# Navigation Simulator

Version **1.12**

## Reference Manual

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# Table of Contents

END

# Introduction

## Note Regarding Use and Requirements

Thank you for using the Navigation Simulator from luizmonteiro.com. Please note that this tutorial is designed to help you learn how to use the simulator, however, it is not designed to teach you how to perform VOR, NDB, or ILS navigation. If you would like to know how to use these navigational aids there are several resources available, including the Instrument Flying Handbook published by the FAA (Federal Aviation Administration in the USA). At the time this tutorial was written an Adobe PDF version of the handbook could be found at the following web site: http://www.faa.gov/library/manuals/aviation/

The simulator has been tested on Mac OSX, Windows XP, Windows Vista (32/64-bit), and Windows 7 (32/64-bit). However you must use the trial version to test the software before purchasing since memory, and computer speed among other factors determine if this software will work adequately on your computer.

## What you can do with the Navigation Simulator

Navigating by instruments is based on interpreting instruments that show the aircraft's relationship to special radio stations whose positions are known. By practicing these skills the use of instruments becomes second nature and the pilot/navigator can be capable of handling more tasks and reduce training an actual aircraft.

This simulator can be used by students and flight instructors to learn the basics of instrument navigation by "flying" a virtual aircraft and receiving feedback on what typical flight instruments display. The position of the aircraft and the navigational aids can also be manipulated by the user.

This simulator focuses deliberately on the navigation part of flying, rather than the "feel" of the controls, and the person using the simulator plays the role of a navigator rather than the pilot. This allows the user to learn to navigate and concentrate on this task rather than divert his/her attention on keeping the aircraft on the desired course, bank angle, descent rate, etc.

The control of the aircraft is done through keyboard input. Essentially the user, who is playing the role of the navigator, is telling the computer to bank the aircraft to a certain angle and maintain that, level the aircraft, or maintain a descent rate. The computer will do what would be required in terms of flight controls (yoke or stick, rudder pedals, throttle, flaps, etc.) to achieve this. This is the equivalent of asking the pilot of an aircraft to turn, stop the turn, level the aircraft, etc. The pilot will move the controls of the aircraft in order to achieve this, but you don't have to worry about how the pilot does this.

The "aircraft" that you are flying in the simulator is as generic as possible in order to simulate the widest spectrum and therefore has a very wide range of speed, turn, and climb/descent characteristics which in reality would be unrealistic if not impossible for a single aircraft to have.
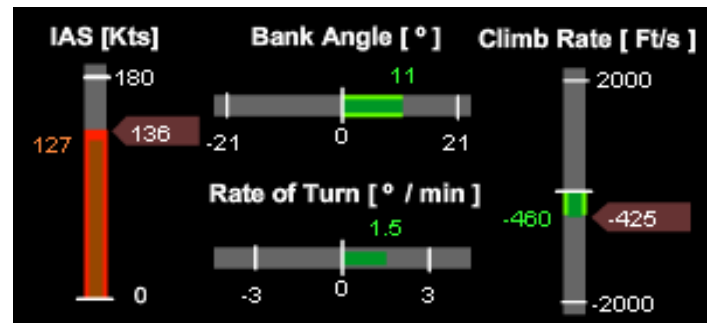

*Aircraft Motion Control Screen*
*(controlled though keyboard)*

Some of the maneuvers and procedures that can be learned using the software are:

1. VOR and NDB course intercepting and tracking
2. VOR and NDB holding patterns
3. DME holding patterns
4. Procedure turns
5. ILS localizer and glide slope intercepting and tracking
6. Intersection holding patterns including those based on VOR and VOR radials, NDB bearings and VOR radials, localizer and VOR radials or NDB bearings, with or without DME
7. DME arcs
8. Missed approach procedures
9. Other course reversal procedures

It can also be used as a tool to teach:

1. The effects of wind on:
   a) Aircraft ground speed
   b) Climb and descent angle or path
   c) Course drift
   d) Determining the appropriate time and heading adjustments required in holding patterns

2.  Off-course correction and intercept problems

3.  Estimating time/distance to a VOR without using DME

4.  Identifying intersections

5.  Homing vs. tracking visualization

6.  Correct interpretation of ADF, RMI, HSI and VOR/ILS course indicators with the aircraft located in specific locations from the tuned nav radio source.

7. The effect of aircraft heading changes on ADF, RMI, HSI and VOR/ILS display indications when tuned to a nav radio source.

8. The effect of course selection on the display of HSI and VOR/ILS indicators when tuning VOR or ILS frequencies

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## Instrument Simulator Application - Versions

There are two versions of the simulator depending on the screen resolution. The first one is for monitors that are at least 1280 x 1024 pixels. In this version the General Settings/Navaid Information tabs are always visible. The second version, which is more appropriate for smaller monitors and small widescreen monitors like those on laptops that have a lower than 1024 pixel height, is for screen resolutions of at least 1200 x 750 pixels. This version requires the General Settings/Navaid Information tabs to be toggled on and off by pressing the "O" key or through the options menu.

Starting with the Navigation Simulator 1.11, you can resize the simulator to any size you like. Vector graphics help ensure quality at non-native resolutions. This allows the software to run in any monitor as long as the user can see the scaled graphics (if scaled down).

**1280 x 1024 pixels version**



**1200 x 750 pixels version**

## Instrument Simulator Application - Main Parts

**Menu Bar**



**Horizontal Panel / Horizontal Navigation View**

**Main Instruments**

**Navaid/NAV settings**



**Vertical Panel / Vertical Navigation View**

**Miscellaneous Info**



**Aircraft Motion Start / Pause Control**

**Aircraft Miscellaneous Instruments**

**Aircraft Movement Control Display**

**Options Menu**
1. General Settings
2. Navaid Information
3. Other Settings

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## Instrument Simulator Parts - Horizontal and Vertical Navigation Panels



Navigational Aid (Navaid) Symbol

Navaid Number 1

From Region Navaid 1

Intersection Symbol

Projection Flags

To Region Navaid 1

Navaid 1 CRS Setting From

Aircraft Horizontal Path Trace

Navaid Number 3 (NDB)

Aircraft Horizontal Symbol

Compass Rose Navaid 1

Wind Triangle

Navaid Number 2

Aircraft Radial from Navaid 1

Navaid 1 CRS Setting To

To / From Legend (Navaid 1)

Map Scale

Projection Flags

Aircraft CRS / GS Vector

Aircraft HDG / TAS Vector

Aircraft Vertical Symbol

Wind Direction / Wind Speed Vector

Aircraft Vertical Path Trace

Horizontal Navigation

Vertical Navigation

Not to scale

60 Nm

## Instrument Simulator Parts - Horizontal and Vertical Navigation Panels (continued)

### Additional Parts

**To Region Navaid 2**

**From Region Navaid 2**

**Navaid 2 CRS Setting From**

**Intersection Symbol**

Horizontal Navigation

**Compass Rose Navaid 2**

**Aircraft Bearing from Navaid 3**

**Aircraft Radial from Navaid 2**

**Navaid Number 3 Magnetic North**

To
From

30 Nm

**Navaid 2 CRS Setting To**

**Glide Slope Symbol**

**Aircraft Vertical Symbol**

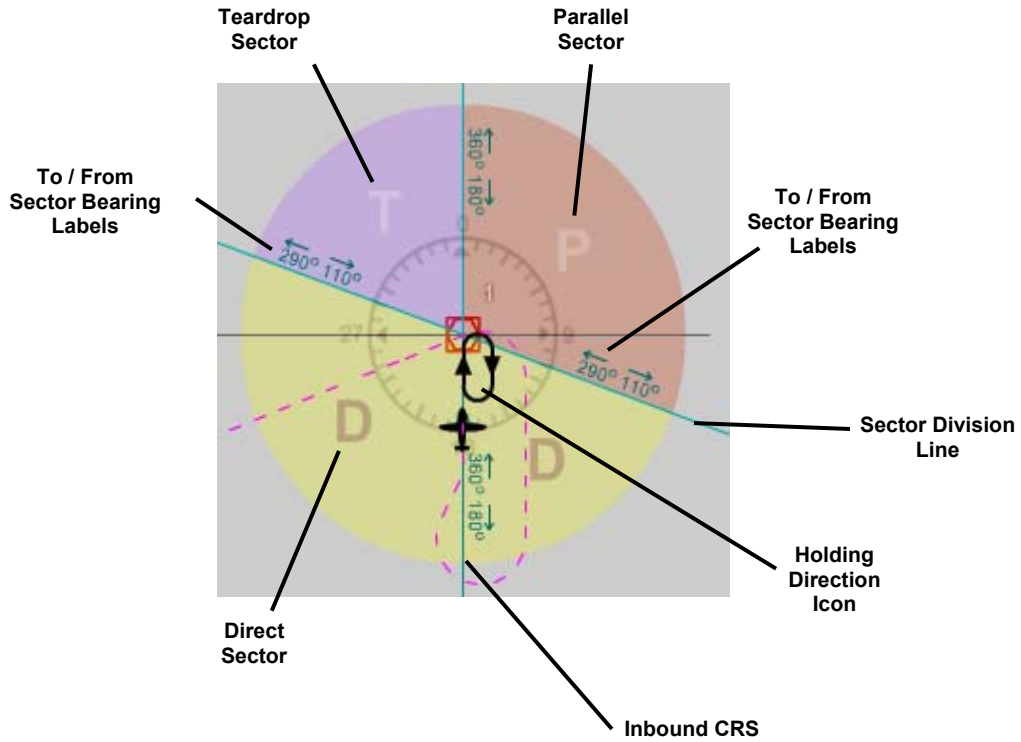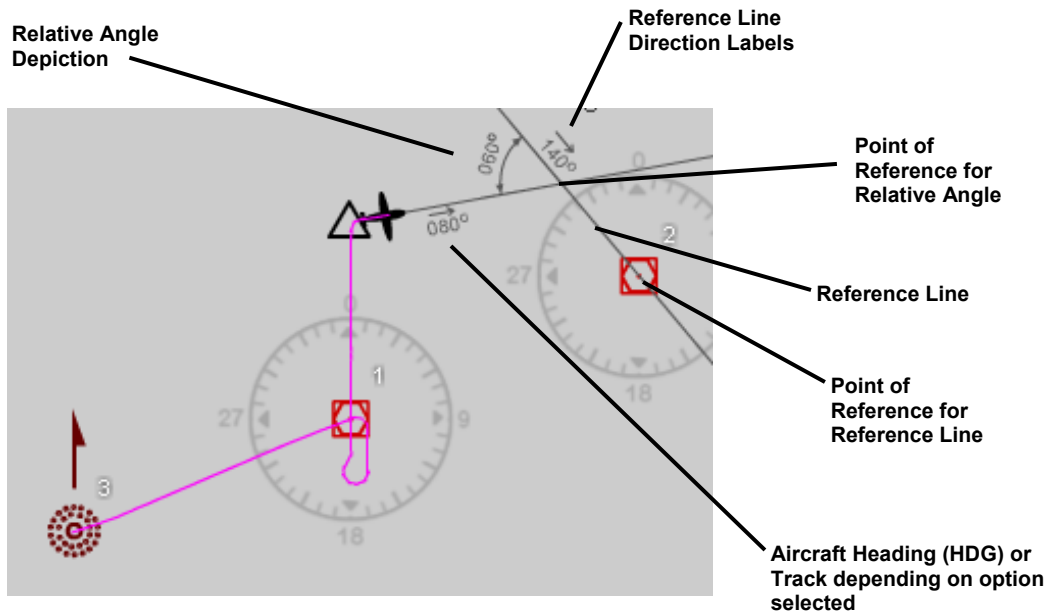Not to scale

Vertical Navigation

## Instrument Simulator Parts - Horizontal and Vertical Navigation Panels (continued)

### Additional Parts

Holding Pattern Template



**Teardrop Sector**

**Parallel Sector**

**To / From Sector Bearing Labels**

**To / From Sector Bearing Labels**

**Sector Division Line**

**Holding Direction Icon**

**Direct Sector**

**Inbound CRS**

Auxiliary / Reference Marks



**Relative Angle Depiction**

**Reference Line Direction Labels**

**Point of Reference for Relative Angle**

**Reference Line**

**Point of Reference for Reference Line**

**Aircraft Heading (HDG) or Track depending on option selected**

## Instrument Simulator Application - Options Menus and Settings

### General Settings Tab

General Settings | Navaid Information | Other Settings

**Wind Triangle**
- Show Triangle ✓ Show Arrow
- Size Medium
- Label:
- ✓ Direction ☐ HDG ☐ CRS ☐ WD
- ✓ Magnitude ☐ TAS ☐ GS ☐ WS

**Wind**
- Spd [kts] 0
- Dir [deg] 360

**Trace Path**
- ☐ Trace On
- ✓ ShowTrace
- Clear Trace

**Map Zoom**
- Zoom Out In
- Max Zoom In 30 Nm
- ☐ Auto Zoom In

**Aircraft Motion Settings**
- Sim Speed 1 x
- Max Bank [deg] Std Rate

**Global View**
- ✓ North Up
- ✓ Show Map
- ✓ Show Aircraft
- ✓ Show Non-Essential
- Map Symbols Medium
- Declutter Map

**Altitude Range**
- Max Altitude [ft] 10000
- Min Altitude [ft] 0
- Alt Set [InHg] 29.92
- Enter Parameters

**Panel Setting**
- Glass Cockpit
- Max IAS 180 kts
- ✓ Show Magnetic Compass
- Latitude (deg) 0 N

**Performance**
- CPU Speed Slow
- Note: If performance is still slow try doing the following:
- (1) Disable "Trace On" then click on "Clear Trace".
- (2) Use slower aircraft speeds.
- (3) Avoid using "Heading Up"

**NAV 1 and 2 "Radio"**
- NAV 1 tuned to: Navaid 1
- (VOR 1, HSI, DME, and RMI)
- NAV 2 tuned to: Navaid 2
- (VOR 2, DME, and RMI)

**Memory**
- Load M1 M2 M3 M4 Default
- Save M1 M2 M3 M4 Clr All

*General Settings*

### Navaid Information Tab

General Settings | Navaid Information | Other Settings

**VOR1 Information**
- OBS Setting: 030
- DME Dist*: 9.8Nm

**Other Information**
- Heading Bug: 050
- *Navaid 1*
  - Acft Radial: 221
- *Navaid 2*
  - Acft Radial: 279

**VOR 2 Information**
- OBS Setting: 360
- DME Dist*: 14.4 Nm

**RMI Information**
- NAV1 Acft Radial: 221
- NAV1 Acft Mag Bearing To: 041
- NAV2 Acft Radial: NA
- NAV2 Acft Mag Bearing To: NA
- ADF Mag Bearing From Station: 247
- ADF Magnetic Bearing To (MB): 067

**Complementary / Analogous Instuments**
- ✓ HSI
- ✓ ADF

*Navaid Information*

### Other Settings Tab

General Settings | Navaid Information | Other Settings

**Holding Pattern Template**
- ☐ Show Template
- ☐ Non Standard (left turns)
- Relative to: Navaid 1
- Inbound Course 360
- View
  - ✓ Sector Direction Labels
  - ✓ Sector Division Lines
  - ✓ Inbound CRS
  - ✓ Course Abeam Lines
  - ✓ Holding Symbol

**Auxilary / Reference Marks**
- ☐ Show Reference Line
- Relative to: Navaid 1
- Ref Line Course 360 Recip
  - ○ Ref on Outbound Course
  - ○ Ref on Inbound Course
  - ● Ref on Both
- ✓ Show Ref Line Labels
- ✓ Show Angle Relative to Acft
  - ● Relative to Heading
  - ○ Relative to Acft Track
  - ○ Relative to Rad or ○ Brg
- ✓ Show Angle Forward of Point

**Aircraft Random Position**
- Rad/Brg: Min 000 Max 359
- Distance: Min 5 Max 15
- Relative to: Navaid 1
- Randomly Place Aircraft

**Aircraft Random Heading**
- Rad/Brg: Min 000 Max 359
- Randomly Set Aircraft HDG

**Positioning Wizards**
- Navaid 2 Navaid 3
- Intersection Aircraft

**Attitude Indicator**
- ☐ Show pitch up / down when climbing / descending

**ILS / LOC DME Offset**
- Offset greater / less (+/-):
- 0.00 [Nm]

*Other Settings*

### Navaid/NAV settings

**Navaid 1 Type**
- VOR DME
- Inb. CRS: 360
- GS Angle: 3.00 [deg]
- ☐ Glide Slope Available

**Navaid 1 Map Options**
- ✓ Show Compass Rose
  - ✓ Large
- ☐ Show Projection Flags
- ☐ Show Aircraft Radial

**Navaid 2 Type**
- VOR DME
- ✓ Navaid 2 Active

**Navaid 2 Map Options**
- ☐ Show Compass Rose
- ☐ Show Aircraft Radial

**Navaid 3 Type**
- NDB
- ✓ Navaid 3 Active

**Navaid 3 Map Options**
- ☐ Show Magnetic North
- ☐ Show Bearing

**Intersection**
- ☐ Show Intersection
- Position Wizard

**Show Mag Direction Labels**
- ✓ Radials / Bearings
- ✓ OBS CRS

**NAV 1 Visualization Aids**
- ☐ Show To / From Region
- ☐ Show OBS CRS To / Fr

**NAV 2 Visualization Aids**
- ☐ Show To / From Region
- ☐ Show OBS CRS To / Fr

*Navaid / NAV settings*

## Instrument Simulator Application Parts Description

## *Main Parts*

### Menu Bar

Displays the following options:

*File:* where you choose to save or load all your settings including the aircraft's position.

The files that are saved are backwards <u>and</u> forwards compatible. For example, If loading a file that was saved on a previous version, the simulator will load all the features that were available in the previous version and use the default settings to fill in the missing new features. In the event that you are loading a file that comes from a newer version the simulator will only load the features and settings up to its version.

*About:* contains information regarding licensing of the software and a form for entering your permanent registration key.

*Help*: in this section you'll find at the keyboard shortcuts that can be used in the simulator.

