

SpaceX

FALCON HEAVY

v.220707
for Orbiter 2016 (v.160828)

INSTALLATION

Extract all files to the root of your Orbiter program directory, preserving the directory structure. This should NOT overwrite anything in the standard Orbiter package.

RECOMMENDED ADD-ON

"LC39A SpaceX"

<https://www.orbithangar.com/searchid.php?ID=7090>

Orbiter2015 Hi-Res Texture Pack for West Coast USA "EarthHi_11_05.zip"

https://mirror.orbiter-radio.co.uk/orbiter/assets/packages/Earth/EarthHi_11_05.zip

WHAT'S IN THIS ADD-ON?

The SpaceX "Falcon Heavy" launcher with optional Star48BV kick motor, adaptors, etc.

Launch pads for LC39A, SLC40 and SLC4E (VAFB).

LZ Landing pads, FRV and ASDS vessels for fairing recovery and booster landings.

Launch scenarios for various test-masses and orbits, STP2 and Tesla Roadster launches.

Elev-mod tiles for flat landing zones at KSC and VAFB.

Features: Control Panel for launch parameter input, optional Ascent-to-Orbit autopilot and 1st stage boosters Flyback-EDL autopilot.

Payload "attachment" by editing .scn file, or in-sim by payload name input.

Expendable, Dragon Adaptor, No Fairing, Custom Adaptor mesh, Charred look options in .cfg file.

QUICKSTART

Scenarios are in the "FalconHeavy for Orbiter2016" folder on your Orbiter launch pad.

Select a scenario and press [V] at T-10s to start the ascent autopilot.

All launch parameters are set and 1st Stage Core and Boosters Auto-Flyback-EDL to the ASDS recovery vessel or LZ landing pads is already enabled (if appropriate).

SCENARIOS

Test scenarios are in separate folders arranged by orbit type:

LEO 200km circular orbit at 29° inclination.

GTO 200km circular orbit at 29° inclination, 2500m/s dV remaining.

ISS 350km circular orbit at 51.6° inclination.

POLAR 700km circular orbit at 96° inclination.

Each orbit type has scenarios for various different booster recovery modes at the maximum payload mass.

FALCON HEAVY COCKPIT CONTROLS

Available commands and launcher status info are displayed on the HUD.

K = Open / Close Launch Control Panel

V = Start Launch Autopilot at T-10s

N = Manual Jettison Boosters or Core

J = Manual Jettison Fairing or Payload

E = Set View +Z / -Z

B = 2nd Stage Fuel Dump

FALCON HEAVY LAUNCH CONTROL PANEL

Press K to Open/Close Launch Control Panel

Type required value in appropriate box and click “Enter” to input.

The screenshot shows the 'FalconHeavy Launch Control' window with a red close button in the top right. The interface is divided into several panels:

- Payload Management:** Includes 'New Payload' (with 'Enter Name' and 'Attach' buttons), 'Current Payload' (showing '33K_Sat' and 'N/A'), and 'Total 33000kg'.
- Target Orbit Parameters:** Includes 'Inclination' (-29.0000 deg.), 'Perigee' (200.0 km), 'Apogee' (200.0 km), 'Core Stg. Apogee at MECO' (175.0 km), and 'Upper Stg. Orbit Insertion Alt.' (200.0 km), each with an 'Enter' button.
- CORE Flyback-EDL:** Includes 'Flyback Autopilot Status' (ENABLED, On/Off), 'Flyback Mode' (FLYBACK-EDL, Change), 'Flyback Target CORE' (ASDS, Enter), 'Flyback Fuel Reserve' (65000 kg, Enter), 'Estimated Fuel Required' (65000 kg, Apply), and 'Acceleration Limiter' (39.24 m/s², Enter).
- BOOSTERS Flyback-EDL:** Includes 'Flyback Autopilot Status' (ENABLED, On/Off), 'Flyback Mode' (FLYBACK-EDL, Change), 'Flyback Target PORT' (LZ2, Enter), 'Flyback Target STBD' (LZ1, Enter), 'Flyback Fuel Reserve' (48749 kg, Enter), 'Estimated Fuel Required' (48749 kg, Apply), and 'Estimated FRV Position' (Lng. 0.000, Lat. 0.000).
- Estimated ASDS Position:** Shows 'Lng. -74.985 Lat. 27.899 Core' and 'Lng. -77.441 Lat. 28.219 Boosters'.
- Launch Control:** Includes 'T-10 Launch Autopilot' (START/STOP button, OFF), 'Launch Time UTC' (hh mm ss: 00 00 00, Set button, OFF, On/Off), and 'Hardback Gantry' (ENGAGE/RETRACT button).
- Manual Jettison:** Includes 'Fairings' (Jettison button) and 'Booster' (Jettison button).
- Buttons:** A 'Refresh' button is located at the bottom right.

