GRT Avionics

Heads-Up Display/Android Compute Stick Package

Installation and Configuration Instructions

Rev H   Feb 2020

Revision History

Rev H – First Release of GRT HUD/Android Compute Stick Package Installation/User Manual.

Contents

Introduction

Welcome to the GRT Avionics heads up display (HUD), the HUD for experimental aircraft. You will soon discover the ease of accessing vital flight information by simply looking out the window…a leap forward in aircraft instrumentation that has been preferred by military and commercial pilots for many years.

Those who are familiar with HUDs will notice that the Hudly, and other automotive HUDs are not a "perfect" aviation HUD. For example, the images provided to the pilot maybe focused in the pilots far vision, but not close at infinity as is typical for a true aviation HUDs. By the end of your first flight with the HUD, you will find these short-comings to be much smaller than expected, and the benefits larger than expected. Combined with the very low cost, this HUD technology is an extraordinary step forward.

Design Philosophy

As is typical of our avionics, GRT draws on existing conventions wherever possible. This is true for our HUD, as symbology and function are based on existing commercial and military HUDs wherever possible. User settings are provided to allow users significant flexibility in many aspects of the HUD, and to allow adapting to future HUD hardware choices.

Scope

These instructions describe the installation of the Hudly Classic automotive after-market heads up display with the GRT Avionics EFIS but is also applicable to other HUDs. Descriptions of the symbology and functionality applies to any HUD driven by this software, including the Hudly Classic, Hudly Wireless, Kivic, EPIC Eagle, as well as the and Epson BT200, BT300. This installation is compatible only with GRT Avionics EFIS systems.

Supported Modes of Operation

The software supports augmented reality, and condensed modes of operation. The augmented reality mode shows background symbology, such as the pitch ladder, flight path marker, runway outline, etc., positioned to correspond with the outside world. For example, the horizon line will appear on the actual horizon (at lower altitudes). This is the mode in which airline and military aviation heads-up displays operate. The practicality of this mode depends on the accuracy of the EFIS magnetic heading data, but offers the greatest potential for situational awareness.

Condensed mode operation provides a greater angular representation on the HUD. This allows the flight path marker more motion before becoming display limited.

These modes are nearly identical, with the sole difference being the setting for the "Background Scaling". The default "background scaling" provides condensed mode operation with the Hudly, scaling the background to show about 12 degrees of vertical field-of-view on the Hudly display. This can be increased or decreased as desired using this setting.

When using Epson BT-200 or BT-300 , the default setting of 100 is recommended, providing augmented reality mode (1:1 scaling between symbology and the real world view), with the obvious difference that the HUD image is not fixed to the direction the airplane is pointed (since it worn, not mounted to the airplane).

Recommended Mode

Mounting the HUD for augmented reality mode is practical when the combiner glass is positioned close enough to the pilot to provide a suitable angular field of view, such as is typical in Van's RV-6, -7, -9, etc. Since installation requires more care with regard to the position of the combiner glass, and since re-mounting the combiner glass is easy, many users will find it desirable to start by operating the HUD in condensed mode and taking the time to fine tune the installation for augmented reality mode after they have had their initial experience with the HUD. Installation time should be well under an hour when operating in condensed mode, and less a couple hours to achieve a good augmented reality mode installation.

What is needed

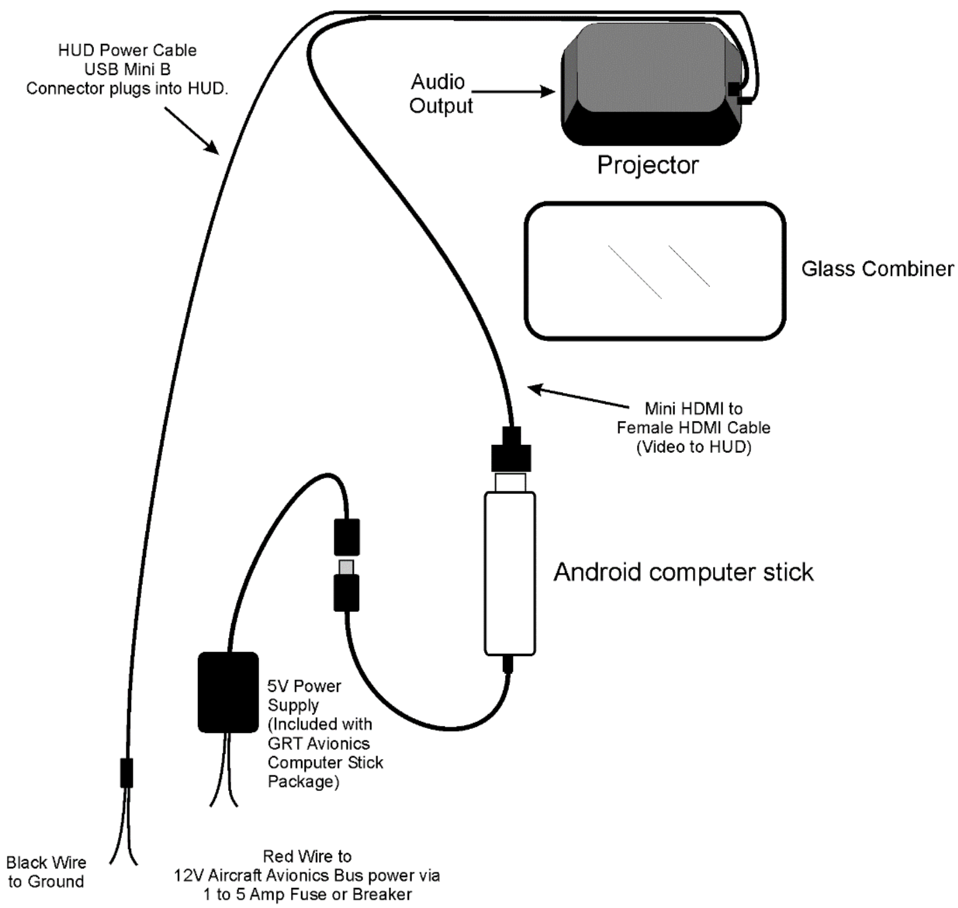
The GRT HUD Package includes the HUD and a pre-programmed android compute stick. These instructions describe installation using this package. A description of HUDs that are compatible with the GRT App are listed in section "