### Horizontal Panel

Displays the horizontal position of the aircraft in relation to navigational facilities the same way an IFR enroute chart or an approach plate's plan view would.

### Vertical Panel

Displays the vertical position of the aircraft in relation to the navigational facility (Navaid 1) the same way an approach plate's profile view would. It is used for several purposes, including:

1) Simulate the slant range error in DME readings

2) Enable the simulation of the glide slope

### Main Instruments

Area where the digital panel resides, or the nine main analog instruments, such as airspeed indicator, attitude indicator, altimeter, turn coordinator, HSI, VOR, vertical speed indicator, RMI, heading indicator, and ADF are located. The panel can be chosen under the "General Settings", "Panel Setting" section.

### Navaid/NAV settings

Is used to select the type of navigational facility. Some features such as DME or glide slope will only work with certain types of facilities. It also allows other options such as displaying the to/from region, course selected, showing radial line, showing compass rose, bearing line for the

ADF, and enabling and disabling the navaids.

<u>Navaid 1 Type</u>

*Navaid 1 Type selection box*: selects the number 1 type of navigational facility on the map.

*Inb CRS*: when the navaid type is an ILS, LOC, LDA or SDF this selects the direction of its inbound course.

*GS Angle*: when the navaid type is an ILS, or any other type with a glide slope, this option selects the angle of that glide slope in degrees.

*Glide Slope Available*: on LDA types of navaids this option is selected if the user wishes for a glide slope to be available. Since and ILS by definition has a glide slope, this option is not available when the ILS is selected.

*Navaid 1 Map Options*:

*Show Compass Rose*: selects if a compass rose will be displayed on the map and whether it will be displayed large or small.

*Show Projection Flags*: selects whether or not projection flags are visible the map.

*Show Aircraft Radial*: selects whether a line drawn from the navaid through the aircraft, showing the aircraft's radial in relation to that navaid, is displayed.

<u>Navaid 2 Type</u>

*Navaid 2 Type selection box*: selects the number 2 type of navigational facility on the map.

*Navaid 2 Active*: selects whether the number 2 navigational facility is displayed on the map, and interpreted by the instruments.

*Navaid 2 Map Options*:

*Show Compass Rose*: selects if a compass rose will be displayed on the map and whether it will be displayed large or small.

*Show Aircraft Radial*: selects whether a line drawn from the navaid through the aircraft, showing the aircraft's radial in relation to that navaid, is displayed.

<u>Navaid 3 Type</u>

*Navaid 3 Active*: selects whether the number 3 (NDB) navigational facility is displayed on the map, and interpreted by the instruments.

*Navaid 3 Map Options*:

*Show Magnetic North*: selects if a Magnetic North symbol will be displayed on the map on the navaid.

*Show Aircraft Bearing*: selects whether a line drawn from the navaid through the aircraft, showing the

## Instrument Simulator Application Parts Description (cont.)

aircraft's bearing to that navaid, is displayed.

### Intersection

*Show Intersection*: selects whether the intersection symbol is visible on the map.

*Position Wizard*: if the intersection symbol is visible, this button allows the user to position the intersection using a wizard.

### *Show Mag Direction Labels*:

*Radials/Bearings*: selects whether text displaying the radial or bearing will be shown on the map when the Show Aircraft Radial or Show Bearing is selected.

*OBS CRS*: selects whether a text displaying the value of the OBS setting will be shown on the appropriate navaid when the OBS CRS To/Fr option is selected.

### *NAV 1 Visualization Aids*:

*Show To/from*: selects whether the to and from area of the navaid tuned to NAV 1 will be shaded and displayed on the map.

*Show OBS CRS To/Fr*: when NAV 1 is tuned to a navaid other than an ILS, LOC, LDA or SDF this option selects whether a line will be drawn through the navaid showing the OBS CRS to and from that navaid. Otherwise a line will be drawn through the inbound course.

### *NAV 2 Visualization Aids*:

*Show To/from*: selects whether the to and from area of the navaid tuned to NAV 2 will be shaded and displayed on the map.

*Show OBS CRS To/Fr*: when NAV 2 is tuned to a navaid other than an ILS, LOC, LDA or SDF this option selects whether a line will be drawn through the navaid showing the OBS CRS to and from that navaid. Otherwise a line will be drawn through the inbound course.

## Miscellaneous Info

Displays other information that although is not present or essential in the real aircraft it can be used to illustrate how climb angle is affected by ground speed, what is the exact track or course the aircraft is on, outside air pressure and other useful information.

## Aircraft Motion - Start / Pause Control

The start / pause button controls when movement begins or

pauses. Flight time and chronometer stop when aircraft motion stops. Aircraft circulating icon reinforces if aircraft is moving and what rate is the simulation speed. This control can also be activated through the keyboard shortcut "P".

## Aircraft Miscellaneous Instruments

Location for other instruments such as DME, flight time, and chronometer.

## Aircraft Movement Control Display

Area where indicated airspeed, bank angle, and climb / descent rates are shown. These are directly controlled by the keyboard commands.

## General Settings

Use this sections to select and activate different features.

### Wind Triangle

*Show Triangle*: selects whether the wind triangle will be visible on the map.

*Show Arrow*: if show triangle is selected, this option will place arrows on the wind triangle vectors.

Size: sets the size of the wind triangle displayed on the map.

*Label*: selects whether labels will be drawn next to the wind triangle vectors showing the value for their direction and magnitude depending on options selected.

### Wind

*Spd*: sets the value of the windspeed.

*Dir*: sets the value for the direction from where the wind is coming.

### Trace Path

*Trace On*: when enabled, the path that the aircraft is taking will be recorded in memory. Please note that if you have a slower computer this might cause the simulator to significantly lose performance.

*Show Trace*: if the path of the aircraft was recorded or is being recorded through the "Trace On" option, a line will be drawn through the points that the aircraft traveled on the map.

### Map Zoom

*Zoom Out / in*: changes the scale of the map so that features can be zoomed in or out. Note that if zooming in will cause the aircraft to lie outside of the map, the

## Instrument Simulator Application Parts Description (cont.)

Zoom in button will not allow further zoom in.

*Max Zoom In*: selects the maximum zoom in scale.

*Auto Zoom In*: selects if zooming in is automatic when the aircraft is moving

### Aircraft Motion Settings

*Sim Speed*: this option selects the timescale for the simulator. For example if 2x is selected time will pass twice as fast and the aircraft will appear to move twice as fast.

*Max Bank*: this selects the maximum banking limit when using the keyboard commands to bank. The default "Std Rate" automatically limits the bank to standard rate based on the aircraft's current speed.

### Global View

*North Up*: if selected, the map orientation will be north facing up. When deselected, the map orientation will be the aircraft's heading facing up.

Note that when "North Up" is NOT SELECTED additional computer processor performance will be necessary to keep moving the map as the aircraft heading changes. This can reduce the simulator's performance. If you see that the simulator's performance is slow it is best to keep the "North Up" option selected.

*Show Map*: when deselected, hides all of the features on the map. Use this mode to navigate on instruments alone and test your navigation skills.

*Show Aircraft*: when deselected, hides the aircraft icon on the map, along with aircraft specific map features.

*Show Non-Essential*: shows information such as aircraft CRS / TRK , ground speed, crab angle, climb angle, outside air temperature, outside air pressure. These may be nice to know items but are usually not available to pilots in their cockpit and are included in the simulator for teaching purposes.

*Map Symbols*: selects the size of aircraft and navigational aid icons on the map.

*Declutter Map:* removes all map features except for aircraft, navigational aids, and intersection symbol.

### Altitude Range

*Max Altitude*: the maximum true altitude that the aircraft can go.

*Min Altitude*: the minimum altitude that the aircraft can go. This can be the airport altitude for example.

*Alt Set*: the value for the station's or airport's altimeter

setting. Not to be confused with the altimeter setting in the aircraft's altimeter instrument.

Note: the three settings above require the "Enter Parameters" button to be pressed, once you've entered the values above, for settings to take effect.

### Panel Setting

*Drop-down menu*: selects the type of instrument panel that will be displayed by the simulator.

*Max IAS*: maximum indicated airspeed. In the analog panel this setting also affects the scale of the airspeed indicator.

*Show Magnetic Compass*: determines whether or not the magnetic compass should be visible.

*Latitude (deg)*: is used by the magnetic compass to simulate dip errors.

### Performance

*CPU Speed*: for processors prior to Intel's Core2 Duo or Core2 Quad it is recommended that this setting be left at "Slow". For faster computers that setting will increase the smoothness of the map animation and the size of the aircraft's traceable path.

### NAV 1 and 2 "Radio":

*NAV 1 tuned to*: selects which navigational aid on the map will be referenced by the aircraft's NAV 1 instruments.

*NAV 2 tuned to*: selects which navigational aid on the map will be referenced by the aircraft's NAV 2 instruments.

### Memory

*Load*: retrieves all the settings and aircraft position from a memory slot.

*Save:* stores all the settings and aircraft position in a temporary memory slot.

*Default*: restores all default settings and default aircraft position.

*Clr All*: clears all the temporary memory slots.

## Navaid Information Section

Displays additional information regarding the instruments and aircraft positions relative to the navaids. It also includes a section with the complementary / analogous instruments.  This displays the instruments that are not

selected through the panel settings and can be used to compare these instruments with their complementary or analogous counterparts displayed in the main instruments area. The analogous instruments will only be visible when an analog panel is selected.

## Other Settings Section

In this section you will find settings for:

Holding Pattern Template

*Show Template*: selects whether or not the "Holding Pattern Template" will be visible on the map.

*Non Standard (left turns):* if enabled, the holding template will be shown for left turn holding patterns. If disabled, the standard right holding pattern turns will be depicted.

*Relative to*: selects if the holding pattern template will be relative to a particular navaid or intersection.

*Inbound Course*: the course in degrees for the holding pattern's inbound course.

*View*:

*Sector Direction Labels*: shows labels in degrees both outbound and inbound for each sector.

*Sector Division Lines*: draws the line at the division of each sector.

*Inbound CRS*: draws a line and arrow in the direction of the inbound course.

*Course Abeam Lines*: draws two lines abeam the inbound course.

*Holding Symbol*: shows a race track pattern symbol that depicts the direction of turns for the holding pattern. Note that this symbol is not drawn to scale and should only be used to determine the direction of turns for the holding pattern.

Auxiliary / Reference Marks

*Show Reference Line*: selects whether or not the Reference Line will be visible on the map.

*Relative to*: selects if the reference line template will be relative to a particular navaid or intersection.

*Ref Line Course*: selects the direction that the reference line will be drawn. "Recip" button changes that value in 180°.

*Ref on Outbound Course*: selects if the line will be drawn from, or outbound of, the reference point.

*Ref on Inbound Course*: selects if the line will be drawn to, or inbound of, the reference point.

*Ref on Both*: selects whether the line will be drawn both inbound and outbound of the reference point.

*Show Ref Line Labels*: if selected displays labels for the direction in degrees of the course of the reference line.

*Show Angle Relative to Acft*:

*Relative to Heading*: draws a line from the aircraft in the direction of its heading. If that line intersects the reference line an angle symbol and a label displaying the relative angle in degrees between the two lines will be displayed.

*Relative to Acft Track*: draws a line from the aircraft in the direction of its track. If that line intersects the reference line an angle symbol and a label displaying the relative angle in degrees between the two lines will be displayed.

*Relative to Rad:* draws a line from the Navaid to the aircraft and displays an angle between that line and the reference line. Additionally a label showing the value for the radial in degrees relative to the aircraft position is drawn.

*Relative to Brg*: draws a line from the aircraft to the Navaid and display the angle between that line and the reference line. Additionally a label with the bearing from the aircraft to the navaid in degrees is drawn.

*Show Angle Forward of Point*: determines if the angle displayed between the reference line and the second line is drawn before or after the point that they intersect.

Aircraft Random Position

*Rad / Brg*: the computer will pick a random angle from the reference point. This angle will be between the specified Min and Max values inputted by the user. For example: (1) if Min=25 and Max=90 the computer will pick an angle between 25 and 90. (2) if Min=280 and Max=70, the computer will pick angles between 280 and 360 and 0 to 70. Notice that in example 2 if the Min angle is greater than the Max angle the computer will pick values clockwise from the Min angle to 360 then from 0 to the Max angle.

*Distance*: the computer will pick a random value for the distance that the aircraft will be positioned from the reference point.

*Relative to*: selects if the reference point that the previous settings are relative to.

*Randomly Place Aircraft*: once the range of values have been picked, pressing this button will position the aircraft randomly. This button can be pressed multiple times if desired.

Aircraft Random Heading

*Rad / Brg*: the computer will pick a random HDG. This

## Instrument Simulator Application Parts Description (cont.)

value will be between the specified Min and Max values inputted by the user. For example: (1) if Min=25 and Max=90 the computer will pick an angle between 25 and 90. (2) if Min=280 and Max=70, the computer will pick HDG values between 280 and 360 and 0 to 70. Notice that in example 2 if the Min HDG is greater than the Max HDG the computer will pick values clockwise from the Min angle to 360 then from 0 to the Max HDG.

Position Wizards

Use these position wizards to place a navaid, aircraft or intersection in a precise location based on options and settings that you select.

Attitude Indicator

*Show pitch up / down when climbing / descending*: when this option is selected the aircraft will pitch up or down proportionally to its ascent or descent angle. By default this option is turned off (see attitude indicator for details).

ILS / LOC DME Offset:

In many approaches with glide slope, the DME transmitter does not coincide with the glide slope transmitter. Use this option to set the distance that the DME transmitter is from the glide slope transmitter. The value is negative if the DME transmitter is before the glide slope, and the value is positive if it is after the glide slope. This option is useful if you are trying to replicate an existing approach plate.

## *Additional Parts Description*

## Navigational Aid Symbol

Represents the Navigational Aid selected and is similar to the representation found on aeronautical charts.

## Intersection Symbol

Represents a position that can be used as a reference by the user when navigating. This intersection is a reference only and is not used by the instruments. However it can be set in a position that is relative to the navaids and then, indirectly, it can be used for navigation.

## From Region

Shows on the Horizontal Navigation panel the region where the VOR / HSI flag will display From if the aircraft is positioned in the From region regardless of heading.

## To Region

Shows on the Horizontal Navigation panel the region where the VOR / HSI flag will display To if the aircraft is positioned in the To region regardless of heading.

## Aircraft Horizontal / Vertical Path Trace

Displays the path that the aircraft has flown.

## Aircraft Horizontal / Vertical Symbol

Used to show aircraft's horizontal / vertical position in relation to the navigational facility (navaid).

## Wind Triangle

Shows the vectors that make up the wind triangle. It shows the green (heading and true airspeed) plus the blue (wind direction and wind speed) resulting in the orange (course and ground speed) vectors.

## Aircraft Radial Line

A brown line showing the radial that the aircraft is on in relation to the navaid.

## Projection Flags

IFR approach plates have a profile view that displays the sideways vertical projection of the approach course. The projection flags serve to help visualize how and where this projection is made from the Horizontal Panel view. Notice how the aircraft moves on the Horizontal panel when it is dragged on the Vertical panel and vice versa. The movement is made in alignment with the projection flags. The projection is made in relation to navaid 1 only.

## Compass Rose

Used as an aid to show the orientation of the Horizontal Navigation panel. It serves the same purpose as the compass rose symbol on IFR enroute charts to show direction in relation to the magnetic north.

## Magnetic North Symbol

Similar to the compass rose in that it is used to indicate the direction of the magnetic North. In this case it is the symbol on the NDB (navaid 3).

## Course (CRS) Setting From / To Line

Shows a line passing through the navaid in the direction of

## Instrument Simulator Application Parts Description (cont.)

the course that is set in the instrument and another line that is reciprocal to that course.

### Aircraft Bearing From Symbol

Line passing through the NDB (navaid 3) and the aircraft showing the bearing that the aircraft is in relation to that navaid.

### Map Scale

Displays the width of the horizontal panel map in nautical miles.

### Glide Slope Symbol

When applicable to the navigational facility (navaid), displays the glide slope path referenced by the instrument.

### Holding Pattern Template

The holding pattern template is available to assist entry and execution of the holding patterns. Labels with inbound course and sectors are also displayed in this template.

### Auxiliary / Reference Marks

The ability to display on the map intercept angle, angle in relation to course, and angle in relation to radial has been added. This can be found under Other Settings, Auxiliary/ Reference Marks.

## Instrument Simulator Parts - Instrument Layout (Analog Panel)

**Airspeed Indicator (ASI)**

**Attitude Indicator (AI)**

**Magnetic Compass (MC)**

**Altimeter (ALT)**

**Turn Coordinator (TC)**

**Heading Indicator (HI)**

**Vertical Speed Indicator (VSI)**

**VOR 2 Instrument**

**Radio Magnetic Indicator (RMI)**

*Main instrument panel*

**VOR 1 / Glide slope Instrument**

**Chronometer**
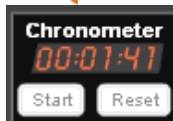
**Flight Time**
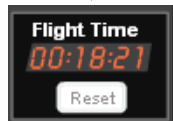
**Distance Measuring Equipment (DME)**

**Horizontal Situation Indicator (HIS)**

**Automatic Direction Finder (ADF)**

## Important Note

### Attitude Indicator (Analog)

The **attitude indicator (AI)** shows the bank and pitch of the aircraft. In this simulator it is used primarily to show the bank angle that is required to achieve a certain rate of turn. In a stable turn the bank angle is dependent on the speed and rate of turn. The greater the airspeed and rate of turn, the greater the bank angle required.



*Attitude indicator (AI)*

In an actual aircraft it is possible to have a different pitch for the same exact climb or descent angle. This depends on many different factors including the type of aircraft, how much power thrust, lift, and other factors. Typically in instrument flying there are only slight variations in pitch. In order to simulate a very wide range of aircraft in this program, the pitch is left at zero unless the aircraft is in a steep bank and in that case the pitch goes up slightly as it would be necessary to compensate for the load factor. In other words, except when banking, the pitch is kept level as a default option even when the aircraft is climbing or descending. To illustrate why this simplification is made, below are several different aircraft at varying



*Pitch is increased when banking*

speeds and climb or descent rates. Despite this all of them can be flying at a zero pitch attitude. It is important to stress that when actually flying an aircraft, pitch will be extremely important and should not be disregarded. However since the simulator is very generic there is little sense in simulating pitch display on the attitude indicator for the purposes of learning navigation.

