

MSFS

Spitfire LF Mk IXc

FOR MICROSOFT FLIGHT SIMULATOR
BY FLYINGIRON SIMULATIONS

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Foreword

Greetings Pilots!

Firstly, we want to say THANK YOU. Every single one of you that has purchased one of our aircraft has helped to make our dreams possible of being able to work together creating aircraft simulations. Without you there would be no FlyingIron, no beautiful Spitfire simulation, and we wouldn't be able to continue making more aircraft for you to fly around the gorgeous world of Microsoft Flight Simulator (MSFS).

It has been an honor to work on the Spitfire, an airframe that we feel is truly a timeless classic and one of the most beautiful airframes ever created. We've done our very best to bring this legend to life, and it has been a true joy to work on and to fly around in MSFS. We hope you have as much fun flying it as we have had developing it!

You may notice that some sections of the manual are a little thin – we apologise for this! As I write this, I know that many people are very eagerly awaiting to fly around their favourite places in the Spitfire. To avoid delaying release any further, we have gone ahead with this slightly thinner manual to save some time. The manual will be continually updated with each release, so be sure to check back after each update! We hope you don't mind and thank you for your endless patience.

Finally, once more, thank you. We couldn't do this without you.



*Hoping to see you in the skies of MSFS,
Dan & Alex
FlyingIron Simulations*

Installation & Setup Guide

Purchases from our Website

Installation is quite straightforward here – simply download the files from our website after purchase, and extract the zip file into the 'Community' folder of your Microsoft Flight Simulator installation folder.

The Spitfire will now be ready in your hangar the next time you load up the simulator! You can choose between the standard Spitfire, or the clipped wings variant.

Updates will be distributed to you via email, so be sure to make sure we aren't flagged as spam!

Purchases from the Microsoft Marketplace

Once purchased through the Microsoft Marketplace, the Spitfire should appear in your hangar after a short download. Updates are managed automatically through the Microsoft marketplace.

Controls Setup

The Spitfire does not require any special bindings – simply use your normal joystick configuration.

Although the aircraft uses a brake lever, you can control the differential brakes in the Spitfire with your normal toe-brake setup, or more realistically by using a brake binding (X on xbox) and rudder controls.

We recommend binding elevator & rudder trim for ease of flying, as well as flaps and gear bindings.

Update History & Known Issues

Current Version: 1.0.2

Known Issues, bugs & workarounds

- Tail-wheel does not have true free-castoring due to limitations in the SDK.
- Glass flickering bug.

UPDATE 1.0.1

This update is our first update since release, and aims to address some remaining bugs & issues pointed out by our users, prioritizing improving the user experience, adding missing sounds & features and further improving the flight model.

Overall, the flight dynamics have been made more realistic and therefore the Spitfire is now slightly more difficult to fly (especially on takeoff). You will need to use your rudder trim more effectively, and manage your engine power more carefully.

Art

- External LODs improved, icing LODs fixed
- Clipped Wing icing issues fixed
- Animated oxygen valve, external tank lever
- Windshield Fluid Port textures added

Sound

- Touchdown Sounds added
- Additional cockpit sounds added (wobble pump, primer, various switches)

Systems & Flight Model

- Parking Brake made clickable
- Flight Model improvements (thanks to Raimond aka GotGravel for pitching in and making several contributions here)
 - Stall speeds increased slightly
 - Stall behavior adjusted
 - P-factor increased (you will notice a much stronger tendency to swing left on takeoff. Counter this with some right rudder trim)
 - Torque/Propwash dynamics adjusted
 - Roll inertia, stability adjusted
 - Control sensitivity at various airspeeds adjusted
 - General control & trim sensitivity adjusted
 - Prop Inertia reduced
 - Engine throttle response speed increased
- ATC Power now tied to Radio Unit – to be able to contact ATC, select any preset channel on the radio (A-D) to power it on
- Oxygen Flow now requires oxygen flow valve on the starboard side of the cockpit to be opened
- Negative G's starve engine of fuel (WIP, needs additional work)
- Engine Temperature model adjusted slightly (still WIP)

UPDATE 1.0.2

Art

- Modern Radio & Transponder unit added
- Windshield scratches decreased
- Cockpit control hitboxes improved, made easier to use
- Pilot head basic animation
- Fuel Slipper Tank added
- Fixed Compass & Directional Indicator
- Prop blur adjusted at low RPMs
- Cockpit Camera collisions added
- Various small bugfixes

Systems

- Custom C++ Merlin Temperature model integrated (replaces default MSFS thermodynamics system)
- Fuel system overhauled + External Tank integrated
- Custom oxygen system integrated
- Fuel Primer functionality integrated - now required for startup (note that requirements vary with weather conditions)
- Engine failures revised, overheat failures improved. The engine must now be flown inside real-world operating limits or it will very likely fail
- Camera/quick-views overhauled
- Door & Canopy overhauled - increased realism, includes locking mechanism. Door must be closed to operate canopy slide.

Flight Model

The flight model has been overhauled and improved, with many small corrections adding up to make for a significantly more realistic experience.

- Geometry corrections, wing surface areas corrected
- CG locations & limits revised
- Lift & Drag curves revised
- Flaps pitching moment & drag corrections (nose-down tendency more realistically modelled)
- Moments of Inertia revised
- Roll rates & control authority adjusted
- Weathervaning tendency improved
- Takeoff run increased realism - more stable along roll axis, reduced P-factor torque
- Braking force increased, tipping tendency reduced slightly
- Engine modelling adjusted slightly, inverted flight restored

Sound

- Brakes pneumatic sound added
- Flap sound improved
- Engine 3D Sound panning bug fixed, attenuation improved
- Door, lock & canopy sounds updated

UPDATE 1.0.3

Update 1.0.3 focuses on updating the Spitfire for MSFS's July Update, which includes Xbox integration and a new interaction system. We've also included some particle FX and a few other goodies for you.