GRT App compatible HUDs Ratings and Recommended Settings" near the end of this manual. If not purchasing the GRT HUD package, the following is required:

- Any supported Heads-Up Display (See the "Supported HUD" section).
- A GRT EFIS enabled for heads-up display with a USB blue tooth dongle. (Not available for WS and HS models at this time.)
- An android device to generate the video for the heads up display.

Electrical Connections

All electrical connections are made with the supplied cable assembly and 5V power supply as shown below. Note that the android device will receive its EFIS data via the Bluetooth connection to a GRT EFIS.

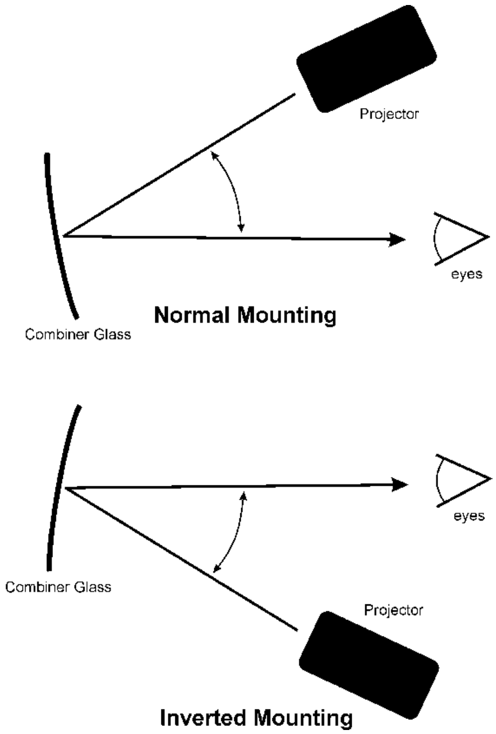


Electrical Connections to the Hudly with GRT Avioinics Computer Stick Option

Electrical connection with GRT Computer Stick.cdr

Projector Location Options

The app allows the HUD (projector) to be mounted in its normal position or inverted. If the projector is mounted inverted, the check box in the GRT Remote app setting for inverted mounting must be checked.



Mounting the Projector and Combiner Glass

The Hudly is mounted using supplied double-sided foam tape. We found this method works great for the projector. The combiner glass will may shake at some RPMs, as we found in our company RV-6A. Shaking has not been observed by all customers however, and our impression is that our company RV-6A may vibrate more than average and might benefit from balancing of the propeller.

Even with this vibration, we found a simple “U” shaped bracket, secured to the glare shield with double-sided foam tape completely eliminated all shaking of the combiner glass, resulting in a very clear image at all RPMs. Double sided foam tape, without the protective backing removed on one side, was applied to the bracket so that it could grip the glass combiner.

The combiner glass should be about 7.3” from the projector. Hudly supplies a template to help achieve this. We found that it is not critical that it be exactly at this distance, and found that positioning the glass slightly further away made the image slightly larger, and still allowed plenty of head movement.

Positioning of the Combiner Glass

When using the HUD in condensed mode, the position of the combiner glass is not critical. However, if practical, recommend positioning the combiner glass to support augmented reality mode so this mode may be evaluated.

Positioning the combiner glass for augmented reality mode requires that the actual horizon appears about ¾ of the way up in the combiner glass when the airplane is in its zero-pitch attitude orientation, which should correspond to zero degrees pitch. (This position allows for a greater field-of-view below the horizon, which is where the runway appears when on approach, where the flight path marker should appear, etc.) In addition, the center of the combiner glass (in the left/right direction) should correspond to straight ahead, thus aligning the combiner glass in yaw.

Determining where the actual horizon is at requires a view through the windscreen of the distant horizon, without the horizon being obscured by trees, buildings, etc. Rising or falling terrain could provide a miss-leading sense of the horizon. (The water perfectly represents the horizon.)

Since the image provided by most HUDs is not focused at infinity, it will appear to move slightly with motion of your head. For this reason, you should be seated as you normally do when flying. When looking through the combiner glass, you will tend to unconsciously position your head consistently, as not doing so will cut off part of the image.

If someone else flies your airplane, they will need to adjust the seat height (or add or remove cushions) so that their eye position matches the position set for you.

The recommended step-by-step procedure for positioning the combiner glass and projector are as follows:

1. Fly the airplane at normal cruise speed. Adjust the pitch ladder offset (Set Menu -> Primary Flight Display Setup), or the AHRS orientation via the AHRS orientation setting for adaptive AHRS, so that the pitch attitude is zero or a degree or two negative (meaning that the horizon line is slightly above the pitch ladder reference).
2. On the ground, position the airplane with the pitch attitude (shown on the EFIS) of 0 degrees (within 0.5 degrees), and with a view of the distant horizon. (For a tailwheel airplane, it will probably be necessary to elevate the tail.)
3. Using double sided foam tape, temporarily mount the combiner glass so that the actual horizon is 3/4 of the way up the combiner glass.
4. Power on the HUD and connect an android device so that the a full-screen image is being displayed. (The default HUD startup graphics that are shown when there is no connection to an Android device may not fill the screen, making it difficult to adjust the HUD for best viewing.
5. Mount the projector. For the Hudly Classic this is done with double-sided foam tape, using the supplied template. This will position the projector will be about 7.3 inches from the combiner glass mounting clamp. Small adjustments to this distance can be made to adjust the size of the image so that it fills about 80-90% of the combiner glass vertically. Note that the mount for the projector allows adjustment in roll. Other brands of HUD will require different mounting provisions.
6. Adjust the “Pitch Offset” setting (in the android device) so that the ***HUD horizon line*** is on the actual horizon. Ideally, this should occur when the pitch offset is set to +1.0 degrees.

