

KLN94 GPS WORKSHOP

1 VFR Operations

1.1 Overview of GPS Technology

- The GPS constellation consists of at least 24 satellites.
- Location accuracy is anywhere from 1 to 100 meters.
- There are two important pieces of information pertinent to each satellite:
 - Exact time (with relativistic corrections added!!!)
 - Exact location (ephemeris)
- By measuring the amount of time it takes the signals from each satellite to travel to the receiver, the GPS receiver can determine its relative distance from each satellite.
- Since the GPS receiver knows the exact position of each satellite relative to the surface of the earth, it can triangulate and compute a position solution.
- At least 3 satellites must be visible by the receiver to calculate the position.
- At least 4 satellites must be visible by the receiver to calculate altitude.
 - Computed altitude accuracy is not as good as position accuracy .
 - It can be off by several hundred feet.

1.1.1 Accuracy Augmentation Techniques

- Most inaccuracies in GPS position calculation are caused by the variation of atmospheric conditions.
- Wide Area Augmentation System WAAS:
 - Satellite based system that broadcasts the measured error for a particular region.
 - Requires WAAS capable GPS.
- Local Area Augmentation System (LAAS):
 - Local area measured error is transmitted via a ground based antenna.
- Accuracy Summary
 - GPS with SA: < 100m
 - GPS without SA (normal mode): < 13m Horizontally, 22m Vertically
 - WAAS: < 3m Horizontally, < 4m Vertically

- LAAS: < 1m Horizontally

1.1.2 Receiver Autonomous Integrity Monitor (RAIM)

- All IFR GPS receivers continually perform a sanity check to make sure that the position reports from all satellites agree with each other.
- If a satellite starts sending bad information, a GPS with RAIM capability will automatically stop using that satellite in its position calculations.
- In order to isolate a faulty satellite, the GPS needs to see at least 5 satellites.
 - Alternatively, 4 Satellites and a pressure sensing altimeter.