- Implementation of the new UI & Interaction system – including improved tooltips and controls (primer & door controls fixed)
- Integration of Garmin 430 GPS in the cockpit – gunsight can now be toggled between gunsight & GPS via the Gunsight Reticule switch
- Addition of basic Visual FX – engine smoke, contrails, tyre particles etc. More to come in future updates!
- Integrated engine block vibrations
- Numerous Flight Model & Ground Handling refinements & improvements (By GotGravel)
- Refined & improved Oxygen system realism
- Engine Damage now optional – can be toggled ON/OFF via Radio Preset Button D
- Improved Prop Animation
- Fixed lighting knob controls
- Fixed temperature gauge dropouts & bugs
- Numerous bugfixes & miscellaneous improvements to Art & systems
- Manual & quick-start guide updated

UPDATE 1.1.0

This update includes the highly anticipated flame VFX of the Merlin engine which fires in the correct sequence, the FlyingIron Tablet which includes a huge amount of helpful information and tools, and finally an FM overhaul which has lead to the most realistic simulation of our Spitfire yet!

- Accurate Moments of Inertia according to factory data
- Flight Model entirely re-tuned due to the above
- Faster acceleration during take-off
- Renewed Instrument Camera setup and tuned QuickViews L1/R1
- Overall camera improvements
- Added Tablet & all the goodies along with it
- Fire in the pipes ... 12 x awesomeness
- A bunch of sound improvements: additions, remixing and rebalancing
- Programmable Radio (use tablet to program and radio buttons A-D to use)
- Added loading tips
- Fixed Mag 2
- Fixed cockpit light dimmers
- Improved cockpit texturing
- Added VR stick control
- Fixed radio clickables
- Fixed clock animation
- Many more fixes and improvements

UPDATE 1.2.0

Systems:

- High-fidelity engine simulation tuned in cooperation with an active MkIX pilot
- Solved fuel qty rounding error in MSFS Fuel screen
- Slightly adjusted empty CG to prevent out of CG error at 99% main fuel tank only
- Corrected pilot description tag
- Fixed Autopilot binding issue
- Improved VR Pilot camera view
- Adjust brake lever animation to be analogue
- Brake lever animation much more responsive
- Brake pressure needles much more responsive
- Fixed fuel pump issue
- Added CANOPY OPEN simvar in support of fan hardware
- Added more loading screen tips
- Refined various cameras
- Improved exterior HUD
- Setup detailed electrical system
- Improved the fuel pressure system
- Added volts to tablet live data
- Improved the start-up simulation
- Implemented MS/FS supercharger gears and made various refinements to the supercharger
- Changed boost button variable
- Added ability to toggle GPS power
- GPS button brightness is now based on the maximum of the two spotlight rheostats
- Improved the dynamic engine stresses
- Added more informative mouse-over tips
- Added engine backfiring (low MP, high RPM)
- Greatly improved the thermodynamics model, taking into account things such as the gear disrupting radiator airflow and the flaps blocking it entirely
- Added common power settings to the checklist
- Fixed RPM stress algorithm

Flight Model:

- High-fidelity flight model tuned in cooperation with an active MkIX pilot
- Added modern prop physics
- Reduced brake power to ease nose dipping
- Corrected differential brake value
- Slightly increased prop efficiency at idle to match the real-world Spitfire
- Minor correction to wheel contact points
- Increased flap deployment dip
- Increased adverse yaw
- Tweaked flap and gear drag
- Tuned parasitic drag
- Added custom prop disc braking

- Added compensation for the SU9 wind issues

Art:

- Fixed the windshield deice lever animation
- Fixed gun barrel frost showing if there are no guns
- Added low altitude dust FX
- Fixed rudder and elevator trim tabs
- Added wing tip vortices
- Added cockpit light bounce & improved cockpit lighting
- Modified LOD sizes for better optimization
- Fixed the rudder trim knob not responding to the click spot correctly
- Improved the instrument panel texture
- Added canopy physics (the canopy can now slide shut if the canopy is open and the door is locked)
- Disabled engine smoke (will likely be re-added and improved down the line)
- Fixed collision box for the cockpit
- Fixed animation for the boost coil cover so that it no longer clips with the fuel lever
- Fixed door collision so that it's easier to click the port switches
- Fixed gunsight ambient occlusion issue
- Added the ability to toggle between the default ASOBO pilot and the WW2 pilot

Sound:

- Gear thud added
- Propwash sound improved
- Ground sounds mix improved
- Engine Backfiring improved
- Improved starter sound
- Rattles, Winds and flaps mix improved

UPDATE 1.2.1

Systems:

- Reverted fuel pump to OFF during cold start
- Set default pilot to WWII
- Improved fuel valve logic. The fuel valve can now be toggled with the Toggle Engine 1 Fuel Valve keybind.
- GNS430 can now be powered on/off with the COM1 volume button
- Improved the rudder trim wheel interaction speed
- Fixed radiator flap not responding to manual override
- Fixed clock animation
- Halved the speed of icing
- Improved the baro knob
- Wobble pump logic improved
- Added aileron trim control to tablets settings. Be sure to TURN OFF 'Auto Rudder' in the assistance settings as this is causing major right roll.
- Base oil temperature slightly decreased
- Optimized primer animation and interaction code
- Canopy slide auto-shuts under a steeper angle now, making it easier to open on approach.
- Transponder digit rolls corrected
- Fixed checklists by removing incorrect idle/cutoff reference
- Fixed CTD when saving custom camera views