It is possible (version 1.12 up) to enable pitch display when the aircraft descends or ascends by checking the option in the "Attitude Indicator" section in the "Other Settings Tab".
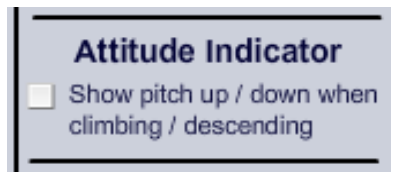


*Enabling pitch indication box*
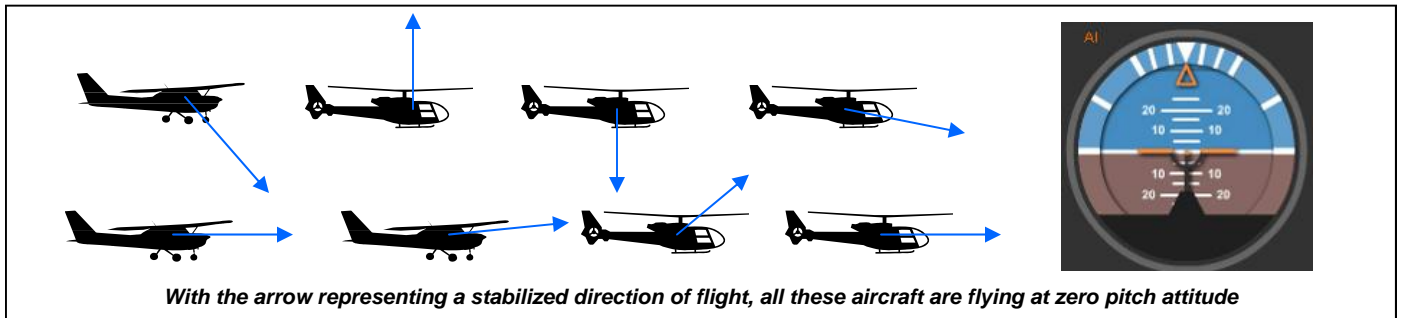


*With the arrow representing a stabilized direction of flight, all these aircraft are flying at zero pitch attitude*

## Instrument Simulator Parts - Instruments

### Airspeed Indicator (Analog)

The **airspeed indicator (ASI)** displays the aircraft's approximate airspeed in relation to the air according to the pressure differential sensed by the pitot static system of the aircraft. Typically this instrument does not display a Mach reading however in this simulator it has been added as a nice to know feature. It



*airspeed indicator (ASI)*

is important to note that the true airspeed (TAS) which is the actual speed that the aircraft is moving in relation to the air, as a general rule, increases in relation to the indicated airspeed (IAS) as the air gets thinner (less dense) and the altitude increases. The airspeed indicator is calibrated so that it would show true airspeed at sea level under standard atmospheric conditions. A pilot usually applies the necessary power and flight controls in order to maintain an indicated airspeed, therefore this is

the speed that is controlled through the keyboard (please refer to the section on keyboard control) in this simulator. The indicated airspeed is also the airspeed that is referred by air traffic controllers when they ask to maintain a certain airspeed. It is also the speed referred to for speed limitations and holding patterns and certain types of airspace.
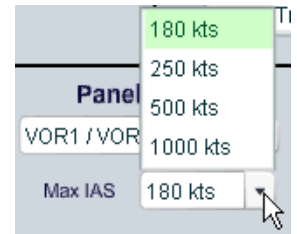


*Speed range selected through the options menu*

Several ranges of aircraft speed can be selected in this simulator. The airspeed indicator instrument will have the appropriate scale. Please see below the different airspeed indicators, each having a different scale.
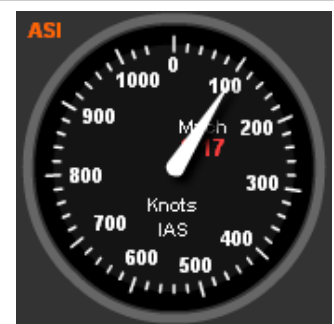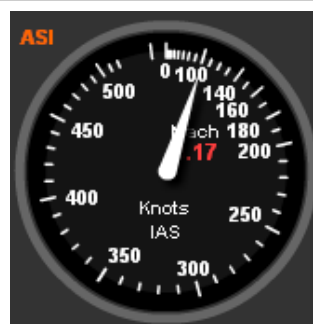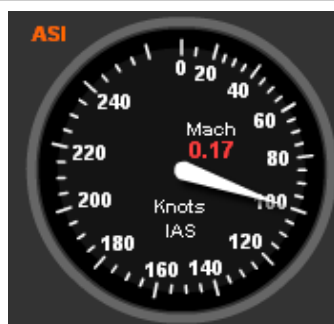


*Several airspeed indicators with different scales*

## Navigation Simulator Parts - Instruments

### Altimeter (Analog)

The **altimeter (Alt)** indicates the approximate altitude of the aircraft sensed by the aircraft's static port. Since this instrument is basically a barometer calibrated to show the aircraft's altitude in standard atmosphere, it is not accurate when flying in different conditions (non-standard).

*Altimeter (Alt)*

The altimeter setting, which the pilot can set on the altimeter's Kollsman window, allows the instrument to somewhat compensate for some of these errors. However the altimeter will still only show the correct altitude when flying at the altitude where the station that the altimeter setting was taken is located. In other words when the pilot gets the altimeter setting for the airport that he/she is at, the altimeter will only be accurate at the altitude of that airport unless the pressure and temperature conditions are that of standard atmosphere.

The default altimeter setting is set at 29.92 inches of mercury. However, it can be changed by the user using the knob on the instrument.

**hundreds of feet needle**

**Ten thousands of feet needle**

**Kollsman Window**

**thousands of feet needle**

**Knob used to Set Kollsman Window**

**This striped flag starts showing when the altitude on the altimeter is less than 15,000 feet and is completely shown when below 10,000 feet (this may very depending on the altimeter on actual aircraft)**

*Parts of the altimeter*

## Navigation Simulator Parts - Instruments

### Turn Coordinator (Analog)

The **turn coordinator (TC)** indicates rate of turn, rate of roll, and whether the aircraft is skidding or slipping. The rate of turn and rate of roll are sensed usually by gyroscopes in the aircraft. The ball (skid or slip indicator) is just a ball in a concave transparent tube filled with fluid that moves to the outside of the turn when the aircraft is skidding (centrifugal force greater than



*Turn coordinator (TC)*

centripetal force) or to the inside of a turn during a slip (centripetal force greater than centrifugal force).

In this simulator the computer will always keep the ball in the center (keep aircraft coordinated) and the user will only have to worry about banking the aircraft using the keyboard controls. When banking to establish a rate of turn, the simulator will limit the maximum bank to a certain amount of degrees or the bank required for a standard rate (3° per minute) for the particular airspeed the aircraft is at. This is selected through the options menu.



*Parts of the turn coordinator*
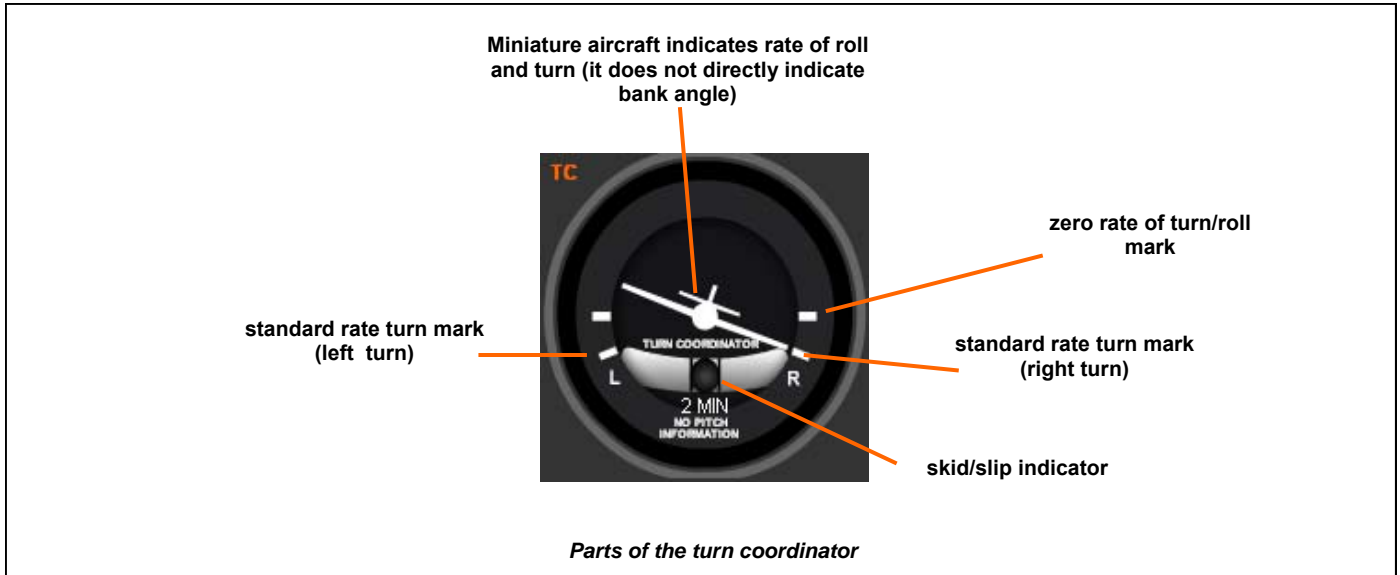
## Navigation Simulator Parts - Instruments

### Heading Indicator (Analog)

The **heading indicator (HI)** displays the heading of an aircraft. It works with a gyroscope that stays rigid while the aircraft turns. The pilot usually has to keep re-adjusting this instrument to the compass approximately every 15 minutes since it has a tendency to drift due to gyroscopic precession. In this simulator it is kept aligned and there is no need to worry about setting it so that the user can concentrate on navigation.

There is also a red heading bug that can be used to remind the pilot of certain headings.

*Altimeter (Alt)*

360° relative bearing mark

315° relative bearing mark

Heading bug

Compass card

045° relative bearing Mark

270° relative bearing mark

090° relative bearing mark

Miniature aircraft

Heading bug knob

225° relative bearing mark

180° relative bearing mark
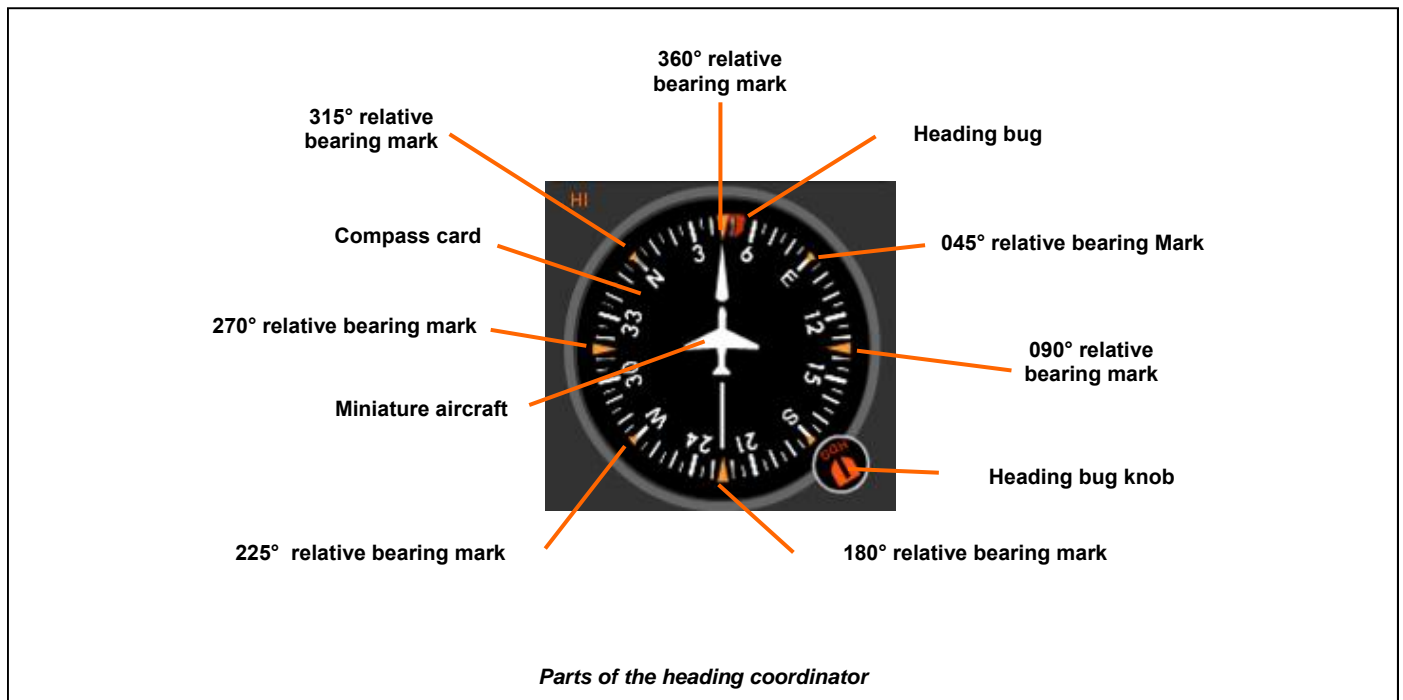
*Parts of the heading coordinator*

## Instrument Simulator Parts - Instruments

### Vertical Speed Indicator (Analog)

The **vertical speed indicator (VSI)** displays the aircraft's approximate vertical speed in feet per minute by sensing changing pressure through the aircraft's static air port.

In the simulator, when selecting different ranges of airspeed, the VSI instrument will change scale to that
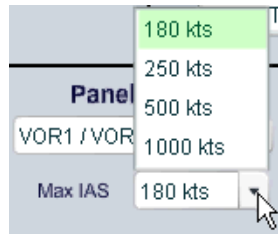


*Speed range selected through the options menu automatically selects the appropriate air speed indicator*

appropriate to that range. In general the faster the aircraft goes the faster is its ability to climb and descend. Please see below the different vertical speed indicators, each having a different scale.
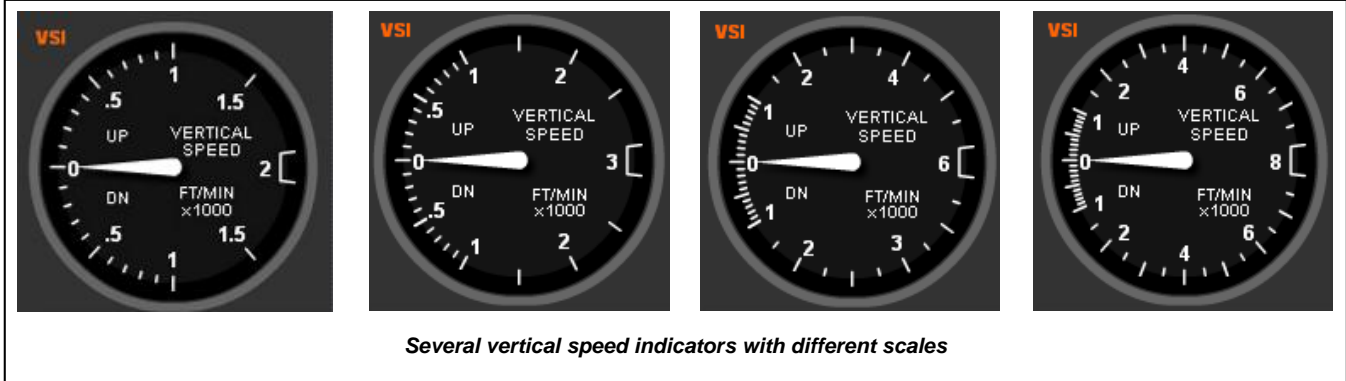


*Several vertical speed indicators with different scales*

## Instrument Simulator Parts - Instruments

### HSI (Horizontal Situation Indicator) - (Analog)

The **HSI** instrument displays the aircraft's position relative to a navigational facility located on the ground at a known position. This instrument is dependent on receiving VHF type frequencies from the facility. In the actual aircraft the frequency is set through a radio panel and the facility is selected by that frequency. In this

*Navaid 1*

simulator the HSI instrument is set by default to the Navaid 1 facility. However, it can be changed to reference Navaid 2 through the NAV 1 and NAV 2 "Radio" panel in the "General Settings" tab. The type of facility can be selected through the "Navaid settings" panel.