Above: The simple bracket we used to eliminate vibration of the combiner glass for the Hudly Classic. This bracket was later removed after the propeller was balanced, as it was no longer necessary.

Blue-Tooth Pairing and Configuring the App

After connecting the Android compute stick to the Hudly in the airplane, power everything up, including the GRT EFIS with a Bluetooth dongle in its USB port. If a Mini,Sport EX or Sport SX is being used to drive the HUD, the blue-tooth dongle must be installed in a USB hub that is connected to the EFIS USB port. A USB mouse must be connected to the compute stick for this setup, and if you wish to make changes to the app preferences. Follow these instructions to pair the Bluetooth of the compute stick to the EFIS.

1. On the EFIS, select the "Set Menu", and open the "Wireless" menu. Open the Bluetooth Menu.
2. The status should show "Enabled", which indicates the Bluetooth dongle was recognized by the EFIS. If the status is "Not Available", make sure the blue tooth dongle is installed (with a USB hub for Mini or Sport SX/EX models).
3. The Hudly should be showing the GRT App. Right click as necessary and exit the app. Select the settings icon and select "Bluetooth".
4. Change the discoverable setting to "YES". The Hudly should show that the GRT EFIS is available for paring. Click on it.
5. Confirm the pairing code and click on "PAIR".
6. Cycle the power to the android stick (or use your mouse to start the GRT App). Live data should appear on the HUD.
7. Right-click on the mouse to exit the HUD portion of the app. Select the "Menu" icon, and configure the app as described by the following table. Most of the default settings will be adequate for initial use. We started with the "Compressed" mode of operation until we were satisfied our combiner glass/pilot eye position was such that the actual horizon was passing through the top third of the HUD combiner, at which time we switched to "augmented reality" mode. Read about the modes of operation below.

Setting	**Value**
PFD-HUD Mode	Lo-Res
EFIS Screen Dimming also dims HUD	Checked
Wide Screen	Un-checked
Correction for HUD screen distortion	A small value (+/- 25 or less) will typically reduce screen distortions. We use +15 for our RV-6 Installation.
HUD Mounted Inverted	Usually un-checked
Background Scaling	For augmented reality mode, approximately 30 For compressed mode, 100 or as desired
Pitch Offset	For augmented reality mode, about 2 degrees For compressed mode, about 6 degrees
Pitch Ladder 1-degree increments	For augmented reality mode, checked. For compressed mode, unchecked
HUD Line Width Setting	9
HUD Line Color	0 (Green) or 3 (Cyan), or according to preference

Start-Up

An auto-starter app is included and pre-configured on the pre-programmed android compute stick included with the GRT HUD Package. The compute stick will start the app and the HUD will become functional about 30 seconds after power is applied.

HUD Modes of Operation

The scaling of all symbology that represents real world information, such as the runway, pitch ladder and position of the flight path marker can be configured to approximately overlay the real world (augmented reality mode), or scaled as desired to provide a wider than actual field of view (compressed mode).

Compressed Mode

When scaled in this manner, a larger field of view is represented on the HUD than is seen through the HUD. This results in symbology will not corresponding to the position of the real-world items they represent. For example, the horizon line will not stay on the horizon when the airplane is pitched above or below the horizon.

Setup for Operating in Compressed Mode

Adjust the scale factor to provide the field of view desired. The following table lists the typical field-of-view as a function of the scale factor.

Scale Factor	**Vertical Field-of-View (degrees)**
100	12
200	24

Augmented Reality (1:1) Mode

This is the mode in which aviation HUDs typically operate. It allows the HUD to augment the real world by approximately drawing its symbols over the real-world items they represent. Approximately is used here intentionally, as movement of the pilot's head will cause some motion of the symbology relative to the outside world, and this mode is also sensitive to magnetic heading (magnetometer) errors, as magnetic heading is used to position the symbology on the HUD, as well as the position of the combiner glass and the adjustment of the pitch offset.

Careful setup can minimize these errors, allowing the HUD to operate quite successfully in the traditional augmented reality mode.

Setup for Operating in Augmented Reality Mode

The following procedure is recommended to optimize the setup of the HUD. This procedure is intended to result in more view below the horizon than above, which matches the pilot's view during approach.

1. Follow the steps under "Positioning the Combiner Glass".
2. While on the ground, and seated in your normal position, perform the following steps:
3. Adjust the HUD Scaling. This is accomplished by comparing the pitch ladder something of known angular size. The angular size can be computed from the following table, or with the equation Angle = arc sin (height/distance).

