Glideslope 2.1 MFD User Documentation

Introduction

Glideslope 2.1 MFD is a spacecraft reentry management tool developed for Orbiter 2010. It is an update to the original Glideslope MFD created by Chris Jeppesen (kwan3217), enhanced with new management screens, HAC geometries, updates to the algorithms and miscellaneous changes throughout.

List of Changes since v2.0

Feature:

1. Created Configuration Screen to allow more options to change the configuration in flight.
2. Reference Glideslope now selectable in flight (via config and via new GLIDESLOPE lines in GS2.cfg). (Thanks *Cras* & *boogabooga* for the suggestion.)
3. New color treatment throughout – reference data is now blue, actuals good are green, high yellow, low red.
4. Glideslope screen now has added data in the bottom right (range, delta azimuth and delta reference energy), allowing you to fly just off one screen if you prefer. (With toggle * flash effect warning as you approach the HAC)
5. Return of the reentry screen from the old Glideslope, via a config screen setting. New display data and ability to adjust hypothetical PeA up and down to match BaseSync's output. Predictors for resulting glideslope angle and vertical speed at entry interface.
6. Horizontal situation screen now has new information at the top relevant to phase of reentry, including delta reference total energy on all phases, range to WP1 and DelAz on reentry, WP2 arc and distance for HAC flight, and crossrange and PAPI distance on final. (Note – adjusting the HAC geometry recalculates the new reference total energy, meaning you get real-time feedback on your HAC adjustments relative to your energy situation.) (Thanks *boogabooga* for the suggestion.)
7. Glideslope 2 now saves and restores config settings in the scenario file, overriding the GS2.cfg defaults. (E.g. remembering where you were flying towards, and what your HAC geometry was).

Minor:

8. Suppressed invalid reference values on Data screen before entry interface.
9. Suppressed glideslope indicator on Horizontal Situation until we are in the HAC.
10. Added an autopilot active indicator on each page (AUT in top right corner). (Thanks *AssemblyLanguage* for the suggestion.)
11. Glideslope trace reset option (via config) … to clean up the glideslope history. (Thanks *Cras* for the suggestion.)
12. AoA setting now locked to degrees (no more millidegrees). (Thanks *indy91* for point this out.)
13. Optional display of internal diagnostics (via config setting).
14. Fixed rare / random CTD on Glideslope 2 launch. (Thanks *Cras* for flagging this one.)
15. Reduced the size of the source code zip. (Thanks *Enjo* for the tip!)

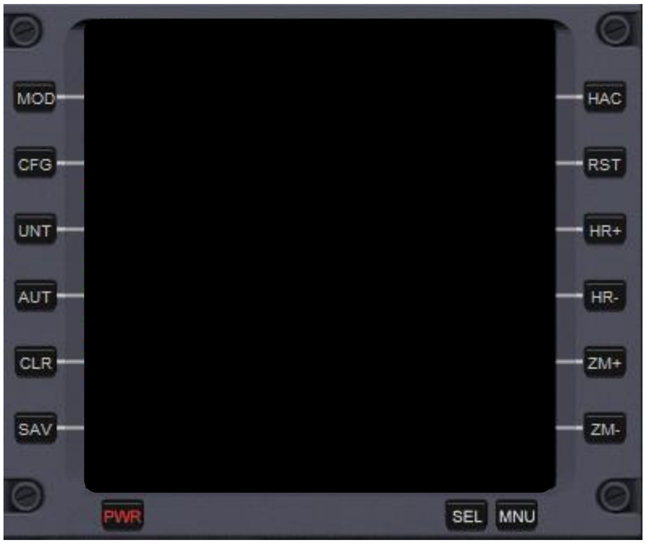
Pre-requisites

You need to install the MSVC++ 2010 SP1 redistributable from Microsoft. (Go here: http://www.microsoft.com/en-us/download/details.aspx?id=26999). Telltale sign of not doing this … it will complain about a missing MSVCR100.dll file. (Thanks *Wrangler* and *Orb* for flagging this dependency.)

MFD Purpose

Glideslope 2.1 MFD is intended to assist the Orbiter pilot to make a safe reentry, descent, HAC turn and landing at a base and runway of their choice on Earth, or on a planet with an atmosphere. It provides vertical & horizontal situation displays and digital & tapes-formatted flight descent data to provide the pilot with the optimal situational awareness to maximize their chance of making a safe unpowered descent and landing.

Left Side MFD Button Definitions and Usage



- **MOD = Mode Select**
  - Toggles through the four primary modes: vertical situation, digital descent, tapes descent and horizontal situation, plus an optional Diagnostic screen and Deorbit screen if enabled on the Config menu.
- **CFG = Configuration Settings**
  - Switches to the Config menu screen.
- **UNT = Units Select**
  - Toggles Metric or US (Imperial) measurements.
- **AUT = Autopilot**
  - Toggles on/off a Basic autopilot. If your spaceship has attitude control, use that instead.
- **CLR = Clear Track History**
  - Resets the track history (for example, to declutter the screen after selecting a different runway).
- **SAV = Save User Glideslope**
  - Creates a user saved glideslope in configuration file format, so you can set up your own reference glideslopes per spacecraft or planet, etc.