*Navaid 2*
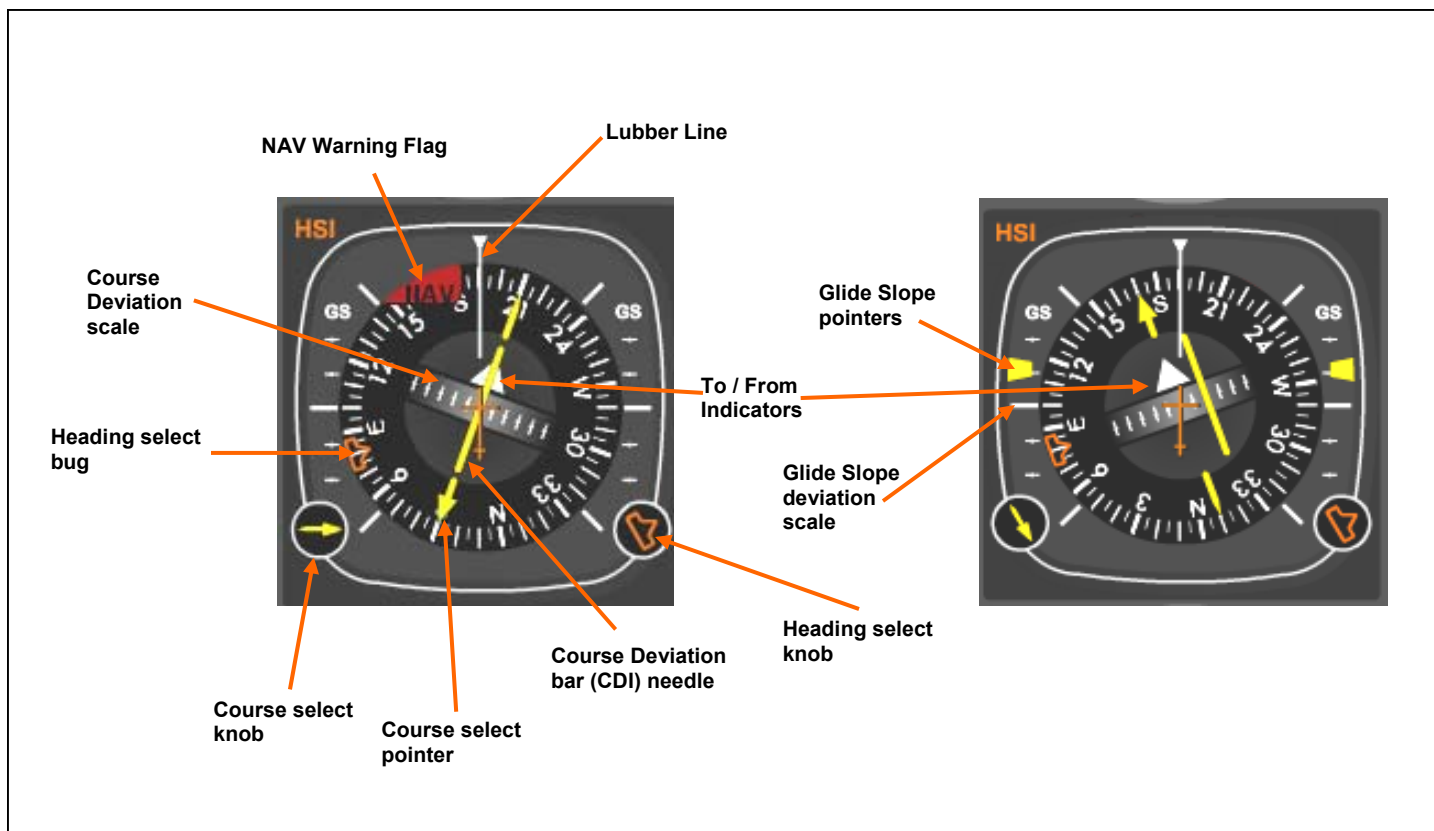


**Course select pointer**
Points to the course selected by the OBS

**Course Deviation Indicator (CDI) needle**
Shows aircraft's deviation from the course. Sensitivity depends on the type of navigational facility (navaid).

**To / From Indicator**
Shows an arrow flag pointing to the appropriate To or From region if the aircraft is positioned there and adequate signals are received.

**NAV Warning Flag**
When not receiving adequate VOR or Localizer signals such as when the aircraft is out of range or in the cone of confusion, the NAV flag will be displayed

**Course select knob**
Selects the course referenced by the HSI instrument

**Glide Slope pointers**
If the navigational facility has a glide slope, positioning the aircraft above or below the glide slope causes the glide slope pointers to move in the opposite direction (provided the aircraft is within rage of the signal)

**Lubber line**
The line that is aligned with the longitudinal axis of the aircraft reinforcing the heading.

**Heading select knob**
Moves the heading bug that is used as a reference for the pilot.

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## Instrument Simulator Parts - Instruments

### VOR / Glide Slope (VOR 1) instrument (Analog)

The **VOR / Glide Slope (VOR 1)** instrument displays the aircraft's position relative to a navigational facility located on the ground at a known position.  This instrument is dependent on receiving VHF type frequencies from the facility.  In the actual aircraft the frequency is set through a radio panel and the facility is selected by that frequency.  In this simulator the VOR 1 instrument is set to the Navaid 1

*Navaid 1*

facility by default. However, it can be changed to reference Navaid 2 through the NAV 1 and NAV 2 "Radio" panel in the "General Settings" tab. The type of facility can be selected through the "Navaid settings" panel.

The glide slope function allows for vertical navigation when the facility such as a ILS transmits the glide slope signal.
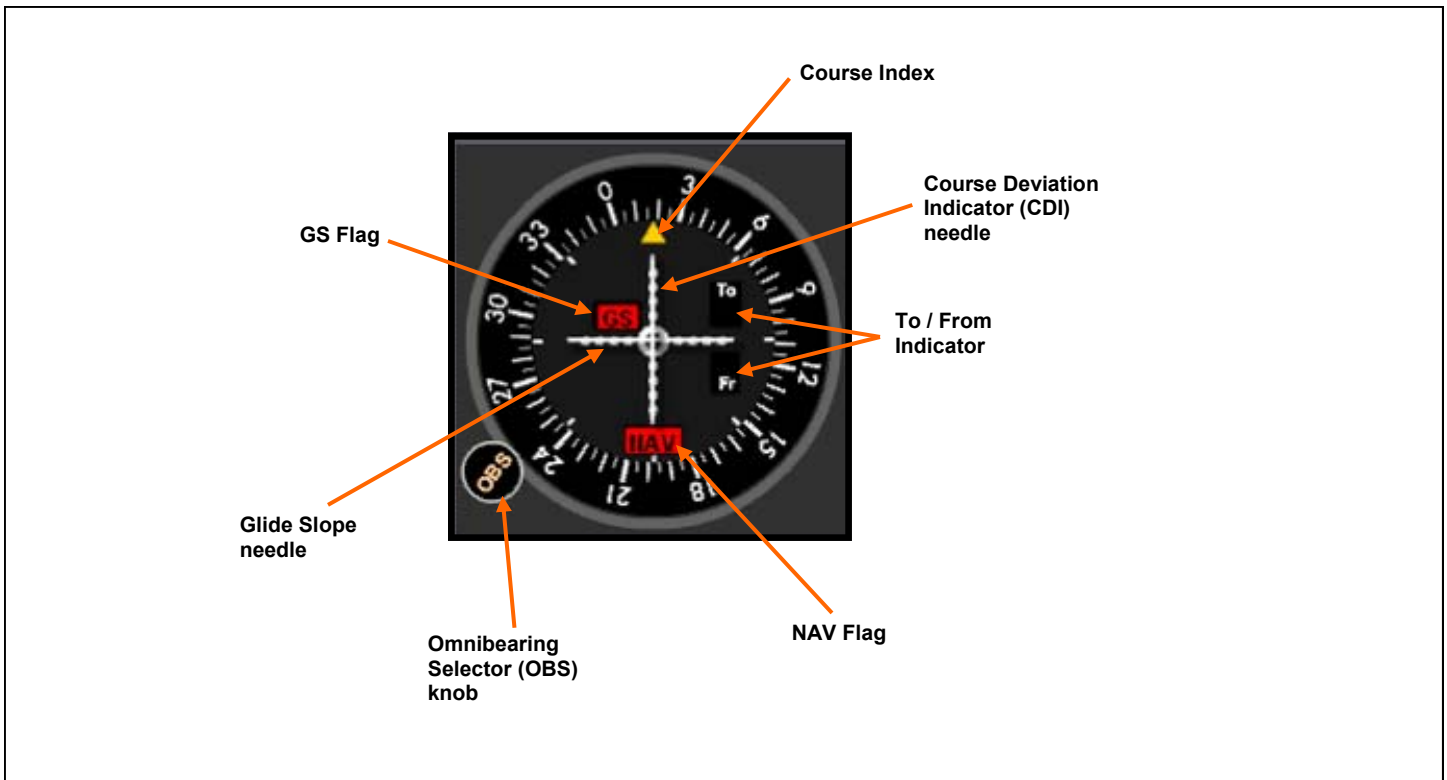
*Navaid 2*



**Course Index**
Points to the course selected by the OBS

**Course Deviation Indicator (CDI) needle**
Shows aircraft's deviation from the course. Sensitivity depends on the type of navigational facility (navaid).

**To / From Indicator**
Shows an arrow flag pointing to the appropriate To or From region if the aircraft is positioned there and adequate signals are received.

**NAV Flag**
When not receiving adequate VOR or Localizer signals such as when the aircraft is out of range or in the cone of confusion, the NAV flag will be displayed

**Omnibearing Selector (OBS) knob**
Selects the course referenced by the VOR instrument

**Glide Slope needle**
If the navigational facility has a glide slope, positioning the aircraft above or below the glide slope causes the glide slope needle to move in the opposite direction (provided the aircraft is within rage of the signal)

**GS Flag**
When not receiving adequate Glide Slope signals, such as when the aircraft is out of range, the GS flag will appear.

## Instrument Simulator Parts - Instruments

### VOR 2 instrument (Analog)

The **VOR 2** instrument displays the aircraft's position relative to a navigational facility located on the ground at a known position. This instrument is dependent on receiving VHF type frequencies from the facility. In the actual aircraft the frequency is set through a radio panel and the facility is selected by that frequency. In this simulator the VOR 2 instrument is set to the Navaid 2 facility by default. However, it can be changed to reference

*Navaid 2*

Navaid 1 through the NAV 1 and NAV 2 "Radio" panel in the "General Settings" tab. The type of facility can be selected through the "Navaid Settings" panel.

Unlike the VOR 1 instrument this instrument does not have glide slope. However it is almost identical in functionality.
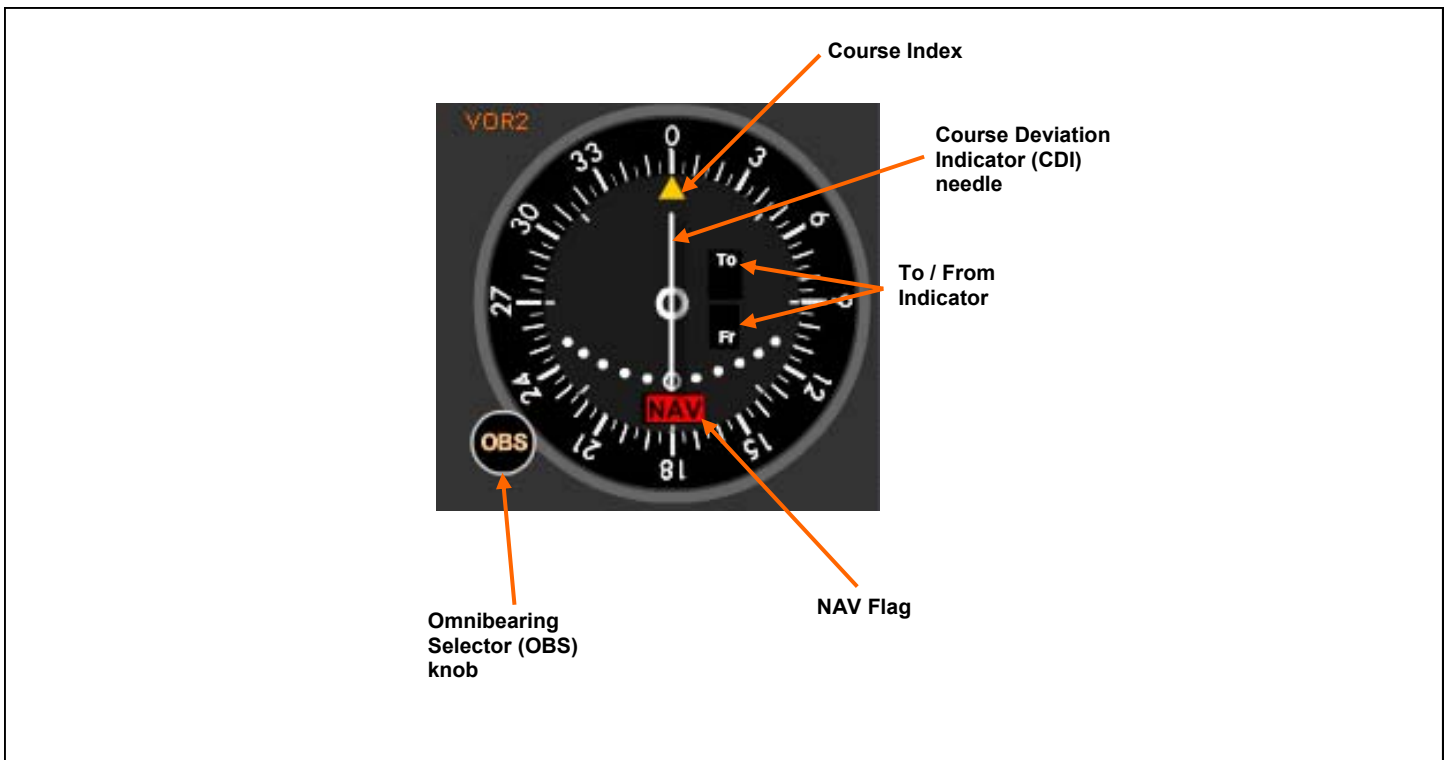
*Navaid 1*



**Course Index**
Points to the course selected by the OBS

**Course Deviation Indicator (CDI) needle**
Shows aircraft's deviation from the course. Sensitivity depends on the type of navigational facility (navaid).

**To / From Indicator**
Shows an arrow flag pointing to the appropriate To or From region if the aircraft is positioned there and adequate signals are received.

**NAV Flag**
When not receiving adequate VOR or Localizer signals such as when the aircraft is out of range or in the cone of confusion, the NAV flag will be displayed

**Omnibearing Selector (OBS) knob**
Selects the course referenced by the VOR instrument

## Instrument Simulator Parts - Instruments

### Radio Magnetic Indicator (RMI) instrument (Analog)

The **RMI** instrument displays the aircraft's position relative to a navigational facility located on the ground at a known position, much like the previous instruments. However instead of using needles that show the deviation from the selected course this instrument is basically a heading indicator with arrows that point to the navaid facilities chosen. This particular RMI is capable of receiving signals from two simultaneous navaids and choose between three different navaids. This instrument is dependent on receiving VHF type frequencies from the facility for VOR type signals and frequencies for NDB type facilities. In the actual aircraft the frequency is set through a radio panel

and the facility is selected by that frequency. In this simulator the NAV 1 selection is set to the Navaid 1 facility, the NAV 2 selection to Navaid 2, and the ADF to Navaid 3. The types of facilities can be selected through the "Navaid settings" panel.



*The RMI in this simulator can be set to two navaids simultaneously and be selected from three different navaids*
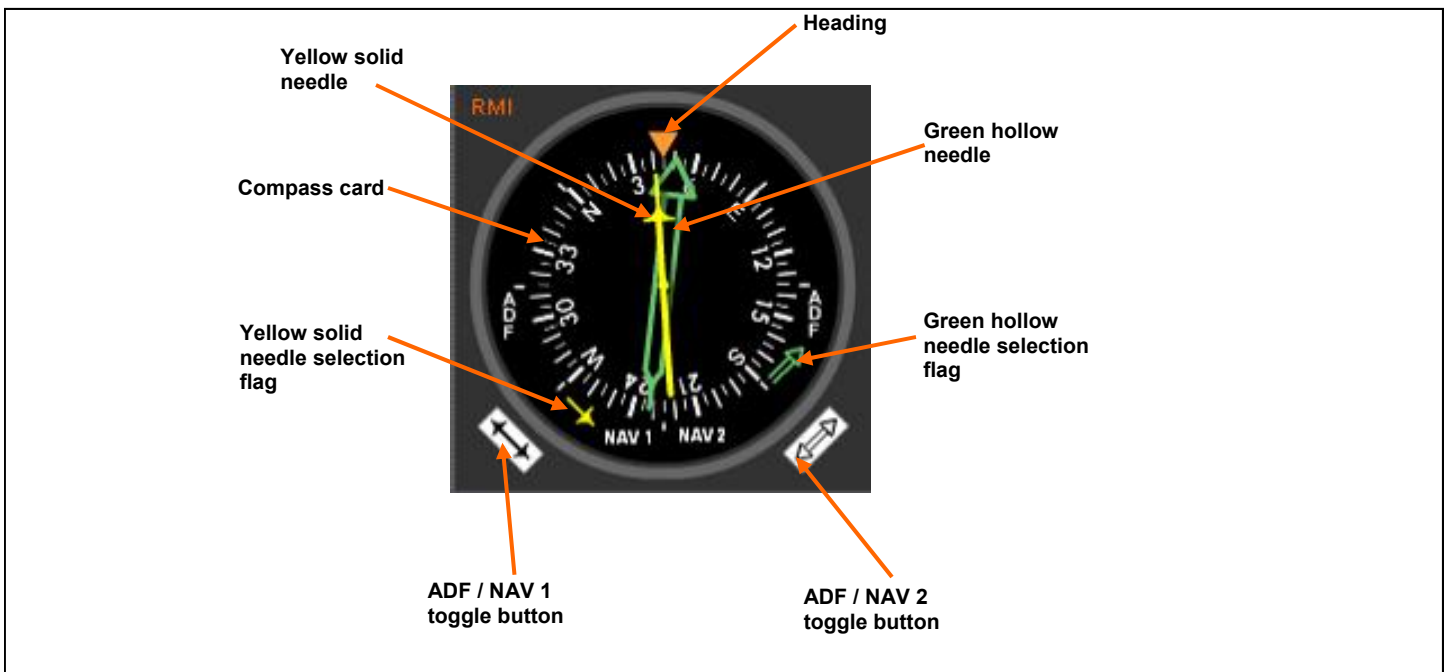


**Heading**
Points to the heading on the rotating compass card

**Yellow solid and green hollow needles**
Point to the selected navaid relative to the aircraft's position. The two needles have two distinct behaviors when not receiving an adequate signal. In this particular RMI the needle associated with a VOR type navaid will always point to the 180 heading of the RMI when not receiving a signal. The needle associated with the NDB type signal will stay at 3 o'clock position regardless of the heading when not receiving a signal.