Angle	Height of Object (feet)	Distance in feet to object from viewers eyes
1	1	57
2	1	29
3	1	19
1	2	114
2	2	57
3	2	38
4	2	29
5	3	34

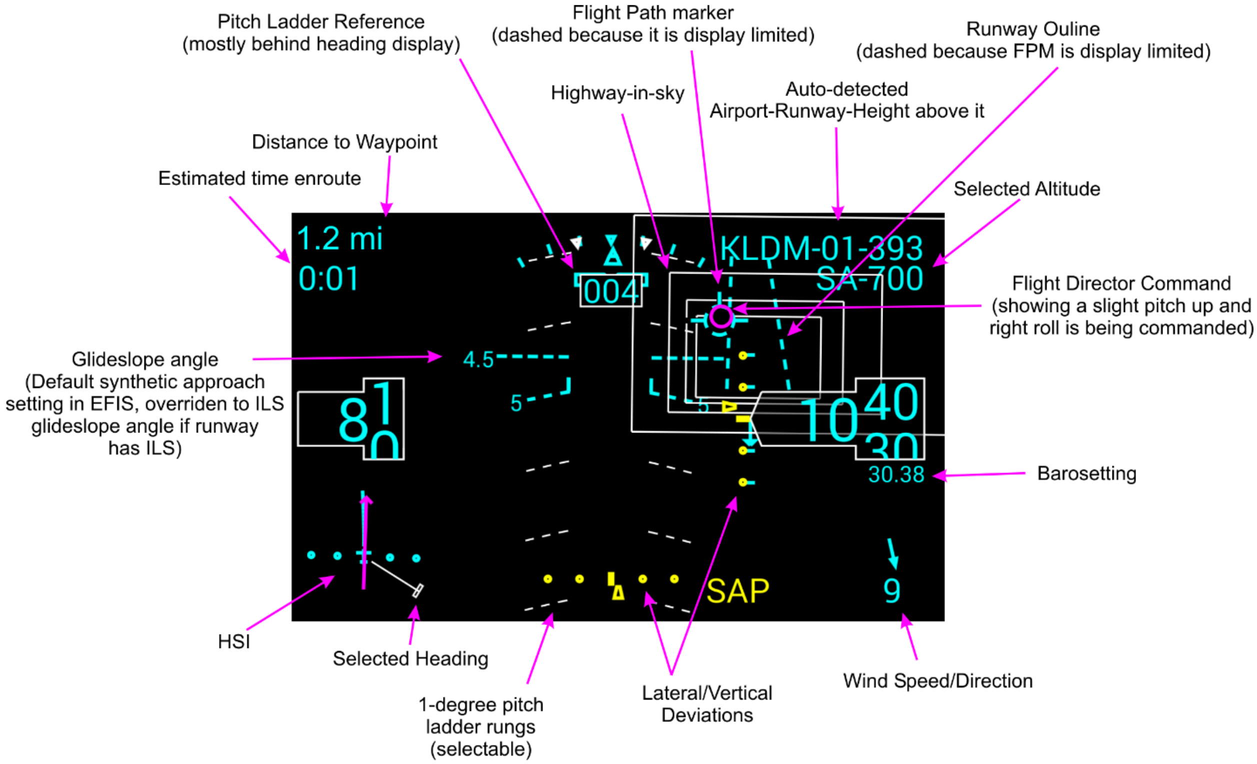
a. Measured Height Object using pitch ladder in degrees: ___________
b. Actual Height of Object in degrees: ______________
c. Factor = line b / line c
d. New "Background Scaling" = Current "background Scaling" setting / Factor

Example: Starting with the default "background scaling" of 100, we measured the angular height of a 1-foot object, 57 feet away (a 1-degree high object) using the pitch ladder scale through the HUD as 3 degrees. We computed the new "background scaling" factor by taking the current background scaling, (100) and dividing by a factor of 3 (measured height (3 degrees)/actual height (1)), resulting in a new background setting of 100/3 = 33.

4. Adjust the pitch offset, if necessary, so the HUD horizon line appears on the actual distant horizon. If the combiner glass was precisely positioned, the pitch ladder reference symbol should be in the top ¾ of the HUD screen.

Flying with the HUD

For your initial flight experience with the HUD, we recommend using default settings. The current software does not show warnings, obstacles, or autopilot trim requirements, or traffic so we recommend using audio alerts in the EFIS to keep you aware of these things. HUD specific functions and symbology is described below.



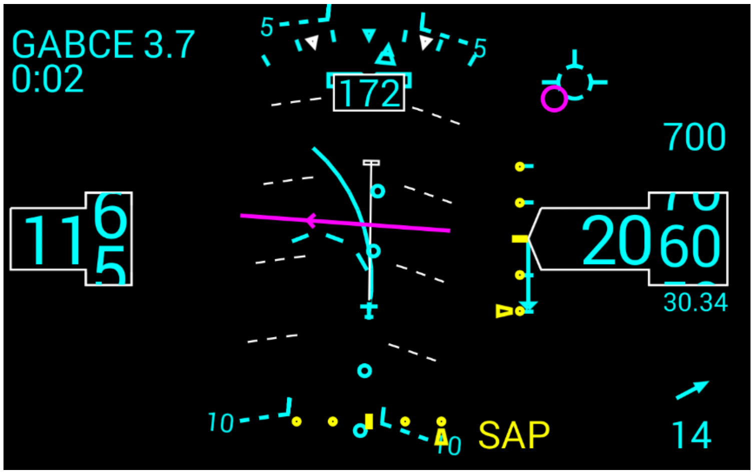
Selected HUD Symbology

Flight Path Marker and Flight Director

Autopilot/flight director settings made on the EFIS are used to drive the HUD flight director also. The HUD flight director symbology provides roll and pitch commands to the pilot that ***will result in the airplane flying to the targets selected on the EFIS***. For example, when altitude hold and heading hold is selected on the EFIS (with, or without a connected autopilot or servos), the EFIS will generate a roll command to hold the selected heading, and a pitch command to hold altitude. These commands include have a predictive nature, making precise control of the airplane easy. For example, the pitch command will provide anticipation of altitude capture and will reduce the pitch command depending on the vertical speed. Similarly, the lateral commands include capture of new courses, etc.

Caution: The flight director mode will always match the mode selected on the EFIS. If HITS is enabled on the app, but the flight director mode is not set to SAP, the flight director guidance will not agree with the HITS guidance.