(The right side buttons will be covered later with the Horizontal Situation description)

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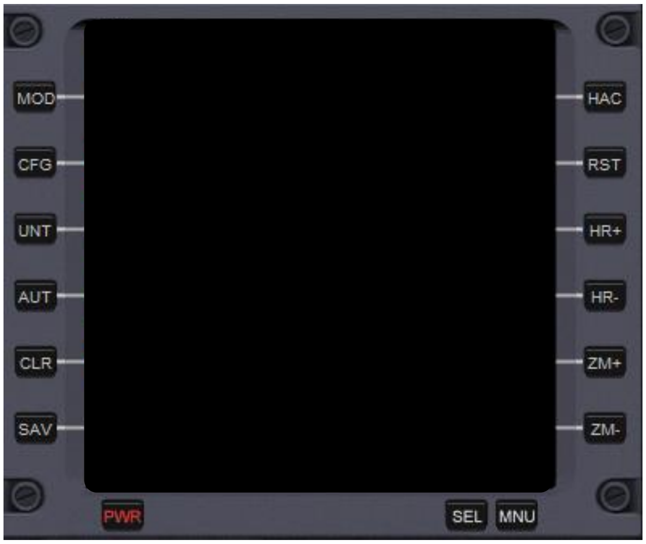

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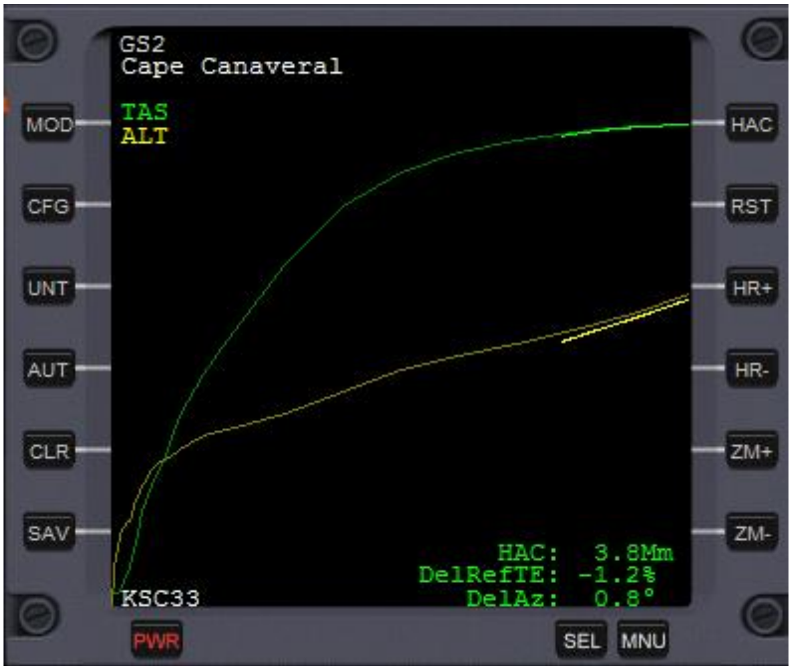
Config Menu Mode

This menu allows you to adjust general configuration settings in flight.

- **OK = Return**
    - Hit Ok to return to the previous mode screen.
- **PB / NB = Previous / Next Base**
    - Selects the previous/next base in the config file (or does nothing if just one base defined)
- **PR / NR = Previous /Next Runway**
    - Selects the previous/next runway at this base in the config file (or does nothing if just one runway defined at this base)
- **PG / NG = Previous /Next Glideslope**
    - Selects the previous/next pre-defined Glideslope in the config file (Note – if you do not specify a glideslope in the config file, a default/unselectable one will be selected).
- **DEO = Toggles the Deorbit screen on or off**
    - This option toggles display of the Deorbit screen into the mode cycle (MOD button) on the main display
- **DIA = Toggles the Diagnostic screen on or off**
    - This option toggles display of the Diagnostic screen into the mode cycle (MOD button) on the main display. Nothing too interesting down here – just some added data like Mach number and Heat Flux, and whatever I was debugging last!

