

# Orbit Calculator 2.0

## Introduction

Hi Folks, here's version 2.0 of my Orbit Calculator program. It's got a few bells-and-whistles over the original version:

- integrated my MJD Calculator program into it
- ability to specify the ships position in orbit (relative to the ecliptic)
- automatically generates RPOS and RVEL vessel parameters to copy into your custom Orbiter scenario

## Installation

None really, just extract the program & documentation into any convenient folder...your main Orbiter folder would be fine. Create shortcuts as desired.

## Basic Operation

1. When you start up the program you'll be faced with something like this:

The screenshot shows the 'Orbit Calculator' window. It has a left column of labels and a right column of input fields and calculated values.

Label	Value
Reference Body	Custom
Reference Mass ( $10^{23}$ kg)	0.001
Reference Radius (km)	1000
Periapsis Altitude (km)	0
Apoapsis Altitude (km)	100
Semi-Major Axis (km)	1050
Eccentricity	0.047619
Energy	-0.003
Period (seconds)	82759.260
p	1047.619
h	83.608
Periapsis Velocity (km/s)	0.084
Apoapsis Velocity (km/s)	0.076
Ecl. Latitude (-90..+90)	0.00
Ecl. Longitude (-180..+180)	0.00
Periapsis Details	RPOS 1000000 0 0 RVEL 0 0 84
Apoapsis Details	RPOS 1100000 0 0 RVEL 0 0 76

Additional fields on the right side of the window:

- Date: 1/11/2002 (with a 'Now' button)
- Time: 1:00:00 PM
- MJD: 52579.5416686343
- Radius (km): 1000
- Radius (km): 1100
- Period: 22:59:19.260
- ☐ Retrograde Orbit (East-to-West)

2. Enter the date & time you'll be orbiting to calculate the corresponding MJD. Right-click on the displayed value, copy the text to the clipboard & paste into your custom scenario.
3. Select the body you'll be orbiting from the pull-down list, or manually enter the mass & radius values.
4. Adjust the Periapsis & Apoapsis altitudes. The program will calculate & display orbital parameters as shown (heck, I STILL don't know what half of them are for either).
5. Enter the ships latitude & longitude **RELATIVE TO THE ECLIPTIC**. These values are NOT based on the reference body. (So entering zero longitude when orbiting Earth will probably NOT start you on the Greenwich meridian). Since most (all?) bodies are rotating relative to the ecliptic, your actual position over the surface will depend on the date & time you select.

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6. If you wish to orbit in a retrograde direction (say you've just done your Apollo LOI burn) place a check in the box provided.
7. The program generates two sets of RPOS and RVEL values...one assumes the selected orbital position occurs at Periapsis, the other assumes it occurs at Apoapsis. Once again, you can right-click and copy the text for a custom scenario.

## Creating A Custom Scenario

Let's create a scenario file for Apollo 33, a (hypothetical) landing at the Brighton Beach lunar base on Christmas Day, 2003. This will require you to have the AMSO Orbiter add-on installed to use the CSM + LEM vessels, otherwise you can make do with the standard DeltaGlider...the instructions below will indicate where the alternative changes need to be made.

Start up your favorite text editor (Notepad is fine) and start a new file. Begin by creating a scenario description that will show in the Orbiter Launchpad when someone selects your scenario.

```
BEGIN_DESC
```

```
Apollo 33: Lunch on the Moon
```

```
After a textbook launch, nominal TLI burn and uneventful trans-lunar coast you performed a flawless LOI. Having just finished a perfect DOI burn you've begun your descent towards the lunar surface. All that's left to do now is to wait until it's time for PDI...
```

```
END_DESC
```

Fire up Orbit Calculator and set the parameters as follows:

REFERENCE BODY = Moon

PERIAPSIS ALT = 15 km (the low point of your DOI burn; where your PDI burn will start)

APOAPSIS ALT = 110 km (high point of your DOI burn; this is where you'll start the scenario from)

Orbit Calculator will display your orbital period (about 1 hour 54 minutes). It'll take half this time to get from apoapsis to periapsis (57 minutes); allow another 15 minutes for PDI, approach and landing (72 minutes); take this away from your "projected" landing time (say 12:00 PM, just in time for Christmas lunch) and you find the DOI burn must have been made at 11:48 AM. Set these parameters in Orbit Calculator:

DATE = 25/12/2003

TIME = 11:48:00 AM

Now create a section in your scenario for this particular solar system, and copy in the MJD details:

```
BEGIN_ENVIRONMENT
```

```
System Sol
```

```
Date MJD 52998.4916724537
```

```
END_ENVIRONMENT
```