Flying the flight director command is achieved by rolling the airplane to move the magenta circle inside of the flight path marker laterally and pitching the airplane to move it vertically. The response to the command should be gentle…roll/pitch the airplane in the commanded direction until the magenta circle and flight director come together. Avoid “chasing” the flight director with aggressive maneuvering…just try to maneuver in the commanded direction.



Above, in the upper right, the flight path marker and flight director are shown. Rolling the airplane left, and pitching down, will move the flight director magenta circle toward the inside of the flight path marker. Note that the flight path marker is displayed with dashed lines, indicating it is "display limited". This means the flight path marker position was limited on the screen so that it would remain visible. This means that the actual path of the airplane in the real world will not correspond to the position of the flight path marker on the HUD.

When the HUD is used in augmented reality mode, and the magnetic heading and alignment of the combiner glass is accurate, the flight path marker shows you where the airplane's path relative to the outside world you see behind it.

Lateral and Vertical Deviations (ILS, GPS, and Synthetic Approach)

The lateral and vertical deviation scales are driven by ILS, GPS approach deviations, and synthetic approaches. They appear when an ILS frequency is tuned and the EFIS navigation mode is "NAV" (radio), when a GPS approach is selected with includes vertical guidance and the vertical guidance is valid, or when a synthetic approach is active. The scales are shown in yellow are their source is identified as follows:

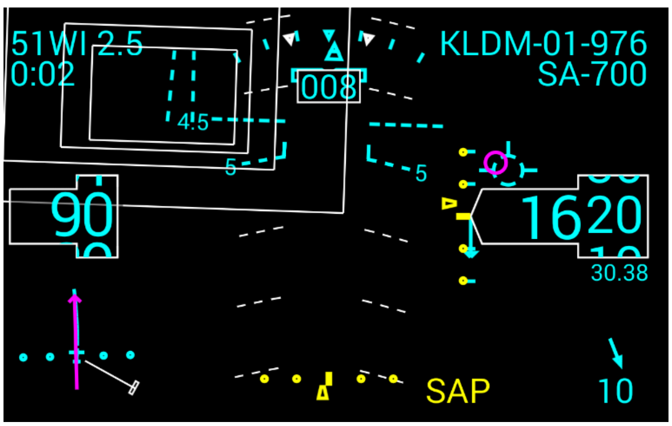
Source Identifier	Source of Data
SAP	Synthetic approach with Baro-Altitude used for the vertical reference.
SAP-G	Synthetic approach with GPS Altitude used for the vertical reference.
ILS	The ILS Navigation Radio selected on the EFIS. (The ILS scales will appear when the EFIS navigation mode is "NAV" and an ILS is tuned.)
GPS	The approach GPS navigation source selected on the EFIS. (The approach deviation scales will be displayed when the vertical GPS deviation is valid, and the EFIS nav mode is GPS.)

Goto Waypoint Display

The GPS current goto waypoint and distance to this waypoint (in the units you set in the app) are displayed in the upper left corner. This estimated time to the destination, based on the track relative to the bearing (track made good), and the groundspeed can be displayed below this by selecting this option in the settings on the app. (The default for the ETA is "OFF".)

Automatic Runway Detection - Runway ID and Height Above Runway

As shown below, the runway is automatically identified by the HUD software as you approach the runway. The airport identifier will precede the runway number if the current goto is not the same as the airport you are approaching. The height above the runway (based on baro-altitude) appears to the left of the runway. This information will initially appear in the upper center part of the screen to alert you, and then move to the upper right.



In this screenshot the runway and airport have been identified as KLDM, runway 01. The airplane is currently 976 feet above the runway.

Runway Outline

A runway outline is displayed when enabled via the app settings. When operating the HUD in augmented reality mode, this outline would ideally outline the actual runway seen through the HUD, when the flight path marker is not display limited. In our experience, even with imperfect heading accuracy and HUD alignment, we found the runway outline was close to this actual runway position out the window, and we found it very useful to quickly locate the actual runway. This was especially true at night, or when visibility was limited.

When the flight path marker is display limited (shown with dashed lines), the runway outline will also be displayed with dashed lines, and its position on the screen will not represent the real-world position of the runway. However, the relative location of the runway outline to the flight path marker will remain accurate, allowing you to navigate to the runway by placing the flight path marker (display limited or not) on the runway outline.

If desired, the centerline of the runway can also be displayed. This is controlled by the app setting, "Show Runway Centerline".

Highway-in-the-Sky Approach Mode

App settings allow the HITS boxes to always be displayed whenever a runway is detected, displayed only with a synthetic approach has been selected on the EFIS, or never displayed. Selecting “Whenever a Runway is Detected” will not result in the EFIS showing a synthetic approach. The synthetic approach must be selected on the EFIS for it to be displayed there.

The HITS boxes on the HUD are slightly smaller than those on the EFIS and could differ in position laterally. The HUD will position its HITS boxes along the runway centerline, and will use the glideslope angle it receives from the EFIS. The EFIS will override runway centerline guidance to the localizer centerline (which could be different than the runway centerline) for runways that have a localizer. Differences in the lateral position of the HITS boxes may also be noticed when the EFIS navigation mode is ILS, as the localizer will cause the EFIS to alter its HITS boxes to agree with the localizer data, but the HUD will not.

In addition, the vertical placement of the boxes on the EFIS can differ from the HUD if the HUD is using GPS altitude for it’s approach reference, as the EFIS will always use baro-altitude, and when navigation radio glideslope data is being received. (The EFIS will alter its HITS boxes to agree with glideslope data, but the HUD will not.)

Synthetic Approach and ROLAP uses GPS Altitude

When checked, the runway overrun and low approach function (ROLAP) and the HITS boxes are generated based on GPS altitude (not baro-altitude), when GPS altitude is available. This eliminates the need to verify the altimeter setting, however can be subject to GPS errors (usually small).