**Compass card**
A card that rotates to display the aircraft's heading under the heading mark.

**ADF / NAV 1 and ADF / NAV 2 toggle buttons**
Used to select which needle will be associated to navaid 1 (NAV 1), navaid 2 (NAV 2), or navaid 3 (ADF).

**Yellow and green needle selection flags**
Show which navaid is selected through the toggle buttons.

## Instrument Simulator Parts - Instruments

### Automatic Direction Finder (ADF) instrument (Analog)

The **automatic direction finder (ADF)** instrument displays the aircraft's position relative to a navigational facility located on the ground at a known position. It is basically a fixed (does not move automatically with the heading) compass card with an arrow that points to the navaid. In the actual aircraft the frequency is set through a radio panel and the facility is selected by that frequency. In this simulator it is set to Navaid 3 (NDB) facility.
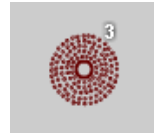


*Navaid 3*
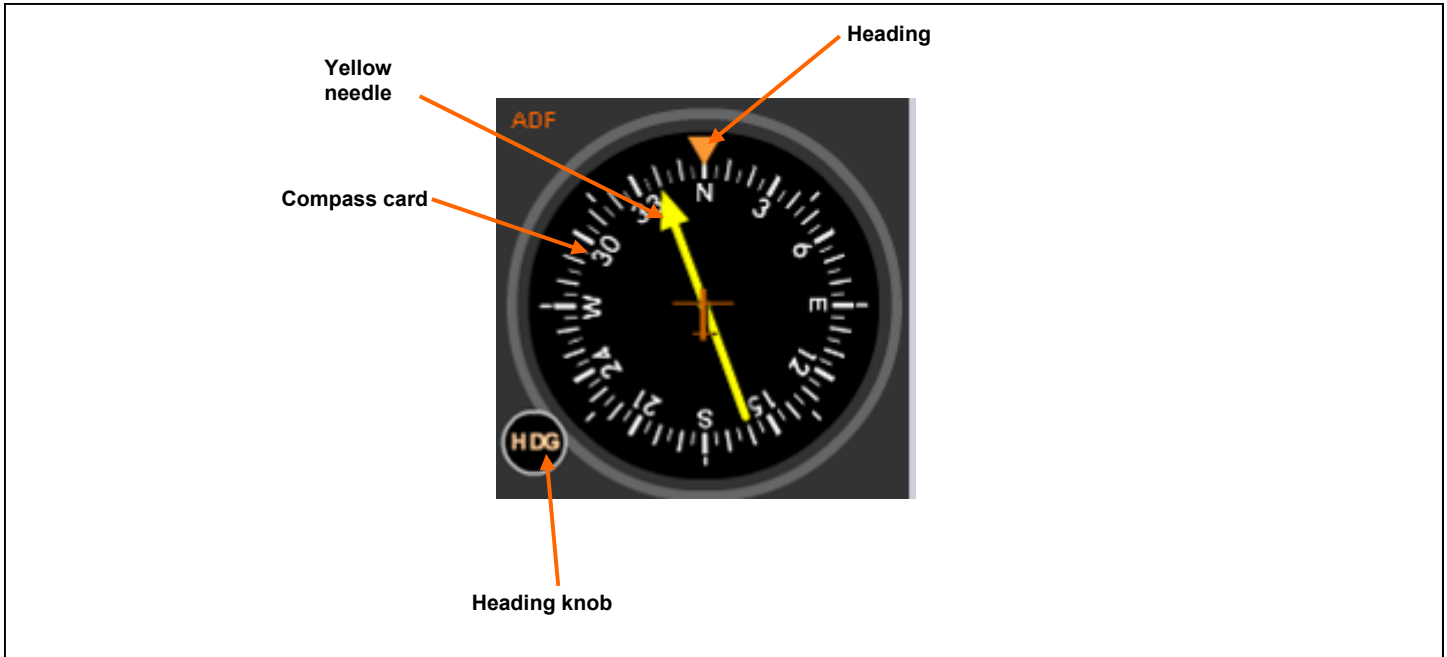


**Heading**
Points to the heading on the rotating compass card

**Yellow needle**
Points to navaid 3 (NDB) when receiving adequate signals from that facility. When not receiving adequate signals the needle will not point to any particular direction and the instrument will become unreliable. In actual aircraft the pilot will need to continuously monitor a Morse code signal transmitted through the frequency to determine if those signals are being received or not.

**Compass card**
A card that can be rotated manually using the heading knob to set the card to the aircraft's heading. Note that unlike the RMI, the ADF's compass card does not rotate automatically with the heading.

**Heading knob**
Used to rotate the compass card.

## Instrument Simulator Parts - Instrument Layout (Analog Panel)

### Main Instruments Layout—Analog Instruments

The main instrument layout can be modified in the options panel under "Panel Setting". This allows the user to choose which main navigation instruments will be displayed. The instruments that are not displayed with the main instruments will be in the "Navaid Information" tab under the category "Complementary / Analogous Instruments". This way the user can compare the similarities between the HSI and the VOR, or the RMI and ADF instruments. The table below shows which instruments are visible in different panel settings.

| 1 | 2 | 3 |
| 4 | 5 | 6 |
| 7 | 8 | 9 |
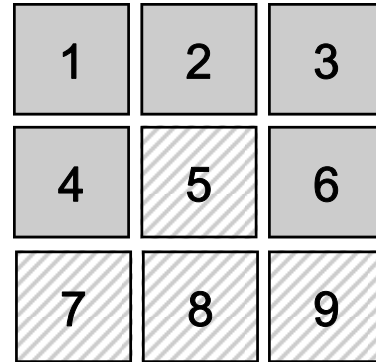
*Main instrument panel layout*

**Panel Setting**

HSI / VOR2 / RMI

- HSI / VOR2 / RMI
- HSI / VOR2 / ADF
- VOR1 / VOR2 / RMI
- VOR1 / VOR2 / ADF
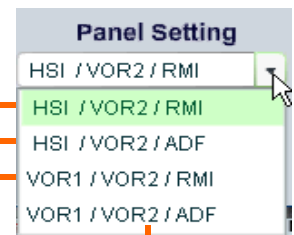
| | HIS / VOR2 / RMI | HSI / VOR2 / ADF | VOR1 / VOR2 / RMI | VOR1 / VOR2 / ADF |
|---|---|---|---|---|
| ASI | 1 | 1 | 1 | 1 |
| AI | 2 | 2 | 2 | 2 |
| ALT | 3 | 3 | 3 | 3 |
| TC | 4 | 4 | 4 | 4 |
| HSI | 5 | 5 | | |
| VSI | 6 | 6 | 6 | 6 |
| RMI | 7 | | 7 | |
| HI | 8 | 8 | 5 | 5 |
| VOR1 | | | 8 | 8 |
| VOR2 | 9 | 9 | 9 | 9 |
| ADF | | 7 | | 7 |

## Instrument Simulator Parts - Instrument - Navaid Association

### Navaid Association

Each navigational instrument is associated with one or more navaids. The table below lists these associations.
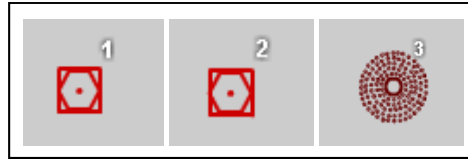


*There are three different navaids available in this simulator*

| | Navaid 1<br>( VOR, VOR DME, VORTAC, LOC, ILS, LOC BC, LDA, SDF types) | Navaid 2<br>( VOR, VOR DME, VORTAC types) | Navaid 3<br>(NDB type) |
|---|---|---|---|
| **HSI** | Yes* | Yes* | No |
| **RMI** | Yes*<br>( via NAV1 selection ) | Yes*<br>( via NAV2 selection ) | Yes**<br>( via ADF selection ) |
| **VOR1** | Yes* | Yes* | No |
| **VOR2** | Yes* | Yes* | No |
| **ADF** | No | No | Yes** |
| **DME** | Yes*<br>( via NAV1 selection ) | Yes*<br>( via NAV2 selection ) | No |

* In an actual aircraft the selection is done through a NAV radio.  Through it, it  is possible to select any compatible navigational aid via a frequency in megahertz.  In this simulator this is done via the NAV 1 and 2 "Radios"  located in the General Settings section. The default setting is NAV 1 radio tuned to Navaid 1 and the NAV 2 radio tuned to Navaid 2.

Do not confuse Navaid and NAV.  The Navaid is the transmitter on the ground which is used by the instruments in the aircraft  through the NAV radios. Therefore NAV is the navigation radio that can tune VOR and localizer type frequencies.  Usually you have two in the aircraft (NAV 1 and NAV 2) and they can be tuned to a compatible Navaid on the ground.  Different instruments will use the input from NAV 1 and 2. This is shown in the chart above. NAV 1 and 2 radios are not compatible with NDB frequencies so there is a separate radio for the NDB Navaid which is used by the ADF instrument.


** In an actual aircraft there would be an ADF radio which would be used to select an NDB frequency in kilohertz that would be used for the ADF type instruments. However, since we are using only one NDB facility there is no ADF radio displayed on the simulator.
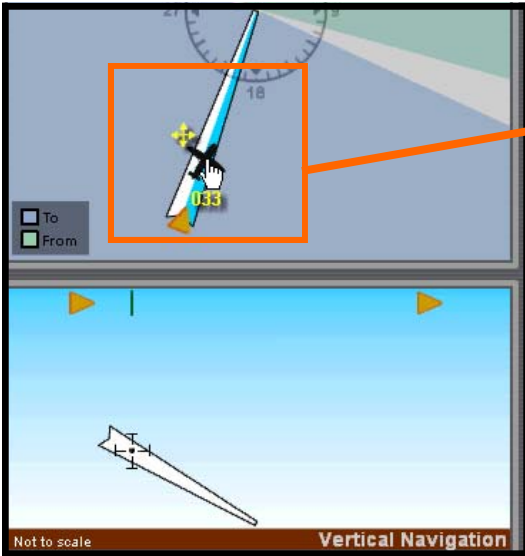
## VOR / Localizer and Glide Slope Simulation



**Course Deviation Needle Deflection**
Positioning the aircraft left or right of course will cause needle to deviate. The direction depends on several factors.

CDI needle deflection
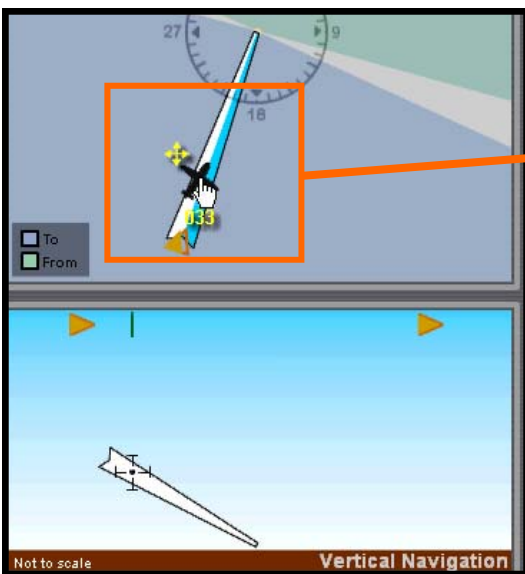
CDI needle deflection

## VOR / Localizer and Glide Slope Simulation (cont.)
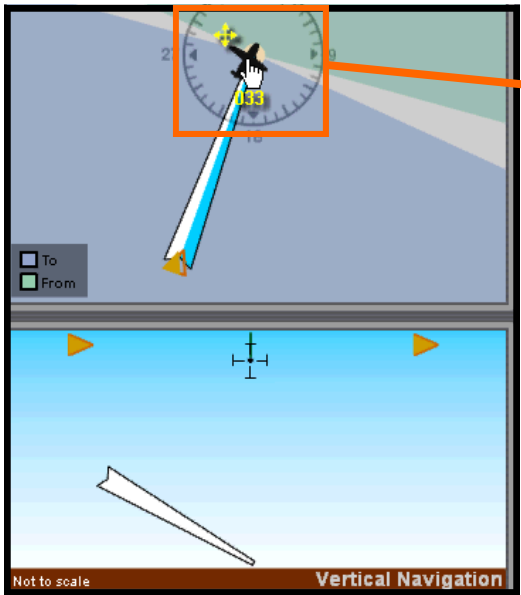


Cone of Confusion

**NAV Flag**
When not receiving adequate VOR or Localizer signals such as when the aircraft is out of range or in the cone of confusion, the NAV flag will be displayed
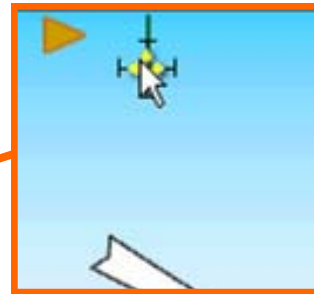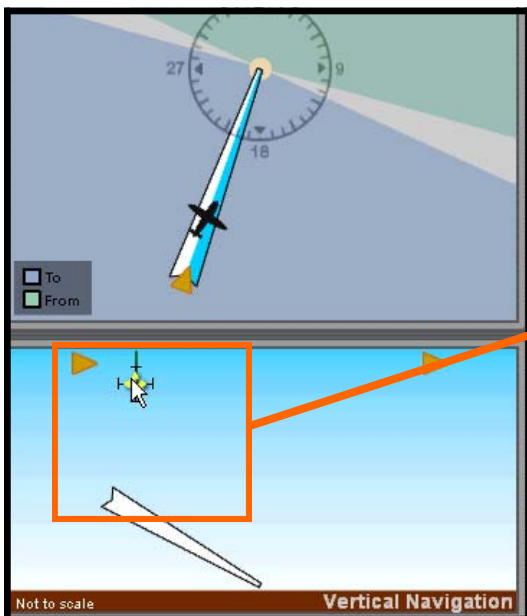
NAV Flag

**GS Flag**
When not receiving adequate Glide Slope signals, such as when the aircraft is out of range, the GS flag will appear. In this case the aircraft is too high.

Glide Slope (GS) Flag

## VOR / Localizer and Glide Slope Simulation (cont.)



Not to scale — Vertical Navigation
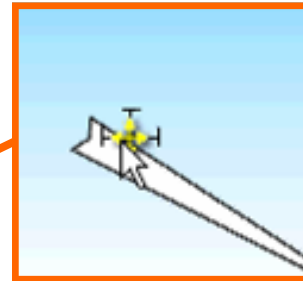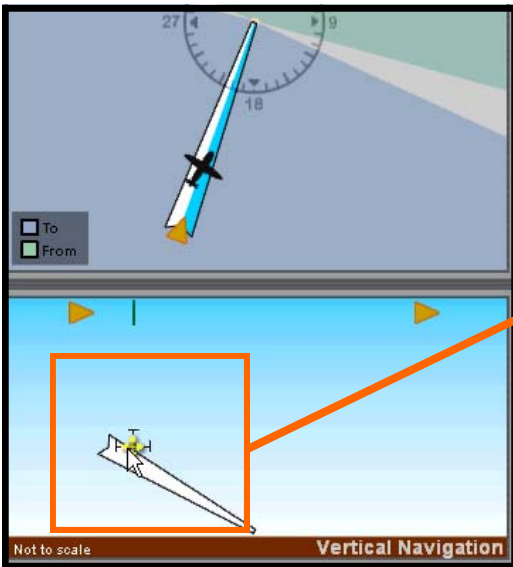


**Glide Slope Deviation Needle Deflection**
Positioning the aircraft above or below glide slope causes glide slope needle to move in the opposite direction



**Glide Slope needle deflection**



Not to scale — Vertical Navigation
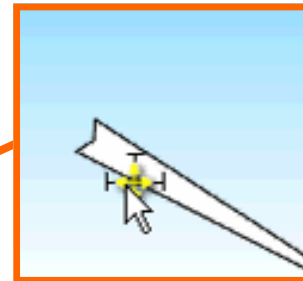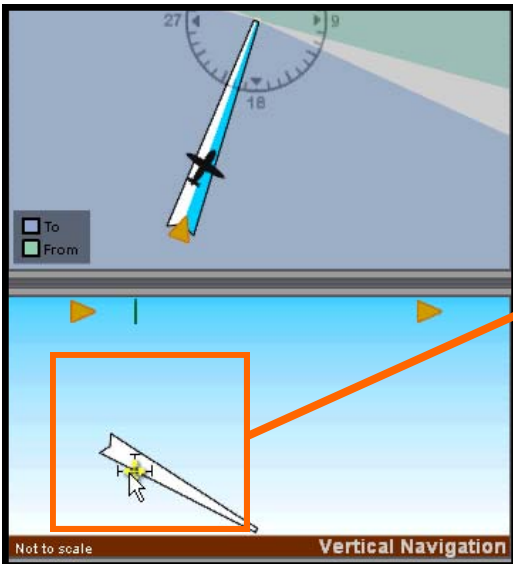


**Glide Slope needle deflection**

## Glass (Digital) Panel - Main Parts

### G1000* Style Panel

The glass cockpit panel is based on the style of the popular G1000* instrument display. Many other digital avionics panels also have a similar feel. This panel is adapted to the simulator for basic instrument training, which is what the simulator was meant for. Many of the more complex functions that the actual G1000* would have are beyond the scope of the simulator and not included or replicated. Only buttons that are functional have been placed on the panel. At the moment the panel provides VOR, ADF, DME, RMI, and ILS navigation capabilities, however GPS navigation is not included.