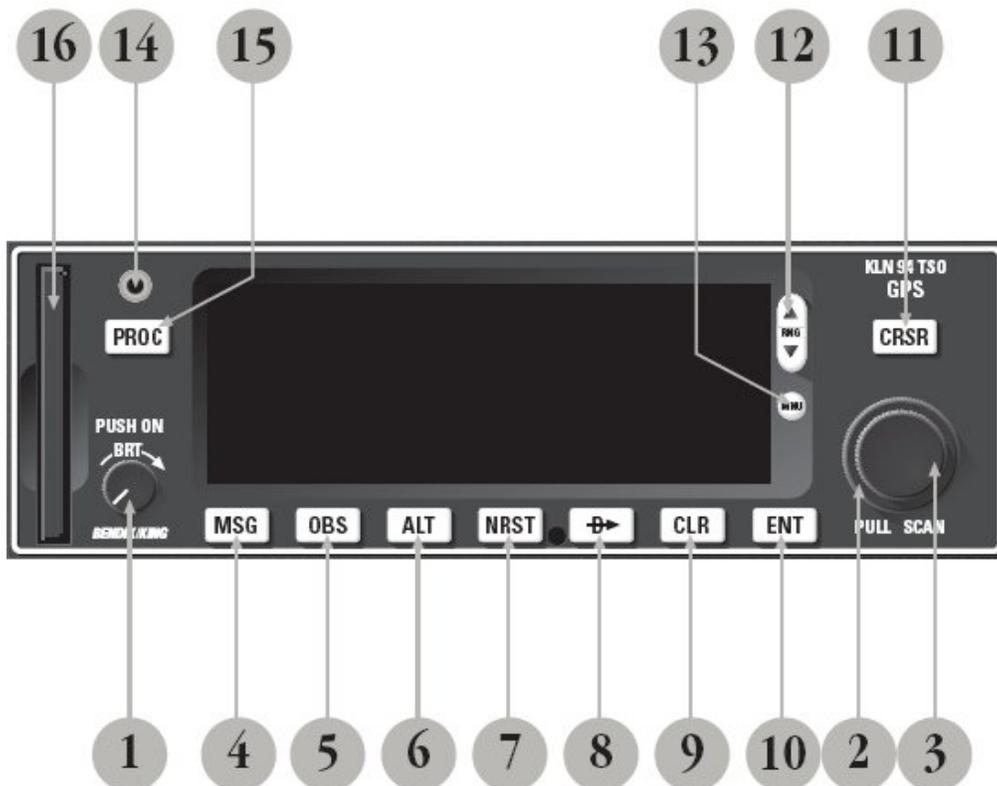


Illustration 1: KLN 94 Buttons

1.2 Overview of the buttons

1. Brightness Control / On off Switch
2. Large selector
3. Small selector (pulls out)
4. Message button. Push this button when the **MSG** text is displayed.
5. Toggles the GPS from OBS mode to leg mode
6. Altitude Button
7. Nearest Button
8. Direct To button (your friend)
9. Clear Button
10. Enter Button
11. Cursor mode toggle button
12. Range selector

13. Sub menu button
14. Computer interface receptacle
15. Instrument Procedure button
16. Database card

1.3 Simulate Mode

- KLN 94 can be configured to simulate movement across ground at a given speed. This mode can only be activated in when the unit is in “take-home” mode and connected to external power supply.
- To put the GPS in simulate mode:
 1. Use the outer knob to select the “SET” page.
 2. Use the inner knob to select the “SET 1” sub page.
 3. Press the “Cursor” button.
 4. Use the outer knob to navigate a field (position, airspeed, heading).
 5. Press “Enter” when done with a field.
 6. Select “OK” and press “Enter”.

1.4 Overview of the most important pages

- The lay out of the GPS pages is organized into two tiers:
 - Page: This tier groups several functionalities. Think of this as directory on a computer.
 - Sub Page: Each page in this tier takes input and controls a single task. Think of this as a file within a directory on a computer.



Illustration 2: Page and Sub-page

1.4.1 Navigation Pages (NAV)

- The navigation pages show information about the active leg.
 - Definition of terms:

- DTK: Desired Track \equiv The magnetic course you should be following to get to the next way point
- TK: Current Track \equiv The magnetic course you are currently tracking over ground

Under normal conditions, the *TK* should be the same as *DTK*.

- NAV 1 Page



Illustration 3: NAV 1 Sub-Page

- To get to this page:
 1. Rotate the outer knob to select the NAV page.
 2. If not already on the NAV1 page, rotate the inner knob to select NAV 1 sub page.

- NAV 4 Page

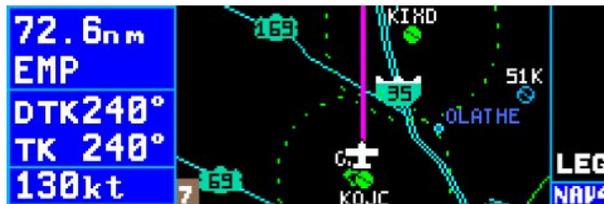


Illustration 4: NAV 4 Sub-Page

- To get to this page:
 1. Rotate the outer knob to select NAV page.
 2. Rotate the inner knob to select the NAV 4 Page.

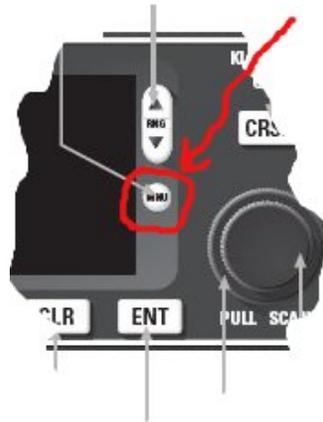


Illustration 5: Menu Button

- Alternatively, press the menu button (see Illustration 5: Menu Button).

1.4.2 Pending Message

- When the unit needs to notify you of an event, a yellow *M* is displayed on the right side of the screen. You can view the pending message by pressing the [MSG] button. Pressing the [MSG] button again will take you back to the page you were on.



Illustration 6: Pending message

1.4.3 Active Flight Plan 0 page (FPL 0)

- This page shows the active flight plan, the current leg and a list of loaded waypoints.



Illustration 7: Active Flight Plan Page

1.5 Direct to Operations

- By using the “direct to” button, we can ask for course guidance to a single waypoint. The direct-to course is always the shortest “great circle” distance to the target waypoint. In order to select a waypoint to go to:
 1. Press the “direct to” button.
 2. Use the inner knob to select a letter.
 3. Use the outer knob to move to the next space.
 4. When the fix id is selected, press enter.
 5. The GPS will show the name of the selected waypoint.
 6. Press enter to confirm.
 7. (Optional) Set the OBS on the slaved CDI.