PAYLOAD MANAGEMENT

There can be up to 100 payload attachment points specified in the .cfg file.

Default position is located at the centre of the payload-attach-ring on the 2nd Stage.

Payloads can be added by editing the scenario and using the “Attached” parameter (see example scenarios included).

Alternatively, any vessel already existing in the scenario can be attached by entering the payload *name* and clicking the “Attach” button.

The first available attachment point on the payload will be used for attachment.

TARGET ORBIT PARAMETERS

Inclination

Enter the required orbit inclination (Equatorial frame), Use negative value for Southerly launch azimuth, positive for Northerly launch azimuth. Minimum value is current latitude.

Perigee

Enter target orbit Perigee (km)

Apogee

Enter target orbit Apogee (km)

CORE STG. APOGEE AT MECO

Core booster stage apogee target at MECO(2nd stage separation) – *calculated automatically*, but can be changed manually if you want to try different flight profiles.

UPPER STG. ORBIT INSERTION ALT.

Upper stage altitude at final orbit insertion – *default setting is orbit insertion at perigee*. Can be set to any value between, or equal to, apogee and perigee. Insertion at perigee is most fuel efficient.

CORE FLYBACK-EDL

Flyback Autopilot Status

Enable or disable the autopilot for core stage Flyback-EDL

Flyback Mode

Select either 3-burn *Flyback-EDL* mode, or 2-burn *EDL-Only* mode.

(If stage is to return to launch site LZ pad, full *Flyback-EDL* mode should be used)

Flyback Target CORE

Enter the name of vessel(landed) or surface-base, as target for core stage flyback and landing. Enter NULL for no target.

Flyback Fuel Reserve

Enter the amount of fuel reserved by core booster for Flyback-EDL (kg).

Estimated Fuel Required

Flyback-EDL fuel requirement calculated from core apogee, port/starboard booster fuel reserve, flight azimuth, target position, etc. Not always reliable!

Click "Apply" to enter this value as Flyback Fuel Reserve.

BOOSTERS FLYBACK-EDL

Flyback Autopilot Status

Enable or disable the autopilot for Port and Starboard booster stages Flyback-EDL

Flyback Mode

Select either 3-burn *Flyback-EDL* mode, or 2-burn *EDL-Only* mode.

(If stages are to return to launch site LZ pads, full *Flyback-EDL* mode should be used)

Flyback Target PORT

Enter the name of vessel(landed) or surface-base, as target for Port booster stage flyback and landing. Enter NULL for no target.

Flyback Target STBD

Enter the name of vessel(landed) or surface-base, as target for Starboard booster stage flyback and landing. Enter NULL for no target.

Flyback Fuel Reserve

Enter the amount of fuel reserved by Port and Starboard boosters for Flyback-EDL (kg) per booster.

Estimated Fuel Required

Flyback-EDL fuel requirement (per booster) calculated from core apogee, flight azimuth, target position, etc. Not always reliable!

Click "Apply" to enter this value as Flyback Fuel Reserve.

ACCELERATION LIMITER

Main engine automatically throttled to limit maximum acceleration. Default 4g.

ESTIMATED ASDS POSITION

Suggested locations for ASDS recovery vessels. Calculated from fuel reserve, flight azimuth, core apogee, etc. Not always reliable!

Usually a good idea to separate the Port and Starboard ASDS vessels by a few hundred meters (otherwise boosters land on top of each other!)

ASDS Position and Flyback Fuel Reserve are *interdependent* – if you change one you may need to change the other to match.

LAUNCH CONTROL

T-10 Launch Autopilot

Click "Start/Stop" button to activate/disable ascent-to-orbit autopilot.

Launch Time UTC

Set lift-off time (hh mm ss), click "On/Off" to enable or disable.

