BaseSyncMFD - Version 3.1 (10.09.2016)

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Credits

Jarmo Nikkanen is the original author of this MFD. Andrew Stokes has done minor modifications to the MFD since it was open-sourced in 2015. This software is created for Martin "martins" Schweiger's Orbiter Space Flight Simulator versions 2016 and 2010.

Installation

Extract the package into the Orbiter installation folder, respecting the folder structure in the .zip file. If you have done this correctly, you will be able to activate the MFD by selecting the tick-box opposite BaseSyncMFD in the Modules tab in the Orbiter Launchpad (i.e. the first window you see when you run Orbiter.exe or Orbiter_NG.exe).

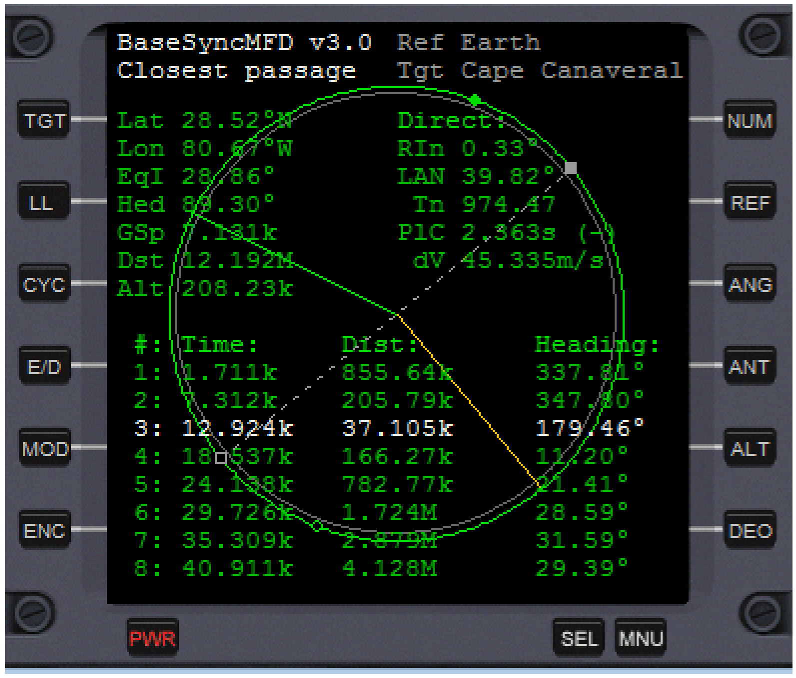
Keyboard commands:

Shift-B	Open this MFD
Shift-T	Setup target base
Shift-L	Setup latitude and longitude manually
Shift-C	Cycle between pages of orbit solutions (if number of orbits > 8)
Shift-D	Switch between equatorial and direct modes
Shift-M	Select display mode (text, graphics, both)
Shift-E	Select encounter mode (Closest Passage, Apoapsis, Periapsis, or Latitude)
Shift-N	Select number of orbits
Shift-Z	Setup Re-Entry Angle (vertical descent angle at re-entry point)
Shift-X	Setup Re-Entry Anticipation (degrees in front of the target at re-entry point)
Shift-A	Setup Re-Entry Reference Altitude (altitude at re-entry point)
Shift-V	Enable re-entry mode

Config file commands (see Config/MFD/BaseSyncMFD.cfg in Orbiter):

EQU_DIR_MODE	Set to EQU for Equator, or DIR for Direct
DISPLAY_MODE	Set to TXT for text only, GRA for graphics only, or BOTH for both
ENC_MODE	Set to CLOSEST, AOPAPSIS, PERIAPSIS, or LATITUDE
NUM_SOLUTIONS	Set to 1-99 for the number of solutions you prefer
RE_ANGLE	Set in degrees to your desired default re-entry angle
RE_ANTICIPATION	Set in degrees to your desired default re-entry anticipation angle
RE_ALTITUDE	Set in km to your desired reentry altitude.
Color_01 to _12	Adjust the color values for text and graphical elements (e.g. if you have difficulties seeing certain colors). The values all have the format 0x00bbggrr, where the bb, gg, and rr represent a hex value between 00 and ff for the intensity of the color.

Introduction



BaseSyncMFD is a multi-function display utility to allow you to precisely target a base or a set of landing coordinates for deorbit and landing. It allows you to predict the optimal orbit for a re-entry burn, and assists with burn timing and magnitude to put you on a precise path and angle to a desired re-entry point.