Flight Model:

- Slightly tweaked performance to compensate for SU9 changes (slightly lowered thrust at take-off)
- Reduced wheel brake power

Sound:

- Engine starter whine sound re-added
- New engine booster sound added
- Added startup pops and backfires
- Added prop sound when engine is turned off
- Engine shutdown timing with sound improved
- Improved groundroll and propwash transitions
- General rebalancing

Art:

- Greatly improved the cockpit shadows and eliminated almost all light leaking
- Modified clock arms to more accurately reflect the real gauge

Quick-start Guide

UPDATES, CHANGES & QUICK-NOTES

- With the introduction of the July 2021 Update to MSFS, some controls have changed slightly. For example the primer (which is now operated by holding left click and using right click to pump)
- Engine damage is optional – to turn it off or on, use the radio block. Preset Channel D will toggle damage on or off. Set it to off for a frustration free flight or screenshot flying.
- Use the gunsight reticule switch (left of the gunsight) to toggle between a gunsight & GPS
- External tanks can be removed by setting the external fuel to 0% before the flight, or by using the jettison control on the right side of the seat to remove it in flight
- Visible smoke coming from the engine gives you a heat that an engine failure is imminent if you do not cool the engine down. Act accordingly!

GETTING STARTED

To get started after installation, you should select the Spitfire as your aircraft, set your fuel load (we suggest maximum for most flights) and then selecting your departure airport.

Once loaded into the cockpit, we recommend following the interactive checklist available inside the sim from the top menu. This will guide you through an engine start and get you up and running!

TAXI & TAKEOFF

Be sure to disengage the parking brake (a lever in the center of the control stick) by using the default keybind Ctrl + Num-period(or D-pad Right) or by clicking the parking brake lever. Taxi in an 'S' pattern for visibility, using short bursts of the throttle and the prop lever full forward. Be careful on the brakes! Use the rudder and differential braking to steer. Keep the stick aft to maintain back pressure and improve ground handling stability.

Before takeoff, ensure the flaps are up, fuel boost pump is on and trim is set correctly. Use a mild boost setting for takeoff (up to +7) and have the prop lever full forwards. Use careful rudder control to stay straight, before lifting off between 85-105 mph.

We recommend using a rudder trim between 1 and 3 degrees, depending on how much takeoff power you use. More power = more trim. You will need to be very delicate on the rudders, to prevent an early swing out of control. On-top of that, you will also need to carefully manage the ailerons to avoid rolling the aircraft during the takeoff roll.

CRUISE

Optimal fuel consumption is between 170 – 200 mph, try to achieve this by setting boost to +7 and reducing RPM, reducing boost if speed is still too high. The engine can maintain a max continuous setting of +7lb Boost and 2650 RPM. Remember that the fuel quantity gauge only shows your bottom tank.

When flying above 12k ft in altitude, ensure that the fuel pressurization cock is set ON to prevent engine failure. Do not exceed 100°C Oil Temperature and 125°C Coolant Temperature.

APPROACH & LANDING

Reduce speed below 160mph before lowering gear & flaps, any higher can cause damage. The flaps will drastically slow speed and cause a strong nose down tendency when lowered; adjust trim accordingly after deployment. Set RPM to 2650 and manage boost to maintain approximately 90-110 mph on final.

After crossing the runway threshold, cut the throttle to idle and gently glide the aircraft down into a 3-point landing. Touchdown should be between 65-80 mph with flaps deployed. Once rolling down the runway and the tail has dropped onto the tarmac, use careful and precise rudder movements to maintain a straight course down the runway. At speeds below approximately 50 mph, the flight stick can be pulled fully aft to help maintain stability on the tail and prevent wing scrapes and oscillations.

SHUTDOWN

Pull the mixture control lever back to idle-cutoff, turn the magnetos off, the main fuel cutoff to off, dust yourself off and enjoy a beer! Congratulations on flying a Spitfire for the first time, and well done if you successfully landed your first Spitfire flight!

Aircraft Design & History

Spitfire MkIXc

From Britannica.com

Spitfire, also called Supermarine Spitfire, the most widely produced and strategically important British single-seat fighter of World War II. The Spitfire, renowned for winning victory laurels in the Battle of Britain (1940–41) along with the Hawker Hurricane, served in every theatre of the war and was produced in more variants than any other British aircraft.

The Spitfire was designed by Reginald Mitchell of Supermarine Ltd., in response to a 1934 Air Ministry specification calling for a high-performance fighter with an armament of eight wing-mounted 0.303-inch (7.7-mm) machine guns. The airplane was a direct descendant of a series of floatplanes designed by Mitchell to compete for the coveted Schneider Trophy in the 1920s. One of these racers, the S.6, set a world speed record of 357 miles (574 km) per hour in 1929. Designed around a 1,000-horsepower, 12-cylinder, liquid-cooled Rolls-Royce PV-12 engine (later dubbed the Merlin), the Spitfire first flew in March 1935. It had superb performance and flight characteristics, and deliveries to operational Royal Air Force (RAF) squadrons commenced in the summer of 1938. A more radical design than the Hurricane, the Spitfire had a stressed-skin aluminum structure and a graceful elliptical wing with a thin airfoil that, in combination with the Merlin's efficient two-stage supercharger, gave it exceptional performance at high altitudes.