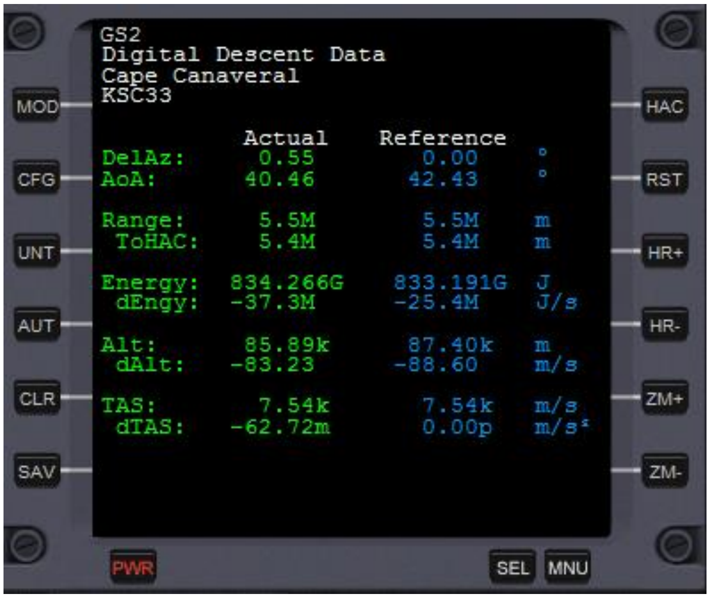
Vertical Situation Mode

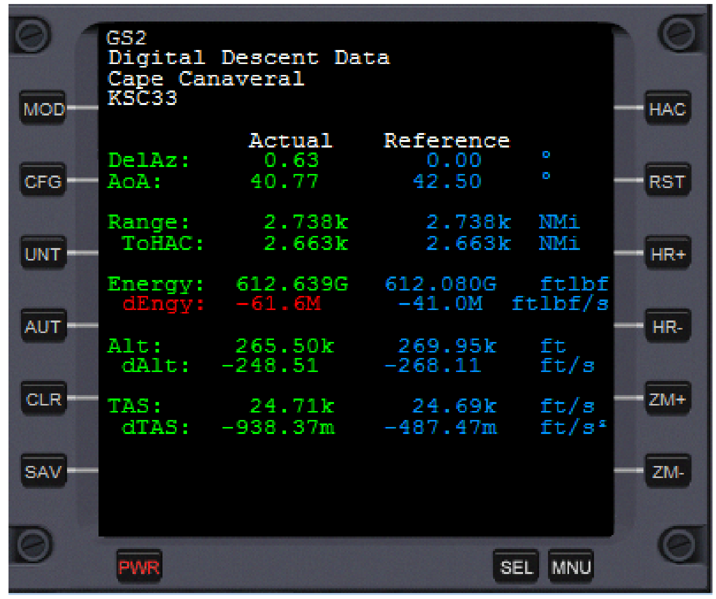


This mode shows the vertical airspeed and altitude profile for the glide slope. It's the primary mode for the descent phase to the HAC. The Information displayed is as follows:

- **Green traces = Current True Air Speed (bright green) versus Reference Air Speed (dull green), and**
- **Yellow traces = Current Altitude (bright yellow) versus Reference Altitude (dull yellow)**
  - You can get the actual values from the Digital Descent Data screen. These trend lines allow you to fly more intuitively, trending the current trace lines towards reference.
  - Note that the X-axis represents range to landing. Therefore when close to base and you change the runway or HAC geometry, expect to see discontinuities and jags on these traces. (You can clear the trace history using the **CLR (Clear Traces**) button.
- **HAC = Range to HAC entry**
  - Indicates your range to the HAC. When this is within 200km of the HAC, you will notice an alternating flashing asterisk next to the HAC to draw your attention to the impending end of the main descent phase.
- **DelRefTE = Delta Reference Total Energy**
  - This is a percentage indicator of your energy situation relative to the reference glideslope. Total Energy is the sum of Potential Energy (from altitude) and Kinetic Energy (from airspeed). Use this to monitor your overall energy state and trend as you come down the main descent.
- **DelAz = Delta Azimuth**
  - This is the track offset to the HAC waypoint. Trend this to zero by the time you get to the HAC.

Digital Descent Data Mode

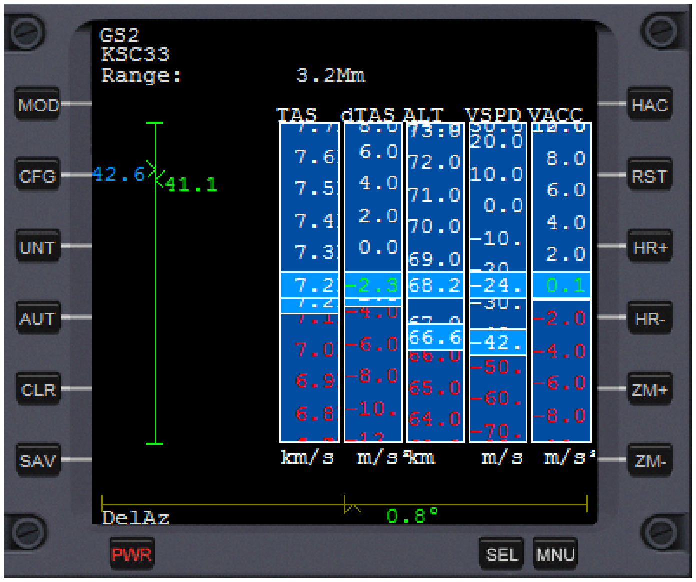




This mode shows the critical descent parameters you need to focus on. These two screenshots show the units in metric mode and in US (Imperial) mode as toggles by pressing the UNT key. The actuals will be in green (ideal), red (low) or yellow (high). Reference is always in blue.

- **DelAz = Delta Azimuth**
  - Indicates your groundtrack bearing offset to the next waypoint. There are three waypoints on the descent: the entry to the HAC (WP1), the exit from the HAC (WP2) and the touchdown point (TDP). During the main descent, you are tracking to WP1. In the HAC, WP2. On final, TDP.
- **AoA = Angle of Attack (Alpha angle)**
  - This is your wing angle relative to airflow, and critical for lift / stall, and vertical descent control.
  - Try to pay close attention to this as you come down the main descent through the highest heat phase, adjusting by half-degrees to keep your vertical speed (dALT) where you need it.
- **Range, ToHAC = Range to TDP, and Range to HAC entry**
  - Indicates your range to touchdown point, and additionally the range to HAC on the main descent. As range to HAC comes down to say 50km to go, ensure you have the Horizontal Situation up for the HAC.
- **Energy, dEngy = Total Spaceship Energy, and Delta Energy (rate of change of energy over time)**
  - Sum of gravitational potential energy (PE) and kinetic energy (KE). Use this to keep your overall energy situation under control, and to track the delta energy to trend it towards reference.
- **Alt, dAlt = Altitude, and Delta Altitude (Vertical Speed)**
  - Keep an eye on your altitude and rate of change, relative to reference. If everything is in the green, then watch dALT and keep that close to the reference by adjusting AoA up and down 0.5 degrees at a time.
- **TAS, dTAS = True Air Speed, and Delta True Air Speed**
  - You need to get your TAS down to around 800 m/s before HAC entry. Slow down faster by presenting more resistance to the airflow – i.e. raising your AoA. But balance this with the increasing vertical speed. Trend both air speed and altitude to keep your total energy in the green (high and slow / low and fast are both easily correctable).