Now tell the scenario the name of the ship you'll be controlling (we'll set up the ship itself later):

```
BEGIN_FOCUS
```

```
Ship AS-533
```

```
END_FOCUS
```

Let's switch the HUD to Orbit mode:

```
BEGIN_HUD
```

```
TYPE Orbit
```

```
END_HUD
```

We'll switch the left MFD to Surface mode:

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```
BEGIN_MFD Left
  TYPE Surface
END_MFD
```

And the right MFD to Map mode with Brighton Beach selected as a target base:

```
BEGIN_MFD Right
  TYPE Map
  REF Moon
  BTARGET Brighton Beach
END_MFD
```

Though not a requirement, let's include a space station orbiting the Moon. These orbital details were just copied from the standard DeltaGlider scenario. Notice how the EL\_MJD entry specifies the stations initial orbit at another starting point...Orbiter will crunch the numbers to work out where the ship will be at our required time. Trying to calculate your own ELEMENTS values to set up custom station orbits is a bit tricky... (Hmmm...something to include for version 3??). You can also define multiple stations in a scenario...just include multiple details within the BEGIN\_STATIONS..END\_STATIONS section.

```
BEGIN_STATIONS
Luna-OB1:Wheel
  REF Moon
  EL_MJD 51981.60000000
  ELEMENTS 2238169.2 0.00020 89.98457 359.99510 8.65574 258.07653
  AROT 0.00 0.00 -153.29
END
END_STATIONS
```

Now it's time to define your ship details (you can also define multiple ships in a scenario...just include multiple vessel details within the BEGIN\_SHIPS..END\_SHIPS section).

Firstly, give the ship a name, and specify the vessel type. *If you don't have the AMSO add-on installed, use **DeltaGlider** as the type.*

Then specify it's positional status...in this case you'll be in lunar orbit (see the ORBITER.PDF documentation for full details of this [and all other] scenario configuration details).

As for latitude and longitude on the Orbit Calculator, leave them both zero to start with until we can determine which way the Moon is facing at the selected date & time. Make sure you've ticked the "Retrograde Orbit" option, and then copy the Apoapsis details into the scenario.

Give yourself a reasonable fuel supply for a later TEI burn (about 28% minimum).

If you're using the AMSO add-on, tell it to start with the basic CSM + LEM configuration (not needed for the DeltaGlider).

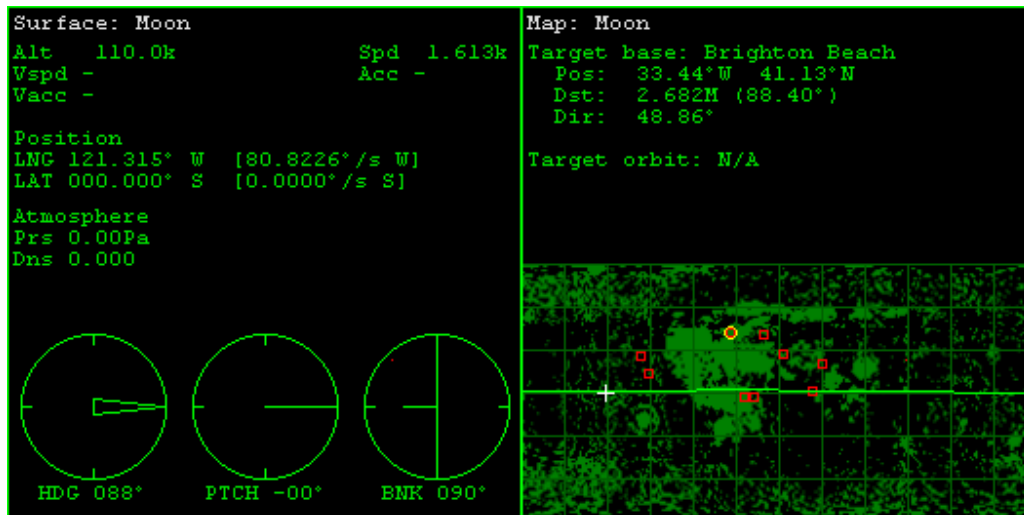
```
BEGIN_SHIPS
AS-533:Apollo
  STATUS Orbiting Moon
  RPOS 1848000 0 0
  RVEL 0 0 -1608
  FUEL 0.338
  CONFIGURATION 10
END
END_SHIPS
```

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Now save this new scenario file into the ORBITER\SCENARIOS folder with an appropriate name (say APOLLO 33.SCN)

## Scenario Test #1

Run Orbiter, and load in your new scenario. Pause the scenario when it starts. Checking the MFD's you'll see:



Notice the following:

- 1) since the Moon has a slight inclination to the ecliptic (only about 1.5°) you aren't quite orbiting over the lunar equator. Over Earth or Mars (both with an inclination of about 24°) the initial orbit will be markedly "off-level". By entering the reference bodies inclination as a starting latitude (maybe positive or negative, depending on orbital direction), you can get into an equatorial orbit.
- 2) since the base is 41.13° North of our latitude, the apoapsis should be 41.13° south. If you're "rigging" the initial orbit as above, this means start 41.13° FURTHER south. If this adjustment makes your starting latitude greater than 90° (positive or negative), make your new latitude equal to (180 - old latitude) e.g. -100° becomes -80°, +135° becomes +55°, then reverse the orbital direction (check/uncheck the retrograde box to the opposite choice).
- 3) periapsis (start of PDI burn) is normally 15° East of the landing site (for a ship in retrograde orbit). So from our current position we have to move 87.875° East (121.315° - 33.44°) to reach the base, another 15° to the PDI point then another 180° to apoapsis, for a total of 282° to the East. This is equivalent to moving 78° to the West (since longitudes must be between -180..+180).

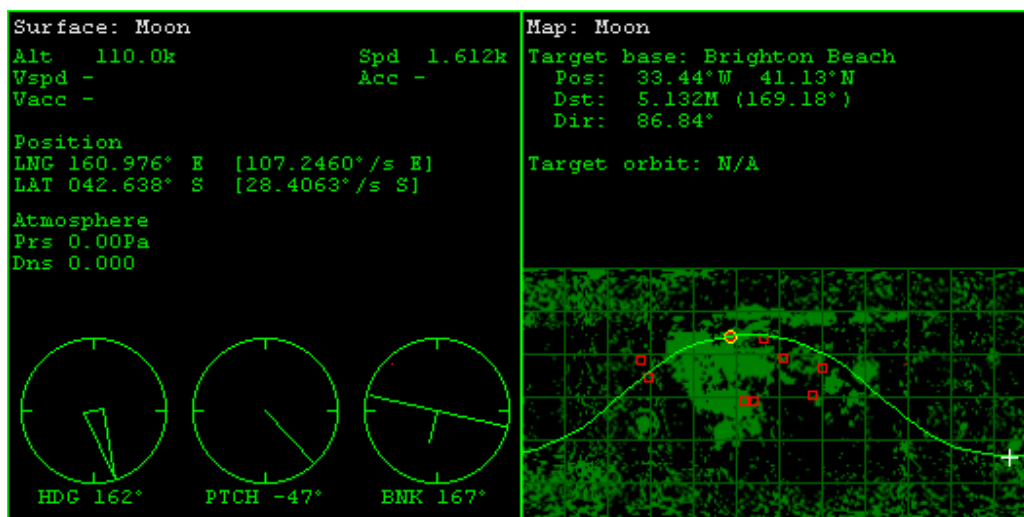
Jump back into Orbit Calculator, and set it up as originally defined earlier. Now change the ship latitude to -41.14° and the longitude to -78° (as calculated above). Copy the new RPOS and RVEL for the apoapsis, and paste these values into the scenario to replace the initial guesses.