The default display shows both text data for the solutions, and a graphical overlay. The white highlighted solution is the best for your target, and the yellow line indicates the timing of that encounter point relative to your orbit (in green) and your current position (the green line). The dotted line represents the axis of the node-points to adjust the optimal solution to reduce the off-plane distance if desired. If you do not see a whit-highlighted orbit, then press CYC to cycle through the orbital solutions to find the best one.

Landing targets are specified by one of the following three methods:

1. Enter the Latitude/Longitude coordinates, by pressing LL and entering the values directly. The format can be one of the following: +28.52 -80.67, or N28.52 W80.67, or 28.52N 80.67W.

2. Enter the base name directly, by pressing TGT and entering the name. The base has to be present on the planet you are orbiting, or, you can override the reference planet or moon using REF, to allow you to set the target before you reach its gravitational influence, if you prefer.

3. Connect BaseSync to Glideslope 2.4 or higher, by pressing TGT and entering GS2 as the target. (See the following section for more on this method).

The NUM setting allows you to select how many solutions you want to display (between 1 and 32). Up to 8 solutions will fit a page, and you can cycle through up to 99 solutions using the CYC button. You should look ahead say 16 or 24 solutions to find the best, and then as this orbit finds its way to the top, reduce the NUM value accordingly to lock in on the specific solution you have found. (If you do not do this, and you have a large NUM value – e.g. 99 – then you may get frustrated to see your desired target orbit rolling up to the #1 position, only to be beaten by a better orbit 99 orbits away!).

The E/D button selects Equator or Direct mode for the data display (i.e. relative to the equator, or relative directly to the target). See more information below on this. MOD selects whether you want text, graphics, or both to be displayed. ENC selects the desired encounter mode, and this will be discussed in more detail below.

The ANG, ANT, and ALT buttons set re-entry parameters for the de-orbit program, and DEO selects the de-orbit program. This is fully described below.

The display data is as follows:

1. the Lat/Lon are the coordinates of the target, either auto-set from the target base, auto-set from Glideslope 2, or manually set via LL.
2. EqI is the Equatorial Inclination of our orbit.
3. Hdg is the heading to the base.
4. GSp is the ground speed.
5. Dist is the current distance to the base.
6. Alt is the altitude at the encounter point.
7. The right column shows either Equator or Direct synchronization, depending on the mode.
8. RIn is Relative Inclination (of our orbit to the target).
9. LAN is the longitude of the ascending node (for normal or anti-normal burns to align planes).
10. Tn is the time to the node
11. PlC is the Plane Change burn in seconds to align the white selected solution directly over the target.
12. (The (+) or (-) indicates normal or anti-normal direction for the burn).
13. dV is the change in velocity required to align the spacecraft to fly directly overhead the base.

The solution data shows solution number, time, distance, and heading from the encounter point to the target. For the Latitude mode, it just shows the time to the selected latitude, and the longitudinal offset at that encounter.

Deorbit mode has different data, shown below in the deorbit section.

Slaving BaseSync to Glideslope

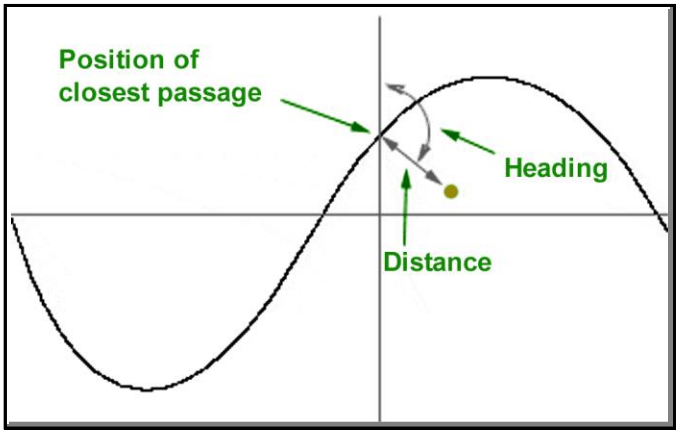
If you are using both BaseSync and Glideslope, then as of this release, these two MFD’s can now work very closely with each other. Glideslope will provide the targeting data (down to the landing point on the targeted runway or landing pad), and the reentry Altitude, Angle, and Anticipation data. Basesync will compute the right orbit, and the burn data. Glideslope will then execute the burn via its deorbit autopilot.

In order to enable this, please ensure you have BaseSync 3.0 or higher, and Glideslope 2.4 or higher, and you install the mandatory perquisite Module Messaging Ext addon (which provides the MFD interconnection code).

To activate the linkage between Base Sync and Glideslope, simply select target GS2 from BaseSync. You will see “Linked to GS2” in the upper right corner of the main display, and “Ang, Ant, Alt from GS2” on the Deorbit display. Note that while slaved to GS2, you will not be able to manually set ANG, ALT, or ANT.

