as example scenarios during ground training.

It is the instructor's responsibility to follow up with the ground training by using various evaluation tools, including verbal quizzing, written examination and/or flight evaluation. During each phase of the evaluation, emphasis should be placed upon aeronautical decision making (ADM) and single-pilot resource management (SRM).



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**NOTE:** Ground lessons should be completed before starting flight training.

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**NOTE:** In this training guide, each lesson contains exercises as well as a list of resources that are recommended before completing these exercises.

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### Flight and Ground Instruction

It is important to coordinate the ground lessons with a properly trained flight instructor. The instructor should work with the student to make sure that the system is fully understood and to ensure that the flight lessons cover all appropriate material. Note that the instructor may determine that additional training is required to review aircraft systems, procedures, airspace, or other knowledge areas. The student should practice to attain full proficiency with the G1000 system.

### Level of Knowledge Attained

The material contained in the Pilot's Training Guide is designed to help the student progress from basic to advanced levels of knowledge. The basic skills of interpreting the Primary Flight Display (PFD), tuning the radios and operating the audio panel are covered early in the training material. Later sections cover navigation, terrain and other more complex material. The Pilot's Training Guide was designed in this manner so that the student could begin basic training quickly.



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**NOTE:** It is not necessary to complete the Navigation portion of the material before taking off on a local training flight.

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# Ground Lesson 1

## INTRODUCTION AND G1000 SYSTEM OVERVIEW

### Objectives

Upon completion of this lesson, the pilot should be able to do the following:

- Describe the basic components of the G1000 Integrated Avionics System
- Describe the communication between G1000 components

### Resources

- G1000 Pilot's Guide
- Aircraft Flight Manual (AFM) and supplements
- Pilot's Operating Handbook (POH) and supplements
- Aeronautical Information Manual (AIM)
- Federal Aviation Regulations (FAR)

### Exercise 1.1: Terminology and Review of Pertinent Federal Aviation Regulations

1. Define the following navigation abbreviations and acronyms:
  - TRK = **Aircraft ground track**
  - DTK = **Desired aircraft ground track; GPS-derived course across the ground; used as the GPS course line**
  - VNAV = **Vertical Navigation; used to alert the pilot to meet programmed descent profiles**
  - CTS = **Course To Steer; GPS-derived guidance to intercept a given course**
2. Explain the use of and limitations of a TSO-C129a GPS during instrument approaches per the AIM.  
**This class of GPS is to be used for LNAV non-precision approaches and as a substitute for ADF and DME so long as the Navaid and/or fix is located, as part of the database, in terminal and approach phases of flight.**
3. When filling a flight plan, what suffix is used for a current Global Positioning System (GPS) database?  
**/G**
4. When can GPS be used in lieu of DME and ADF?  
**When the Navaid and/or fix is located as part of the Jeppesen database; this includes flying DME arc procedures and as a Locator Outer Marker (LOM) in the case of the ADF.**
5. Describe the differences between a fly-by and a fly-over GPS waypoint and draw their respective symbols.  
**Fly-by waypoints allow for turn anticipation, whereas fly-over waypoints must be crossed, most often due to terrain clearance issues. Both symbols can be found on approach plates.**
6. What does RAIM stand for? Describe its purpose.  
**Receiver Autonomous Integrity Monitoring; provides the integrity check capability to ensure the safe use of GPS for IFR flight operations (see AIM for drawing verification).**
7. A pilot is on the RNAV(GPS) 17 approach into KIXD (New Century Aircenter, Olathe, KS) and the system displays the "RAIM UNAVAIL" alert inside the Final Approach Fix. The weather is reported as 500 feet overcast with 2 statute miles of visibility. What action(s) should the pilot take and why?  
**Immediately abandon the approach and notify the tower both that the aircraft has a RAIM warning on the approach and that non-GPS missed approach instructions are needed**

**Exercise 1.2: Component Review**

1. Define the following equipment abbreviations and acronyms:
  - AHRS = **Attitude and Heading Reference System: solid-state electrical gyro system**
  - ADC = **Air Data Computer: calculates and digitizes pitot, static and temperature inputs**
  - TIS = **Traffic Information Service: FAA Mode S carried traffic awareness**
  - Terrain = **Non-certified terrain avoidance situational awareness tool**
2. Describe the function of the following components of the G1000 Integrated Avionics System:
  - GRS 77 = **AHRS**
  - GMU 74 = **Tri-axis magnetometer**
  - GIA 63 = **System interface and COM/NAV/GPS system**
  - GDU 1040 = **PFD and MFD displays**
  - GTX 33 = **Mode S transponder**
  - GMA 1347 = **Digital audio panel**
  - GDL 69 = **Weather datalink receiver**
  - GMA 1347 = **Automatic Flight Control System**
3. What is the primary interface used between the G1000 components?  
**Digital, uni-directional Ethernet bus using a proprietary Garmin protocol**

## Ground Lesson 2

### TRANSITION TO THE PRIMARY FLIGHT DISPLAY (PFD)

#### Objectives

Upon completion of this lesson, the pilot should be able to read, understand and interpret the primary six (6) instruments that are displayed on the PFD and that indicate airspeed, attitude, altitude, vertical speed, turn rate/coordination and heading.

#### Resources

- G1000 Pilot's Guide
- G1000 Cockpit Poster

#### Exercise 2.1: Instrumentation Layout

In the space provided below, sketch the primary six (6) instruments as displayed on the PFD.



#### Exercise 2.2: Instrumentation Depiction

Assume that the aircraft is flying with the following indications and fill in the appropriate fields on the sketch with this data:

- Airspeed = 120 KIAS
- True Airspeed = 120 KTAS
- Altitude = 6760 ft.
- Vertical Speed = 0 fpm
- Heading = 95°
- Altimeter Setting = 30.15" Hg

## Ground Lesson 3

### POWER-UP, SELF-TEST, CHECKLIST

#### Objectives

Upon completion of this lesson, the pilot should be able to correctly identify proper alignment of the AHRS/ADC, complete a system self-test and verify the database data.

#### Resources

- G1000 Pilot's Guide
- G1000 PC-based Simulator

#### Exercise 3.1: System Initialization

1. Is the aircraft required to remain stationary while the AHRS and ADC align?  
**No, the AHRS/ADC can align on the move and even in flight at bank angles of up to 20 degrees for the AHRS.**
2. Is there any warm-up time required for the engine instrumentation to be accurate?  
**No.**
3. What is the pilot action that should be taken if the MFD system self-test does not pass?  
**Shut down the aircraft and contact maintenance.**
4. Where can one verify the effective dates of the Jeppesen database during the initial system start-up?  
**Right-hand side of the MFD at the conclusion of the scrolled text sequence.**
5. If the Jeppesen database is not current in the G1000, can the system still be used for IFR flight?  
**Yes, but one cannot file /G for GPS use and one cannot use the GPS for instrument approach procedures.**
6. A pilot is planning a flight to KAPA (Centennial Airport, Denver, CO) from KCOU (Columbia, MO). When arriving at the aircraft, the pilot notices that the Jeppesen database is out of date by 3 cycles (84 days).
  - 6a. Can the pilot make the flight under Instrument Flight Rules (IFR)?  
**Yes, but one cannot file /G on the flight plan form, and the VOR/LOC/GS receivers must be used for navigation**
  - 6b. What en route flight planning considerations must be made?  
**All en route ground Nav aids must be operational. This can be verified by checking the NOTAMs.**
  - 6c. What destination flight planning considerations must be made?  
**One can only accept a VOR/LOC/ILS approach at KAPA.**

## Ground Lesson 4

### TRANSPONDER OPERATION

#### Objectives

Upon completion of this lesson, the pilot should be familiar and comfortable with the operation of the integrated transponder controls located on the PFD of the G1000 system. This includes the selection of the transponder operating mode, squawk code entry and IDENT activation.

#### Resources

- G1000 Pilot's Guide
- G1000 PC-based Simulator

#### Exercise 4.1: Operating Modes and Code Entry

1. Which transponder mode of operation does the G1000 system default to when it is first powered up if it is equipped with the Garmin mode S transponder (GTX 33)?

**Ground mode, shown by the letters GND in the mode field of the Transponder Status bar.**

2. Describe the process for entering a newly assigned transponder code.

**On the PFD, press the XPDR softkey, then press the CODE softkey and use the appropriate digit softkeys to enter the assigned code.**

#### Exercise 4.2: Practice (Optional)

Using the G1000 PC-based Simulator, review the start-up process while verifying the Jeppesen database effective dates and then practice entering various transponder codes and operating modes using the PFD softkeys.

## Ground Lesson 5

### COM RADIO AND AUDIO PANEL OPERATION

#### Objectives

Upon completion of this lesson, the pilot should be comfortable tuning and selecting communication frequencies using the manual and database tuning features of the G1000 system, while properly configuring the selections on the GMA 1347 audio panel.

#### Resources

- G1000 Pilot's Guide
- G1000 Cockpit Poster
- G1000 PC-based Simulator

#### Exercise 5.1: COM Operation and Methods of Frequency Tuning

1. Is the active frequency being used displayed to the inside or to the outside relative to the bezel of the G1000 navigation displays (GDU 1040)?

**Inside**

2. In what color is the active frequency displayed?

**Green**

3. Which key should be pressed to change between the standby and active frequency? Draw this key.

**Frequency Toggle key (refer to system documentation for a depiction)**

4. If the COM radio frequency toggle key is held for 2 seconds, what occurs?

**121.50 MHz is placed in the active field of the selected COM radio.**

5. When manually tuning a frequency, what is the purpose of the large COM knob? What is the purpose of the small COM knob?

**The large COM knob changes the MHz, while the small knob changes the kHz.**

6. When the NRST softkey is pressed on the PFD, a list of the nearest airports appears, with runway length and tower/CTAF frequencies listed. How can the frequency be tuned in directly without manually tuning it into the COM radio?

**Press the FMS knob, use the large knob to highlight the desired frequency, then press the ENT key (this places the frequency into the selected COM1 or COM2 standby field based on location of the COM tuning box). Press the COM Frequency Toggle key to place the frequency into the active field.**

## Exercise 5.2: Practice (Optional)

Using the G1000 PC-based Simulator, power up the system.

1. Verify the Jeppesen database effective dates and note those dates in the space provided below.
2. Enter the transponder code “3470” and set the transponder to “ALT” mode.
3. In COM 1, enter 124.30 MHz as the active frequency and 133.00 MHz as the standby frequency.
4. In COM 2, enter 135.325 MHz as the active frequency and 118.90 MHz as the standby frequency.

## Exercise 5.3: Audio Panel Operation

1. Which key should be used on the audio panel (GMA 1347) to monitor a COM radio frequency without using it to transmit on?

**The COM key for the selected radio (COM1 or COM2)**

2. Describe how the split COM feature works and provide a sample scenario of its use.

**Split COM allows the pilot to use COM1 while the copilot uses COM2. This proves very helpful for talking to an FSS en route without leaving the ARTCC frequency. Pressing the COM 1/2 key on the audio panel turns on Split COM mode.**

3. Describe the function of the digital clearance recorder.

**Records the last 2.5 minutes of communication**

**Pressing the PLAY key once plays back the latest recorded block, then returns to normal operation. Pressing the PLAY key during playback of a block halts the playback of this block, plays back the preceding block, then returns to normal operation (this permits cycling through the stored blocks to reach the desired block). Pressing the MKR/MUTE key during playback halts the playback and returns to normal operation.**

4. What purpose does the red button located at the bottom of the audio panel (GMA 1347) serve?

**Forces display backup mode**

5. When the PILOT ICS key is pressed, can the other passengers in the aircraft communicate with each other via the intercom?

**Yes, but the pilot cannot hear passenger intercom communications.**

6. Does the COM MIC key selection have any impact on the display of the COM frequencies on the PFD or MFD? Explain.

**The selected COM MIC key causes the selected frequency to be green. Note that COM1 and COM2 frequencies in the COM Frequency window can only be green simultaneously when in Split COM mode (i.e., when COM 1/2, COM1 MIC and COM2 MIC are annunciated on the audio panel).**

7. Two pilots are flying a long cross-country flight and encounters bad weather. The pilot flying the plane wants to get a weather update, but is struggling to get on frequency and be heard because the ARTCC frequency is very busy handling multiple reroutes. What tools are available to get the necessary weather information to continue the flight?