The version of the Spitfire that fought in the Battle of Britain was powered by a Merlin engine of 1,030 horsepower. The plane had a wingspan of 36 feet 10 inches (11.2 metres), was 29 feet 11 inches (9.1 metres) long, and reached a maximum speed of 360 miles (580 km) per hour and a ceiling of 34,000 feet (10,400 metres). Faster than its formidable German opponent the Bf 109 at altitudes above 15,000 feet (4,600 metres) and just as maneuverable, Spitfires were sent by preference to engage German fighters while the slower Hurricanes went for the bombers. More Hurricanes than Spitfires served in the Battle of Britain, and they were credited with more "kills," but it can be argued that the Spitfire's superior high-altitude performance provided the margin of victory.

Meanwhile, Supermarine was developing more-capable versions of the Spitfire driven by progressively more-powerful Merlins. The eight 0.303-inch machine guns gave way to four 0.8-inch (20-mm) automatic cannons, and by war's end the Spitfire had been produced in more than 20 fighter versions alone, powered by Merlins of up to 1,760 horsepower. Though outperformed by the German Fw 190 upon that aircraft's introduction in 1941, the Spitfire restored parity the following year and eventually regained the advantage. It remained a first-line air-to-air fighter throughout the war. Spitfires were used in the defense of Malta, in North Africa and Italy, and, fitted with tail hooks and strengthened tail sections, as Seafires from Royal Navy aircraft carriers from June 1942. Spitfires helped to provide air superiority over the Sicily, Italy, and Normandy beachheads and served in the Far East from the spring of 1943. Fighter-bomber versions could carry a 250- or 500-pound (115- or 230-kg) bomb beneath the fuselage and a 250-pound bomb under each wing.

One of the Spitfire's most important contributions to Allied victory was as a photo-reconnaissance aircraft from early 1941. Superior high-altitude performance rendered it all but immune from

interception, and the fuel tanks that replaced wing-mounted machine guns and ammunition bays gave it sufficient range to probe western Germany from British bases.

In late 1943 Spitfires powered by Rolls-Royce Griffon engines developing as much as 2,050 horsepower began entering service. Capable of top speeds of 440 miles (710 km) per hour and ceilings of 40,000 feet (12,200 metres), these were used to shoot down V-1 “buzz bombs.” During World War II, Spitfires were exported in small numbers to Portugal, Turkey, and the Soviet Union, and they were flown by the U.S. Army Air Forces in Europe. When production ceased in 1947, 20,334 Spitfires of all versions had been produced, 2,053 of them Griffon-powered versions.

Fighter versions of the Spitfire were dropped from RAF service during the early 1950s, while photo-reconnaissance Spitfires continued in service until 1954.



Clipped Wing Variant

From FlyASpitfire: <https://flyaspitfire.com/clipped-spitfire-wings-why-did-some-spitfires-have-clipped-wings>

Clipped Spitfire Wings are often questioned from an aesthetic perspective. The classic elliptical wing of the Spitfire is regarded by many as the key to its beauty and itself the most identifiable symbol of Britain’s stand against the Luftwaffe in the Battle of Britain.

So why would you even think about 'ruining' its beauty?

From early 1941, well after the Battle of Britain had been fought and won, there suddenly appeared a new shape in the skies over occupied Europe. Early reports of a new Luftwaffe fighter were initially met with derision, but losses soon began to mount and the realisation was that this latest adversary had a significant advantage with its incredible rate of roll and maneuverability. Something had to be done.

Did they actually cut the wings?

To increase the roll rate of the Spitfire and improve its combat fighting qualities, the wingspan needed to be made shorter. Fortunately, ever since the first Spitfires, the wingtips were a separate piece constructed from wood with an aluminum skin, often by Rolls-Royce coachbuilding firms such as Freestone and Webb. They were attached with two bolts and a number of small screws to hold a covering strip where the wing and the tip joined, so naturally, it was an obvious idea to unmount them and fit a simple fairing in its place. All you needed to do was remove the two bolts, undo the screws, remove the tip, remembering to disconnect the wingtip light and replace it with a simple cover fairing, which was held in place by the same screws. With the light reconnected the job was done. Simple, and effective – but just how effective?

Comparative trials

A test flight was arranged by the Air Fighting Development Unit at RAF Duxford, comparing a standard wing Spitfire Mk V with the new modified version at various heights up to 25,000 feet. It was discovered that the clipped Spitfire wing made the aircraft 5mph faster at 10,000 feet and slightly faster at 25,000 feet, but with better acceleration across the board. In a dive, the clipped wing aircraft could pull away from the standard version and in a dogfight, the improved roll rate meant it could shake off the pursuing unmodified Spitfire. Climb performance wasn't affected much and there was no noticeable change to the take-off and landing performance.

Better view

The Spitfire wing is quite large and actually blocks out a lot of the ground from the pilot's perspective, which could potentially hide an enemy aircraft, but the removal of the wingtips, shaves over four feet from each side. Clipped Spitfire wings improve the downward view considerably. From a combat perspective, a downward view becomes a sideways view at large angles of bank.

Late war

Having improved the performance of the Spitfire Mk V, in conjunction with supercharger modifications (although losses were still heavy against the FW190s), the latter stages of the war saw the clipped wing configuration become a very common, almost standard specification on Mk 9 and Mk16 Spitfires, as high altitude sorties became fewer and low altitude missions such as ground strafing became a priority.