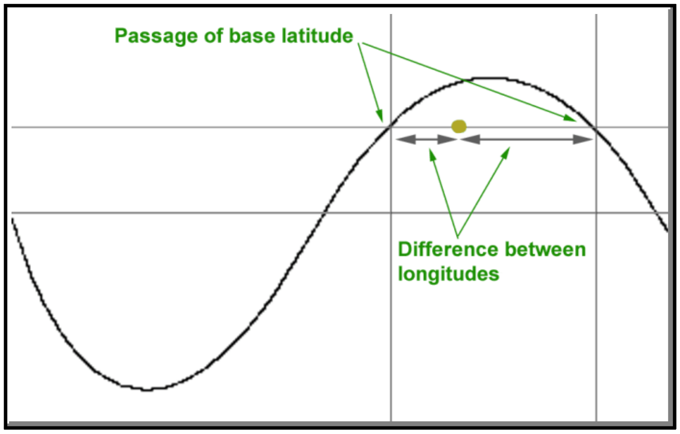
Encounter (Synchronization) Modes:

Closest Passage



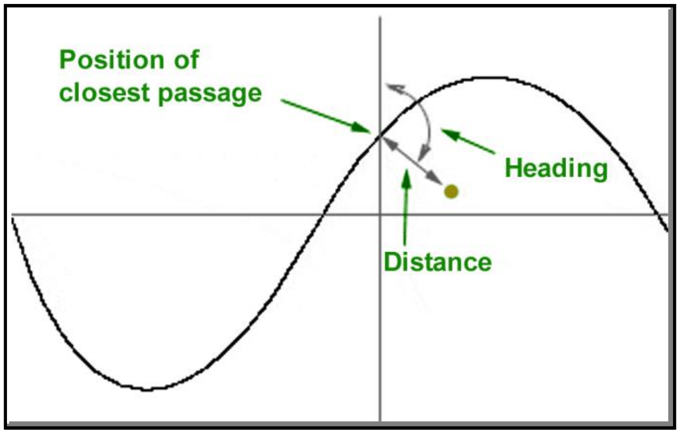
This is the standard mode for Base Sync, and the one you will use most often. This mode searches for the orbital point where you have the least perpendicular distance to the target.

The image on right represents this search mode. Typically there is just one closest solution per orbit. The solution list on a screen shows the time to position, distance in meters and the heading to the target. For example, from the screenshot on the previous page in the Introduction section, we are targeting Cape Canaveral, and the best solution will occur on the third orbit, 13,063 seconds from now, where we will be 471.20km from the target, at a bearing of 223.57 degrees.



Latitude

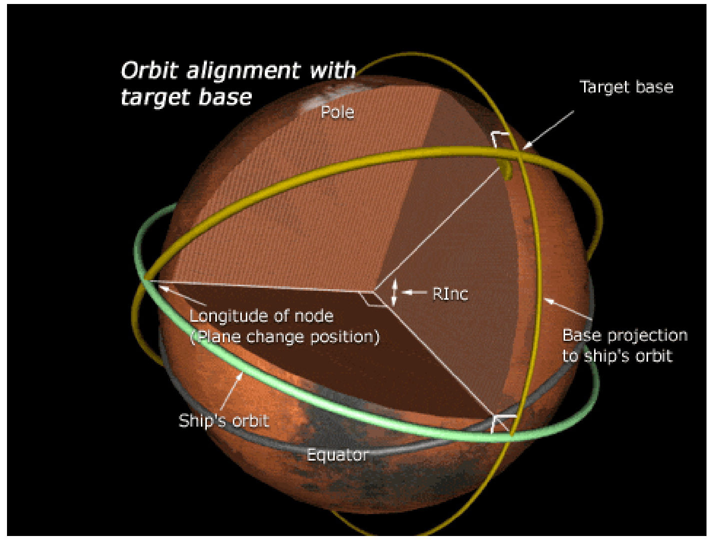
Latitude mode is used for analyzing orbit positions where the spacecraft is exactly at the target latitude. If the inclination is not large enough to touch this latitude, then you will see Target Out of Range, as there will be no solutions. If the inclination precisely touches the desired latitude, then there will be a single solution for each orbit. In all other cases, there will be two solutions per orbit, as illustrated in the diagram here. The solution display will show the longitude difference at the point we go through the selected latitude.