**A Stormscope or datalink weather may be available, although the most useful tool is the other pilot. By using the split com frequency, (the PIC) the ARTCC frequency can be monitored on COM1 while the other pilot can contact Flightwatch or the Flight Service station on COM2.**

## Ground Lesson 6

### NAVIGATION

#### Objectives

Upon completion of this lesson, the pilot should be able to navigate using ground-based Navaids and GPS, while manually tuning VOR/LOC/ILS frequencies and creating direct-to and flight-plan-based GPS navigation.

#### Resources

- G1000 Pilot's Guide
- G1000 Cockpit Poster
- G1000 PC-based Simulator

#### Exercise 6.1: Land-based Navigational Aids

1. Is the process to manually tune in the NAV frequency the same as it is to manually tune in a COM frequency?  
**Yes.**
2. When using the database to tune in a NAV frequency, is the process the same as it is for tuning a COM frequency?  
**Yes.**
3. What type of information is provided about a ground-based navigation aid when it is highlighted by panning on the MFD map and pressing the ENT key?  
**Navaid name, type of Navaid and frequency.**
4. How and where can the pilot select the CDI information displayed on the HSI for the NAV 1 or NAV 2 frequencies?  
**By pressing the CDI softkey on the PFD**
5. Does the G1000 system automatically attempt to identify the tuned NAV frequency? How is this visually presented?  
**Yes, a three-letter identifier (for VOR) or a four-letter identifier (for ILS, LOC) is displayed to the right of the NAV frequency.**

#### Exercise 6.2: Practice (Optional)

Using the G1000 PC-based Simulator, power up the system and configure the G1000 as needed for the following IFR clearance out of KAPA (Centennial Airport, Denver, CO): **“N12345 is cleared to the Goodland, KS, airport via the Thurman VOR, Byers VOR, then direct. Climb and maintain eight thousand, expect one-two thousand in ten minutes. Departure frequency is 126.75, squawk 3470.”**

**The student should have accomplished the following actions:**

- **Entered the following active flight plan: KAPA – TXC – BVR – KGLD.**
- **Set the altitude reference bug to 8,000 feet.**
- **Entered the departure frequency 126.750 in a standby COM field.**
- **Entered the transponder code of 3470.**



### Exercise 6.3: GPS Navigation

1. Can a direct-to navigation/flight plan be created using the GPS on both the PFD and the MFD or must one or the other be used – and if so, which one?  
**Either one can be used; the data automatically cross-fills.**
2. Describe the process for canceling a direct-to GPS navigation.  
**Press the Direct-to key, then the Menu key. This brings up the option “Cancel Direct-to Nav”. Press the ENT key.**
3. Describe the process for entering a flight plan.  
**Press the FPL key on either display. When on the ground at start-up, the departure airport is automatically entered if the GPS has acquired a solution. Press the FMS knob to activate the cursor, then use the small FMS knob to change alpha-numeric characters and the large FMS knob to change character locations. Once an identifier is entered, press the ENT key and repeat the process on the next line.**
4. When using the Flight Plan function, does the unit auto-sequence the waypoints and does the autopilot continuously fly the programmed route?  
**Yes, that is the key reason for using the FPL function.**
5. Describe some of the advantages of using the Flight Plan function as opposed to continuous direct-to navigation.  
**The Flight Plan function reduces workload during the en route phase of flight, allows for smooth autopilot navigation, and minimizes the number of key presses when an assigned route changes (for example, it allows one to skip waypoints in a SID or STAR, as instructed by ATC, without losing the rest of the procedure).**

### Exercise 6.4: Practice (Optional)

Using the G1000 PC based Simulator, power up the system.

1. Verify the Jeppesen database effective dates and note those dates in the space provided below.
2. Enter the transponder code “1252” and set the transponder to “ALT” mode.
3. In COM 1, enter the ATIS frequency for KAPA as the active frequency and the ground control frequency as the standby frequency.
4. In COM 2, enter the KAPA Tower frequency as the active frequency and the Departure frequency for an eastbound departure as the standby frequency.
5. Tune in and place the Thurman, CO VOR (TXC) into the active NAV 1 frequency; tune in and place the Byers, CO VOR (BVR) into the active NAV 2 frequency.
6. Create a Flight Plan from KAPA to KIXD via Thurman, Goodland, Hill City, Salina, Topeka VORs and the RUGBB intersection.

## Exercise 6.5: Instrument Approaches

1. When first selecting an approach, what is the default option that appears when the PROC key is selected?  
**“Select Approach”**
2. What is the difference in how the HSI presents data between selecting Vectors-to-Final and selecting an Initial Approach Fix during an instrument approach?  
**In Vectors-to-Final mode, the HSI sets the inbound approach course automatically and it can be intercepted in the same way as one would when getting vectors to a ground-based Navaid. When the full approach is selected, the system provides guidance to the Initial Approach Fix.**
3. Describe the CDI sensitivity scaling that occurs when flying a GPS approach.  
**When transitioning to within 30 nm of the destination, the CDI gradually scales down from 5.0 nm to 1.0 nm full-scale deflection. When within 2 nm of the FAF, the CDI gradually scales down to 0.3 nm full-scale deflection.**
4. When navigating using the GPS, if an ILS, LOC, or VOR approach is selected, where is the frequency for the primary approach navigational aid automatically placed?  
**In the active frequency field of NAV1.**
5. When flying an ILS approach, where do the glideslope indicator and marker beacon annunciation appear on the PFD?  
**The glideslope indicator appears to the left of the altimeter and the marker beacon annunciation appears above the glideslope indicator.**
6. Can GPS be used to fly a VOR approach?  
**Yes, but only if the title of the approach plate is “VOR or GPS”.**
7. Does GPS provide guidance data to the autopilot to allow it to fly a coupled holding pattern?  
**No.**
8. Can GPS be used in lieu of DME when flying a DME arc associated with a VOR, LOC, or ILS approach procedure?  
**Yes, provided the arc procedure is depicted in the database.**
9. What key must be pressed to access the ability to add a departure procedure (DP or SID) and/or arrival procedure (AP or STAR) to a flight plan?  
**The PROC key. The add-a-departure option can then be accessed by scrolling down the list of options. Note that softkeys on the Flight Plan Page also allow addition of a departure or an arrival procedure.**
10. When navigating in VOR1, VOR2, LOC1, or LOC2 mode, if an ILS, LOC, or VOR approach is selected, where is the frequency for the primary approach navigational aid automatically placed?  
**In the standby frequency field of the selected NAV.**

## Exercise 6.6: Practice (Optional)

Using the G1000 PC-based Simulator, power up the system.

1. Verify the Jeppesen database effective dates and note those dates in the space provided below.
2. Enter the transponder code “5455” and set the transponder to “ALT” mode.
3. In COM 1, enter the ATIS frequency for KAPA as the active frequency and the ground control frequency as the standby frequency.
4. In COM 2, enter the KAPA Tower frequency as the active frequency and the Departure frequency for an eastbound departure as the standby frequency.
5. Assume that a pilot is departing KAPA and select and load the Plains Two Departure, Goodland Transition (PLAIN2.GLD). The rest of the flight plan goes from KAPA to KMKC via the Hill City and Salina VORs with the Jayhawk Five Arrival via the Emporia Transition (EMPJHAWK5). Expect the ILS 3 Approach into Kansas City Charles B. Wheeler Downtown Airport.
6. Load VOR frequencies as appropriate to monitor the progress of the flight along with the GPS navigation.
7. Initiate the flight on the Simulator. En route just east of Goodland, the pilot receives the following amended clearance from ARTCC: **“N12345, I am showing level-4 radar returns on my radar over the Hill City VOR, in a line that runs from 40 miles to the southwest of Hill City to 150 miles to the northeast. The entire storm appears to be moving east at 30 knots.”** The pilot was planning on stopping for fuel in Salina, but realizes that the storm will be on top of the airport by the time of arrival. Note that the aircraft is not equipped with a Stormscope or datalink weather. What are the pilot’s options? Rank these options from best to worst.

**Best option – Deviate to another airport for fuel - possibly even to Goodland - check the weather on the ground and plan the rest of the flight based on weather deviations.**

**Acceptable option – Continue to the next airport closest to Hill City where one land for fuel and check weather, asking ARTCC for PIREPS as the aircraft approaches the area of the storm.**

**Poor option – Continue on the current flight path, delaying decision on deviation actions until closer to the weather and hoping that ARTCC has the capacity for vectors around the storm.**

**The problem with this proposed scenario is twofold:**

- **ARTCC may prove too busy to provide vectors.**
- **ARTCC radar has limited ability to detect areas of significant weather accurately**

**Worst option – Continue the current flight path and try to penetrate the storm.**

## Ground Lesson 7

### MULTI FUNCTION DISPLAY (MFD) OPERATION

#### Objectives

Upon completion of this lesson, the pilot should be able to locate, use and configure data on the MFD during flight operations.

#### Resources

- G1000 Pilot's Guide
- G1000 Cockpit Poster
- G1000 PC-based Simulator

#### Exercise 7.1: MFD Configuration and Controls

1. Which main type of data is presented on the default MFD display?  
**Map data.**
2. What data types can be overlaid on the MFD map? Where are the controls for this data overlay located?  
**Terrain, topo, traffic and weather. The options for overlay are selected by pressing the MAP softkey; the respective softkey selections then appear on the MFD.**
3. Which MFD page group and page must be accessed to verify the status of the two (2) GPS receivers?  
**The GPS Status Page (AUX 3) within the AUX page group.**
4. How are the Nearest (NRST) pages accessed?  
**By turning the large FMS knob on the MFD. Note that, on the PFD, a Nearest Airports window can be accessed by pressing the NRST softkey.**
5. What types of information can be accessed via the Waypoint (WPT) pages?  
**All of the Jeppesen database data for airports, Nav aids and any user-created waypoints.**
6. From which page and via which key can the map display be changed between north-up and track-up presentations?  
**From the Navigation Map page (MAP 1), press the Menu key, then with 'Map Setup' highlighted, press the ENT key. Use the large FMS knob to go to the Orientation field, then use the small FMS knob to select the desired orientation and press the ENT key.**
7. When panning on the Map page, where does information appear about the terrain location over which the cursor arrow is?  
**Below the page title located at the top of the display.**
8. Which page should be accessed in order to change the data field options at the top of the MFD display?  
**The System Setup Page (AUX 4).**
9. Which key should be pressed and held for 2 seconds to automatically and quickly return to the Navigation Map page?  
**The CLR key.**

*(exercise continued on next page)*

10. A pilot is on a flight from KAPA (Centennial Airport, Denver, CO) to KGJT (Grand Junction Airport, Grand Junction, CO) over the mountains. Weather is predicted to be MVFR with scattered rain over the entire route of flight. How would one configure the MFD to give the best presentation of data for this flight? Assume that a GDL-69 weather datalink is installed in the aircraft.

**Since visibility is marginal, display the terrain overlay by selecting the Terrain softkey on the MFD to ensure terrain clearance over the mountains. Periodically, check the dedicated weather page in the Map page group to check the areas and strength of precipitation. The combination of terrain elevation and weather information allows better planning of the flight route, but one must be prepared for unexpected deviations.**

## Ground Lesson 8

### PRIMARY FLIGHT DISPLAY (PFD) OPERATION

#### Objectives

Upon completion of this lesson, the pilot should be able to configure and interpret data presented on the PFD during all phases of flight operations.