Tapes Descent Mode



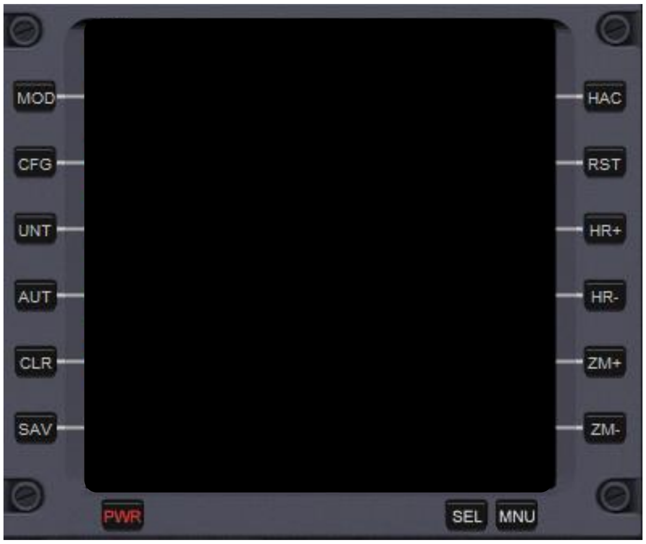
This is an alternative display of the reentry data, mimicking an analog cockpit if you prefer your data in that format. You have similar data to the Digital Descent Data Mode, but this is a more visual way to fly the descent rather than focus on the numbers so much.

- **Range**
  - Simple range to base measurement
- **Vertical pointer line**
  - Angle of Attack data, with the reference in blue on the left, and the current on the right (color-coded white, red or green for high, low or nominal).
- **Horizontal pointer line**
  - Delta Azimuth data, showing deviation to the desired track
- **TAS tape**
  - True Air Speed tape, showing current speed in the middle and the reference speed on the tape
- **dTAS tape**
  - Delta True Air Speed, showing rate of change of airspeed
- **ALT tape**
  - Altitude tape, showing current altitude
- **VSPD tape**
  - Vertical Speed (or delta Altitude), showing rate of change of altitude
- **VACC tape**
  - Vertical Acceleration tape, showing rate of change of VSPD

This mode is retained for historical reasons, as it was the primary data interface for the original Glideslope, but the Digital Descent Data is now the preferred mode for accessing this information.

Right Side MFD Button Definitions and Usage

Before describing the Horizontal Situation modes, we need to introduce the right side MFD buttons:



- **HAC = Heading Alignment Circle Geometry Selection**
    - Toggles through four HAC modes: left-entry closed HAC, left-entry open HAC, right-entry closed HAC and right entry open HAC. These modes govern the positioning of the HAC, where you enter and exit, and whether or not you need to do a full lap before exiting the HAC or not.
- **RST = Heading Alignment Circle Reset**
    - Resets the HAC settings back to default geometry, HAC radius and Auto-Zoom. Useful to allow you to play with various settings and then quickly reset back to normal.
- **HR+ = Heading Alignment Circle Radius Increase**
    - Increases the size of the HAC and the distance of the final approach. Useful when you are high energy (particularly high speed so you cannot pull a tight turn). This mode has a reset at 3x the HAC radius, so you do not increase the HAC turn without limit!
- **HR- = Heading Alignment Circle Radius Decrease**
    - Decreases the size of the HAC and shortens the final approach. Useful for low energy situations, where you cannot afford to do the full circle, or you want to tighten the approach as much as possible to a straight-in landing. This mode shrinks the HAC radius as tight as 500m (fly it “open”) and the final to 8km to allow a minimal final line-up before landing.
- **ZM+, ZM- = Manual Zoom In and Out**
    - By default this mode will auto-zoom appropriate to your range to touchdown. These buttons override the auto-zoom and allow you to lock it to your preferred zoom. This is useful in certain recovery situations where you want to see a broader view of the HAC, or where you want to zoom in to see a more close view of your flight path relative to the HAC.

Horizontal Situation Mode

This mode presents your horizontal situation relative to the HAC turn and final approach to landing. The display elements change depending on what phase you are in on the reentry. The first screen is the Descent mode, indicated by "Descent" after the selected runway. The screen elements here are as follows:

- **Runway, Phase, HAC size, HAC entry, HAC open/closed**
  - Runway name is obvious (in this case Kennedy runway 33)
  - Phase is "Descent" for the Main Descent to the HAC until you reach the HAC turn.
  - The HAC information shows the current HAC radius (15km), entry (left-turn) and open or closed (open meaning you will do a partial lap, closed meaning you will do a lap and a bit).
- **Range, ToHAC**
  - Range to runway and Range to HAC turn, as on the Digital Descent Display, color coded to indicate nominal difference to the reference (green), above reference (yellow) or below reference (red).
- **DelAz**
  - Delta Azimuth, as on the Digital Descent Display, and color-coded appropriately.
- **DelRefTE**
  - Delta Reference Total Energy. This is a percentage indicator of your energy situation relative to the reference glideslope. Total Energy is the sum of Potential Energy (from altitude) and Kinetic Energy (from airspeed). In this example, you can see we are -3.8% below reference energy.
- **Main yellow track**
  - Reference horizontal flight path, showing the deflection to the HAC waypoint 1 (WP1).
- **Green track and Green Cross indicators**
  - Current track and predictions for the next minute, based on bank angle and turn rate
- **Horizontal pointer and value**
  - Delta Azimuth presented visually.