1.6 Go to nearest in case of an emergency

- One of the most powerful capabilities of the KLN 94 is course guidance to the nearest airport in case of an emergency. To go to the nearest airport:
 1. Press the “NRST” button.
 2. Select “APT” for airport.
 3. If the first displayed airport is not the desired airport:
 - a. Pull out the inner knob.
 - b. Rotate the inner knob to scan through the closest airports list.
 4. When the desired airport is selected, press the “direct to button”.
 5. Press enter to confirm the airport ID.
 6. Press enter again to confirm the airport name.



Illustration 8: Nearest Page

1.7 Getting Airport/VOR information/frequencies from the GPS

- The KLN 94 has a database of most of the information found in the AFD about airports and navigational aids. To access the information page about a navigation aid/airport:

1. Use the outer knob to navigate to the APT/VOR/NDB/INT page.
2. Press the cursor [CRSR] button.
3. Use the inner knob to select letters of the navigation aid/airport id.
4. User the outer knob to move between spaces.
5. If the inner knob is pulled out, the GPS goes into scan mode and will cycle through all the waypoints starting with the selected letters.
6. Press the enter [ENTER] key.
7. Cycle through the sub pages to find the information you are looking for.



Illustration 9: Sample Airport Page

1.8 Entering Flight Plans

- Typically, the route to our destination will be made up of a sequence of waypoints. This is especially true during instrument flying since the planned route will be part of the clearance and must be strictly adhered to. A simple way to fly a route is to fly directly to the first waypoint using the direct-to operation and after arriving at the waypoint use the direct-to operation again to go to the next waypoint. The KLN94, however, is capable of loading and storing 25 different flight plans. Once a flight plan is active, the GPS unit will start sequencing through all the waypoints making up the route. It will also be able to perform turn-anticipation based on the current ground speed. Also, the waypoints in the flight plan will show up first when the GPS is put in scan mode by pulling out the inner knob.
- To create a flight plan:
 1. Use the outer knob to navigate to one of flight plan pages
 2. If you want to erase the flight plan that is already there, press the [CLR] button.
 3. Put the unit in cursor mode by pressing the [CRSR] button
 4. Use the inner and outer knob to select the letters for the waypoint
 5. When done entering a waypoint press [ENT]
 6. The unit will display information about the selected waypoint to confirm that it is indeed the waypoint you intended to select. Press [ENT] once more to confirm.

- a) If the waypoint is not what you wanted, press [CLR] to cancel out of the selection
- 7. Repeat steps 4-6 to input all the route's waypoints
- 8. After all the waypoints are entered, use the outer knob to select the [USE?] field and press enter.
- To insert a waypoint into an existing flight plan:
 1. Select the desired flight plan
 2. Put the unit in cursor mode by pressing the [CRSR] button.
 3. Use the outer knob to navigate to the line after where you want to insert a new waypoint.
 4. Use the inner knob to select the first letter of the waypoint.
 5. Use the outer knob to move the letter location.
 6. When done entering the waypoint id, press [ENT]
 7. Confirm the waypoint by pressing [ENT] one more time



Illustration 10: Sample Flight Plan Entry page

- To remove a waypoint form an existing flight plan:
 1. Select the desired flight plan
 2. Put the unit in cursor mode by pressing the [CRSR] button.
 3. Select the waypoint you want to delete
 4. Press the [CLR] button
 5. Confirm deletion by pressing the [ENT] button
- Let's assume that you just made a flight to your destination and now want to go back home using the same route you came in. Since flight plan 0 was the last flight plan used, we can copy it and use the inverted route. Here are the steps we would follow:
 1. Use the outer knob to go to the flight plan page
 2. Use the inner knob to select an unused flight plan, other than 0. If one doesn't exist, erase an existing flight plan (other than 0 of course).
 3. Put the unit in cursor mode by pressing [CRSR]

4. Select the “Copy FPL 0?” using the outer knob and press [ENT]. See Illustration 2.
5. Now flight plan zero will be copied to the current flight plan (FPL 2 in Illustration 2)