#### Resources

- G1000 Pilot's Guide
- G1000 Cockpit Poster
- G1000 PC-based Simulator

#### Exercise 8.1: PFD Configuration and Controls

1. Where is the control for cycling between the GPS, VOR1, VOR2, LOC1, and LOC2 CDI selections that appear on the HSI?  
**On the PFD, as the CDI softkey.**
2. Name the two (2) types of presentation that are available for the HSI? (Note: there is only one type of presentation available on the Beechcraft A36/G36 and Baron 58.)  
**360-degree mode and Arc mode (not available on the Beechcraft A36/G36 or Baron 58).**
3. What type of data can be overlaid on the Map Inset?  
**Traffic, terrain, topo and weather.**
4. Can the data fields located at the top of the PFD be changed by the pilot?  
**No.**
5. From the PFD, can the pilot enter, view and edit a flight plan?  
**Yes, by pressing the FPL key and then using the FMS knob.**
6. Where is the course selection knob or OBS (omni-bearing selector) knob located?  
**On the right-hand side of the PFD bezel as the small, triangular CRS knob located in the center of the BARO knob.**
7. What happens when the HDG knob is pressed?  
**This centers the heading bug on the current aircraft heading.**
8. What happens when the CRS knob is pressed?  
**This centers the CDI on the radial on which the aircraft currently is and shows a "To" indication.**
9. Where is the control for the altimeter barometric pressure located?  
**On the right-hand side of the PFD bezel as the large knob surrounding the triangular CRS knob.**
10. How many feet of altitude and how many knots of airspeed make up the viewable portions of the altimeter and airspeed indicator, respectively?  
**600 feet and 60 knots.**

*(exercise continued on next page)*

11. A pilot is flying through the Rocky Mountains and decide to land at KASE in Aspen, CO. The RNAV (GPS) 15 approach via radar vectors is assigned. It is daytime, although visibility is limited to a few miles with cloud tops at 10,000 feet MSL. What options should be selected to display on the PFD map inset?

**Going into Aspen, one should focus on the approach as well as on the other key item – terrain. Therefore, declutter the display to show the approach and turn on the terrain and traffic options. Eliminating the topo shading brings higher contrast in the colors to the display, allowing the pilot to focus on avoiding a CFIT (Controlled Flight Into Terrain) accident and to stand a better chance of being able to see and avoid traffic departing runway 33 out of KASE.**

## Ground Lesson 9

### WEATHER, TERRAIN AND TRAFFIC AWARENESS

#### Objectives

Upon completion of this lesson, the pilot should be able to accurately interpret terrain awareness and Traffic Information Service (TIS) data while both incorporating this information into the aeronautical decision making process and understanding the limitations of these systems.

#### Resources

- G1000 Pilot's Guide

#### Exercise 9.1: Weather, Terrain and TIS Operation

1. When flying an aircraft with the WX-500 Stormscope installed, where can the lightning data be displayed?  
**On the PFD Inset Map and on the MFD Navigation Map and Stormscope pages (MAP 1 and MAP 3)**
2. How is the data presented by the G1000 system for the WX-500?  
**As a lightning bolt and a plus symbol**
3. When a lightning bolt is changed to a "+" symbol, what does this change denote?  
**This means that the data is over one minute old (note that a smaller "+" symbol appears when the data is over two minutes old).**
4. Describe the service volume for the Traffic Information Service.  
**7 nm from the aircraft, 3,500 feet above and 3,000 feet below**
5. Is the terrain awareness feature in the G1000 system certified to allow deviations from ATC assigned altitudes?  
**No, because it is not a certified terrain avoidance system.**
6. In the terrain awareness feature, what do the colors red and yellow each represent?  
**Red signifies that the aircraft is within 100 feet or below the terrain altitude and yellow that the aircraft is within 1,000 feet of terrain.**
7. Finish the following sentence: "TIS traffic and the terrain awareness feature of the G1000 are **situational awareness** tools".
8. With TIS, when does the G1000 system provide an audible alert of "Traffic"?  
**When traffic is within 0.5 nm or 34 seconds of the aircraft and +/- 500 feet of vertical separation**



## Ground Lesson 10

### EMERGENCY PROCEDURES

#### Objectives

Upon completion of this lesson, the pilot should be able to navigate using ground-based Navaids and GPS while manually tuning VOR/LOC/ILS frequencies and creating direct-to and flight-plan-based GPS navigation.

#### Resources

- G1000 Pilot's Guide
- G1000 Cockpit Poster
- G1000 PC-based Simulator

#### Exercise 10.1: Emergencies and Failure Modes

1. If one display fails, which mode does the system automatically go into?  
**Display Backup mode (also referred to as "Reversionary mode").**
2. How is an AHRS failure indicated on the G1000?  
**An AHRS failure is indicated by red-X lines over the affected instruments and a loss of horizon picture.**
3. When the AHRS and/or ADC fail, what remedial action should be taken by the pilot?  
**The pilot should refer to standby instruments.**
4. What information is presented to the pilot when a display is operating in Reversionary mode?  
**Engine instruments, attitude, airspeed, altitude, vertical speed and HSI information.**
5. Describe the aircraft on-board power sources that remain in case of alternator failure and also provide an explanation as to their operation, including a basic description of each power bus.  
**Please, refer to the AFM or POH.**
6. In flight, during a cross country, an AHRS failure occurs (failure indicated by a red X over the attitude indicator). Note: the aircraft is equipped with a third-party autopilot which has its own rate-based gyro as well.
  - 6a. Aside from the backup attitude indicator, what items can be used to ensure safe flight?
    - **Autopilot**
    - **ARTCC**
    - **Magnetic compass**
    - **DTK and TRK datafields at the top of the PFD**
    - **Map overlay**

*(exercise continued on next page)*

6b. What are the next actions that should be taken concerning the completion of the flight? Note that, depending on the circumstances, the following action items may occur in a different order.

- 1. Activate the autopilot if it is not already activated; set it to Roll and Pitch mode.**
- 2. Notify ARTCC both of the failure and of the need to deviate. Do not hesitate to ask for no-gyro turns if the aircraft must be hand-flown.**
- 3. Based on the information provided by ARTCC, set up a direct-to GPS navigation to the nearest VFR airport or to a nearby airport with the next best conditions.**
- 4. Check the DTK and TRK datafields at the top of the PFD to help determine whether the aircraft is in straight flight or in a bank angle and use the magnetic (“whiskey”) compass to perform cross-checks against the DTK and TRK data. Note that this is the type of situation in which having an active GPS NAV as an additional cross-check tool is important.**
- 5. Use the map overlay to verify heading changes.**
- 6. Optimally, set the autopilot to fly the approach.**

6c. When the AHRS fails, what is the other piece of information that is lost besides attitude?

**When the AHRS has failed, so has the magnetometer, hence magnetic heading indications are no longer displayed on the HSI and a red X appears over the Heading window. Therefore, use the DTK and TRK numbers from the GPS for direction to the runway, and perform cross-checks against the magnetic (“whiskey”) compass in the aircraft.**

## Ground Lesson 11

### DATA WEATHER LINK

#### Objectives

Upon completion of this lesson, the pilot should be able to understand and interpret weather information displayed in the cockpit. The pilot will be able to use this information as supporting information to enhance the decision making process before and during the flight.

#### Resources

- G1000 Pilot's Guide
- G1000 PC-based Simulator
- [www.xmradio.com](http://www.xmradio.com)
- [www.wxworx.com](http://www.wxworx.com)

#### Exercise 11.1: Weather and Digital Audio Entertainment

1. Briefly describe the theory of how weather and radio information are provided to the aircraft.  
**WxWorx's current weather information is delivered through continuous satellite broadcast of data from XM's Satellite Network. Weather data is retrieved and updated constantly from WxWorx sources located at thousands of points across the nation. XM's satellite delivery solution is driven by two commercial satellites. Both satellites simultaneously transmit data and are always in view. With the XM service subscription, the GDL 69/69A receives XM Weather data and displays it on the G1000 system.**
2. What types of data link weather are displayed on MFD/PFD, and what appropriate steps must be taken to get there?  
**XM Weather information is displayed by the Multi Function Display (MFD) and Primary Flight Display (PFD).**

##### Multi Function Display

1. **Navigation Map Page:** By pressing the MAP softkey and then the appropriate softkeys, NEXRAD, Cell Movement, TFRs, and XM Lightning data can be displayed.
2. **Nearest Pages:** By turning the large FMS control knob to Nearest Pages, pressing the MAP softkey, then by pressing the appropriate softkeys, NEXRAD, Cell Movement, TFRs, and XM Lightning data can be displayed.
3. **Airport Information Page:** Press the WX softkey to display METAR and TAF text information.
4. **AUX - Trip Planning Page Map:** By pressing the MAP softkey and then pressing the appropriate softkeys, NEXRAD, Cell Movement, TFRs, and XM Lightning data are displayed.
5. **Flight Plan Page Maps:** By pressing the MAP softkey and then pressing the appropriate softkeys, NEXRAD, Cell Movement, TFRs, and XM Lightning data are displayed.
6. **The Weather Data Link Page displays all available weather products.** Turn the large FMS knob to select the Map Page Group. Turn the small FMS knob to select the Weather Data Link Page.

##### Primary Flight Display

1. **INSET Map:** Press the INSET softkey and by pressing the appropriate softkeys, display NEXRAD, TFRs, and XM Lightning data.

*(exercise continued on next page)*

3. List the weather products and corresponding update rates that are available through XM Weather.

<b>NEXRAD</b>	<b>5 min.</b>	<b>Cloud Tops</b>	<b>15 min.</b>
<b>Cell Movement</b>	<b>12 min.</b>	<b>County Warnings</b>	<b>5 min.</b>
<b>METARs</b>	<b>12 min.</b>	<b>AIRMETs</b>	<b>12 min.</b>
<b>TAFs</b>	<b>12 min.</b>	<b>SIGMETs</b>	<b>12 min.</b>
<b>Lightning</b>	<b>5 min.</b>	<b>Echo Tops</b>	<b>7.5 min.</b>
<b>TFRs</b>	<b>12 min.</b>	<b>Winds Aloft</b>	<b>12 min.</b>
<b>Surface Analysis</b>	<b>12 min.</b>		

4. Reported/forecast products use a date/time stamp. On what are the date and time based?  
**Date and time are based on Zulu time as reported by appropriate weather stations, not on when the data is received by the data link sensor.**
5. When and how is weather data information received?  
**Before the GDL 69/69A can be used, the XM Satellite Radio subscription must be activated. XM Satellite Radio offers several subscriptions at different service levels. Refer to the XM Satellite Radio website for information regarding subscription options.**
6. What type of lightning strike information does XM Weather provide?  
**Only cloud-to-ground lightning is provided by XM. To receive cloud-to-cloud lightning strike information, the aircraft must be equipped with additional lightning detection equipment, such as Stormscope.**
7. What is NEXRAD?  
**NEXRAD (NEXt generation RADar) is a Doppler radar system that has greatly improved the detection of meteorological events such as thunderstorms, tornadoes, and hurricanes.**
8. What are the coverage areas of the XM Satellite signal? At what altitude must the aircraft fly to receive the XM signal?  
**The XM signal provides full coverage of the continental United States. The information can be received on the ground and while flying at any altitude throughout North America.**
9. A pilot is planning a cross-county flight. Does weather data provided by WxWorx satisfy FAR 91.103 preflight action?  
**No, weather data received in the cockpit is not approved to satisfy FAR 91.103. One must receive approved weather data from the National Weather Service/FSS. Use data link weather as a supporting reference only. XM Weather is not to be used as a main source for making decisions before or during flight.**
10. A pilot is on a VFR flight from KXYZ to KABC. Currently, the altitude is 9,500 feet, 50 miles from KABC. Weather is predicted to be MVFR at the destination airport. Using the MFD, describe the steps that must be taken to receive a METAR and/or TAF at the destination airport.
- 1. Navigation Map Page: Turn the small FMS knob to the right until the Weather Data Link page is displayed.**
  - 2. Press the METAR softkey to display colored flags at the airports.**
  - 3. Press the LEGEND softkey to see descriptions of graphic symbols and color codes.**
  - 4. Turn the large FMS knob to the WPT page group.**
  - 5. Turn the small FMS knob to select the Airport Information Page.**
  - 6. Select the destination airport and press the WX softkey to display METAR and TAF text.**

## Ground Lesson 12

### GFC 700 AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS)

#### Objectives

Upon completion of this lesson, the pilot should be able to understand the operation of the Garmin Automatic Flight Control System (AFCS) and use the Autopilot throughout various phases of flight.