This view of the Horizontal Situation mode is now approaching the HAC, with 65km to the turn. As you can see, the yellow track now shows the full HAC, the final approach and the runway is now visible in green at the end of the glideslope track.

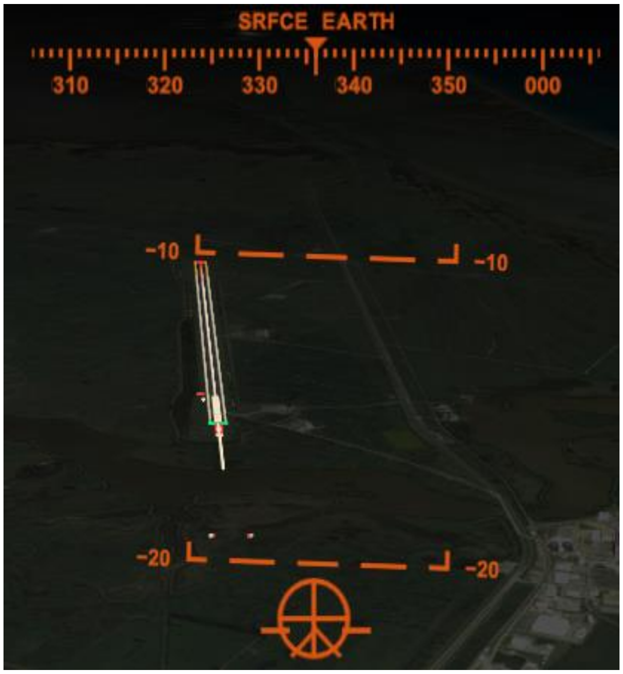
Also notice that the energy situation on this approach is now low (-9.6% off-nominal), so an adjustment to the HAC turn should be considered to reduce the deficit.

A few more kilometers down the glideslope, and as you can see, I have adjusted the HAC to now be an 8km turn, right entry, open ended (i.e. exiting without doing a whole lap). This geometry brings the Delta Ref TE closer to nominal energy again, and we are doing a nice circle-to-land approach, crossing over finals with the runway on our left side.

This screen shot shows the second phase of the reentry, now in the HAC turn.

The new screen elements here are as follows:

- **Runway, Phase, HAC size, HAC entry, HAC open/closed**
    - Phase is now "On HAC" indicating we are on the HAC turn
- **To Final**
    - The 'To HAC' range now turns into 'To Final', meaning the top of the final descent to landing.
- **HAC Arc**
    - This indicates the remaining arc degrees to final.
- **Main yellow track**
    - This track will now be auto-zooming to present a larger display. You can override this with the manual zoom (ZM+/ZM-) buttons.
- **Glideslope indicator**
    - The reference glideslope is 20°. As you come around the HAC, your actual glideslope will adjust according to your attitude. Typically you enter the HAC with the Glideslope low (say 5-10°), and watch it come up towards nominal as you do the HAC turn. As it gets close to target, adjust your descent to hold that slope until the PAPI lights.



This screen shot shows the third and final phase of the reentry, now on final approach. (The cockpit view is also shown for comparison to the Glideslope 2 display).

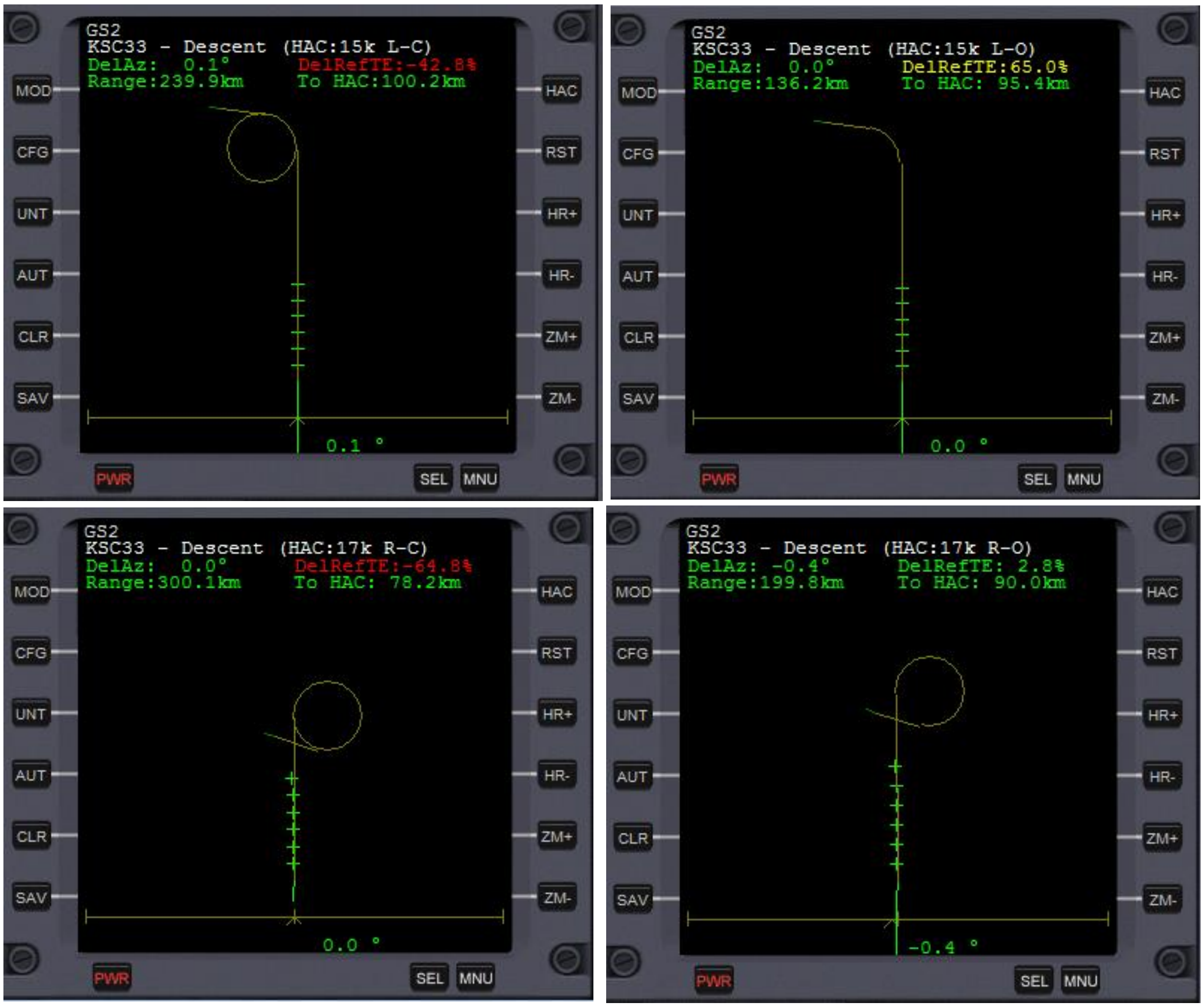
The new screen elements here are as follows:

- **Runway, Phase, HAC size, HAC entry, HAC open/closed**
  - Phase is now “On Final” indicating we are on final approach.
- **XRange**
  - The ‘XRange’ range is the cross-range offset to the PAPI lights (notice the PAPI’s on the cockpit view – offset 2km from the runway threshold). Use this as an aide for precision line-up, though by now you should be focused on the actual runway!

Fly towards the PAPI lights, using your airbrake as needed to get your speed ready for landing (e.g. 180-220 m/s for an XR spaceship). Very close to the PAPI’s, deploy your gear, and smoothly pull up your nose into a 1%-3% slope to pick up the inner glideslope VASI or Ball/Bar lights. An ideal inner glideslope puts the white ball on top of the red bar. (Notice on the cockpit view above, the whist ball is below the red bar, as we are still on the steeper outer glideslope.

Your touchdown point should be adjacent to those lights.

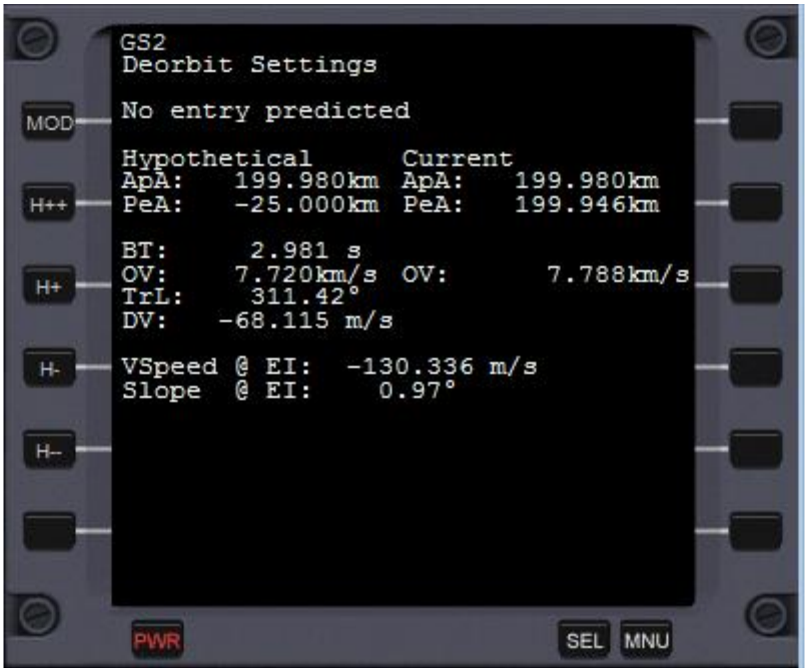
HAC Geometries on the Horizontal Situation Mode



These four sample screens show the four HAC geometries, selected with the HAC button.

- **Left-Closed (L-C)**
  - You will fly the rest of the approach to the HAC entry point (WP1), left turn into the HAC, do a full lap and then exit at the top of final (WP2) for landing. Range to base is the remainder of your approach to WP1, a full lap of the HAC, the arc range from WP1 to WP2, and the final distance to touchdown.
- **Left-Open (L-O)**
  - Opening the HAC removes the requirement to fly the full circle. Use this mode when you are low energy. Range is now just range to WP1, arc to WP2, final to touchdown.
- **Right-Closed (R-C)**
  - Right entry moves the HAC position to the far side of the runway. Useful for high energy, where you want more space to slow down pre-HAC entry.
- **Right-Open (R-O)**
  - Same as L-O, removing the requirement to fly the full lap.
- Press **RST to reset** the geometry and size to default.