Note: The flight director commands shown on the HUD are generated in the EFIS. Since the EFIS will only use baro-altitude data for its synthetic approach guidance, the altimeter must be correctly set in the EFIS to allow the flight director to providethe flight diis driven by baro-altitude only when the EFIS is commanding it for a synthetic approach. (See flight director section.)

Selected Altitude

The selected altitude is show in the upper right corner, preceded by “SA-“. The previous figure shows a selected altitude of 700 feet.

Enhanced HSI Display

A horizontal situation indicator is provided in the lower left corner of the EFIS. It operates similarly to a conventional HSI, showing the selected course and cross-track deviation with a magenta arrow, cross track deviation dots, and a selected heading symbol. The ground track of the airplane is shown under the selected course as a straight-line segment.

When the EFIS sets the HSI scaling to approach scaling (less than 1 nmi full scale deviation), the projected ground track of the airplane will show a predicted path over the ground, based on bank angle, speed, and current winds. When this happens, the path will curve with bank angle. This aids in capturing new courses during approach.

When significant course changes occur during waypoint sequencing of non-fly over waypoints, the enhanced HSI enlarges and moves to the center on the screen to alert you to the upcoming course change. The predicted path will be displayed, as well as the dashed line path based on a standard rate turn. The standard rate turn path also includes the effect of speed and winds, with a bank angle that will result in a 3 degrees/second heading rate. This HSI will return to its normal position automatically.

This alerting of course changes can be disabled in the app settings, using the “Large HSI for New Course (Waypoint) Capture” setting.

Runway Overrun/Low Approach Protection Function (ROLAP)

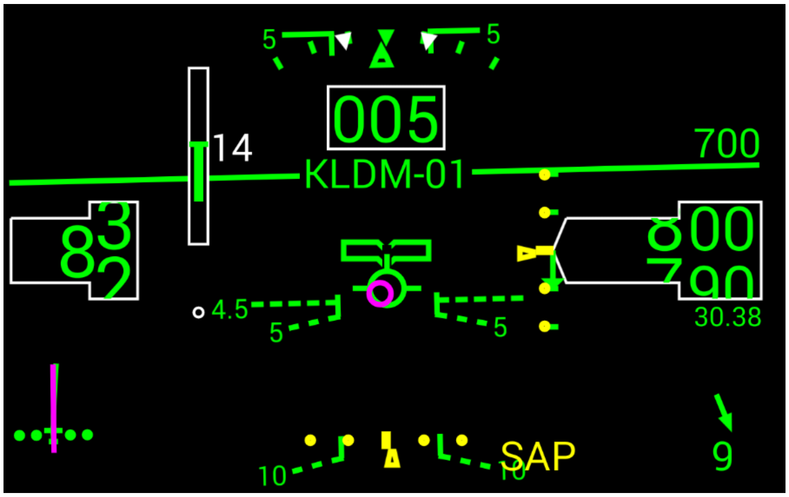
This function is designed to address accidents involving over-running the available runway, as well as shallow approaches that could result in collision with obstacles. The function requires no pilot input, activates automatically at 250 feet above the runway, and continues to monitor the approach and landing until the airplane exits the runway. The function turns off if the vertical speed indicates a climb, such as would occur on a go-around. Alerting is provided via large colored text near the center of the HUD screen for low approach, overrun, or when using the runway margins that have been set.

The ROLAP function predicts the runway required based on the current airplane speed and baro-altitude or GPS altitude (dependent on the setting of the “, and accounts for the effect of density altitude. This estimate is continuously updated, allowing the pilot to be alerted if the flare is extended with the use of power.

CAUTION: The ROLAP function assumes the landing roll distances entered set in the app and does not account for the possible loss of braking action due to reduced friction of wet, icy, sand covered, or other compromised runway surfaces.

CAUTION: The ROLAP function uses baro-altitude or GPS altitude for its prediction, and thus is dependent on the pilot to correctly set the barometric pressure before landing when baro-altitude is used.

Note: The ROLAP function is available for all runways included in the US government navigation database for US airports.



Show above, landing on runway 01 at KLDM. The ROLAP function is predicting 1400 feet of runway will remain beyond the landing distance plus margin set in the app. The green rectangle within the white rectangle illustrates the current prediction of the runway that will be used from touchdown to full stop. Winds are currently 9 knots, nearly on the nose. Synthetic approach is active.

Required App Settings for ROLAP Function

Stall Speed (in selected units) – The ROLAP function will assume the airplane is on the ground when the airplane is at or below this speed. Enter the stall speed in the landing configuration, in the units set for the app. The default setting is 57.

Landing Configuration Glide Angle – The flight path angle below level flight when the airplane is gliding with idle power (or more accurately, the power that is typically used when in the flare), flaps and gear configured for landing. This angle can be computed from as Arcsine(descent rate in feet per minute/(5280/60 * approach speed in mph), or Arcsine (descent rate in feet per minute/(6076/60 * approach speed in knots). The entry must be made in degrees. The default setting of 7.5 degrees is a good setting for most airplanes. Typical settings will be in the 5-8-degree range. Lower values will cause the ROLAP function to predict more runway is required to slow the airplane during the flare, and may be appropriate if some power is typically retained during flare.

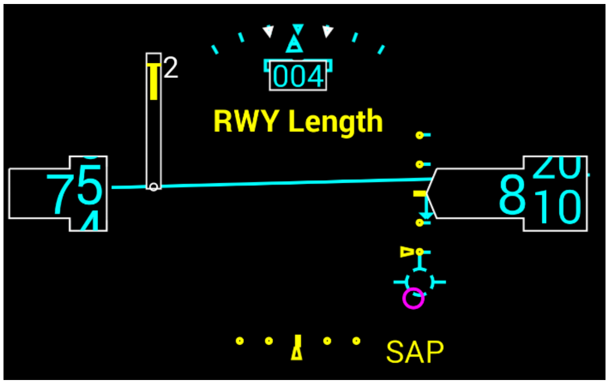
Landing Rollout Distance – The distance in feet required to stop the airplane from the stall speed entered above. Note that if the value entered is for dry paved runways, the actual stopping distance will be longer for other runway types and conditions.