Ascent-to-Orbit autopilot is engaged automatically at T-10s.

Countdown is displayed on screen.

Hardback Gantry

Click "Engage/Retract" to raise or lower gantry (while FalconHeavy on pad)

MANUAL JETTISON

Fairings - Click "Jettison" to release fairings.

Booster - Click "Jettison" to release Port/Stbd. Boosters, click again to release Core.

REFRESH

Click to check current parameter values.

1st STAGE BOOSTER COCKPIT CONTROLS (post stage separation)

M = <i>Set Flyback Mode</i>	Toggle between full Flyback-EDL and EDL-Only modes
B = <i>Enable Auto Flyback-EDL</i>	Enable / disable autopilot
P = <i>Engine Selection</i>	Cycle through either 9, 3 or 1 engines
J = <i>Deploy/Stow Grid Fins</i>	
G = <i>Deploy Landing Gear</i>	
E = <i>Set View +Z / -Z</i>	

ASCENT-TO-ORBIT AUTOPILOT SEQUENCE

T-10s	Countdown
T-2s	Throttle-up to 100%
100m alt.	Start roll to launch azimuth
200m alt.	Start pitch down, follow gravity turn, Core throttle down to 40%
50km alt.	Start guidance steering
Bstr.Reserve Fuel limit	Booster separation, core throttle up to 100% (4G limit)
Core Reserve Fuel limit	Core separation, 2nd stage ignition
Core sep. +20s	Fairing separation
Final Orbit reached	MECO

CORE/BOOSTER “FLYBACK-EDL” SEQUENCE

Core/Booster sep.	Go to flyback burn attitude, perform burn
MECO	Go to reentry attitude
130km alt.(Boosters 100km)	Enable/perform reentry burn
15km alt., < Mach2	Start aerodynamic steering
1-2km alt.	Start landing burn, gear deploy

CORE/BOOSTER “EDL-ONLY” SEQUENCE

Core/Booster sep.	Go to reentry attitude
160km alt.(Boosters 100km)	Enable/perform reentry burn
15km alt., < Mach2	Start aerodynamic steering
1-2km alt.	Start landing burn, gear deploy

RECOVERABLE FAIRINGS

By default, the FalconHeavy has recoverable fairings equipped with RCS, a parafoil and guidance. The parafoil is automatically deployed at 6-7km and the guidance will steer a course (accounting for wind) for any vessel named “FRV”.

You can use “passive” fairings without parafoil by setting the *NoFairRecovery* = 1 flag in the .cfg file (see below).

CONFIG FILE OPTIONS (.cfg)

Config files for the FalconHeavy are located in Config/Vessels/FalconHeavy/ folder.
By editing the .cfg file for the FalconHeavy, you have various options:

<i>TimeAccLimit = TRUE</i>	Time acceleration limited to 1 at staging
<i>Expendable = 1</i>	Core expendable, boosters reusable
<i>Expendable = 2</i>	Core expendable, boosters expendable
<i>Dragon = 1</i>	Cargo Dragon adaptor, no fairing
<i>Dragon = 2</i>	Dragon2 adaptor, no fairing
<i>NoFairing = 1</i>	No Fairing
<i>NoFairRecovery = 1</i>	Use passive fairings (no parafoil)
<i>CntrUsed = 1</i>	Charred skin – Centre Booster
<i>PortUsed = 1</i>	Charred skin – Port Booster
<i>StbdUsed = 1</i>	Charred skin – Starboard Booster
<i>PayloadAttach0 = pos dir rot</i>	Payload attachpoint Pos Dir Rot vectors
<i>Adaptor = FalconHeavy/star48bv_adaptor*</i>	Adaptor file path/mesh name

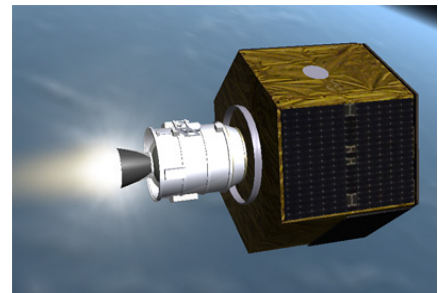
*Adds adaptor mesh at centre of 2nd stage payload interface ring.
Origin (0,0,0) should be at bottom of adaptor mesh.

See examples in *f9h.cfg* file, in Config/Vessels/FalconHeavy/.