Apoapsis / Periapsis

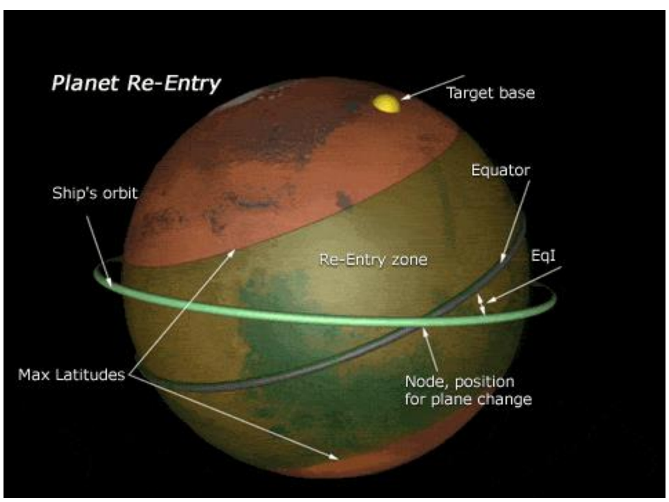
These modes will use the Apoapsis or Periapsis of the spacecraft's orbit for synchronization. The orbit list will show a distance between the projection of the Apoapsis/Periapsis onto the surface, and the selected base or the point. These modes would only be used in special situations where you want to align an eccentric orbit with a base.

Inclination Modes:
Direct



Direct mode represents a direct synchronization with target. The target is projected perpendicularly onto the spacecraft's orbit to determine the relative inclination and the longitude of the ascending node, such that plane burns can be made to reduce the offset distance if needed. (Note that BaseSyncMFD automatically computes the appropriate node burn parameters for the best solution, and displays them on the top right of the MFD window.

Direct mode is good for final adjustment with all targets. It can be used after a de-orbit burn after which the orbit synchronization may drift a little.

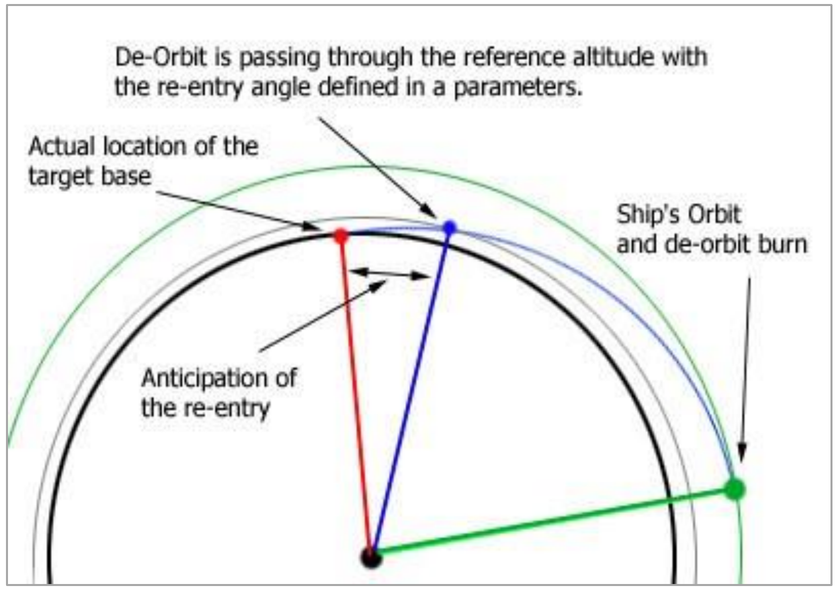


Equator

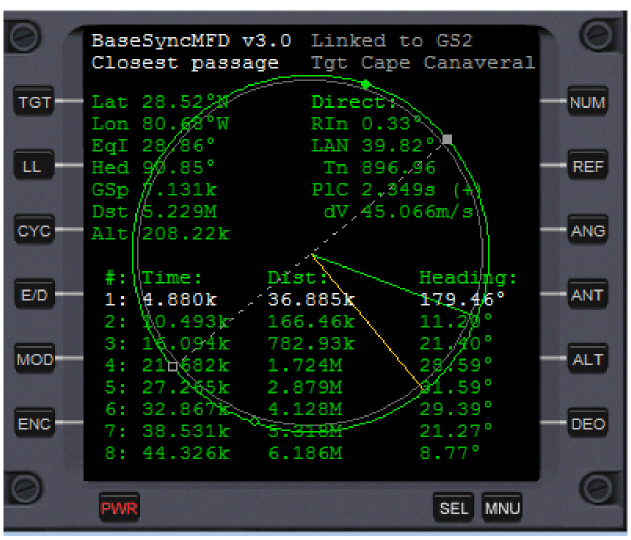
Equator mode is more applicable when working in Latitude mode, where you may need to adjust the equatorial inclination to be able to overfly the target. In this mode, the two nodes per orbit are the traversals of the planet's or moon's equator, and at those points, a plane change burn (in the correct normal or anti-normal direction) will raise your inclination to overlay the target. Note that this maneuver can be very expensive on fuel, so prior planning is much more advised to get into the correct trajectory from launch, or from orbital insertion.