This panel is also linked to the analog instrument panel. If you change the settings on this panel the equivalent settings will be changed on the analog instrument panel and vice versa. This feature is great when comparing the differences and similarities between the two panels, particularly for students and pilots transitioning from a analog type instrument aircraft to a glass cockpit panel aircraft. It's also possible to compare both types of instruments simultaneously on the simulator by pressing "I" to activate the dual panel view.
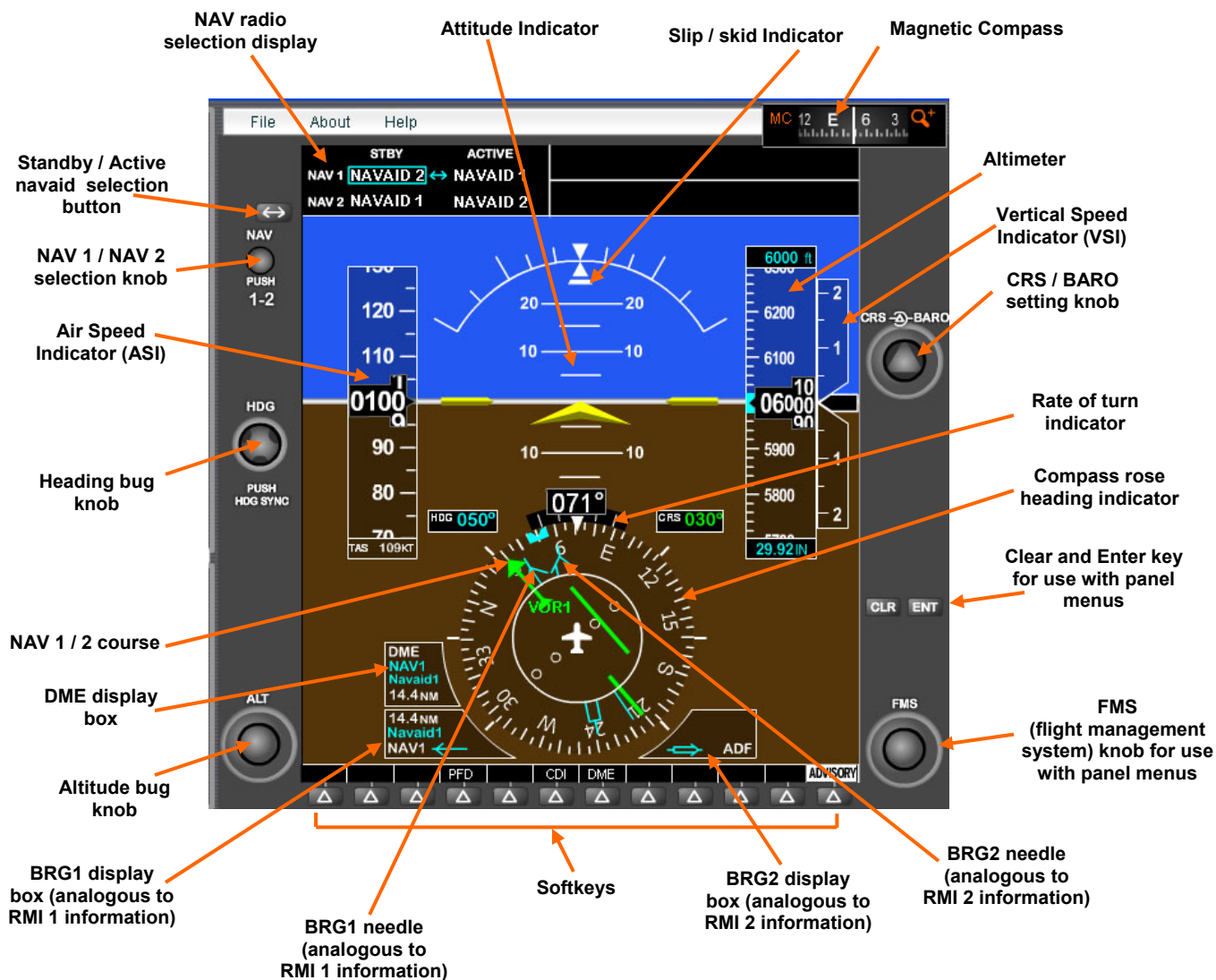


*G1000 is a registered trade mark of Garmin Ltd. This product has not been endorsed by Garmin or intended as a substitute for training in Garmin approved G1000 simulators.

## Instrument Simulator Parts - Relative Positions Window

### Relative Positions

The Relative Positions window can be toggled on and off by pressing the "R" key. This window shows the relative relationships on the map for the aircraft, navaid's, and intersection. You can use this window while positioning these items on the map or simply to see exactly where they're located.

In the case of the intersection symbol it is also possible to set it
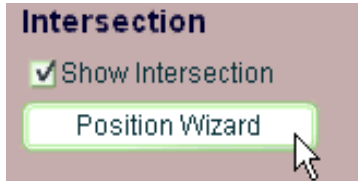
*Position Wizard launches a separate window where the user can select the exact placement of the intersection manually*

precisely relative to the navaid(s) by using the "Position Wizard" button under the Navaid settings section. This is useful when the intersection is needed for holding patterns or practicing airway navigation.

Other position wizard's are available for the navaids and aircraft in the "Others Settings" tab in the options menu.
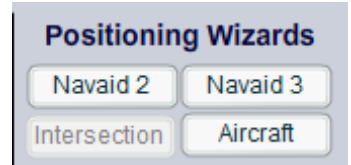
Relative Positions (A relative to B)

| | | Acft | NAV1 | NAV2 | NDB (3) | Intersection |
|---|---|---|---|---|---|---|
| **Relative Horizontal Position** | Acft | | 7.4 S NM<br>6.4 W NM | 2.2 N NM<br>14.2 W NM | 6.9 S NM<br>15.9 W NM | 16.5 S NM<br>11.8 W NM |
| | NAV1 | 7.4 N NM<br>6.4 E NM | | 9.6 N NM<br>7.8 W NM | 0.5 N NM<br>9.5 W NM | 9.1 S NM<br>5.4 W NM |
| | NAV2 | 2.2 S NM<br>14.2 E NM | 9.6 S NM<br>7.8 E NM | | 9.1 S NM<br>1.7 W NM | 18.7 S NM<br>2.4 E NM |
| | NDB (3) | 6.9 N NM<br>15.9 E NM | 0.5 S NM<br>9.5 E NM | 9.1 N NM<br>1.7 E NM | | 9.6 S NM<br>4.1 E NM |
| | Intersection | 16.5 N NM<br>11.8 E NM | 9.1 N NM<br>5.4 E NM | 18.7 N NM<br>2.4 W NM | 9.6 N NM<br>4.1 W NM | |
| **Horizontal Distance** | Acft | | 9.8 NM | 14.4 NM | 17.4 NM | 20.3 NM |
| | NAV1 | 9.8 NM | | 12.4 NM | 9.6 NM | 10.6 NM |
| | NAV2 | 14.4 NM | 12.4 NM | | 9.3 NM | 18.9 NM |
| | NDB (3) | 17.4 NM | 9.6 NM | 9.3 NM | | 10.4 NM |
| | Intersection | 20.3 NM | 10.6 NM | 18.9 NM | 10.4 NM | |
| **Bearing To and From Object** | Acft | | 40.9 To<br>220.9 Fr | 98.9 To<br>278.9 Fr | 66.6 To<br>246.6 Fr | 35.6 To<br>215.6 Fr |
| | NAV1 | 220.9 To<br>40.9 Fr | | 140.9 To<br>320.9 Fr | 93.0 To<br>273.0 Fr | 30.8 To<br>210.8 Fr |
| | NAV2 | 278.9 To<br>98.9 Fr | 320.9 To<br>140.9 Fr | | 10.8 To<br>190.8 Fr | 352.7 To<br>172.7 Fr |
| | NDB (3) | 246.6 To<br>66.6 Fr | 273.0 To<br>93.0 Fr | 190.8 To<br>10.8 Fr | | 336.7 To<br>156.7 Fr |
| | Intersection | 215.6 To<br>35.6 Fr | 210.8 To<br>30.8 Fr | 172.7 To<br>352.7 Fr | 156.7 To<br>336.7 Fr | |
| **DME** | Acft | | 9.81 NM | 14.41 NM | 17.38 NM | 20.29 NM |

**Press "R" to toggle this screen on/off**

*Relative Positions Window*

## Instrument Simulator Parts - Control

### Keyboard Control of the Simulator

The following are the keys that control the aircraft:

"A" - increase bank left
"D" - increase bank right
"S" - neutralize bank (if key is held the aircraft will level at a rate such that the aircraft will overshoot the heading by half the bank angle when the key is originally pressed (similarly to the real aircraft.)
"W" - pitch down
"Z" - pitch up
"Space Bar" -neutralize pitch to level aircraft
"K" - increase speed
"M" -decrease speed

IMPORTANT KEYBOARD CONTROL NOTE: The simulator start button must be pressed and the aircraft rotating-arround-the-

**aircraft rotating-arround-the-globe icon**

globe icon must be moving for the keyboard movement commands to work. In addition, clicking outside the simulator may cause the computer to stop sending keyboard commands to the simulator. You must click on any blank portion of the simulator to allow transfer keyboard of commands to it. You can also still drag and reposition the aircraft even if it is moving

Other keyboard commands:

"R" - toggle relative positions window
"T" - starts/stops/resets the chronometer
"O" - toggle General Settings/Navaid Information tabs when using the small widescreen version of the simulator.
"P" - starts/pauses aircraft movement
" I " - toggle dual analog and digital panel views

**Target indicated airspeed value**

**Target indicated air-speed bar indication**

**Current indicated airspeed value**

**Current indicated air-speed bar indication**

**Target bank angle bar indication**

**Current bank angle value**

**Current bank angle bar indication**

**Target climb rate value**

**Target climb rate bar indication**

**Current climb rate bar indication**

**Current rate of turn value**

**Current rate of turn bar indication**

**Current climb rate value**

*Aircraft Motion Control Screen (controlled though keyboard)*

## Instrument Simulator Parts - Control (continued)

### Keyboard Layout Quick Reference

## Keyboard Commands and Shortcuts

neutralize bank*

increase bank right

increase bank left

toggle relative positions window

toggle dual instrument panel view on/off

toggle General Settings/Navaid Information/Other Settings tabs**

pitch down

Start/Stop/Reset Chronometer

Start/Pause Aircraft Movement

**W** **R** **T** **I** **O** **P**

**A** **S** **D** **K**

**Z** **M**

**Space**

pitch up

increase Speed (IAS)

neutralize pitch to level aircraft

decrease Speed (IAS)

■ pitch and bank control  ■ speed (IAS) control  ■ other

* if key is held the aircraft will level at a rate such that the aircraft will overshoot the heading by half the bank angle when the key is originally pressed (similarly to the real aircraft)

** when using the small widescreen version of the simulator

## Instrument Simulator Parts - Control (continued)

### Keyboard Control Example

**Task:**
- Initial conditions: the aircraft is straight and level and at a 45° heading.
- Fly straight and level for one minute
- Turn right to the heading of 180°
- Fly at that heading for 45 seconds

Use standard rate turns
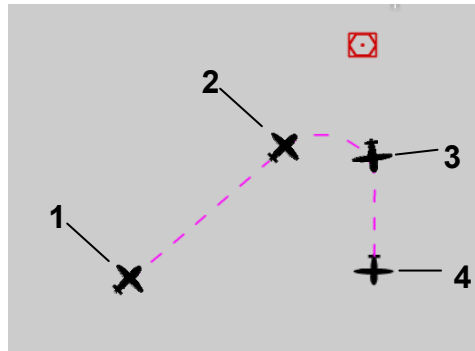


### Position 1:



Assuming that the is straight and level and at a 45° heading (this is the default state when the simulator starts).



Press the start button (shortcut "P") on the aircraft motion control, to begin aircraft movement (notice the aircraft icon rotating around the globe).
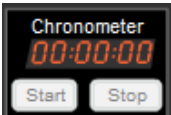


On the chronometer, press the start button to initiate timing (you can use a shortcut "T").



Let the aircraft fly for one minute on the chronometer.

### Position 2
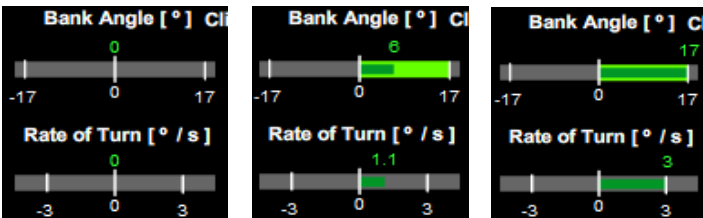


Press and hold the "D" key to turn right until the light green bar reaches the limit. In this case based on the airspeed the simulator automatically limits the bank to 17° which corresponds to the bank for a standard rate turn at that speed. Once the light green bar has reached the 17° limit,

you can release the "D" key. The light green bar determines the target bank. The dark green (the aircraft's actual bank) bar will catch up to the light green bar indicating that the aircraft reached its selected bank.
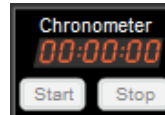


Now that the aircraft is turning at a standard rate, take the time to stop the chronometer by clicking on "Stop", and then resetting it by clicking on "Reset". These two operations can also be done by pressing the "T" key twice.

### Position 3



When rolling out from a bank the aircraft will continue to turn during the rollout for about half of the initial bank angle in degrees. In this case the standard rate bank angle is 17°. Half of that (17°/2) is 8.5°. We can round that up to 9°. This means that if we want to level at a heading of 180° we must anticipate that turn by about 9° in this case 180° - 9° = 171°. Note that if the turn were to the left we would add 9° instead of subtract.
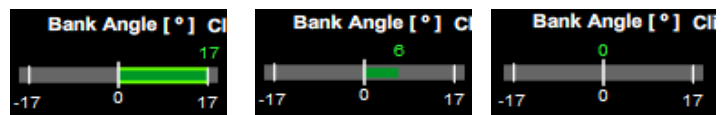


At 171° press the "S" key to level the bank until the light green bar is zero. The dark green bar, which is the actual bank, will follow.

## Instrument Simulator Parts - Control (continued)



The aircraft now should be level at a heading of approximately 180°.



Start the chronometer by pressing "Start" or by pressing the "T" shortcut key.

### Position 4:
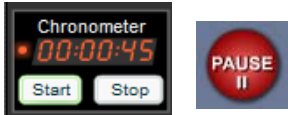


Once the chronometer reaches 45 seconds press the pause button (shortcut key "P") on the aircraft motion control panel to pause the aircraft motion.

You are done!

### Making minor adjustments of heading
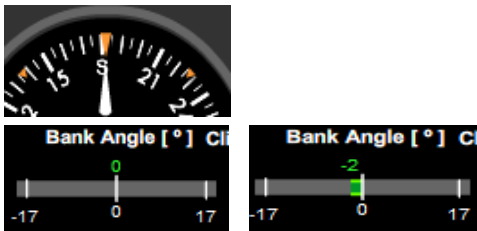


If for example when we leveled off, the heading wasn't quite 180° or rather let's say 182° we can make minor adjustments by just quickly pressing and releasing the keyboard shortcuts for turning and leveling. In this example let's correct the heading by pressing and quickly releasing the shortcut key "A" which is the key for left turns. The larger the correction for more bank we would use to correct.



Once the aircraft's heading is close to the desired heading press "S" to level the aircraft's bank. These adjustments can be done back-and-forth.

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## Positioning Aircraft Manually

### Positioning Horizontally
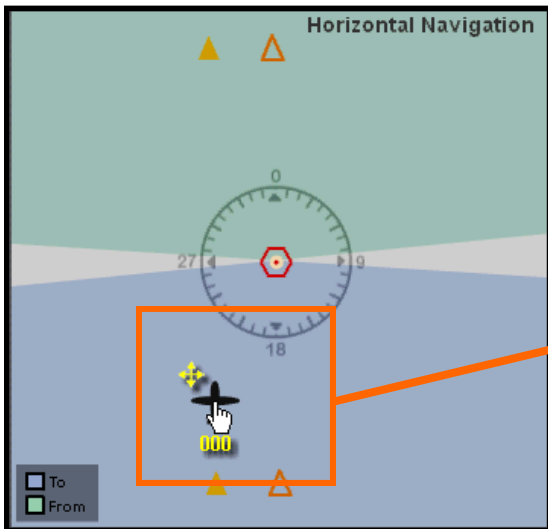


**Move Icon**
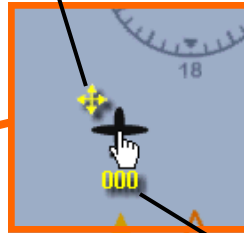
**Step 1**
On the horizontal navigation panel move mouse pointer on the aircraft symbol until the yellow move icon appears