#### Resources

- G1000 Pilot's Guide

#### Exercise 12.1: Flight Director and Autopilot Operation

- List all parts (LRUs) associated with the GFC 700.
  - **GDU 1040 Primary Flight Display (PFD)**
  - **GDU 1042/1043 Multi Function Display (MFD)**
  - **GIA 63 Integrated Avionics Unit (2)**
  - **GSA 81 Servos (3)**
- Where is the Autopilot control located in the cockpit?  
**The MFD has dedicated AFCS keys located on the lower left side of the bezel. Depending on the aircraft type, autopilot controls may be installed on the pilot's control wheel or throttle.**
- Where are the Autopilot mode annunciations displayed? Describe the annunciation mode color.  
**The AFCS Status Bar is displayed towards the top of the PFD, just below the Navigation Status Bar. Active modes are displayed in green, armed modes are displayed in white. In general, roll modes are on the left side and pitch modes are on the right.**
- List the Flight Director pitch and roll limitations.  
**Pitch and roll limitations vary from aircraft to aircraft. Consult the approved Flight Manual or Flight Manual Supplement for specific aircraft limitations.**
- Describe Flight Level Change Mode (FLC).  
**When the FLC key is pressed, FLC mode is activated and a specified airspeed reference is maintained. It is important to adjust the engine power to allow the Autopilot to fly the aircraft at the pitch attitude that corresponds to the airspeed reference and desired flight profile.**
- Describe the function of the Control Wheel Steering (CWS) button.  
**The CWS buttons synchronizes the Flight Director's command bars to the current aircraft attitude.**
- When the Go-Around button is pressed, what Flight Director and Autopilot functions can be expected?  
**Pressing the Go-Around button engages the Flight Director in the wings level, 7-degree pitch up attitude. The Autopilot will disengage and all armed modes will be canceled.**
- List several ways the Autopilot can be disengaged.  
**When there is a system failure, automatic disengagement occurs. Manual disengagement is accomplished by pressing the AP DISC button, the MET ARM switch, or the AP key on the MFD.**

*(exercise continued on next page)*

9. An aircraft has just departed from an airport and is performing a runway heading climbout. Following the departure procedure, the plane climbs to 4000 feet, then turns to a heading of 270 degrees. The final cruising altitude is 9000 feet. How would the pilot configure the Autopilot to follow all of the departure procedure up to the final cruising altitude?

**Upon takeoff, set the Selected Altitude to 9,000 feet using the ALT knob on the PFD. After attaining the desired vertical speed, pitch, or airspeed, press the VS, FD, or FLC button. When the appropriate mode is activated, press the AP key to engage the autopilot. The Pitch mode selected will be coupled with the default ROL mode. Next, set the Selected Heading to 270 degrees using the HDG knob on the PFD. Upon reaching 4,000 feet, press the HDG key. As the aircraft reaches 9,000 feet, the Flight Director transitions from the selected Pitch mode to Altitude Hold mode. From this point, the Autopilot flies at 9,000 feet and holds a heading of 270 degrees.**

10. Using the scenario above, configure the Autopilot to intercept an airway. Currently, the Autopilot is set to HDG mode and ALT hold mode.

**Tune the VOR frequency, then set the HSI mode to the correct NAV receiver by pressing the CDI softkey. Select the desired course using the CRS knob on the PFD. Finally, press the NAV key to arm the Navigation mode. The Autopilot will intercept the course and activate the Navigation mode.**

# Procedure 1

## GPS APPROACH NO PROCEDURE TURN

An approach where there is typically no procedure turn required to get established on the inbound course to the FAF is the first example. We use GPS RWY 12 at KPRC to show how the G1000 sequences through an approach and what type of annunciation and range factor changes can be expected. This example is based upon an active flight plan from KFLG (Flagstaff, AZ Pulliam Airport) to KPRC (Prescott, AZ Love Airport). See figure 1.

1. Select KPRC as the destination, via the **Direct-To** key or as the last waypoint in a flight plan.
2. Press the **PROC** key and select the GPS RWY 12 approach. From the Transitions window, select IRODY as the IAF (select 'LOAD?' or 'ACTIVATE?').
3. Within 30 nm of the destination, the G1000 switches from en route mode to terminal mode. The switch to terminal mode is accompanied by a gradual CDI range transition from 5.0 to 1.0 nm full range deflection.
4. Several miles prior to reaching the IAF (IRODY), review the approach sequence, as necessary. Press the **FPL** key to display the Active Flight Plan Page. Press the **FMS** knob and turn the **large FMS** knob to review each segment of the approach. When finished press the **FPL** key again to return to the previous page.
5. As the plane approaches the IAF (IRODY), the waypoint message 'NEXT DTK 204°' is displayed in the navigation status bar on the PFD. As the IAF approaches, the message is replaced by a turn advisory 'TURN TO 204°'.
6. As the plane approaches the IAP (OKAPY), the waypoint message 'NEXT DTK 124°' is displayed. As the waypoint approaches, the message is replaced by a turn advisory 'TURN TO 124°'.
7. At 2.0 nm from the FAF (MULHU), the G1000 switches from terminal mode to approach mode. CDI scaling is tightened from 1.0 to 0.3 nm full range deflection.
8. As the plane crosses the FAF 'NEXT DTK 124°' is displayed and the destination sequences to the MAP (RW12map, the runway threshold). Keeping the needle centered, fly toward the MAP, observing the altitude minimums dictated by the approach plate.
9. As the plane approaches the MAP, the waypoint message 'ARRIVING AT WAYPOINT' is displayed.
10. As the plane crosses the MAP, 'SUSP' is displayed in the HSI and directly above the **SUSP** softkey, indicating that automatic sequencing of approach waypoints is suspended at the MAP. A 'FROM' indication is displayed on the CDI, but course guidance along the final approach course continues. Do NOT follow this extended course. If a missed approach is required, follow the missed approach procedures as published on the approach plate. Press the **SUSP** softkey to return to automatic sequencing of waypoints.




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**NOTE:** When the message 'RAIM is not available' is displayed in the Alerts Window on the PFD a missed approach must be executed.

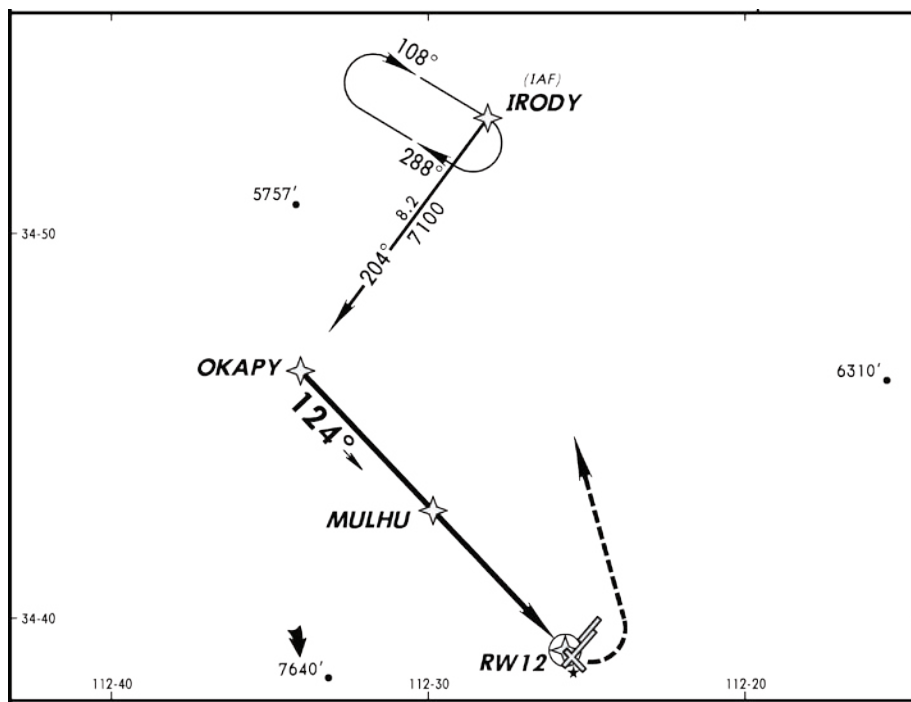
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**NOTE:** The final approach course must be intercepted 2 nm outside of the FAF for the approach to be active.

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Figure 1 Approach with No Procedure Turn



## Procedure 2

### FLYING THE MISSED APPROACH

As the MAP is passed, if the runway is not in view, a missed approach must be performed. The G1000 continues to give guidance along an extension of the final course segment (FAF to MAP) until manual initiation of the missed approach procedure.

1. As the plane crosses the MAP, the waypoint message 'ARRIVING AT WAYPOINT' is displayed in the navigation status bar on the PFD. 'SUSP' is displayed in the HSI and directly above the **SUSP** softkey, indicating that automatic sequencing of approach waypoints is suspended. A 'FROM' indication is displayed on the CDI, but course guidance along the final approach course continues. Do NOT follow this extended course.
2. Initiate the missed approach sequence by following the missed approach procedures as published on the approach plate, for proper climb and heading instructions.
3. If necessary, press the **CDI** softkey to switch external CDI output to GPS for guidance. Press the **SUSP** softkey to return to automatic sequencing of waypoints. The G1000 will guide to the missed approach holding point.
4. A message is displayed in the navigation status bar on the PFD recommending entry procedures for the holding pattern (HOLD PARALLEL, HOLD TEARDROP, or HOLD DIRECT).
5. The G1000 provides course guidance only on the inbound side of the holding pattern. When leaving the holding pattern to re-fly the approach, press the **PROC** key to 'Select Approach?' or 'Activate Approach?' (or use the **Direct-To** key to select another destination).




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**NOTE:** When the message 'RAIM is not available' is displayed in the Alerts Window on the PFD a missed approach must be executed.

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**NOTE:** When flying a non-GPS instrument approach, such as with ground-based navigational equipment (VOR, LOC), with GPS as supplemental guidance to get to MAHP, switch the external CDI output from VOR1, VOR2, LOC1, or LOC2 to GPS. The CDI selection can be changed by pressing the **CDI** softkey.

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## Procedure 3

### FLYING THE PROCEDURE TURN

The procedure turn portion of the approach is stored as one of the legs of the approach. For this reason the G1000 requires no special operations from the pilot (other than flying the procedure turn itself) beyond what is required for any other type of approach. This example is based upon a flight from KILG (Wilmington, DE New Castle County) to KMIV (Millville, NJ Municipal). The approach into KMIV will be NDB or GPS RWY 14 with the RNB transition. See figure 2.

1. Select KMIV as the destination, via the **Direct-To** key or as the last waypoint in a flight plan.
2. Press the **PROC** key and select the NDB or GPS RWY 14 approach. From the transitions window select RNB as the IAF. Choose 'LOAD?' or 'ACTIVATE?'
3. Once cleared for the approach, press the **PROC** key and select 'ACTIVATE APPROACH?'
4. Within 30 nm of the destination, the G1000 switches from en route mode to terminal mode. The switch to terminal mode is accompanied by a gradual range transition from 5.0 to 1.0 nm, full range deflection.
5. Several miles prior to reaching the IAF (RNB), review the approach sequence, as necessary. Press the **FPL** key to display the Active Flight Plan Page. Press the **FMS** knob and turn the **large FMS** knob to review each segment of the approach. When finished, press the **FPL** key again to return to the previous page.
6. As the plane approaches the IAF (RNB), the waypoint message (NEXT DTK 327°) is displayed in the navigation status bar on the PFD. As the waypoint approaches, the message is replaced by a turn advisory (TURN TO 327°).
7. Fly the outbound course keeping the CDI needle centered.
8. After flying approximately one minute past the IAF, the message 'START PROC TURN' is displayed.
9. Turn left to a heading of 282° to initiate the procedure turn. No guidance through the procedure turn is given. The procedure turn is displayed in magenta indicating the active leg. The CDI needle starts moving to the right.
10. After approximately one minute, make a 180° right turn to a heading of 102° to intercept the inbound course. The G1000 sequences to the inbound leg to the FAF, the CDI needle swings to the opposite side to provide proper sensing along the final course segment and 'NEXT DTK 147°' is displayed in the navigation status bar on the PFD.
11. As the CDI needle starts to center, make a right turn to 147° to intercept the final approach course.
12. At 2.0 nm from the FAF (RNB), the G1000 switches from terminal mode to approach mode. CDI scaling is tightened from 1.0 to 0.3 nm, full range deflection.
13. As the plane crosses the FAF, the message 'NEXT DTK 147°' is displayed and the destination sequences to the MAP (RW14map, the runway threshold). Keeping the CDI needle centered, fly toward the MAP, observing the altitude minimums dictated by the approach plate.
14. As the plane approaches the MAP, the waypoint message 'ARRIVING AT WAYPOINT' is displayed.
15. As the plane crosses the MAP, 'SUSP' is displayed in the HSI and directly above the **SUSP** softkey, indicating that automatic sequencing of approach waypoints is suspended. A 'FROM' indication is displayed in the CDI, but course guidance along the final approach course continues. Do NOT follow this extended course. If a missed approach is required, follow the missed approach procedures as published on the approach plate. Press the **SUSP** softkey to return to automatic sequencing of waypoints.