The De-Orbit program

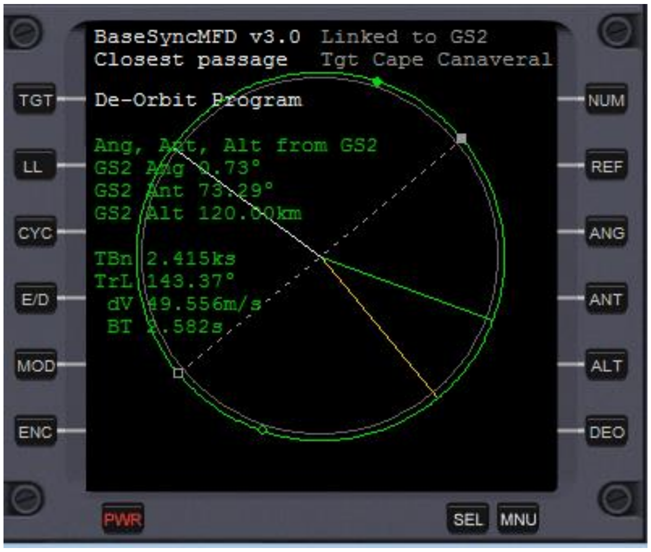
De-Orbit program allows you to make a precise de-orbit burn on the closest approach orbit, to arrive at a reference point (typically the atmospheric entry interface for planets with an atmosphere) at a specific altitude, descent angle, and anticipation angle in front of the desired target. The deorbit parameters (ANG, ANT, ALT) are set by means of the respective MFD buttons, and can also be defaulted from the BaseSyncMFD.cfg file, or overridden from a scenario file. The Deorbit program is selected by pressing DEO.



The diagram illustrates the aspects of de-orbiting from a circular orbit (the green circle), through the entry interface (the grey circle), and on to the target or base on the ground (the red dot). The goal is to apply retrograde thrust at the correct point (i.e. where the green dot is on this diagram), to arrive at the entry interface (the blue dot) at the right altitude, descending at the right angle, and with enough anticipation angle to have good time to slow through the atmosphere and make corrections for final approach and landing. It is highly recommended to use Closest Passage mode and Direct mode in conjunction with the Deorbit program.



The picture to the left is showing an example approach to Cape Canaveral, with the best solution now on the current orbit. You will notice that we are at the green line point on the orbit, and the closest approach is at the yellow line, exactly 4,880 seconds from now. At the yellow line, however, we are at the minimum distance from the target, but still traveling at orbital velocity and we have not de-orbited. Therefore we need to calculate at what earlier point we need to execute the retro-burn to hit the atmosphere (if any) at the right time, and then have space and time to land.



This picture shows the result of pressing the DEO button immediately after the prior picture. You will see that the data display is now de-cluttered down to the minimum needed for the de-orbit burn. The white line represents the burn point, and the green and yellow lines are as usual (the spacecraft's current position, and the closest approach position). As we are slaved to GS2 in this example, the Ang, Ant, and Alt data is provided from GS2. If you wish to see a different set of data from GS2, then you need to create a new reference Glideslope, with the first data point representing the entry conditions. (Glideslope takes the altitude directly into BaseSync. The reentry angle comes from the Vertical Speed relative to the Horizontal Velocity. The anticipation comes from the range, relative to the circumference of the reference planet.)

The burn data is listed: the Time to the Burn (TBn), the True Longitude (TrL) at the burn, the delta Velocity (dV) for the burn, and the Burn Time (BT) at full thrust to achieve the required dV. As with the main display, you can toggle the display mode to show text, graphics or both.

In order to execute an accurate burn, the eccentricity of the orbit needs to be 0.015 or lower. If not, then the display will show a warning. After a retro-burn, the eccentricity will almost always be above 0.015, but you can ignore it because you have completed the burn. At this point, switch back (using DEO) to the main display, and you can use a node point to further tune the off-plane distance to the target if you wish. Do this in Direct mode, of course, as you are referring directly to the target at this point.

Note that different spacecraft have different re-entry parameters, according to their lift characteristics, the atmosphere, and the orbit from which they are descending. A typical setting for a vessel such as the XR-2 or XR-5 returning to Earth from a 200 km x 200 km orbit is a 0.70 degree angle, a 75 degree anticipation, and a 120 km entry interface altitude. You need to experiment with other vessels and planets or moons to determine appropriate settings.