Cockpit Layout



- | | |
|---|---|
| 1. Pneumatic Pressure Gauge | 15. Engine Boost Gauge |
| 2. Oxygen Regulator Control Valve + Oxygen Gauges | 16. Oil & Radiator Temperature Gauges |
| 3. Elevator Trim Gauge | 17. Fuel Quantity Gauge |
| 4. Clock | 18. Wobble Pump |
| 5. Magnetos | 19. Magnetic Compass |
| 6. Mixture Control Lever | 20. Floodlight Controls |
| 7. Radio System | 21. Starter & Booster Buttons (under safety covers) |
| 8. Flaps & Nav Light Controls | 22. Fuel Tank Pressure Cock |
| 9. IAS Gauge (MPH) | 23. Main Fuel Tank ON/OFF Control |
| 10. Barometric Altitude | 24. Primary Compass |
| 11. Artificial Horizon | 25. Supercharger Control & FS Indicator Light |
| 12. Turn & Slip Indicator | 26. Gunsight + Controls |
| 13. Climb Rate | |
| 14. Engine RPM | |

Note that the Spitfire has no battery or electrical controls in the cockpit - in real life the batteries were connected to the terminal on the ground by the ground-crew. In our simulation the battery is engaged via the gear indicator switch (located on the throttle quadrant).

Port Controls



From left to right:

1. **TEST SWITCHES (under safety covers)**
Top switch is the radiator Test, Middle is Supercharger Test, and the bottom is the Engine Test button (non functional)
2. **Rudder Bias Knob**
This is your rudder trim control, offering a range of 5 Degrees right rudder trim and 18 degrees left rudder trim
3. **Radflap (Radiator Control)**
Auto = Automatic radiator control
Open = Full open radiators
4. **Pitot Heat**
5. **Fuel Booster Pump**
This switch is used to switch the booster pump on/off (see fuel section)
6. **Elevator Trim Wheel**
This is the large black wheel - you can read the status of the elevator trim via the Elevator trim gauge on the dash

7. **Carburettor / Dust Filter**

The black lever forward of the elevator trim wheel is the carburettor air filter control. This should be used when taking, taxiing or landing on non-paved surfaces

8. **Throttle**

9. **Airscrew Control (Prop control)**

10. **Mixture Cut-off Control**

11. **Magneto Switches**

12. **Battery**

The battery can be switched on by clicking it or by pushing the throttle forward.

Starboard Controls



From Left to Right:

1. **Undercarriage (Gear) Control Lever**
2. **Windscreen De-Icing Control**
3. **Wobble Pump**
4. **IFF Self-Destruct**
This is the 2 controls above the 'Chassis Emergency Lowering' Placard; they are non-functional in the current build.
5. **Emergency UnderCarriage Control (Red Lever)**
Pressing the lever forward punctures the emergency CO2 reserve to be used for undercarriage lowering
6. **Oxygen Flow Control Valve**
This is the main oxygen flow control valve; opening it allows oxygen to flow into the supply system from the Oxygen Tanks. It is non-functional in the current build.
Clockwise = OPEN
Anticlockwise = CLOSED

Non-Standard Instruments & Gauges

Pneumatic Pressure Gauge

This gauge indicates the status of the pneumatic air supply, used to power both the flaps and the wheel brakes.

The bottom PORT & STARBD indicators show the current pressure in the wheel brakes - the needle should rise linearly as the brake lever is squeezed harder towards maximum depression.

The top SUPPLY indicator shows the available air supply in the pneumatic system - use of the brakes & flaps will slowly drain the available air supply, so use them wisely.*



**Note: This is only currently partially simulated and will be improved upon in future updates.*

Oxygen Indicators & Regulator Control

On the left is the Altitude Delivery Gauge, displayed in ft x1000. This is used to show the status of the oxygen supply system and whether it is working correctly - when the oxygen supply is active & flowing, the gauge roughly indicates your current barometric altitude.

The right gauge is the Oxygen Supply Indicator - this shows your remaining Oxygen supply.

Between the gauges is the Oxygen Supply Regulator control, which controls the regulator unit & thus the flow of Oxygen to the pilot's mask.



VERTICAL = CLOSED

HORIZONTAL = OXYGEN FLOWING TO PILOT

Note that you also need to open the Oxygen Flow Regulator Valve (Starboard wall) in order to get a flow of Oxygen from the tanks to the regulator.

The flow regulator valve controls how much Oxygen is supplied to the pilot – opening it further will increase the rate of Oxygen supply, and therefore deplete oxygen reserves faster.

Turn & Slip

Unlike most indicators, the RAF turn & slip gauge has the Slip indicator at the top, and turn is indicated on the bottom of the gauge.

You are advised to make full use of this indicator (particularly sideslip) in order to achieve a balanced rudder trim setting.



Boost Indicator & Supercharger Controls

The British measured boost pressure as lbs./sq.inch (or psi) above a nominal value of atmospheric pressure at sea level. Typically "absolute pressure" is indicated in inches of mercury because "absolute pressure" is dependent on multiple atmospheric influences and can be used to indicate and measure "vacuum", or pressure below atmospheric pressure, as well. Mercury-filled manometers (devices capable of measuring pressures above and below atmospheric pressure also known as vacuum/boost gauges) that apply pressure directly to a column of liquid have much greater vacuum range when the fluid is much more dense than water. (From Wiki)

Inches of Mercury (" Hg)	Pounds of Boost ^[13]
80.9" of mercury=	+25 lb boost
66.6" of mercury=	+18 lb boost
60.5" of mercury=	+15 lb boost
48.3" of mercury=	+9 lb boost
42.2" of mercury=	+6 lb boost

To summarise; the Boost Gauge is essentially you Manifold Pressure indicator, or in simpler terms, how much air & fuel you are feeding the engine.