**NOTE:** Once the FAF is crossed, the final course segment is displayed in magenta and a dashed line extends the course beyond the missed approach point. The dashed line is provided for situational awareness only and should NOT be used for navigation. Please follow the published missed approach procedures.



**NOTE:** When the message 'RAIM is not available' is displayed in the Alerts Window on the PFD a missed approach must be executed.



### Figure 2 Flying the Procedure Turn

## Procedure 4

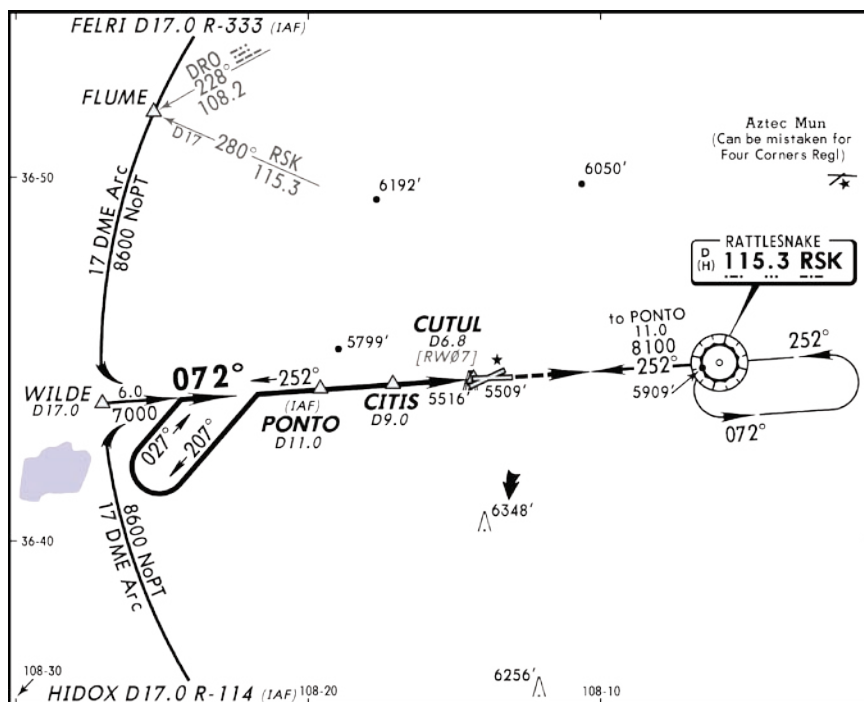
### FLYING THE DME ARC

The GPS overlay for a DME arc approach uses additional Jeppesen provided waypoints to define the arc. When cleared for a DME arc approach, do either of the following to intercept the arc:

- Follow a specified radial inbound to intercept the IAF.
- Follow ATC vectors, which allow interception of the arc at any point along the arc.

This example is based upon a flight from KSAF (Santa Fe, NM Municipal) to KFMN (Farmington, NM Four Corners Regional). The VOR DME RWY 7 approach is selected along with “HIDOX” as the IAF. See figure 3.

1. Select KFMN as the destination, via the **Direct-to** key or as the last waypoint in a flight plan.
2. Press the **PROC** key and select the VOR DMW RWY 7 approach. From the transitions window, select “HIDOX” as the IAF. Choose ‘LOAD?’ or ‘ACTIVATE?’
3. Within 30 nm of KFMN, the G1000 switches from en route mode to terminal mode. The CDI range gradually transitions from 5.0 to 1.0 nm, full range deflection.
4. If the approach has not already been activated, be sure to do so when cleared for the approach.
5. As the plane approaches the IAF (HIDOX), the waypoint message ‘NEXT DTK 206°’ is displayed in the navigation status bar on the PFD. As the IAF approaches, the message is replaced by a turn advisory ‘TURN TO 206°’.
6. Follow the arc, keeping the CDI needle centered.
7. The next point in the approach is an intermediate fix “WILDE”. As the plane approaches “WILDE” the waypoint message ‘NEXT DTK 072°’ is displayed. As the waypoint approaches, the message is replaced by a turn advisory ‘TURN TO 072°’. Initiate a standard rate turn to this course heading.
8. At 2.0 nm from the FAF (PINTO), the G1000 switches from terminal mode to approach mode. CDI scaling is tightened from 1.0 to 0.3 nm, full range deflection.
9. As the plane approaches the FAF, the waypoint message ‘NEXT DTK 072°’ is displayed. Make any adjustments necessary for the final course segment (FAF to MAP).
10. As the plane crosses the FAF, the destination sequences to the MAP (RW07map, the runway threshold). Keeping the CDI needle centered, fly toward the MAP, observing the altitude minimums dictated by the approach plate.
11. As the plane approaches the MAP, the waypoint message ‘ARRIVING AT WAYPOINT’ is displayed.
12. As the plane crosses the MAP, ‘SUSP’ is displayed in the HSI and directly above the **SUSP** softkey, indicating that automatic sequencing of approach waypoints is suspended. A ‘FROM’ indication is displayed on the CDI, but course guidance along the final approach course continues.



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Figure 3 Flying the DME Arc and Vectors to the DME Arc

## Procedure 5

### VECTORS TO THE DME ARC

This example is en route from KSAF to KFMN on a heading of 294°, 25 miles out and ATC gives vectors to intercept the arc outbound from HIXOX. See figure 3

1. If the approach has not already been activated, be sure to do so when cleared for the approach.
2. ATC instructs to turn left to a heading of 270° to intercept the arc.
3. Prior to intercepting the arc the leg must be activated since the arc was not intercepted at the IAF.
4. With the Active Flight Plan page displayed, press the **FMS** knob to activate the cursor.
5. Turn the **large FMS** knob to highlight DME ARC and press the **MENU** key to display a list of options.
6. 'Activate Leg' is now highlighted, press the **ENT** key. A confirmation window is displayed with 'ACTIVATE' highlighted, press the **ENT** key. This activates the arc leg as well as the approach.




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**NOTE:** The leg can also be activated by pressing the **ACT LEG** softkey.

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7. Follow the arc, keeping the CDI needle centered.
8. The next point in the approach is an intermediate fix WILDE. As the plane approaches WILDE the waypoint message 'NEXT DTK 072°' is displayed. As the waypoint approaches, the message is replaced by a turn advisory 'TURN TO 072°'. Initiate a standard rate turn to this course heading.
9. At 2.0 nm from the FAF (PINTO), the G1000 switches from terminal mode to 0.3 nm. CDI scaling is tightened from 1.0 to 0.3 nm, full range deflection.
10. As the plane approaches the FAF, the waypoint message 'NEXT DTK 072°' is displayed. Make any adjustments necessary for the final course segment (FAF to MAP).
11. As the plane crosses the FAF, the destination sequences to the MAP (RW07map, the runway threshold). Keeping the CDI needle centered, fly toward the MAP, observing the altitude minimums dictated by the approach plate.
12. As the plane approaches the MAP, the waypoint message 'ARRIVING AT WAYPOINT' is displayed.
13. As the plane crosses the MAP, 'SUSP' is displayed in the HSI and directly above the **SUSP** softkey, indicating that automatic sequencing of approach waypoints is suspended. A FROM indication is displayed on the CDI, but course guidance along the final approach course continues. Do NOT follow this extended course. If a missed approach is required, follow the missed approach procedures as published on the approach plate. Press the **SUSP** softkey to return to automatic sequencing of waypoints.

## Procedure 6

### FLYING AN APPROACH WITH A HOLD

This example is based upon a missed approach from KSOP (Moore County, NC). Now the pilot has decided to divert to KIGX (Chapel Hill, NC) instead. The RNAV (GPS) RWY 9 approach into KIGX is selected. The RNAV (GPS) RWY 9 approach begins with a holding pattern at the IAF, FIKKA. See figure 4.

1. Press the **Direct-to** key.
2. Turn the **small and large FMS** knobs to enter the destination airports identifier (KIGX).
3. Press the **ENT** key twice. This time select the RNAV (GPS) RWY 9 approach into KIGX. The approach begins with a holding pattern at the IAF (FIKKA).
4. Press the **PROC** key and select the RNAV (GPS) RWY 9 approach.
5. From the transitions window, select FIKKA as the IAF. When asked 'Hold at FIKKA? YES or NO', select Yes and press the **ENT** key. Choose 'ACTIVATE?'; this will load and activate the approach.
6. Once the approach is activated, the Active Flight Plan Page is displayed. Review the approach sequence by pressing the **small FMS** knob and turning the **large FMS** knob to review each segment of the approach.
7. Within 30 nm of the airport, the G1000 switches from en route mode to terminal mode. The CDI range transitions from 5.0 to 1.0 nm, full range deflection.
8. Prior to crossing FIKKA, the message 'HOLD DIRECT' is displayed in the navigation status bar on the PFD to suggest the proper holding pattern entry.
9. Fly the holding pattern (the holding pattern is displayed in magenta, indicating the active leg).
10. As the plane crosses the IAF, 'SUSP' is displayed in the HSI and directly above the **SUSP** softkey indicating that automatic sequencing of approach waypoints is suspended. As the plane makes the turn inbound, 'SUSP' is cancelled and the G1000 returns to automatic sequencing.



**NOTE:** If it is needed to go around the holding pattern again, press the **SUSP** softkey to manually suspend waypoint sequencing **BEFORE** crossing the holding waypoint the second time. If the waypoint has already been passed, re-activate the holding pattern using the **ACTIVE FLIGHT PLAN** page.

11. As the plane approaches FIKKA from within the holding pattern, the waypoint message 'NEXT DTK 090°' is displayed.
12. At 2.0 nm from the FAF, the G1000 switches from terminal mode to approach mode. CDI scaling is tightened from 1.0 to 0.3 nm, full range deflection.
13. As the plane approaches the FAF, the waypoint message 'NEXT DTK 090°' is displayed. Make any course adjustments necessary for the final course segment (FAF to MAP).
14. As the plane crosses the FAF, the destination sequences to the MAP (RW09map, the runway threshold). Keeping the needle centered fly toward the MAP, observing the altitude minimums dictated by the approach plate.



**NOTE:** When viewing the Navigation Map Page, the final course segment is displayed in magenta (the active leg of the flight plan always is displayed in magenta) and a dashed line extends the course beyond the MAP. Do NOT follow this extended course. Instead, follow the published missed approach procedures.

15. As the plane approaches the MAP, the waypoint message 'ARRIVING AT WAYPOINT' is displayed.

16. As the plane crosses the MAP, 'SUSP' is displayed in the HSI and directly above the **SUSP** softkey, indicating that automatic sequencing of approach waypoints is suspended at the MAP. A 'FROM' indication is displayed on the CDI, but course guidance along the final approach course continues. Do NOT follow this extended course. If a missed approach is required, follow the missed approach procedures as published on the approach plate. Press the **SUSP** softkey to return to automatic sequencing of waypoints.



**NOTE:** When the message 'RAIM is not available' is displayed in the Alerts Window on the PFD a missed approach must be executed.