Illustration 11: Copying Flight Plan 0

6. Next, still in cursor mode, use the outer knob to navigate to the “Use Inverted?” field and press [ENT].
 7. Now flight plan 0 (i.e. the active flight plan) will be the inverted version of the original flight plan.
- In order to go to the first waypoint in the active flight plan (FPL 0):
 1. Press the direct-to button
 2. Activate the scan mode by pulling out the inner knob
 3. With the inner knob pulled out, rotate the inner knob to scan through all the waypoints in your flight plan.
 4. Once the desired waypoint is selected, press [ENT]
 - Often times, ATC may ask you to jump ahead to a waypoint and skip over a few of the route's legs. In order to skip ahead to a waypoint in your flight plan, repeat the same steps as the previous bullet.
 - In order to determine the time and distance for each leg of your flight plan:
 1. Use the outer knob and the inner knob to select FPL 0 page
 2. Put the GPS in cursor mode by pressing the [CRSR] button
 3. Select ETE/MST/OBS/ETA field opposite the first waypoint (see Illustration 13)
 4. Use the inner knob to change the leg information column.



Illustration 13: ETE Leg Information



Illustration 12: Distance Leg Information

1.9 Determining Current Position Relative to a VOR

- When making position reports to ATC for flight service, it is nice to be able to convey our current position relative to a nearby VOR. The easiest way to do this to by using the NAV 2 page. This page will automatically show the current position relative to the nearest VOR. Here are the steps to get to NAV2:
 - Use the outer knob to select the NAV page
 - Use the inner knob to select the NAV2 page



Illustration 14: NAV2 Page showing current position

- If we need to determine our current position relative to another waypoint other than the nearest VOR:
 - Use the outer knob to select the NAV page
 - Use the inner knob to select the NAV2 page
 - Press the [CRSR] button
 - Use the inner and outer knobs to enter the id of the waypoint.
 - When the id is completely entered press [ENT] .
 - The GPS will show the information about the selected waypoint. If this information is correct, press [ENT] one more time to confirm. If the wrong waypoint was entered, press the [CLR] button to cancel.
 - If you change away from NAV2 page, the reference point will automatically reset to the nearest VOR.



Illustration 15: Selecting a different reference point

1.10 Using the AUX pages to do E6B operations

- KLN94 has several built in pages that can do E6B flight computer calculations. The following are a few of most useful operations:

1.10.1 Density Altitude

1. Use the outer knob to navigate to the AUX page
2. Use the inner knob to select AUX 7 sub page.
3. Turn on the cursor mode by pressing the [CRSR] button.
4. Select the “**Pressure Altitude**” field by using the outer knob
5. Enter the current pressure altitude.
6. Select the “**Temp**” field by using the outer knob
7. Read the density altitude.

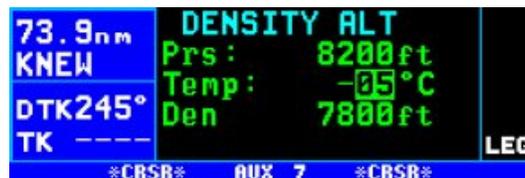


Illustration 16: Density Altitude Calculator

1.10.2 Wind Calculations

1. Use the outer knob to select AUX page
2. Use the inner knob the select AUX9 page
3. Turn on the cursor mode by pressing the [CRSR] button.
4. Use the outer knob to select a field.
5. Use the inner knob to enter field values
6. Read wind direction and wind speed at the bottom of the page.



Illustration 17: Wind Calculator

2 IFR Operations

2.1 GPS usage in IFR operations

- An IFR approved GPS can be used in lieu of the following equipment as long as the waypoints are retrieved from the unit's internal database:
 - DME
 - DME in VOR/DME approaches
 - DME in LOC/DME or ILS/DME approaches
 - Locater Outer Marker
 - NDB Approaches with GPS overlay
- A non-IFR GPS can be used to overlay an existing approach to improve situational awareness.
 - A non-IFR GPS does not have RAIM and other health monitoring features and should not be used as a primary navigational instrument in IFR operations.
- When filing a flight plan to an airport serviced only by GPS approaches, the alternate airport must have a non-GPS approach and the airplane must be equipped to fly that non-GPS approach.
- File flight plans with /G equipment designation if equipped with an IFR approved GPS.