Landing Margin Distance – This distance in feet will be added to the prediction of runway required. If the predicted runway remaining is less than this distance, a “RUNWAY LENGTH” alert will be generated.

Disable Runway Remaining Display – When checked, this inhibits the runway required display unless runway margins, overshoot, or low approach are predicted. The intent of this setting is to allow minimum clutter on the HUD display during approach and landing. This entry defaults to unchecked.

Runway Required Display

At 250 feet above the runway, the runway symbol will appear. A solid rectangle will appear within the runway symbol indicating the predicted runway required. A green rectangle indicates the predicted runway usage is within the bounds of the actual runway with margins as entered in the ROLAP settings. This rectangle will be yellow if the landing margins will be violated, and red if the ROLAP function predicts insufficient runway is available to stop the airplane on the available runway.

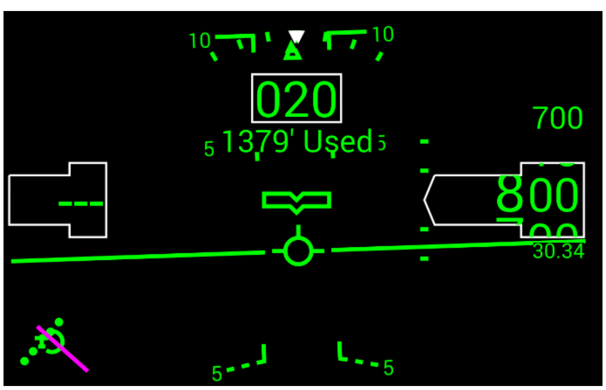


Overrun/Low Approach Warnings

If the runway ROLAP function predicts the airplane will not be able to stop in the available runway, the word "OVERRUN" will appear on the HUD. Similarly, if the airplane descends below a 2-degree slope to the near end of the runway, the message "Low Aprch". These alarms will also change the color of the predicted runway use rectangle to red. (Caution: This 2-degree limit is arbitrary, and does not imply obstacle clearance is assured when above this limit.) In either case, the pilot should take immediate action if either of these warnings appear.

Runway Used Measurement

Upon reaching less than 3 mph, or turning off the runway, the app will compute the amount of runway used. This will be displayed in the center of the screen initially, and then move to the upper right corner. The distance shown will be that required to slow from the stall speed set in the app, to the point you reached 3 mph or less, or when you turned off the runway. This display is intended to make you aware of your personal landing distance requirements.



Automatic Screen Declutter during Landing

When the runway has been detected, certain items on the HUD will be removed when the airplane passes over the approach end of the runway. They will be restored if the airplane executes a go-around, stops, or turns off the runway. The items that are removed include the HSI/Map display in the lower left corner, barometric setting, selected altitude, winds, and runway outline (and centerline).

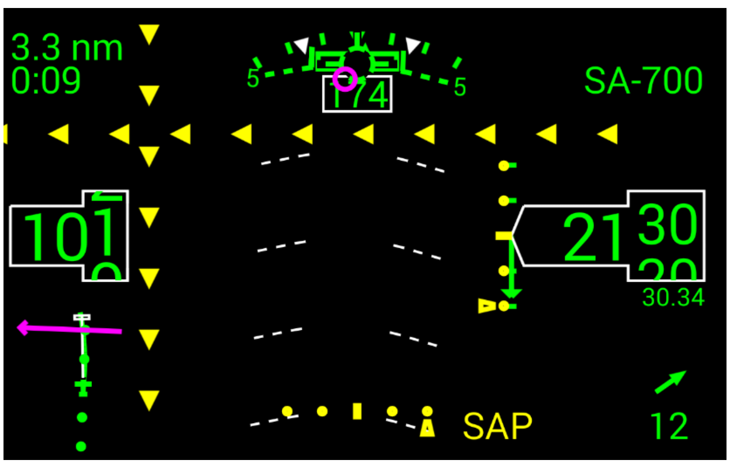
HUD Dimming

The Hudly will dim itself automatically based on its measurement of the ambient light conditions. The HUD is further dimmed by dimming the EFIS screen below level 8.

Note: If dimming the EFIS does not dim the HUD, an EFIS and/or HUD software update is required.

Caution: ***An overly bright HUD image can make it more difficult to judge your height for the flare maneuver when landing in complete darkness and could result in a hard landing.*** Be sure to dim your HUD before night landings.

Experimental Moving Flight Director



The experimental moving flight director yellow triangles indicating a right roll and pitch down is being commanded. The movement of these symbols represents the amount of roll/pitch command.

The experimental flight director function was created to using non-standard symbology to address the non-ideal focus of most HUDs. The intent was to provide moving symbols that can be sensed when the pilot is looking through the HUD but focused on the distant surroundings. This is accomplished by a moving ribbon of symbols horizontally (for roll commands) and vertically (for pitch commands).

A variety of settings are provided to allow the user to optimize the flight director for their preferences.

Experimental Moving Flight Director Mode – Selects when the experimental flight director is on.

Roll and Pitch Scaling – Sets the sensitivity of the motion to roll and pitch commands.

Roll and Pitch Threshold – Allows the flight director symbols to remain motionless until the threshold roll/pitch command is reached.

Moving Flight Director Size – Allows the symbols to be more or less prominent.

HUD Settings

The speed/distance units used for HUD must be selected on the setup menu, and other settings as described in the GRT Remote App user manual. The units selected for the app should match those of the EFIS display unit.