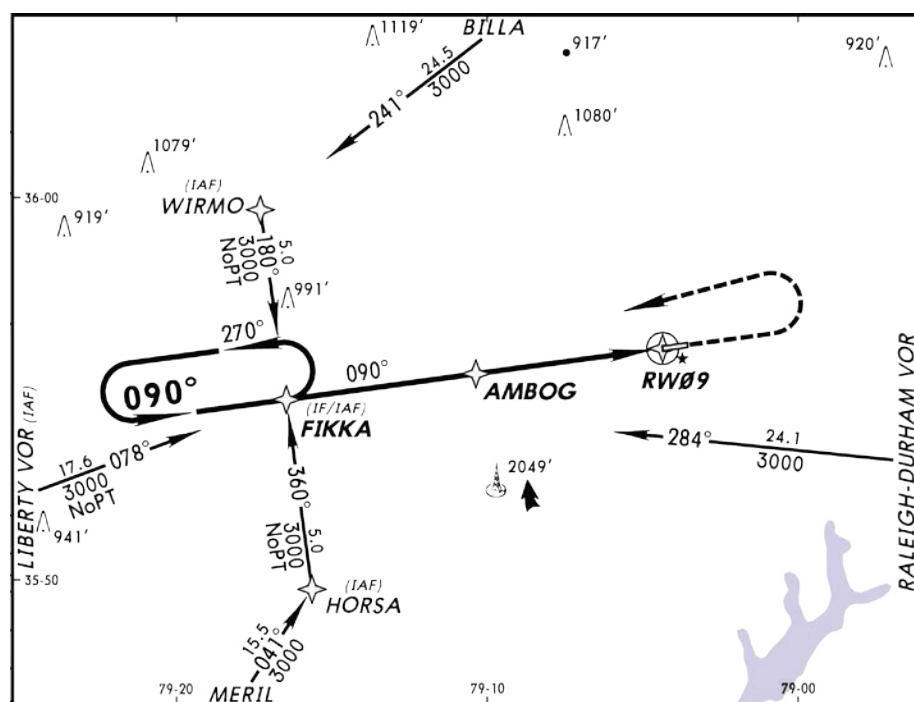


Figure 4 Flying an Approach with a Hold

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## Procedure 7

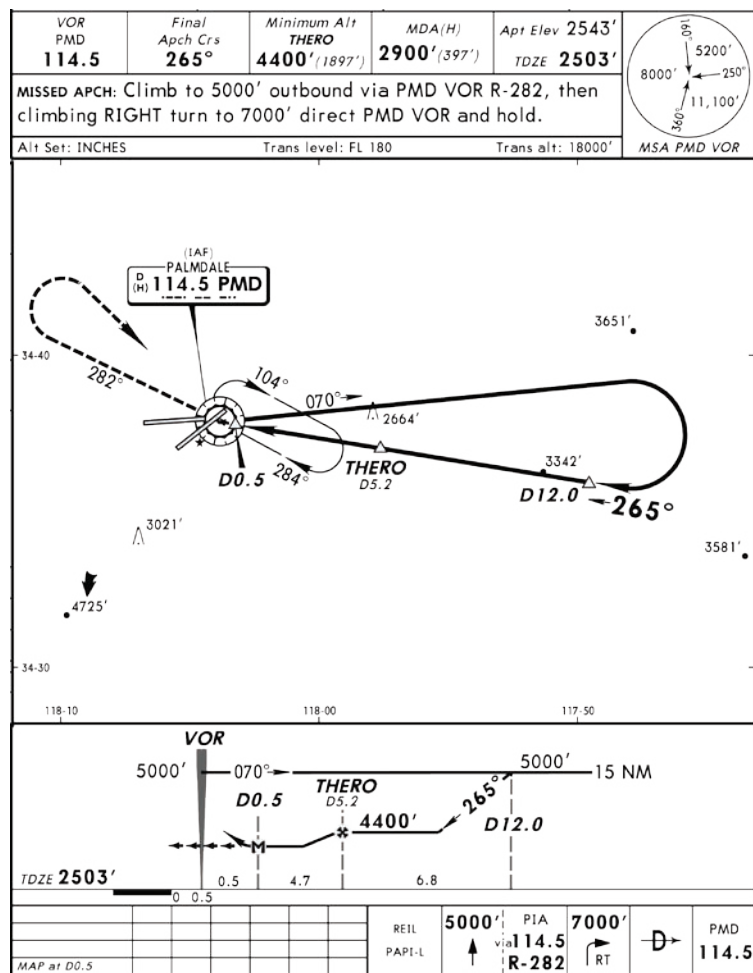
### FLYING A COURSE FROM FIX TO DISTANCE, OR COURSE FROM FIX TO DME DISTANCE

Certain approach, departure and arrival procedures in the Jeppesen database contain course from fix flight plan legs. The G1000 is able to load these legs into the flight plan along with the rest of the procedure data, and to provide navigation along these legs. There are four different types of course from fix legs:

- Course from fix to distance
- Course from fix to DME distance
- Course from fix to an altitude
- Course from fix to manual termination

Course from fix to distance or DME distance legs appear in the flight plan like normal waypoints, but the destination name always begins with a “D”, followed by a distance in tenths of nautical miles from the waypoint fix. This example uses the VOR/DME RWY 25 approach into Palmdale, California (KPMD), and includes a teardrop course reversal. See figure 5.

1. Select KPMD as the destination, via the **Direct-To** key or as the last waypoint in a flight plan.
2. Press the **PROC** key and select the VOR/DME 25 approach. From the transitions window, select ‘PMD’ as the IAF.
3. As the plane reaches the IAF (PMD), the waypoint message ‘NEXT DTK 070°’ is displayed in the navigation status bar on the PFD. As the waypoint approaches, the message is replaced by a turn advisory ‘TURN TO 070°’. The plane is now on the course from fix to distance leg as shown on the active flight plan. The distance displayed in the flight plan is “D13.0”. The flight plan automatically sequences to the next leg upon reaching “D13.0”.
4. As the plane approaches “D13.0”, the waypoint message ‘NEXT DTK 265°’ is displayed. Make a standard rate turn to the right to intercept the final approach course and watch for the CDI needle to center.
5. As the plane approaches the intermediate fix ‘CF25’, the waypoint message ‘NEXT DTK 265°’ is displayed. Fly this inbound course, keeping the CDI needle centered. CDI coupling automatically switches from GPS receiver to the Nav receiver.
6. Within 2.0 nm of the FAF (THERO), the G1000 switches from terminal mode to 0.3. CDI scaling is tightened from 1.0 to 0.3 nm, full range deflection.
7. As the plane approaches the FAF (THERO), ‘NEXT DTK 265°’ is displayed. Continue to keep the CDI needle centered.
8. As the plane crosses the FAF, the destination sequences to MAP (MA25).
9. As the plane approaches the MAP, the waypoint message ‘ARRIVING AT WAYPOINT’ is displayed.
10. As the plane crosses the MAP, ‘SUSP’ is displayed above the **SUSP** softkey, indicating that automatic sequencing of approach waypoints is suspended at the MAP. Course guidance along the final approach course continues. Do NOT follow this extended course. If a missed approach is required, follow the missed approach procedures as published on the approach plate. Press the **SUSP** softkey to return to automatic sequencing of waypoints.



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Figure 5 Course from Fix to Distance or Course from Fix to DME Distance

## Procedure 8

### FLYING A COURSE FROM FIX TO ALTITUDE

'Course from fix to altitude' legs shows the specific target altitude on the active flight plan. This example is based upon a flight from KSMO (Santa Monica Municipal) to KPMD (Palmdale, CA) with VOR/DME RWY 25 approach selected, which includes a course from fix to altitude leg. In this instance, the leg corresponds to the initial phase of the missed approach, which reads "Climb to 5000 outbound via PMD VOR R-282". See figure 5.

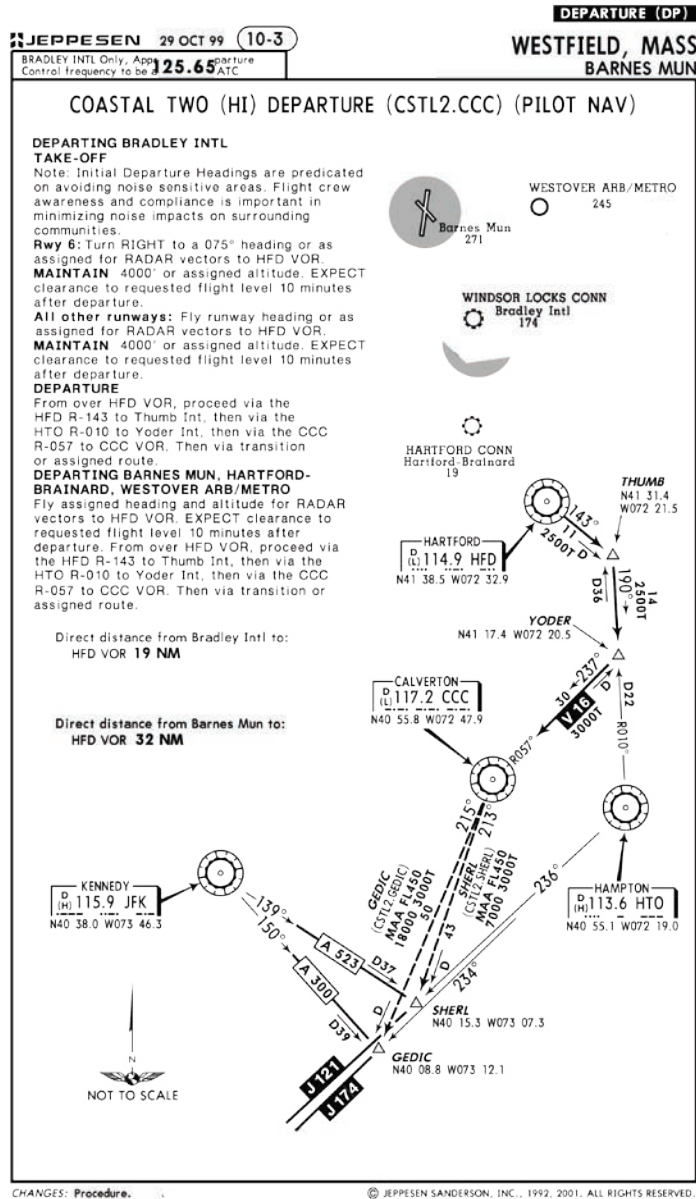
1. After crossing the MAP, press the **SUSP** softkey. The missed approach sequence is automatically offered, starting with the course from fix to altitude leg. The 'NEXT DTK 282°' waypoint message is displayed in the navigation status bar on the PFD. Follow the missed approach procedures, as published on the approach plate, for proper climb and heading instructions.
2. Note that within a few seconds of pressing the **SUSP** softkey to release suspend mode and start the missed approach sequence, 'SUSP' is re-displayed above the **SUSP** softkey as the G1000 returns to suspend mode. This is normal when flying a course from a fix to altitude leg and indicates that automatic leg sequencing is suspended.
3. Fly the outbound course keeping the CDI needle centered. The Navigation Map Page depicts the flight path extending indefinitely from the PMD VOR. The distance increases and indicates the distance back to the PMD VOR.
4. Upon reaching the desired altitude (5000), press **SUSP** to return to automatic leg sequencing. Confirm that 'SUSP' no longer is displayed directly above the **SUSP** softkey.
5. The message 'NEXT DTK 133°' is displayed, guiding to the inbound course. The actual desired track (DTK) depends on the ground speed and distance from PMD VOR. Intercept and fly the inbound course, keeping the CDI needle centered.
6. As the plane approaches PMD VOR (the missed approach holding point), a message in the navigation status bar recommends the holding pattern entry 'HOLD PARALLEL'.
7. Note that the G1000 again displays 'SUSP' above the **SUSP** softkey. Automatic waypoint sequencing is suspended at the missed approach holding point. The waypoint message (ARRIVING AT WAYPOINT) is displayed each time the plane approaches the PMD VOR in the holding pattern.
8. When leaving the holding pattern, press the **PROC** key to reactivate the approach or select a different approach, or press the **Direct-To** key to select another destination.