2.2 Adding DPs and STARs to flight plans

- KLN94 can load Departure Procedures (DPs) and Standard Terminal Arrival Routes (STARs) to an active flight plan. The waypoint in a DP or STAR will become part of the flight plan and will be sequenced by the GPS.
- In order to add a Departure Procedure:
 1. Make sure the departure airport has been added to flight plan 0
 2. Press the procedure [PROC] button
 3. Use the outer knob to select **“Select Depart?”**
 4. Press [ENT]
 5. The departure airport should be selected. If the airport is not highlighted, use the outer knob to select it and press [ENT]
 6. Select the departure procedure using the outer knob and press [ENT]
 7. Select departing runway using the outer knob and press [ENT]
 8. Select the transition by using the outer knob and press [ENT]
 9. Press [ENT] to confirm adding the DP to the flight plan.

10. Use the direct-to and scan procedure to go the the first fix in the DP



Illustration 19: Select departure



Illustration 18: Select DP



Illustration 20: Select Runway



Illustration 21: Select transition

- In order to load a Standard Terminal Arrival Procedure:
 1. Make sure the destination airport is in the active flight plan (FLP 0)
 2. Press the procedure button [PROC]
 3. Select “**Select Arrival?**” using the outer knob and press enter
 4. Verify that the destination airport is under the cursor. If not, use the out knob to highlight the airport and press [ENT].
 5. Select the Arrival procedure and press [ENT]
 6. Select the transition name and press [ENT]
 7. Select the active runway and press [ENT]
 8. Press [ENT] one more time to add the STAR to flight plan 0.

2.3 Approaches

- As we approach the destination airport, the GPS unit will start becoming more sensitive.