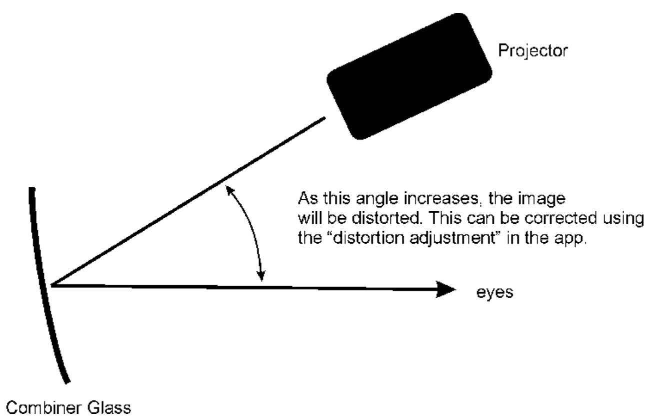
The remainder of the settings are described in the appropriate sections below.

HUD Mode

Follow the “GRT Remote App for Android” instructions for installing the app. Be sure to load the “GRT Remote App w/ HUD Support” version of the app. Once the app is installed, select the “Menu”, and scroll down near the bottom of the menu settings. Select “PFD-HUD Mode”. Select the “Hudly” option. This option will set optimize the graphics for the Hudly, and will cause the app to bypass the main menu at startup, and start in HUD mode. This allows HUD video to be generated without any user inputs, upon power up of the android, when an auto-start app is used to start the GRT Remote app.

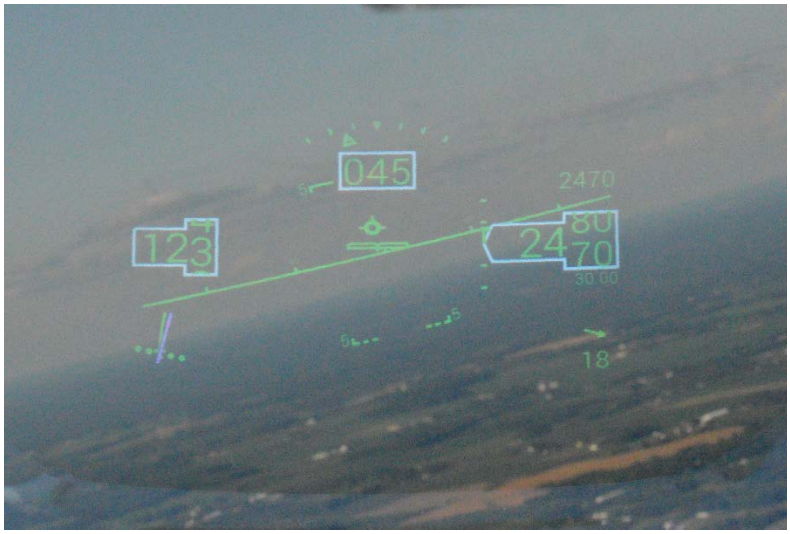
Correcting Optical Distortions

In many installations the image displayed on the combiner glass becomes distorted (straight lines appear curved) as the angle illustrated below increases. This can be compensated using the “Correction for HUD screen distortion” in the app’s set up menu. Trial and error is required with this setting. We found a setting of 15 was optimal in our installation.



The image can also appear to be tilted to one side. This is corrected by adjusting the position of the projector in its “roll” axis.

This image shows that the HUD configured in “condensed” mode, with the pitch reference set to the center of the screen. This image was made with an earlier version of the HUD software which did not display the goto waypoint info, had a smaller HSI, and several other differences, but is representative of the view the pilot sees when in flight. Slight distortion is visible, as the horizon line is slightly bowed up. This could be corrected using the “distortion correction” setting.



Various settings are provided to allow you to optimize the look and feel of the HUD. These settings also allow the app to adapt to new HUD devices as they become available.

Flight Path Marker Shows Drift – When checked, the flight path marker will move laterally on the HUD to show the effect of wind. If the HUD is configured in augmented reality mode, this will allow the flight path marker to show your path relative to the outside world (assuming your magnetic headings are accurate). Unless operating in augmented reality mode, with known accurate magnetic headings, we recommend turning this off (un-checked).

Wide Screen (Epic) – Specific for the Epic Eagle. Not recommended for any other HUDs. A portion of the screen is intentionally blanked by software to reduce internal reflections in the Epic, which would result in part of the screen being blank if used with a non-Epic HUD.

HUD Line Width Setting – Sets the width of the lines used to drawn HUD symbology. Thinner lines can be less distracting but may appear distorted.

HUD Line Color – Selects the color for the majority of the HUD drawing (accents, such as outlines of data, will remain in white). Cyan or green are common choices. We tend to prefer cyan for its slightly better sunlight readability.

1-degree Pitch Ladder Selection – Turns on pitch ladder rungs at every 1 degree increment. This is recommended only when using the HUD in augmented reality mode when the HUD background scaling is less than 100.

Recommended GRT App Settings

GRT App Setting for the Hudly Heads Up Display:

Setting	Value
PFD-HUD Mode	Lo-Res
EFIS Screen Dimming also dims HUD	Checked
Wide Screen	Un-checked
Correction for HUD screen distortion	A small value (+/- 25 or less) will typically reduce screen distortions
HUD Mounted Inverted	Usually un-checked
Background Scaling	For augmented reality mode, approximately 30 For compressed mode, 100 or as desired
Pitch Offset	For augmented reality mode, about +1 degrees For compressed mode, about 6 degrees
Pitch Ladder 1-degree increments	For augmented reality mode, checked. For compressed mode, unchecked
HUD Line Width Setting	9
HUD Line Color	3 (Cyan), or according to preference