Located to the left of the Boost Gauge are the Supercharger Main Controls. The Left switch allows the pilot to choose between AUTO (down) and MS (up). During normal flight operations, the switch should be left in the AUTO position and MS (Medium Speed) should only be used in emergencies, overheat conditions or during particular climbing operations.

MS = Medium Speed, which is the supercharger 1st stage setting and has a critical altitude of around 7000ft in the Merlin 66.

FS = Fast Speed, which is the 2nd stage setting and has a critical altitude of around 17000 ft in the Merlin 66.



To the right of the switch is the Supercharger FS Indicator light. If the supercharger is working correctly & in the AUTO position, the lamp will illuminate when the supercharger switches over to the 2nd stage. This will generally occur around 12-14k ft. The lamp is also used to test the supercharger status, and should illuminate when the Supercharger Test Switch is held.

Oil & Radiator Status Gauges

From left to right: Oil Pressure Indicator, Oil Temperature Indicator and the radiator Temperature Indicator.

The oil pressure indicator is measured in PSI and should be read off at the white triangle.

The temperature gauges are both in degrees Celsius.



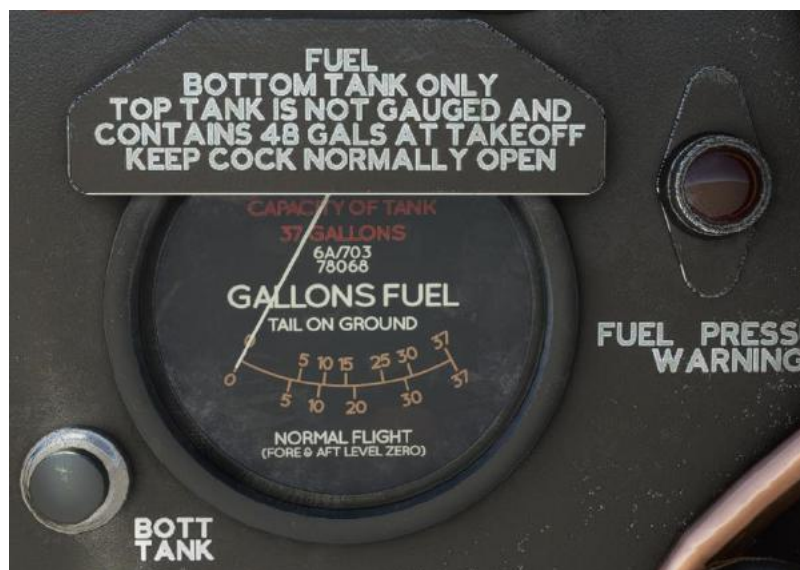
Fuel Quantity Indicator & Fuel Low Pressure Warning Lamp

The Fuel Quantity gauge is electronically powered and is only operative when the pushbutton (BOTTOM TANK) is pressed and held. This design was intended to save battery power.

Consequently, the fuel quantity indicator will only function when

- a) The aircraft has an active electrical supply, either through Ground Power or Battery Supply
- b) The pushbutton is held

Furthermore, the quantity gauge only shows the fuel status of the BOTTOM TANK. The LF Mk IX is fitted with 2 internal fuel tanks, with the larger tank on top (see fuel section). The top tank will always drain first.



The bottom numbers of the quantity gauge are to be used in level flight, with the top markings for use during ground operations.

To the right of the quantity gauge is the FUEL PRESSURE WARNING LAMP, which illuminates whenever the engine fuel supply is at a dangerously low level. This commonly occurs before startup, when EXT TANKS are running low, or when flying at altitude without engaging the fuel pressurisation systems correctly.

Garmin 430 GPS

To make the GPS visible, click the gunsight reticule power switch. The GPS can then be operated via its controls and toggled back to a gunsight by the same gunsight switch.



Merlin 66 – Engine Management

INTERCOOLER SYSTEM

The high temperatures that result from the engines 2-stage supercharger necessitate the introduction of an intercooler that sits between the supercharger and the induction manifolds. This is especially important when the supercharger is used in it's high-gear mode of operation.

Coolant fluid is passed from the radiator under the starboard wing, and then onto the intercooler via the supercharger casing. Heat is exchanged from the supercharged air into the coolant fluid, thus cooling the air before reaching the manifold intakes.

Pilot Controls

The pilot has one main control to operate the radiators and cooling system: on the port wall there is a switch to choose between AUTO & OPEN settings.

AUTO: Radiators are controlled automatically, and will open above 115C radiator temperature

OPEN: Manually open the radiators (full-open position)

During Pre-flight the pilot may check operation of the radiators by pressing & holding the Radiator Test Button, and then verifying that the radiator flaps fully open (this would need to be done with the assistance of Ground Crew in real life)

OIL SYSTEM

The engine is supplied via a 75-gallon (Imperial) tank which is located under the engine mounting. It is pressurised to 2.5 lb/square-inch, passing through a filter before entering the engine. The oil cooler is located on the underside of the port wing.

When carrying an auxiliary drop tank of 170 gallons or more, a larger oil tank is required.