**Aircraft Heading**



**Step 2**
Hold left mouse button down and drag aircraft to desired location and then release mouse button

### Positioning Vertically
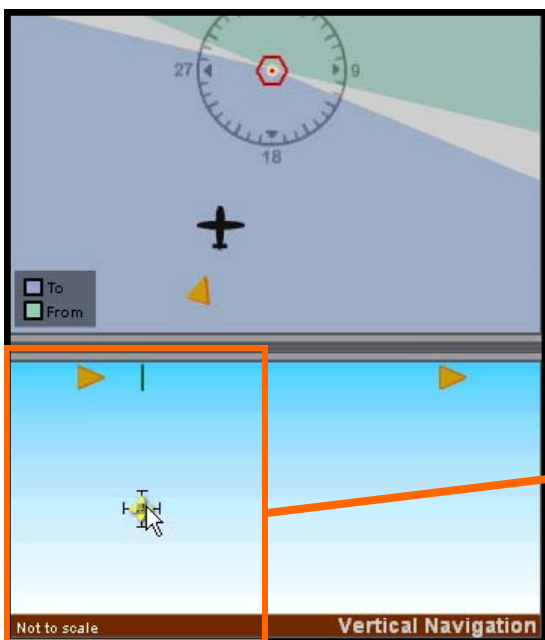


**Move Icon**
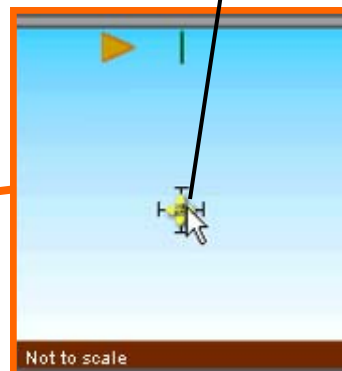
**Step 1**
Move mouse pointer until the yellow move icon appears

## Positioning Aircraft Manually (cont)

### Positioning Vertically (cont.)



**Step 2**
Hold left mouse button down and drag aircraft up or down to change altitude then release mouse button
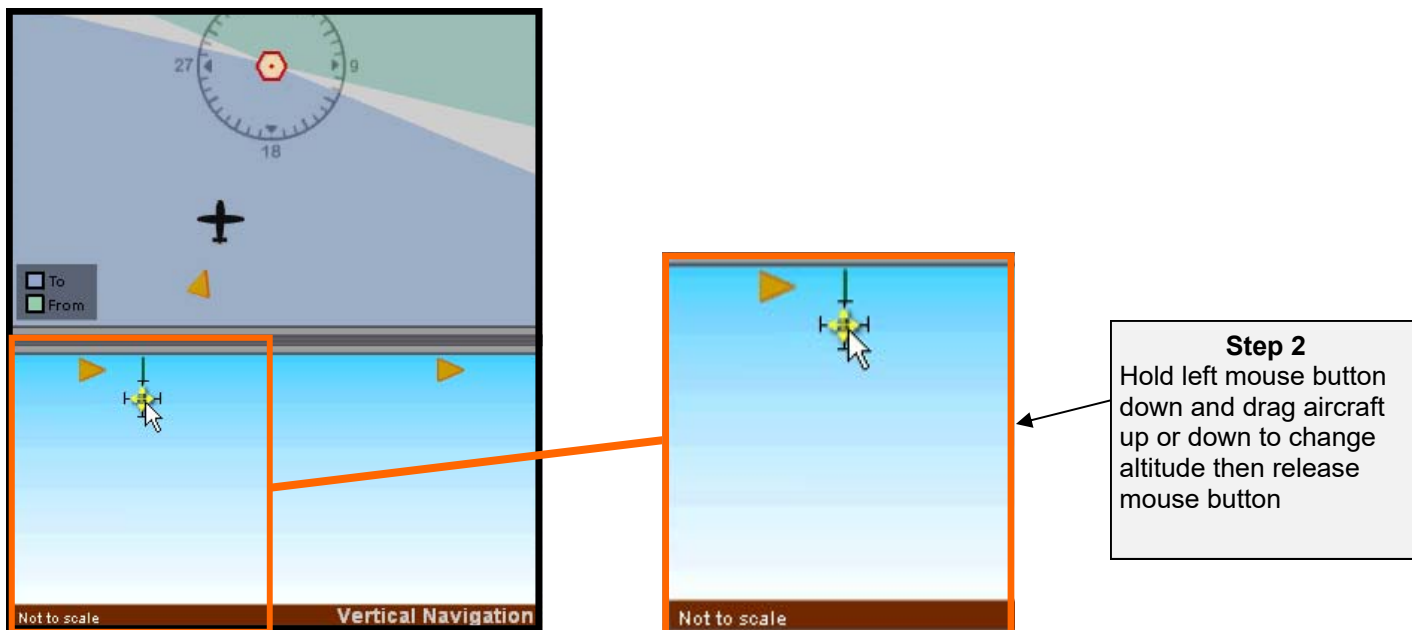
Note that it is also possible to position the aircraft horizontally using the vertical panel. When dragging the aircraft left to right/right to left in the vertical panel, the aircraft will also position itself horizontally parallel to the projection flags.

**Question:**
What is the purpose of the Vertical Navigation panel?

**Answer:**
The Vertical Navigation Panel serves three purposes, which are:
       1) Simulate the slant range error in DME readings
       2) Enable the simulation of the glide slope
       3) Allow other maneuvers where the user needs to change altitude

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## Setting Aircraft Heading Manually

### Rotating Aircraft (North Up Selected)
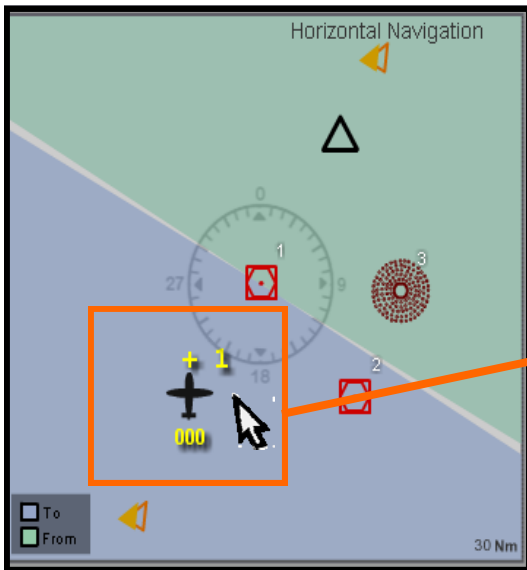


**One Degree Clockwise Rotate Icon**

**Step 1**
Move mouse pointer until the rotate icon appears

**Aircraft Heading**

**Step 2**
Hold left mouse button down until desired heading is selected
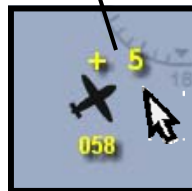
**Five Degree Clockwise Rotate Icon**
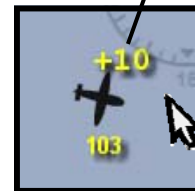
**Ten Degree Clockwise Rotate Icon**

**One Degree Counterclockwise Rotate Icon**

**Five Degree Counterclockwise Rotate Icon**

**Ten Degree Counterclockwise Rotate Icon**

**Rotating Counterclockwise**
Counterclockwise heading change is done in a similar fashion to clockwise except that the mouse is moved slightly to the left
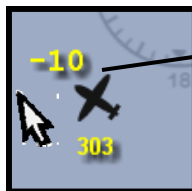
**Rotating Clockwise Faster**
Place the mouse cursor near the aircraft over a region that is horizontally off the center of the aircraft. Placing the cursor on the right side will cause a positive number (+1, +5, or +10) to be displayed. For example, clicking on +5 will cause the heading to be changed 5 degrees to the right. Holding the button down and moving the cursor to the right will allow display of +20 and +45 which will cause very rapid rotation of the heading to the right. Releasing the button will cause rotation to stop.

## Setting Aircraft Heading Manually (Cont.)

### Rotating Aircraft (Heading Up Selected)

**One Degree Clockwise Rotate Icon**

**Heading Value**

**North Up Deselected and Heading Up Selected**

**Step 1**
Move mouse pointer to the right side (clockwise rotation) of the Navaid 1 until the rotate icon appears

**Five Degree Clockwise Rotate Icon**

**Step 2**
Hold left mouse button down until desired heading is selected. Move mouse further to the right side if a greater rate is desired.

**Ten Degree Clockwise Rotate Icon**

**Greater Rate**
Greater rate is obtained by moving the aircraft further to the side of Navaid 1. Moving right of the Navaid 1 increases Heading

**One Degree Counterclockwise Rotate Icon**

**Five Degree Counterclockwise Rotate Icon**

**Ten Degree Counterclockwise Rotate Icon**

**Rotating Counterclockwise**
Counterclockwise heading change is done in a similar fashion to clockwise except that the mouse is moved slightly to the left

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## Setting Aircraft Heading Manually (cont.)



Note that when changing the heading with heading up mode selected it may appear that the aircraft is moving around Navaid 1, but in reality it is not. In this example the aircraft has always remained in the same location only the heading has changed.

**Heading Change**
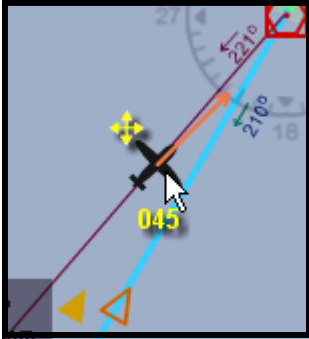Different heading but the aircraft is in the same position



**North Up**
When switching back to the North up mode the aircraft still remains in the same position even though it may seem that the aircraft has moved around the Navaid

## Setting Aircraft Heading Manually - Additional Ways

### Rotating Aircraft Using the "Shift" Key

**1**



**Activate "Shift Mode"**
Holding Shift key down and moving the cursor near the aircraft center will display a blue arrow extending from the center of the aircraft with the current direction of the arrow from the aircraft in degrees displayed on the line.

**2**



**3**



While holding the Shift key down and moving the mouse cursor around the map, the arrow radiating from the aircraft will follow the mouse constantly showing the direction from the aircraft.

**4**



Clicking the mouse button will change the aircraft heading to the current direction of the blue line. Release the Shift button to hide the blue line.

## Setting Aircraft Heading Manually - Additional Ways (cont.)

### Rotating Aircraft Using the Entry Box

**1**



Double clicking on the aircraft will cause a small window near the aircraft to open with the current heading in the edit box.

**2**



**3**



Changing the value in the edit box to any value from 1 to 360 will change the aircraft heading to that heading. Clicking on X or pressing Esc closes the window.

**4**

## Setting the OBS and Other Knobs - Analog Panel

**Changing the OBS Setting**
Changing the OBS setting is done in a similar fashion as setting the aircraft's heading. Move cursor slightly right or left of the OBS knob until the "+1" (right) or "-1" (left) appears. Hold left mouse button down until desired setting is reached. For faster rate, move mouse slightly more to the side until the "+5", "+10", "- 5", or "- 10" sign appears.

**Increasing the OBS Setting**

OBS Knob

OBS Setting

Knob
Rotation
Icon

**Decreasing the OBS Setting**

Note that the same procedure can be used for other knobs in other instruments.

## Setting the OBS and Other Knobs - Additional Ways - Analog Panel

**Setting the Knobs Using the "Shift" Key**

**1**

**2**

**Activate "Shift Mode"**
Holding Shift key down and moving the cursor near the OBS knob's center will display a yellow arrow extending from the center of the compass card with the current direction of the arrow in relation to the card in degrees displayed on the line.

While holding the Shift key down and moving the mouse cursor around the instrument, the arrow radiating from the card will follow the mouse constantly showing the new setting.

Clicking the mouse button will change the OBS setting to the one indicated on the yellow line. Release the Shift button to hide the yellow line.

**3**

**4**

Note that the same procedure can be used for other knobs in other instruments.

## Setting the OBS and Other Knobs - Additional Ways - Analog Panel(cont.)

### Setting the Knobs Using the Entry Box

**1**



**2**



Double clicking on the OBS knob will cause a small window near the knob to open with the current setting in the edit box.

Changing the value in the edit box to any value from 1 to 360 will change the OBS setting. Clicking on X or pressing Esc closes the window.
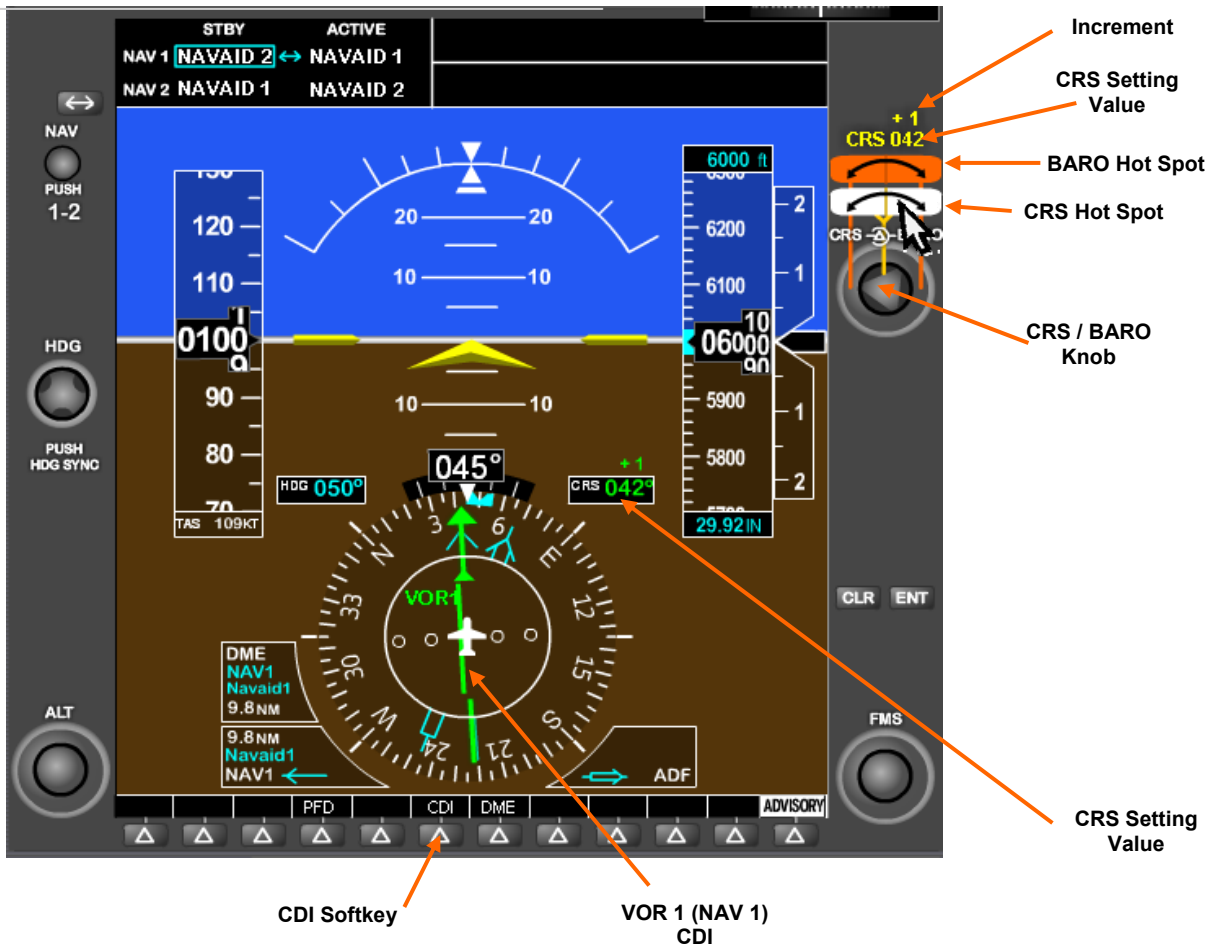
**3**



**4**
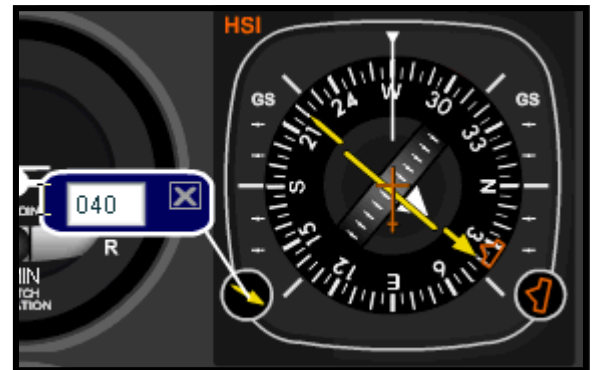


Note that the same procedure can be used for other knobs in other instruments.

## Setting the CRS - Digital Panel

**Changing the CRS Setting**

Changing the CRS setting is done in a similar fashion as setting the OBS for the analog panel. Move cursor on top of the CRS / BARO knob. Next move cursor slightly right or left of the CRS knob hot spot until the "+1" (right) or "-1" (left) appears. Hold left mouse button down until desired setting is reached. For faster rate, move mouse slightly more to the side until the "+5", "+10", "- 5", or "- 10" sign appears.
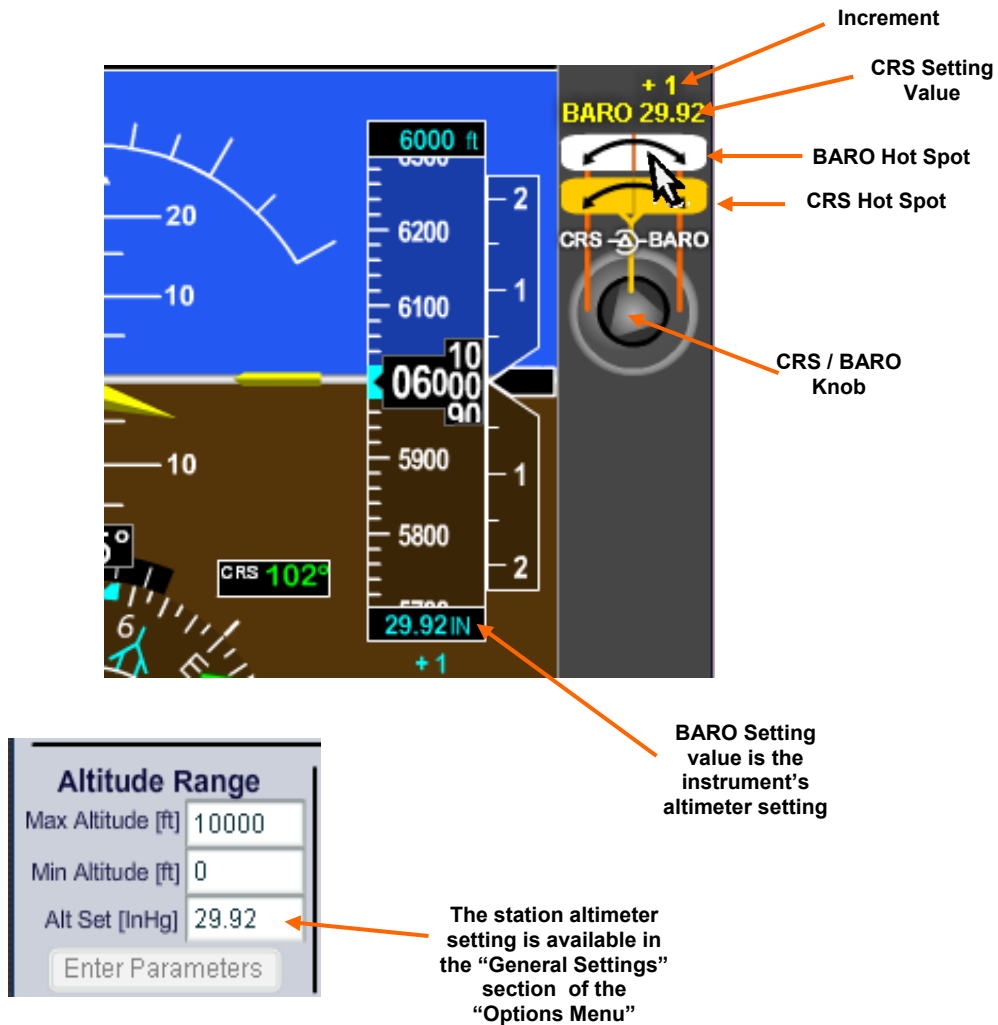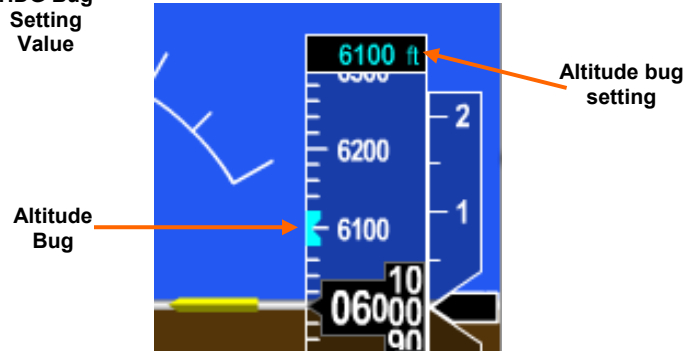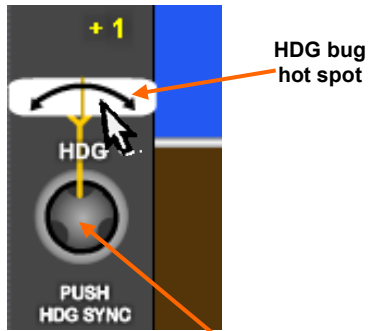


Increment
CRS Setting Value
BARO Hot Spot
CRS Hot Spot
CRS / BARO Knob
CRS Setting Value
CDI Softkey
VOR 1 (NAV 1) CDI
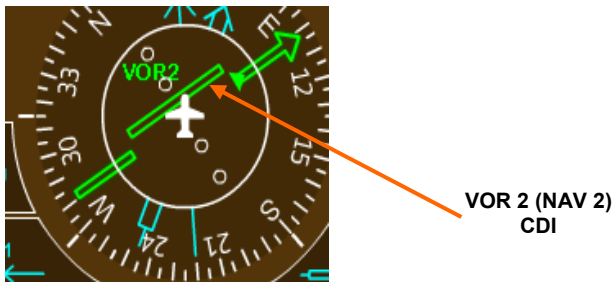


VOR 2 (NAV 2) CDI

Pressing the CDI softkey toggles between VOR 1 (NAV 1) and VOR 2 (NAV 2) selection. CRS knob always sets currently selected NAV.