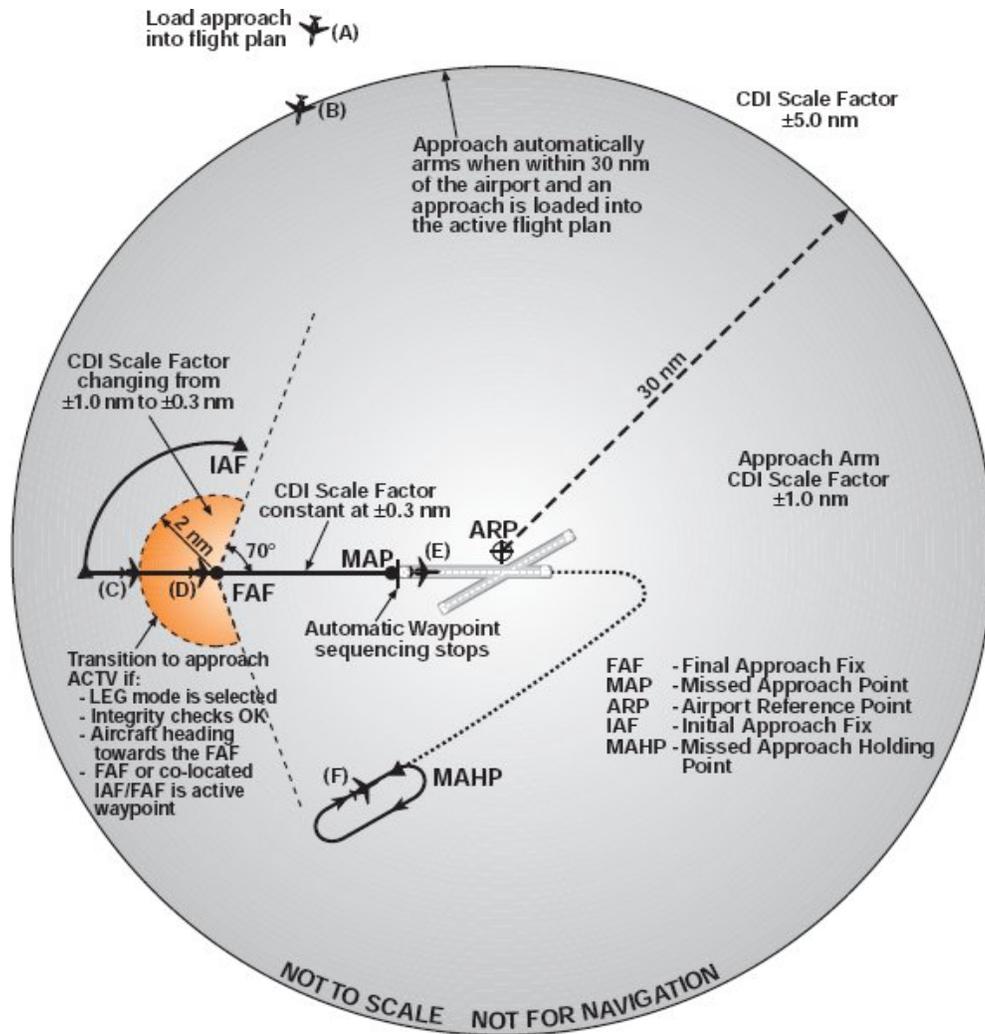


Illustration 22: GPS Sensitivity

- In order for the GPS to work properly the following conditions must be met:
 - Leg mode must be selected (NOT OBS)
 - Internal integrity check must pass.
- If the above conditions are met, the GPS will display “APR ACTV” in the lower right corner of the screen.
- Here is what the AIM says about RAIM availability (1-1-19)
 - If RAIM is unavailable prior to reaching the Final Approach Fix (FAF), the approach should not be attempted.
 - If the unit does not sequence over to APR mode or RAIM is not available at the FAF, the pilot should execute a missed approach and go to the missed approaches point. If RAIM is not available, KLN94 will display the following

message:

RAIM Not Available

APR Mode Inhibited

Predict RAIM on AUX

- If RAIM failure occurs after FAF, the unit can continue operating for 5 minutes without alerting the pilot
- However, if the unit displays a RAIM error, even after the FAF, a missed approach must be executed. The KLN94 will display the following message:

Press PROC Button Now For Navigation

- To load an approach into the GPS:
 1. Make sure the destination airport is in the active flight plan.
 2. Press the procedure [PROC] button.
 3. Select “**Select Approach?**” by using the outer knob and press [ENT]
 4. The destination airport should be highlighted by default . If it is not, use the outer knob to select the airport and press [ENT].
 5. Select the desired approach and press [ENT]
 6. Select the initial fix and press [ENT]. If you are going to be vectored to the final approach course, select **Vectors**.
 7. Move the cursor over the “**Add to FPL 0?**” and press [ENT]. This will add the sequence of waypoints to the active flight plan.
 8. In order to go the initial approach fix:
 - Press direct-to
 - Pull out the inner knob
 - Scan through the waypoints in the active flight plan and select the initial fix
 - The initial fix will end with the letter “i”
 - Press [ENT] to activate
 9. If you were to be vectored to the final approach fix:
 - Press [PROC]

- “Activate Vectors” should be highlighted.
- Press [ENT] to activate vectors to final.

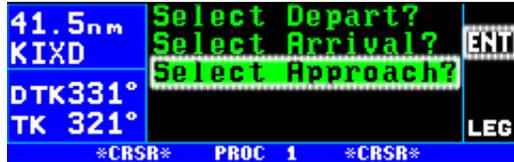


Illustration 23: Selecting Approach Procedure



Illustration 24: Select Airport



Illustration 26: Select Approach



Illustration 25: Select initial fix

2.4 Using the OBS mode/Holds

- When flying approach and flight plans, we usually operate the GPS unit in **leg** mode. In leg mode, the bearing and the distance to the next waypoint is calculated and sequenced as we fly the route. The GPS unit can also operate in **OBS** mode. In OBS mode, the active waypoint is treated as a VOR. A course to or from the fix can be selected using the external slaved CDI. When in OBS mode, the GPS will not automatically sequence through the waypoints if the to/from indicator shows “from”.
- The OBS mode is often used when executing holds. In order to initiate a hold on a radial:
 1. Verify that the hold fix is in the direct-to field (note: hold fixes will have an “h” after the fix name.)
 2. Press the OBS button. The *LEG* indicator in the lower right side of the display will change to OBS.
 3. Select a radial to/form the fix on the external slaved OBS and fly the hold as published/instructed.
- Alternatively we can select a radial using the GPS unit:
 1. Verify that the hold fix is in the direct-to field.
 2. Press the OBS button. The *LEG* indicator in the lower right side of the display will change to OBS.