FUEL SYSTEM

Fuel flow to the engine is controlled via the Fuel Cutoff lever, located on the front dash. When using internal fuel, this is the main fuel supply cut-off and must be ON for the engine to receive fuel. If external tanks are equipped, the pilot can switch on the External Fuel Lever which is located on the right side of the pilot seat.

Note that pulling this lever ON when no external tanks are attached (or they are empty) will cause the engine to shut-down, even if the main fuel supply cut-off is ON.

The External tanks can be jettisoned via a pull lever located next to the external tank fuel lever.

Operating Limits

Below are the recommended operating limits for the Merlin 66 engine; we recommend you stick to these limits and do not exceed them. **Exceeding maximum temperature limits will result in your engine failing.**

Conditions (Max time)	RPM	Boost	Coolant Temp	Oil Temp
Max Takeoff Power to 1000ft	3000	+18	135	95
Max Climb (1hr)	2850	+12	125	90
Max Continuous	2650	+7	105 (115)	90
Combat Limit (5 mins)	3000	+18	135	100

Minimum Oil Pressure: 30 lb/sq.in

Minimum Temps for Takeoff:

- Coolant: 60°C
- Oil: 15°C

Max Temperatures:

- Oil: 100°C
- Coolant: 135°C

Flight Procedures

Startup

CHECKLIST

1. Gear Indicator Switch (battery) - ON
2. Prop Control - FULL FORWARD
3. Carb Air Filter - FILTER IN OPERATION (FWD)
4. Mixture - AUTO (FULL FWD)
5. Fuel Tanks - ON
6. External Tank - OFF
7. Throttle - Open ½"
8. Booster Pump / Wobble Pump - OPERATE UNTIL LOW FUEL PRESSURE LIGHT EXTINGUISHED, THEN SET OFF (BOOSTER)
9. Primer - AS REQUIRED (see below)
10. Starter Coil/Booster Coil Safety Covers - OPEN
11. Mags - BOTH ON
12. Starter & Booster Coil - ENGAGE SIMULTANEOUSLY*

**Note that there is a clickable region between the two starter buttons. Clicking & holding on this will press both buttons simultaneously for you, resolving the need for a keybind*

ENGINE PRIMING GUIDE

Airtemperature °C,	+30	+20	+10	0	—10	-20
Normal fuel	3	4	7	12	—	—

Taxi

The Aircraft should be taxied in an 'S' maneuver; this is important for forward visibility during taxi due to the steep pitch of the aircraft on the ground making it virtually impossible to see what's in front of the aircraft.

The Prop control lever should be kept fully forward, with short bursts of the throttle used to increase taxi speed. Bursts of up to 1500rpm make for slow and manageable taxi speeds.

Directional control is maintained by the rudder pedals (particularly when the engine is powered up and producing propwash) but also by the differential brakes. Tight turns can be achieved by using the toe brakes and maximum rudder deflection. The aircraft uses a free castoring tail-wheel*, and has no linkage

to the rudder for steering. ***NB: At present in the simulator the Spitfire has rudder-linked steering due to limitations with the MSFS SDK. This will be addressed in an update when true free-castoring wheels become available in MSFS, at present we have done our best to 'fake' a free castoring wheel.

Be very careful using the toe brakes when taxiing the aircraft. The aircraft has a strong tendency to nose-over when applying the brakes too forcefully, and many a propellor has been ruined due to the overeager pilot stepping on the brakes too eagerly.

Takeoff

CHECKLIST

1. Elevator Trim – NEUTRAL OR SLIGHT NOSE DOWN
2. Rudder Trim – NEUTRAL OR RIGHT BIAS
3. Prop Control – FULL FORWARD
4. Fuel Cutoff – ON
5. Fuel Booster Pump – ON
6. Flaps – UP
7. Supercharger – AUTO
8. Carb Air Filter – CLOSED (aft)

TAKEOFF NOTES

- Generally, no more than +7 lbs. of Boost should be required for takeoff. Less power means less of a tendency for the aircraft to twist and yaw to the left
- There is a tendency for the aircraft to yaw left on takeoff, this should be carefully corrected with right rudder during takeoff. You will need to make small, constant adjustments and 'dance' on the rudder in some takeoffs.
- After takeoff, retrim the rudder and elevator

Climb

BEST CLIMB SPEEDS

Note that while these speeds listed below represent the rate of best climb, it is not necessarily recommended for flying. In normal flight, you should climb at **180 mph for any weight/load**.

Altitude (x1000ft)	Speed (mph) / (knots)
MSL – 26	160 / 140
26 – 30	150 / 130
30 – 33	140 / 122
33 – 37	130 / 112
37 - 40	120 / 104
>40	100 / 95

*Note that when climbing above 12'000ft, the fuel pressure cock must be switched ON. This pressurizes the fuel tank and prevents vaporization of the fuel at higher altitudes. **Failure to do so will cause your engine to die at higher altitudes as it is starved of fuel.***

The fuel booster pump should be left on at all times during flight, unless using external tanks.

Cruise

Best cruise economy can be achieved at a speed of **170 mph**.

To maintain cruise speeds & economy, engine boost should be maintained at +7 boost and RPM progressively reduced in order to maintain cruise speeds. RPM should not be reduced below 1800rpm, so at low altitudes it may be necessary to reduce the boost pressure to reduce speed.

Approach & Landing

APPROACH SPEEDS

	Engine-assisted	Glide
Flaps down	95 mph	105 mph
Flaps up	105 pmh	110 mph

These speeds are for a clipped wing aircraft, at full fuel load (no external stores). Reduce by 5mph for standard wings.