## Setting the BARO - Digital Panel

**Changing the BARO Setting**

Changing the BARO setting is done in a similar fashion as the CRS settingl. Move cursor on top of the CRS / BARO knob. Next move cursor slightly right or left of the BARO knob hot spot until the "+1" (right) or "-1" (left) appears. Hold left mouse button down until desired setting is reached. For faster rate, move mouse slightly more to the side until the "+5", "+10", "- 5", or "- 10" sign appears.



Increment

CRS Setting Value

BARO Hot Spot

CRS Hot Spot

CRS / BARO Knob

BARO Setting value is the instrument's altimeter setting

The station altimeter setting is available in the "General Settings" section of the "Options Menu"

## Setting the Other Knobs - Digital Panel

### Altitude Bug

- 1000 hot spot
+ 100 hot spot
+ 1000 hot spot
+ 100 hot spot

ALT

HDG Bug Setting Value

6100 ft

Altitude bug setting

Altitude Bug

6200

6100

2

1

10
06000
90

### Heading Bug

+ 1

HDG

PUSH
HDG SYNC

HDG bug hot spot
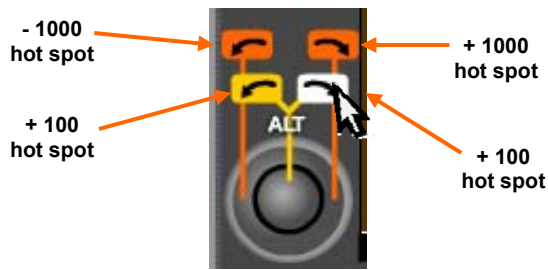
Clicking on the button sets HDG Bug to the aircraft's heading

HDG Bug Setting Value

HDG bug

+ 1
HDG 349°   045°

3   6
N
33
VOR2

HDG 045°   045°

3   6
N
33
VOR2

### FMS Knob

DME TUNING
DME MODE NAV1

NAV1
NAV2
HOLD

ADF

DME        ADVISORY

DME Tuning Menu

CLR and ENT buttons

CLR   ENT

FMS Inner knob Hot Spot

FMS Outer knob Hot Spot

FMS
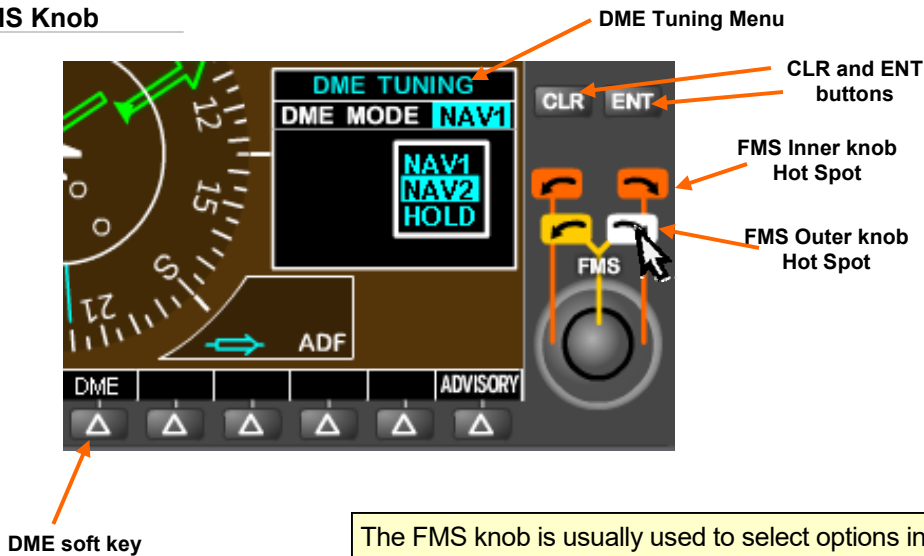
DME soft key

The FMS knob is usually used to select options in the glass panels menus. For example: pressing the DME soft key opens the DME tuning menu. The inner FMS knob is used to move the highlight option. Once the option is highlighted the ENT key above the FMS can be clicked to select the new DME option. The CLR button is used to close the Menu.

## Setting the Other Knobs - Other Ways -Digital Panel

### Shift Method CRS

CRS 030

CRS △ BARO

Hovering over the CRS hot spot and then holding the SHIFT key enables setting the CRS with mouse

VOR1
133°

### Shift Method HDG

HDG

PUSH
HDG SYNC

Hovering over the HDG hot spot and then holding the SHIFT key enables setting the HDG with mouse

TAS 109KT
329°
VOR1
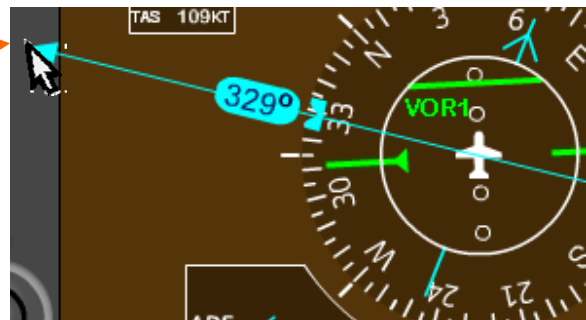
### Double Click Method HDG

Double clicking over the HDG hot spot displays setting box where the setting can be entered manually

HDG 045

045

PUSH
HDG SYNC

0100
90
80
70

HDG 045°

setting box

### Double Click Method CRS and BARO

HDG
setting box

BARO
setting box

CRS and BARO manual setting though double click works similarly to the HDG setting

6200 ft
132
6200
6100
10
06000

CRS △ BARO
1

29.92
6200
6100
10
06000

CRS △ BARO
1

## Setting the NAV Radios - Digital Panel

**NAV 1 active navaid**

**NAV 2 active navaid**

**Toggle active and standby navaids where blue rectangle Is highlighted**

**Toggle blue rectangle highlight between NAV 1 and NAV 2**
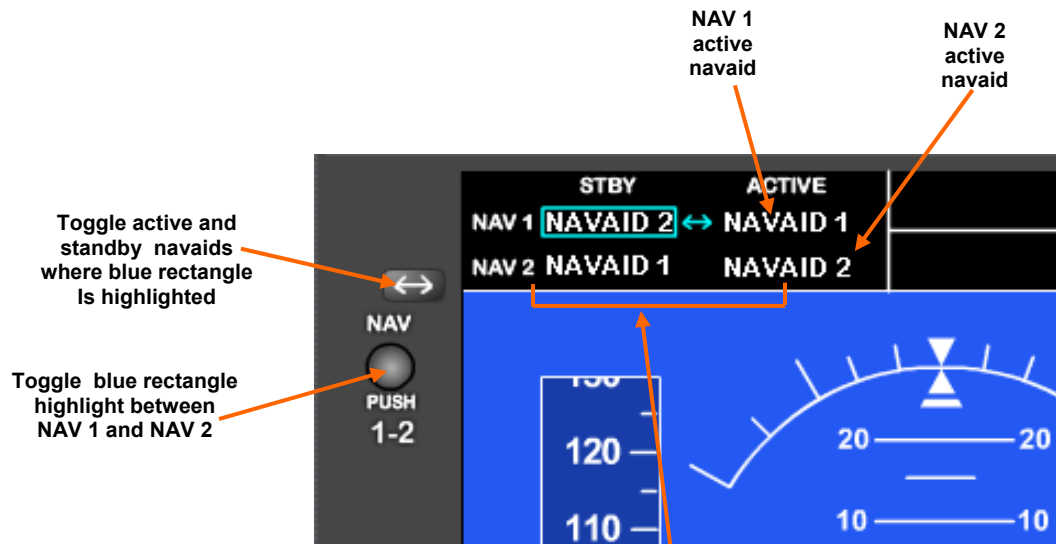
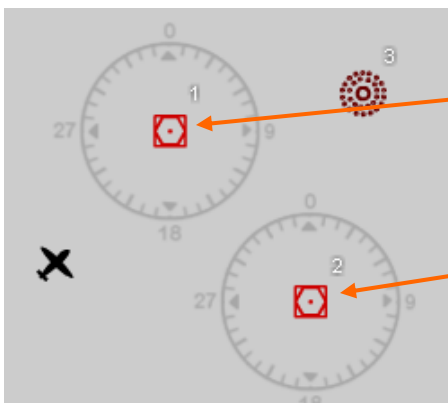**The panel above performs the identical function of the NAV 1 and 2 radio settings on the "General Settings" Panel**

### NAV 1 and 2 "Radio"

NAV 1 tuned to: Navaid 1
(VOR 1, HSI, DME, and RMI)

NAV 2 tuned to: Navaid 2
(VOR 2, DME, and RMI)
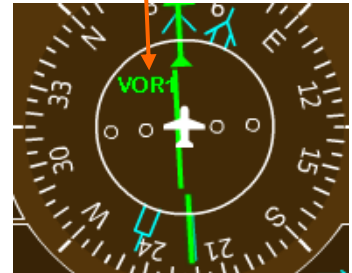
**VOR 1 is associated With NAV 1**

**Navaid 1 refers to the navigational facility 1 on the map**

**Navaid 2 refers to the navigational facility 2 on the map**

**VOR 2 is associated With NAV 2**

## Soft Keys  - Digital Panel

Soft keys are used to select different features and setting in the glass (digital) panel.



DME
Box

BRG2 RMI
Box

BRG1 RMI
Box

CDI Softkey

PFD (primary flight display) button
activates the menu below

DME soft key
opens  DME
Tuning Menu

Alert / Advisory
Soft key
(New message
when flashing)

DME box  toggle
On / Off

BRG1 RMI toggle
NAV 1 / ADF / Off

BACK soft key returns to
previous menu (top)

BRG1 RMI toggle
NAV 1 / ADF / Off
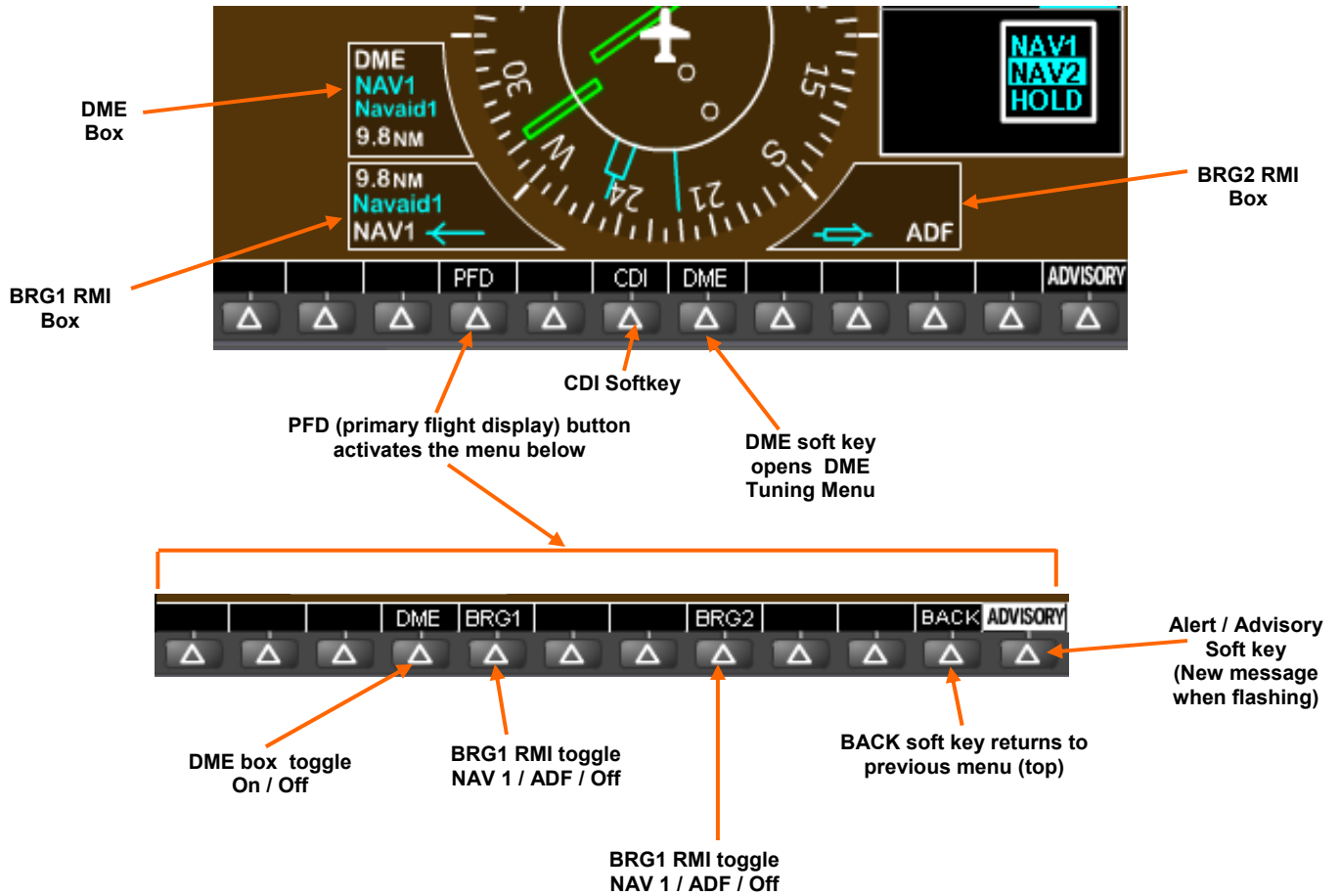
## Dual Panel View

**Toggling Dual Panel View On and Off**

Pressing "I" toggles dual panel view on and off. This is a great feature to compare analog and digital panel functionality. Both panel functions are tied together. Changing settings in the analog panel for example will cause the equivalent settings to be changed in the digital panel as well. For example, if setting the course in the analog HSI instrument the same course will be set on the digital glass instrument panel.

# Glossary

## Acronyms and Abbreviations

**Acft**: aircraft

**ADF:** automatic direction finder

**AI:** attitude indicator

**ALT:** altimeter or altitude (depending on the context)

**Alt Set:** altimeter setting

**Ang:** angle

**ASI:** air speed indicator

**Baro:** barometric setting

**Brg:** bearing

**CRS:** course

**Dist:** distance

**Dir:** direction

**DME:** distance measuring equipment

**FMS:** flight management system

**Ft/s:** feet per second

**Grad:** gradient

**GS:** ground speed or glide slope
(depending on the context)

**HDG:** heading

**HI:** heading indicator

**HPa:** hectopascal

**HSI:** horizontal situation indicator

**IAS:** indicated airspeed

**ILS:** instrument landing system

**InHg:** inches of mercury

**Kts:** knots

**KT:** knots

**LDA:** localizer type directional aid

**LOC:** localizer

**MB:** magnetic bearing

**Min:** minute(s)

**NAV 1:** navigation instrument radio 1

**NAV 2:** navigation instrument radio 2

**Navaid:** navigational aid / ground navigational facility

**MC:** magnetic compass

**N:** North

**NA:** not applicable or not available (depending on context)

**NDB:** non-directional beacon

**Nm:** nautical mile

**OBS:** omni-bearing selector

**PFD:** primary flight display

**RMI:** radio magnetic indicator

**S:** South

**SDF:** simplified directional facility

**STBY:** standby

**TACAN:** tactical air navigation

**TAS:** true airspeed

**TC:** turn coordinator

**Temp:** temperature

**TRK:** track

**VOR:** VHF Omni-directional Radio Range

**VORTAC:** VOR and TACAN combined

**VSI:** vertical speed indicator

**WD:** wind direction

**WS:** windspeed

# End