3. Put the unit in cursor mode by pressing the [CRSR] button.
 4. Use the outer knob to select the **OBS** field.
 5. Use the inner knob to select the desired radial.
 6. Now the internal GPS CDI will show our relative position to the selected radial.
- To exit OBS mode and switch back to leg mode, press the [OBS] button.



Illustration 27: OBS Mode

2.5 Flying ILS/VOR approaches with GPS overlays

- Since the GPS mode cannot be substituted for ILS and VOR approaches, it cannot be used as the primary navigational instrument for these approaches. However, it can be used to enhance situational awareness when executing these approaches. This technique is referred to as an overlay approach. To load an overlay approach, use the same procedure as loading GPS approaches. However, when a non GPS approach is loaded the warning in Illustration 28 is displayed. You will have to press [ENT] to acknowledge this warning.



Illustration 28: Overlay warning

2.6 Flying DME arcs

- When executing DME arcs, it is possible to get lateral guidance throughout the maneuver from the KLN94. In order to load a DME arc as part of an approach, the initial arc fix must be selected as the initial approach fix. The nomenclature for DME arc fixes is as follows: *DrrrR*. All DME arc fixes start with the letter **D**. The *rrr* field is the three digit radial that the fix is on. The last field in the fix name is the distance. Distance is represented as a letter and the ordinal number of letter stands for the distance in nautical miles. i.e. A=1NM, B=2NM, C=3NM, etc. Therefore, a fix on the 179 radial on the 10 DME fix would be designated as: *D179J*. e.g. On the ILS RWY 26R at PUB the south arc initial fix would be D178J.

- Once the arc is loaded, the CDI will provide constant lateral guidance in order to keep the airplane on the selected arc.
- Let's assume that you have the Pueblo D178J fix selected and are headed towards it. But ATC decides to give you a new heading to intercept the arc. Since you will not arrive at the arc near the initial fix, the GPS unit will not start sequencing waypoint and will not provide lateral guidance on the arc. In order to overcome this problem, the KLN94 can calculate a new intercept fix on the arc based on your current heading. In order to re-compute a new fix:
 1. Make sure the DME arc is loaded using its original fix.
 2. Navigate to the FPL 0 page
 3. Once on the new intercept heading, press the [CRSR] button.
 4. Select the initial fix (D178J in this example) and press the [CLR] button.
 5. The GPS will display the following message “**Move?**”.
 6. Press the [ENT] key to confirm moving the intercept point.
 7. A new intercept radial will appear in place of the original DME arc fix.

2.7 Missed approaches

- After reaching the missed approach point, the GPS will not automatically sequence to the missed approach fix. In order to go to the missed approach point:
 1. Press direct-to
 2. If the missed approach waypoint is not already in the direct-to box, pull out the inner knob and scan through the waypoints until the missed approach waypoint is selected.
 3. Press [ENT]

2.8 RAIM prediction

- Before embarking on an IFR trip, a good pilot should check RAIM NOTAMs for his destination airport. GPS RAIM unavailabilities are published as part of the regular NOTAM system. The KLN 94 can also predict RAIM availability based on satellite geometry at the destination airport near the time of arrival. In order to perform RAIM prediction:
 1. Using the outer knob navigate to the AUX page
 2. Using the inner knob select page AUX3
 3. Put the unit in cursor mode by pressing the [CRSR] button
 4. Enter the destination fix id using the inner and outer knobs.
 5. Press [ENT]
 6. Select the ETA time using the inner and outer knobs

7. If you know that a certain space vehicle (SV) i.e. satellite will be out of service you can enter its number in the “Deselect SV” field.
8. Press the [CRSR] button
9. The unit will start the RAIM prediction process and will display the results.



Illustration 29: RAIM prediction page



Illustration 30: RAIM prediction results

2.8.1 Setting Altimeter

- When the GPS unit starts, it displays a page where the altimeter pressure can be set. It is a good idea to set the value of the altimeter pressure to the current altimeter setting. Also before starting an approach, the KLN94 may also ask you to set the altimeter setting via a blinking yellow message. Setting the correct pressure setting will enable the GPS unit to rely on less satellites for RAIM and will increase the fidelity of its internal fault monitoring.
- To set the altimeter setting of the GPS unit:
 1. Press the [ALT] button
 2. Use the inner knob to set the altimeter setting
 3. Press [ENT] when done



Illustration 31: Initial Pressure Display



Illustration 32: Altimeter setting