Deorbit Screen Mode

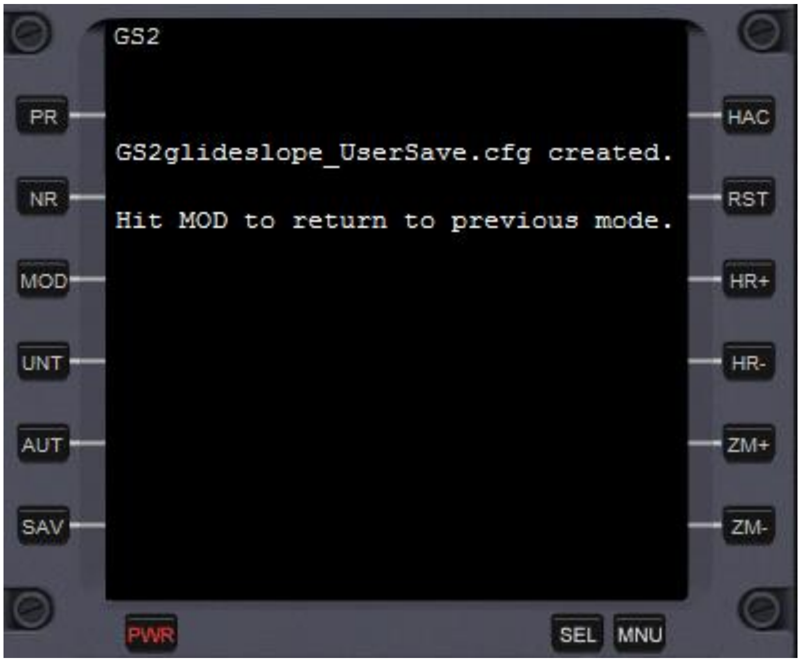


The deorbit screen is intended to be a cross-check to BaseSync MFD. It provides a means to set a hypothetical deorbit periapsis, and see the impact on the glideslope angle and vertical speed at the Entry Interface. The Deorbit Screen is disabled by default. You can enable it on the Config Menu. The buttons and elements are as follows:

- **MOD = Mode Select**
  - Same purpose as on the other screens
- **H++/H-- = Raise/lower the hypothetical PeA by a large increment**
  - Raises or lowers PeA by 1500m
- **H+/H- = Raise/lower the hypothetical PeA by a small increment**
  - Raises or lowers PeA by 100m
- **ApA, PeA = Apoapsis, Periapsis for current orbit and hypothetical orbit post-burn**
  - Same as Orbit MFD
- **BT = Burn Time, retrograde on main engines**
  - Burn time in seconds (match this to BaseSync)
- **TrL = True Longitude**
  - Same as Orbit MFD (burn when this matches the BaseSync TrL value)
- **DV = Delta Velocity**
  - Amount of velocity to burn off. Get this as close to zero as practical post-burn.
- **VSpeed @ EI: Vertical Speed at Entry Interface:**
  - Predicted vertical speed at the Entry Interface
- **Slope @ EI:**
  - Predicted glide slope at the Entry Interface

To use this menu in conjunction with BaseSync, use BaseSync to align the planes and select the deorbit parameters for the selected orbit. BaseSync will compute a predicted burn TrL longitude, and a burn time. Use Glideslope 2.1 to raise or lower your hypothetical periapsis to achieve the same predicted Burn Time. Check that the glide slope matches the requested glideslope in BaseSync (ANG setting), and that the vertical speed at the entry interface looks reasonable (e.g. around -100 m/s).

Save User Glide Slope Data



If you want to review your last descent and landing after exiting the Orbiter simulator, hit SAV. This writes a file GS2glideslope_UserSave.cfg into the Config\MFD\GS2 directory. If that approach was awesome enough that you would like to make it your new glideslope for that vehicle or planet, or even if you want to use it to see how close you can recreate your previous approach, you can use this config file directly as input to Glideslope for your next flight. You do this by setting up the GS2.cfg PREFS to point to UserSave, or rename your glideslope to your choice of name to avoid it being overwritten. For details on the configuration files, please see the next page.

Glideslope 2.1 Configuration Settings

You have extensive ability to configure Glideslope 2.1 through configuration files. Find them in Config\MFD\GS2 in your Orbiter directory tree. The base distribution has a master config file, GS2.cfg, and a number of glideslope config files of format GS2glideslope_{name}.cfg.

The GS2.cfg file

GS2.cfg defines the bases, runways and preferences for Glideslope 2. The default GS2.cfg has extensive comments to help you format it correctly. This is a summary of those comments:

Blank rows and rows starting with semicolons are ignored. Every other line needs to start with either BASE, RUNWAY, GLIDESLOPE or PREFS.

The BASE definition specifies a name for the surface base and its longitude and latitude. Example:

```
BASE "Cape Canaveral" -80.675 +28.5208
```

(You get this information from the respective surface base definition file for the planet).

The RUNWAY definition specifies a runway name, runway near and far end offsets, runway PAPI offsets and VASI offsets. Example:

```
RUNWAY "Cape Canaveral" "KSC33" -8220 -600 -12670 -3155 -2000 671
RUNWAY "Cape Canaveral" "KSC15" -12670 -3155 -8220 -600 -2000 671
```

The runway must reference a previously defined surface base (i.e. BASE “Cape Canaveral”… must exist before RUNWAY “Cape Canaveral” … lines will be recognized). The runway name is something you have to create yourself, as for some reason this is not in the main surface base definition files (this is a main reason Glideslope 2 reads this from a separate file). The runway offsets (e.g. -8220 -600 -12670 -3155 for KSC33) come from the End1 and End2 definitions in the surface base file (parameters 1 and 3 from End1, and the same for End2). The PAPI and VASI information comes from the RUNWAYLIGHTS block for your runway. If not present, -2000 and +500 work just fine. (Glideslope uses the PAPI point to mark the end of the 20-degree final glideslope, and the VASI point to mark the touchdown point. A PAPI of -2000 targets the main glideslope 2km from the foot of the runway, and marks the point you do the pre-flare for a soft landing. A VASI of +671 puts the touchdown point 671m down the runway.)