STAR48BV KICK-MOTOR

An optional Star48BV solid rocket motor is included.
It can be attached to the FalconHeavy like any other payload.

A further payload can be attached to the Star48BV in the same way - an existing vessel can be attached during simulation by pressing **P** and entering vessel name, or edit the ATTACHED parameter in the scenario file before starting the sim.



Payload mass is added to Star48BV.

A 62" to 48" adaptor for attaching the Star48BV to the FalconHeavy is included (see Fairing / Payload Adator Options in CFG files)

Once ignited, the Star48BV will burn at full throttle until depletion.

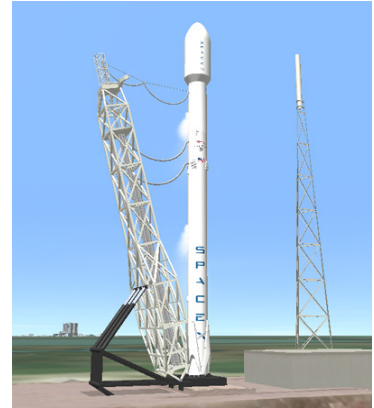
STAR48BV COCKPIT CONTROLS

P = Enter Payload Name Attach existing vessel to the Star48BV, at payload interface ring.
J = Jettison Payload

LAUNCH PADS and LANDING PADS

Launch pads feature retractable gantry, LOX vent and liftoff smoke effects, auto night lights.

[G] = Raise / Lower Gantry [M] = Water Deluge On/Off
[K] = Night Lights On/Off [V] = LOX vent On/Off
[B] = Crew Access Arm Extend/Retract (LC39A)
[N] = Crew Access Arm Visible/Invisible (LC39A)
[P] = Attach Launcher to Pad (enter name, any existing vessel)



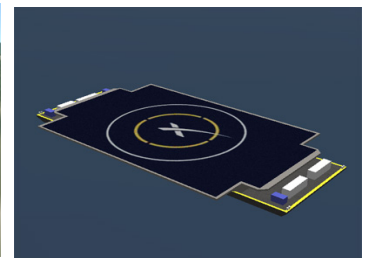
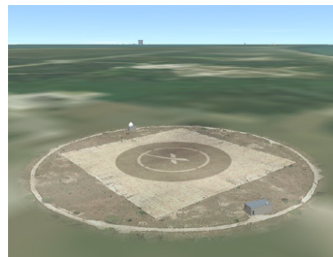
LAUNCH PAD "HOLD DOWN"

If FalconHeavy is attached to launch pad (see ATTACHED parameter in scenario file), attachment is released when main engine reaches %95 thrust (after 2 seconds if using Launch Autopilot)

LZ LANDING PADS and ASDS

Auto proximity night lights – illuminated when any vessel approaches within 5km.

ASDS should be placed along the launch groundtrack, some distance ahead of the booster at separation (or close to booster ballistic impact point if EDL ONLY flyback mode is selected)



[N] = Landing Pad Mesh Visible/Invisible (LZ pad only)

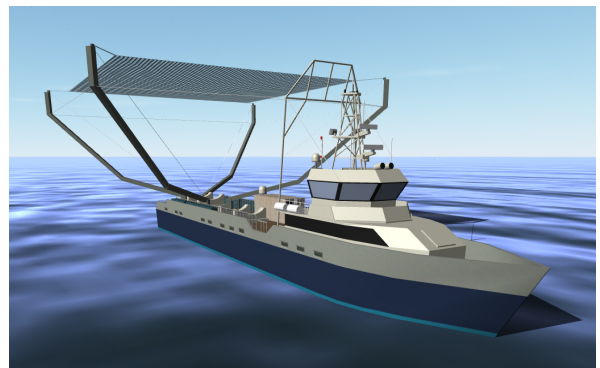
“FRV” FAIRING RECOVERY VESSEL

Place further along flightpath than ASDS.
Will collect and stow fairings if they fall within the net.

Max speed ~30kts, data on HUD, night lights.

Must be named “FRV” for fairing guidance.