```
BEGIN_SHIPS
AS-533:Apollo
  STATUS Orbiting Moon
  RPOS 289402 -1215558 -1361531
  RVEL -1573 0 -334
  FUEL 0.338
  CONFIGURATION 10
END
END_SHIPS
```

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## Scenario Test #2

Run Orbiter, and load in your new revised scenario. Pause the scenario when it starts. Checking the MFD's you'll see:



NOTE: after you reach periapsis and begin the PDI burn, your orbit will continue to move you southward. In the time it takes to get from PDI initiation down to the ground, you may have drifted sideways from the perfect landing approach and miss the base. In this case just start up the calculator, enter your orbit setup details again, and move your apoapsis point slightly south (at 15 km above the Moon, a  $0.1^\circ$  change would move you about  $3 \text{ km} = 1753 \text{ km} * \sin(0.1^\circ)$ ), so the periapsis occurs slightly north of the base and the drift will guide you right in!

Now (if you're using the AMSO add-on) it's just a matter of undocking the LEM ("J" key), performing a small separation burn (switch to RCS thrusters and fire a quick burst) and then switch to LEM control ("M" key).

After that (or if you're in the DeltaGlider) you just coast the next 57 minutes to the PDI point, fire up the engines and land the sucker...

P.S. DOH! Looks like good old Brighton Beach is over in the dark side at Christmas, making it a bit tricky to land. I'll leave it as an exercise to correct this slight oversight:

- change the landing date to 2 weeks earlier/later (half a lunar day so Brighton will be well lit)
- your apoapsis longitude will be wrong now. Set it back to zero, save & restart the scenario, and go through the calculation of a new starting point.

Enjoy...

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