The GLIDESLOPE definition specifies a glideslope name and display name. Example:

```
GLIDESLOPE XR "XR Series"
GLIDESLOPE Shuttle "Space Shuttle"
GLIDESLOPE UserSave "User Saved"
```

The glideslope name corresponds to a valid glideslope file name matching the format: GS2glideslope_{name}.cfg. If the file does not exist, or the data is not parsable as a valid glideslope, then the entry is ignored.

The glideslope display name is the friendly name for the Config Menu. Note – by putting UserSave in the GLIDESLOPE parameters, you can directly re-fly the last saved Glideslope (e.g. if you are practicing the same approach repeatedly).

The PREFS definition specifies your choice of start mode for the left, right and external MFD's, the Units, the default runway, and your glideslope file. Example:

```
PREFS DATA VSIT HSIT METRIC "KSC33" XR
```

The first three terms are the default starting modes for the screens (VSIT = vertical situation, TAPE = tape display, DATA = digital descent and HSIT = horizontal situation, DIAG = Internal Diags, DEOR = Deorbit). The next entry is US or METRIC, to select the starting unit-preference. The next is the default runway (must refer to a RUNWAY line above). Finally is the glideslope name, which must correspond to a pre-defined GLIDESLOPE entry.

Glideslope is hardcoded to 64 bases, 128 runways and 64 glideslopes. (It's easy to increase if you need it, so long as you send me your proposed GS2.cfg file with all the new base definitions so I can roll into the main distro!!)

The GS2glideslope_{name}.cfg file

The last parameter of the PREFS line in GS2.cfg specifies the reference glide slope configuration file. The main distribution comes with three sample glideslopes for XR, Shuttle and DG spacecraft. If you hit SAV after a landing, you will generate a GS2glideslope_UserSave.cfg as well.

You are free to create any number of glideslopes matching this naming format, for different spaceships and situations (e.g. landing a DG-IV to Olympus Base on Mars). Just fly the approach, save your glideslope, rename it to your preferred name (e.g. GS2glideslope_DGIV_Mars.cfg) and reference it from the master GS2.cfg to activate it.

The glide slope format ignores blank lines and semicolon comments. The active components are UNITS, BEGIN GLIDESLOPE and END GLIDESLOPE. Between BEGIN GLIDESLOPE and END GLIDESLOPE, you put up to 256 rows of glide slope waypoints.

UNITS definition is similar to the GS2.cfg – US or METRIC. It sets the units for the glideslope. Note – you can set a glideslope with METRIC units and then display in US units, or vice-versa as you wish. I.e. the UNITS setting here is only to define the glideslope waypoints.

The glide slope data is rows of five numbers, with an optional trailing comment: range, altitude, true air speed, vertical speed and AoA.

The SAV function creates data in this same format. You may edit the values as you prefer, to smooth out any imperfections in your flight, or to drive the reference to achieve something different (e.g. fly at zero vertical airspeed for 40KM before the HAC entry, or hit the HAC much higher). Basically, you can set it up as you wish!

Author's Comments and Recognitions

My name is Andrew Stokes (ADSWNJ) and I have been flying the Orbiter for a couple of years now. It is a truly fascinating simulator, which invites you to engage at any level from casual to deeply technical. From my early days of getting a Delta Glider into orbit, to doing the first landings on the Moon and Mars, and to doing rendezvous with space stations and orbiting bases, to executing deep space voyages out to Saturn and Neptune, it's been an addictive pastime. Dr Martin Schweiger – thank you sir for an amazing platform that has created this community.

At each level of understanding, you can generally figure it out in a few hours to a point of basic competence, but mastering each activity takes a lot longer. In all my journeys, mastering the unpowered descent and landing was my hardest challenge. In January 2012, TMac3000 posted "My first unpowered landing", and the comments from Jarvitä, Tommy and PhantomCruiser inspired me to want to do better. I have used the excellent Glideslope 1 from Chris (kwan3217) Jeppesen for a long time, and I was fascinated to look at the source code he released. I've coded off and on for much of my adult life, on many technologies and levels (assembler on mainframes and VAX to X-Windows on Unix, and Win 32 on Windows). I wanted to get into addon development for Orbiter, and this seemed as good as anywhere to start!

So, with great respect and recognition to Chris's original code, which took me many weeks to figure out how it worked, I now offer back Glideslope 2 to the community, complete with source code. To the casual end-users, I hope that this gives you a greater feeling of control for your reentries and landings back on Earth. To the developers or potential developers, hopefully this source code will inspire you to understand how it works and go build something even more awesome from the bones of this code.

I would like to thank my fellow addon developers, spacecraft designers, graphics clients, MFD's and scenarios, and the scores of rocket scientists and physicists (in the truest sense of the word) who contribute to the forums and make them great places to learn.

Finally, I'd like to extend a special word of thanks to Szymon "Enjo" Ender, for his advice, contributions and encouragement. It's a pleasure working with you, Szymon.

Cheers, Andrew
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