## Procedure 9

### FLYING A COURSE FROM FIX TO MANUAL SEQUENCE

'Course from fix to manual sequence' legs are displayed on the Active Flight Plan Page and the Navigation Map Page with "man seq" in place of a waypoint identifier. An example of this type of course leg appears in the COASTAL TWO DEPARTURE from Westfield, Massachusetts (Barnes Municipal). The example leg corresponds to the departure leg from Barnes Municipal and appears as follows on the Active Flight Plan, Navigation Map Page and Navigation Status Bar: See figure 6.

1. Press the **PROC** key to select the 'CSTL2' departure. Then select the departure runway 'RW02'. From the transitions window select 'GEDIC'.
2. As the plane departs the airport, 'NEXT DTK 025°' is displayed in the navigation status bar on the PFD and 'SUSP' is displayed directly above the **SUSP** softkey. The plane is now on the course from fix to manual sequence leg. The distance displayed is from the waypoint fix (the departure runway RWY 02).
3. Fly the outbound course keeping the CDI needle centered. Once cleared to sequence to the next leg, press the **SUSP** softkey. Confirm that 'SUSP' no longer is displayed directly above the **SUSP** softkey. The message 'NEXT DTK 185°' is displayed to guide to the next waypoint (HFD VOR). The actual desired track (DTK) depends on the ground speed and distance from the HFD VOR.
4. Once the **SUSP** softkey is pressed, the G1000 automatically sequences to each waypoint along the remainder of the departure route, including the selected transition.



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Figure 6 Flying a Course from Fix to Manual Sequence

## Procedure 10

### FLYING THE ILS APPROACH



**NOTE:** When an ILS approach is loaded, the ILS frequency is automatically placed in the NAV Frequency window. Refer to the NAV/COM Pilot's Guide for details.

Precision approaches can be performed with the built in Nav (VOR/localizer/glideslope) receivers. Prior to reaching the FAF the CDI should be set to NAV1 or NAV2. The G1000 automatically switches the external CDI output from GPS to NAV1 or NAV2 as the final approach course is intercepted. When the ILS approach is activated, the G1000 automatically switches within 1.2 nautical miles left or right of the final approach course. This switch will take place within 15.0 nautical miles prior the FAF.



**NOTE:** If an attempt is made to intercept the approach course beyond the FAF, the CDI must be manually switched from GPS to LOC1 or LOC2 by pressing the **CDI** softkey.

The CDI selection can also be changed manually by pressing the **CDI** softkey. Once the switch from GPS to Nav has occurred, either automatically or manually, it does not automatically switch again until the approach is reactivated or another approach is selected. To prevent automatic ILS CDI selection, select the 'Manual' ILS CDI Capture, in the AUX – System Setup Page (the factory default setting is 'Auto', which enables the automatic switch to Nav).

This example is based upon on an active flight plan from KSNA (Santa Ana, CA ) to KSAN (San Diego, CA Lindbergh Field) with the ILS RWY 9 approach and "GATTO" as the IAF, which includes an outbound leg and a procedure turn. See figure 7.

1. Select KSNA as the destination, via the **Direct-To** key or as the last waypoint in a flight plan.
2. Press the **PROC** key and select ILS RWY 9 approach. From the transition window, select 'GATTO' as the IAF. Choose 'LOAD?' or 'ACTIVATE?'. A reminder message is displayed, indicating that GPS can only be used for approach monitoring. 'LOAD' will maintain Direct-to navigation, while activate goes directly to the first fix. Activate the approach once cleared by ATC.
3. Within 30 nm of KSAN, the G1000 switches from en route mode to terminal mode and the CDI range transitions from 5.0 to 1.0 nm, full-range deflection.
4. If the approach has not already been activated, be sure to do so when cleared for the approach.
5. As the plane approaches the IAF (GATTO), the waypoint message 'NEXT DTK 272°' is displayed in the navigation status bar on the PFD. As the distance to the IAF approaches zero, the message is replaced by a turn advisory 'TURN TO 272°'.
6. Fly the outbound course (272°), keeping the CDI needle centered.
7. Once the plane has flown approximately one minute past the IAF (GATTO), the message 'START PROC TURN' is displayed.
8. Turn left to a heading of 227° to initiate the procedure turn. The G1000 does not guide one through the turn (the procedure turn is displayed in magenta indicating the active leg). The CDI needle starts moving to the right.
9. After approximately one minute, make a 180° right turn to a heading of 047° to intercept the ILS. The G1000 sequences to the inbound leg and 'NEXT DTK 092°' is displayed. CDI coupling automatically switches from the GPS receiver to the Nav receiver as the plane completes the inbound turn.
10. As the CDI needle starts to center, make a right turn to 092° to track the ILS approach course.
11. At 2.0 nm from the FAF (GATTO), the G1000 switches from terminal mode to approach mode. The CDI scaling is tightened from 1.0 to 0.3 nm, full range deflection.
12. As the plane approaches the FAF (GATTO), the waypoint message 'NEXT DTK 092°' is displayed.

13. As the plane crosses the FAF, the destination sequences to the RW09map (RW09, the runway threshold). Keeping the CDI needle centered, fly toward the MAP, observing the altitude minimums dictated by the approach plate.
14. As the plane approaches the MAP, the waypoint message 'ARRIVING AT WAYPOINT' is displayed.
15. As the plane crosses the MAP, 'SUSP' is displayed above the **SUSP** softkey, indicating that automatic sequencing of approach waypoints is suspended at the MAP. A 'FROM' indication is displayed on the CDI, but course guidance along the final approach course continues. Do NOT follow this extended course. If a missed approach is required, follow the missed approach procedures as published on the approach plate. Press the **SUSP** softkey to return to automatic sequencing of waypoints.

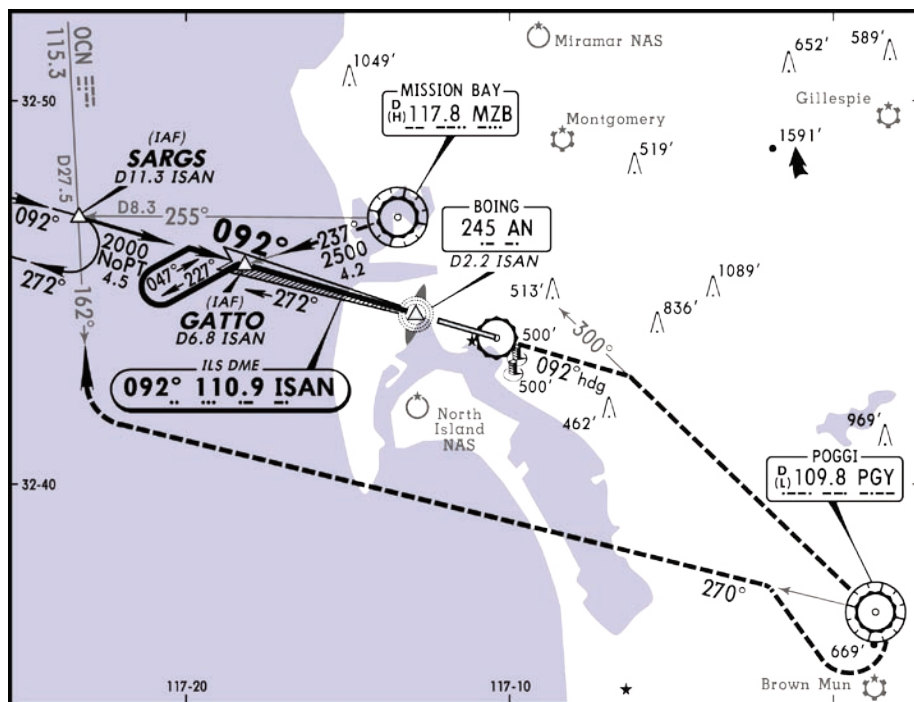


Figure 7 Flying the ILS Approach



## Procedure 11

### FLYING THE VECTORS APPROACH

In some cases ATC tells one to expect vectors onto the final approach course instead of flying the full approach. The two options below can be used to select “vectors to final”:

- When the approach is first selected choose ‘VECTORS’ from the transitions window.
- Load a full approach including the IAF from the transition window. When cleared, press the **PROC** key and select ‘ACTIVATE VECTORS TO FINAL’.

With ‘Vectors To Final’ selected, the CDI needle remains off center until established on the final approach course. With the approach activated, the Navigation Map Page displays an extension of the final approach course in magenta (remember magenta is used to depict the active leg of the flight plan). This example is based upon an active flight plan from KPAN (Payson, AZ) to KSDL (Scottsdale, AZ), with “Vectors” for the “VOR or GPS-A” approach. See figure 8.

1. Select KSDL as the destination, via the **Direct-to** key or as the last waypoint in a flight plan.
2. Press the **PROC** key and select the VOR or GPS-A approach. From the transitions window choose VECTORS.
3. Within 30 nm of KSDL, the G1000 switches from en route mode to terminal mode and the CDI range transitions from 5.0 to 1.0 nm, full range deflection.
4. If not already done, activate the approach (with vectors to final). This allows the G1000 to guide to the final approach course.
5. ATC instructs to turn left to a heading of 170°. This places the plane parallel to the final approach course in the opposite direction. The CDI needle deflection is to the right.
6. ATC instructs to turn right to a heading of 185°.
7. ATC instructs to turn right to a heading of 230°.
8. ATC instructs to turn right to a heading of 325° to intercept the final approach course. As the plane converges with the final approach course the CDI needle moves toward the center.
9. As the CDI needle centers, make any remaining course corrections to establish the plane on the final approach course.
10. At 2.0 nm from the FAF (GELTS), the G1000 switches from terminal mode to approach mode. The CDI scaling is tightened from 1.0 to 0.3 nm, full range deflection.
11. As the plane approaches the FAF, the waypoint message ‘NEXT DTK 002°’ is displayed in the navigation status bar on the PFD. Make any course adjustments necessary for the final approach course segment (FAF to MAP).
12. As the plane crosses the FAF, the destination sequences to the MAP (MABAW). Keeping the needle centered, fly toward the MAP, observing altitude minimums dictated by the approach plate.
13. As the plane approaches the MAP, a waypoint message ‘ARRIVING AT WAYPOINT’ appears.
14. As the plane crosses the MAP, ‘SUSP’ appears above the **SUSP** softkey, indicating that automatic sequencing of approach waypoints is suspended at the MAP. A ‘FROM’ indication is present on the ‘TO/FROM’ arrow, but course guidance along the final approach course continues. Do NOT follow this extended course. If a missed approach is required, follow the missed approach procedures as published on the approach plate. Press the **SUSP** softkey to return to automatic sequencing of waypoints.

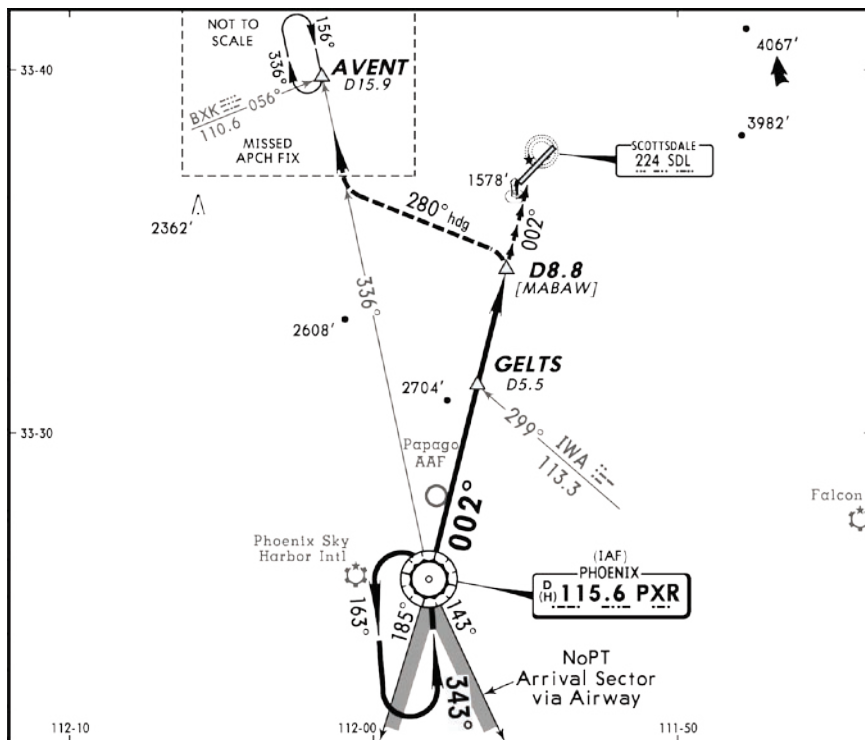



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**NOTE:** When the message ‘RAIM is not available’ appears in the Alerts Window on the PFD a missed approach must be executed.