Note: If not named “FRV”, fairing guidance will not operate and you must use the vessel to chase the fairings as they descend, which can be interesting :-)



FALCON HEAVY ADD-ON SPECS

1st Stage - Core, Port, Starboard Boosters (each)

Empty Mass	22500 kg (Core 25600kg)
Fuel Mass	409500 kg
Max. Thrust SL	845148 N (x 9)
Max. Thrust Vac.	914111 N (x 9)
ISP SL	2767 Ns/kg
ISP Vac	3050 Ns/kg
RCS(N) Fuel Mass	400 kg
RCS(N) Max. Thrust	1000 N (6 pairs)
RCS(N) ISP	800 Ns/kg

2nd Stage

Empty Mass	4000 kg
Fuel Mass	107500 kg
Max Thrust Vac	934000 N
ISP Vac	3385 Ns/kg
RCS(N) Fuel Mass	100 kg
RCS(N) Max. Thrust	500 N (4 pairs)
RCS(N) ISP Vac	800 Ns/kg

Fairings

Mass	875 kg (each)
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Star48BV

Empty Mass	144.7 kg
Fuel Mass	2011.8 kg
Max Thrust Vac	68720 N
ISP Vac	2865.5 Ns/kg
RCS Fuel Mass	20 kg

FALCON HEAVY PERFORMANCE (not complete for all recovery mode combinations!)

Orbit Type	Core Recovery Mode	Booster Recovery Mode	Max.Payload (kg)
GTO	Flyback-EDL to ASDS	Flyback-EDL to LZ	13000
GTO	Flyback-EDL to ASDS	Flyback-EDL to ASDS	14000
GTO	Expendable	Flyback-EDL to LZ	21000
GTO	Expendable	Expendable	27000
ISS	Flyback-EDL to LZ	Flyback-EDL to LZ	24000
ISS	Flyback-EDL to ASDS	Flyback-EDL to LZ	32000
ISS	EDL-Only to ASDS	EDL-Only to ASDS	39000
LEO	Flyback-EDL to LZ	Flyback-EDL to LZ	25000
LEO	Flyback-EDL to ASDS	Flyback-EDL to LZ	33000
LEO	EDL-Only to ASDS	Flyback-EDL to LZ	38000
LEO	EDL-Only to ASDS	EDL-Only to ASDS	41000
LEO	Expendable	Expendable	64000

FalconHeavy performance cont.

<i>Orbit Type</i>	<i>Core Recovery Mode</i>	<i>Booster Recovery Mode</i>	<i>Max.Payload (kg)</i>
POLAR	Flyback-EDL to LZ	Flyback-EDL to LZ	17000
POLAR	Flyback-EDL to ASDS	Flyback-EDL to LZ	22000
POLAR*	EDL-Only to ASDS	EDL-Only to ASDS	(2-burn) 35000

GTO = 200km orbit + 2500m/s dV remaining, 29° inclination

ISS = 350km orbit, 56° inclination

LEO = 200km orbit, 29° inclination

POLAR = 700km orbit, 96° inclination

POLAR* = 200km x 700km orbit + 200m/s dV, 96° inclination

Launch Site: KSC

Launch Site: KSC

Launch Site: KSC

Launch Site: VAFB

Launch Site: VAFB

NOTES

Double Launch

Each launcher in the scenario needs it's own copy of "f9h.cfg" and "f9h.dll"

See the "Double Launch" scenario as an example.

VAFB HiRes Tiles

If you have installed the EarthHi_11_05.zip pack, you should use the scenarios in the "HiRes VAFB Scenarios" sub-folder, for correct placement of SLC4E launch pad and LZ landing pads.

Earth Elev_mod tiles

Includes earth Elev_mod tiles:

/13/000157/000168.elv

/15/000699/001131.elv

For flat LZ areas at KSC and VAFB*(only if VAFB HiRes Tiles installed).

Fuel Reserve Estimate and ASDS Position Estimate

These are calculated by empirically derived curve-fitted functions and may not always be reliable!

Compatible with OrbiterSound4.0 (but OrbiterSound4.0 may not work in Orbiter2016)

CREDITS

Tesla Roadster textures and D3D9 magic by Felix24

Original Tesla Roadster Sketchup model by Craig D.

<https://3dwarehouse.sketchup.com/model/d5b9471bcaaf15d4824c4ee0076cfe45/Tesla-Motors>

THANKS TO.....

MartinS, IronRain, Felix24, Barry, Donamy, Kyle and everyone at the forum

Have fun :-)

BrianJ

July 2022