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Figure 8 Flying the Vectors Approach

## **THE G1000 INTEGRATED AVIONICS SYSTEM AND CONSIDERATIONS OF ITS USE TO ENHANCE THE AERONAUTICAL DECISION MAKING (ADM) PROCESS AND SINGLE-PILOT RESOURCE MANAGEMENT (SRM).**

The Garmin G1000 Integrated Avionics System has brought a number of improvements in cockpit technology to the General Aviation (GA) aircraft. These improvements range from longer life and greater reliability of the primary instruments to a simplified pilot interface. With the addition of new technologies, the G1000 system is capable of providing the pilot with a wider variety of information about the flight environment, thereby leading to greater situational awareness and reduced pilot workload. The G1000 system allows the pilot to focus on aeronautical decision making (ADM) and single-pilot resource management (SRM).

The majority of GA flight operations are single-pilot operations. The single-pilot, IFR, cross-country flight is often regarded as one of the most challenging flight operations. The need to communicate and navigate while relying solely on the aircraft instruments makes the single-pilot cockpit a busy and stressful environment. Since the inability to manage these demands effectively can prove life threatening, understanding and using all of the tools available in the cockpit is key to overcoming the challenges presented by single-pilot IFR flights.

The autopilot is a fundamental tool that is often overlooked in the current aviation training environment. As an SRM tool, no other piece of avionics is as valuable in reducing pilot workload as the autopilot. Pilots should routinely practice using the autopilot and gain a full understanding of their particular system. Using the autopilot allows the pilot to focus on other flight management tasks such as route deviation planning and general aircraft system monitoring without reaching a point of sensory overload.

In the case of system failures or emergencies, the autopilot relieves the pilot of the workload of manually flying the aircraft and thus allows the problem to be addressed. It is important to note that many GA aircraft are equipped with a rate-based autopilot that receives roll inputs from an electric turn-coordinator. In aircraft equipped with a vacuum-driven attitude indicator, failure of the vacuum pump should prompt the pilot to immediately change to a partial panel scan and to engage the autopilot in at least a roll and pitch mode. In aircraft equipped with a GPS coupled to the autopilot, the pilot should activate GPS direct-to navigation to the nearest suitable airport, then place the autopilot in NAV mode to fly straight to the airport. In either case, the autopilot reduces pilot workload by helping to ensure that the wings remain level and that standard rate turns are used.

At initial release, the G1000 system will interface with the third party, rate-based autopilot installed in the aircraft. These autopilots are linked to a remote-mounted rate-based gyro that is independent of the G1000 system; therefore, the above-mentioned methodology still applies if attitude information is lost. Indeed, using the autopilot in roll-control or navigation mode at the point of attitude failure allows the pilot to maintain control of the aircraft while taking appropriate emergency actions. Again, the use of the autopilot reduces pilot workload and should allow the pilot to better manage the emergency. Nonetheless, it is imperative that the pilot double-check all autopilot inputs in order to avoid mode confusion and monitor them to ensure that the intended operation is taking place.

While the autopilot is the single most valuable tool for SRM, it is also important that the pilot develop a consistent approach to using the communication and navigation tools present in the G1000 system. The two COM and NAV receivers combined with the ability to tune COM and NAV frequencies from the Jeppesen database give the pilot a streamlined process for frequency selection and management.

A typical methodology for COM/NAV frequency management is to designate COM1 and NAV1 as the primary airborne and en route frequencies. COM2 can then be reserved for both weather (ATIS, ASOS, AWOS) and ground frequencies. Meanwhile, NAV2 is set as the backup to NAV1. If established as part of a standard operating procedure, these selections help to minimize the confusion over which COM and/or NAV is selected and active. When a consistent approach to frequency management is not used, the pilot is more likely to run into mode confusion concerning the use of the audio control panel; this can in turn lead to missed radio calls and/or transmissions on the incorrect frequency.

While managing frequencies for ground-based Navaids is important, proper use of the GPS flight plan function can also prove beneficial. Rather than performing continuous direct-to navigation with the GPS, taking the time on the ground to enter a full flight plan allows the G1000 to enhance the navigation experience. First, the pilot will be able to visually inspect the route of flight on the MFD map, once at altitude, so as to verify both terrain clearance (using the terrain awareness overlay) and active airspaces (if active, MOAs and Restricted areas would call for a re-routing from ARTCC). Secondly, using the flight plan function allows for seamless autopilot turn anticipation. Finally, taking a moment to program the flight plan on the ground makes it easier to react quickly to in-flight routing changes. Pilots should program the flight plan on even short cross-country flights.

Likewise, the maps on both the Multi Function Display (MFD) and the Primary Flight Display (PFD) help the pilot to manage the navigation functions of the system. By using the maps to verify GPS navigation inputs, the pilot is able to visually cross-check data entry by looking at the course lines drawn on the map. This visual representation of the active navigation is the quickest way to determine whether all of the correct waypoints were entered for the intended route of flight.

In this discussion so far, the focus has been on SRM. Now, attention will be turned to leveraging the various data inputs from the on-board weather sensors, datalinks, traffic awareness and terrain awareness functions. Proper understanding of both the operation of these various tools and their integration with the pilot's aeronautical decision making (ADM) process can bring significant safety gains to the GA fleet.

Weather datalink and airborne lightning detection equipment have brought unprecedented weather avoidance capabilities to the GA aircraft. While these weather tools provide valuable information, they do have limitations that must be considered and they should thus be used appropriately by the pilot in the ADM process.

The primary limitation with both datalink weather and airborne lightning detection equipment is that neither device is to be used for storm penetration. Instead, these planning tools should be used to help the pilot make a timely and well-informed decision on how to proceed with the flight. Indeed, datalink weather receivers can bring a wide variety of information into the cockpit besides the well-known NEXRAD radar images.

While avoiding strong thunderstorms and other areas of heavy precipitation is desirable, the ability to also review textual weather information for en route and destination allows the pilot to maintain better situational awareness for airport selection in case of an emergency. The capability to review textual weather data from ground reporting stations while en route also allows the pilot to evaluate all approach options based on ceilings at the destination airport and to decide whether a diversion should instead be made to an alternate airport much earlier in the flight. This, coupled with the ability to review weather information well outside of the transmission range of ATIS/AWOS/ASOS systems, enables the pilot to better prepare for arrival and reduces last-minute workload.

Thunderstorms are typically used as the main selling point for datalink weather receivers due to their visual NEXRAD presentation, whereas ice – the other main weather concern for flight – is often not emphasized enough. However, it should be stressed that the potential for icing is also provided textually and in some cases, graphically, via datalink weather. This becomes a very powerful tool in the winter months. The ability to bring more information about the icing potential in either format type (textual or graphical) is a significant improvement to the overall safety of flight.<sup>1</sup>

Overlaying both the NEXRAD and lightning images on either the G1000 MFD or PFD map inset serves to corroborate information on the location of the strongest storms. When lightning detection equipment is installed in the aircraft, the unique strike-aging capability of the G1000 provides additional visual cues as to the current state/stage of the storm. Indeed, continuously growing strike rate counts as well as an increase in the number of lightning bolts (bold or normal) often denotes a developing severe thunderstorm. On the other hand, decreasing strike rates combined with a growing number of “plus” (+) symbols indicates a decrease in the strength of the storm and its possible dissipation.<sup>2</sup>

While this type of information is very powerful and convincing, it is important to use it to plan the flight path and not to try to penetrate an area of weather. Indeed, the data should be used to plan a deviation well clear of the storm in order to ensure that the remainder of the flight can be safely executed. One should always remember that discretion is often the better part of valor and that no technology can depict actual meteorological conditions with 100% accuracy.

Traffic Collision and Avoidance Systems (TCAS) represent another technological advance that has been made in the area of traffic avoidance. Originally developed for large commercial aircraft, TCAS technology is now starting to trickle down features and capabilities to the GA fleet. For example, the GTX 33 Mode-S transponder can be used as an optional component in G1000-equipped aircraft and brings Traffic Information Service (TIS) data directly to the cockpit.<sup>3</sup>

TIS data is provided and transmitted by the FAA over Mode-S terminal radar sites and is derived from the actual transponder returns of aircraft as seen on the air traffic controller's scope. A key difference between TIS and a TCAS system is that TIS should only be used as an additional tool to see and avoid traffic. Therefore, the pilot should not become reliant on TIS and try to avoid traffic solely by reference to the traffic display in the cockpit. First, deviations should not be performed until the pilot has visually acquired the threat traffic. Secondly, Mode-S radar coverage and TIS service are only available in areas equipped with Mode-S terminal radar. Since TIS service may not always be available in the en route environment, the pilot should not entirely depend on this tool to acquire traffic visually and should always scan for traffic.

The last tool to be discussed given its benefit to the ADM process is the new generation of GA terrain awareness systems. Terrain awareness systems are split into two generic classes, that is, certified systems and non-certified systems. The certified systems are the TAWS-A and TAWS-B devices. These systems provide a number of terrain avoidance features that are not available in the non-certified terrain awareness systems. The G1000 includes a non-certified terrain awareness feature that can be displayed on both the MFD map and the PFD map inset. TAWS-B will be available as an option for the G1000 system.

The colors used to depict dangerous terrain elevations based on aircraft altitude are red and yellow. Red indicates that the aircraft is within 100 feet of or below the terrain level. Yellow indicates that the aircraft is within 1,000 feet of the terrain. These two colors allow the pilot to look at the planned route and then decide which altitude seems optimal for the completion of the flight. This color scheme also brings additional situational awareness during the critical approach phases of the flight in both VFR and IFR conditions. With the interest in preventing Controlled Flight Into Terrain (CFIT) accidents, even simple situational awareness tools such as the G1000 terrain awareness feature can provide yet another helpful input to the ADM process.

In conclusion, as GA aircraft and pilots transition to 21st-century technology, the G1000 Integrated Avionics System brings a number of safety enhancing benefits. Although automation in the cockpit should be embraced, both its positive and negative impacts on the safety of flight should be recognized and understood. Proper autopilot use is key to enhancing safety by reducing pilot workload - this is particularly true in certain emergency situations. In addition, the ability to develop a methodical approach to other cockpit tasks, even as simple as COM/NAV frequency selection and GPS management, can help the pilot to maintain better situational awareness while minimizing the overall cockpit workload.

The ability to view weather, traffic and terrain information to improve the ADM process represents another significant benefit brought to the cockpit by the G1000 Integrated Avionics System. Indeed, from satellite downlink weather with both NEXRAD radar images and textual weather to real-time lightning detection data, the pilot now has access to a wealth of information directly from the cockpit. Although the combination of weather, TIS and terrain awareness information can increase the safety of flight, it is also critical that the pilot use this information properly and consistently. Too often, human beings rely on technology alone to provide the solution to hazardous situations. However, in the dynamic, three-dimensional flight environment, it is the pilot who represents the most significant component of the avionics system. It is from the cockpit that the most important calculations are made using the information and inputs provided by the avionics to ensure a safe flight. These calculations are enhanced both by regular recurrent training and by the full understanding of the strengths and limitations of the various data inputs. Good ADM and SRM practices are of critical importance to the long-term improvement of the GA safety record.

<sup>1</sup> G1000 GDL-69/69A uses XM Satellite Radio with WxWorx data. Please, refer to <http://www.wxworx.com/> for more information on available weather data products.

<sup>2</sup> Please, refer to the appropriate manufacturer documentation concerning the complete operation of lightning detection equipment.

<sup>3</sup> For more information on the TIS system, please refer to: <http://www.tc.faa.gov/act310/projects/modes/tis.htm>





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