Note that when deploying the undercarriage & flaps, the aircraft will experience a strong nose down pitching tendency. Counter this by increasing aft elevator trim and be prepared for the nose drop when deploying flaps.

LANDING CHECKLIST

1. Reduce speed to 160mph or below and open the sliding canopy
2. Undercarriage (Gear) – DOWN
3. Prop Control – 2650 RPM
4. Carburetor Air Intake Filter – CLOSED
5. Fuel Cutoff – ON
6. Fuel Booster Pump – ON
7. Flaps – DOWN

BEAM APPROACH

The following is a guide to landing speeds & powers, as detailed by the Spitfire Pilots Notes

SPITFIRE Mk. XVI, II "training" load	Preliminary Approach	Inner Marker on Q.D.R.	Outer Marker On Q.D.R.	Inner Marker on Q.D.M.
Indicated height (ft.)	Down to 1,000	1,000	700-800	150
Action	—	Lower the flaps,	Lower the under carriage +	Throttle back slowly
Resultant change of trim	—	Nose down	Nose down	Slightly nose down
I.A.S. m.p.h. (knots)	170 (146)	160(138)	130(111)	110(95)
R.P.M.	2,650	2,650	3,000*	3,000*
Boost (level flight)	—2	-2	-3	
Boost (— 500 ft./mm.)	- 3	-3	-4	
Boost (overshoot)	—	—	—	+7
<i>Remarks</i> t Reduce speed to 160 m.p.h. (138 kts) , I.A.S. before lowering the under-carriage. * With the override lever at MAX. R.P.M., r.p.m. may be 3,000-3,050 (see para. 20) Altimeter error at take-off 50 ft. Altimeter error at touchdown 60 ft. Add 2 mbs. to Q-F.E. to give zero reading at touchdown.			OVERSHOOT Open the throttle to give + 7 lb./sq.in. boost. Raise the undercarriage and climb at 130 m.p.h. (112 kts) I.A.S. Raise the flaps at 300 ft. and retrim.	

MISSED APPROACH

1. Open the throttle steadily & be wary of engine-induced yaw & roll forces. Be gentle on the throttle to minimize these forces.
2. Retract the gear immediately
3. With flaps down, climb at about 130mph
4. Raise the flaps above 300ft and retrim

GENERAL TIPS

- Cut the power as the wheels are about to contact the ground to avoid bouncing; also, be sure that you aren't landing too fast.
- If you do bounce, maintain a high AoA and allow the aircraft to bleed off speed gradually - don't be tempted to pitch your nose down to get back on the runway quickly.
- You can also try a 2-point landing at high speeds if you are struggling with 3-point landings.
- The flaps deploy at 85 Degrees as per the real aircraft - bear this in mind! They are more like air-brakes that provide some lift; they will increase your drag immensely so be prepared to make the necessary throttle changes.
- When on the ground, cut engine power immediately and use the rudders to maintain directional control. This may require quick, constant corrections on the rudder, especially with a crosswind
- The Spitfire has a tendency to drop a wing when on the ground if the pilot does not maintain directional control and stay straight. It can also be caused by pilot-induced oscillations, or overcorrections on the rudder. **To help avoid this, once engine power is cut and the tail has dropped down onto the runway (usually below 50mph), hold the flight stick fully aft. This increases downforce on the tail and helps to maintain stability rolling down the runway.** Effective use of this technique can create an aerodynamic 'tail-wheel lock' and help keep you straight on the runway

Flight Performance & Limits

MAX SPEEDS

Altitude (x1000ft)	Speed (mph) / (knots)
MSL – 20	450 / 385
20 – 25	430 / 370
25 – 30	390 / 335
30 – 35	340 / 292
>35	310 / 265

Flaps Down: 160 mph / 138 knots

Gear Down: 160 mph / 138 knots

MAX WEIGHTS

Takeoff & gentle Maneuvers: 8700 lbs / 3946kg

Landing: 7450 lbs / 3379 kg

STALL SPEEDS

Gear & Flaps Up: 93 mph / 80knots

Gear & Flaps Down: 80 mph / 69 knots

Note that these speeds apply to the clipped wing aircraft, at max weight. Reduce speeds by 5mph for standard wings, and further reduced at lighter fuel loads.

The onset of the stall can be felt some 5-10mph before the stall, with a buffeting of the wings & tail. At the stall, the nose and often one of the wings will drop gently. This wing-drop is much more pronounced with aft stick at the stall. Recovery is straight-forward, simply release the controls or add a slight nose-down and increase power gently.

SPINNING & AEROBATICS

Spinning is possible in the airframe, but the loss of altitude can be great and the following limits should be observed:

- Do not start spins below 10 000ft
- Recovery should be initiated before 2 complete turns

A speed of 180mph or greater should be achieved before starting to ease out of the dive during recovery.

The following maximum speeds are recommended for aerobatics:

- **Loops:** 300 mph
- **Roll:** 240 mph
- **Half-roll off-loop:** 340 mph
- **Climbing Roll:** 330 mph

FUEL CAPACITY

Note that all capacities here are imperial gallons (not US gallons as seen in the sim).

Top Tank: 48 Gallons

Bottom Tank: 37 Gallons

Total: 85 Gallons

FUEL CONSUMPTION

Below +7 Boost:

<i>Boost lb./sq.in.</i>	R.p.m.				
	2,650	2,400	2,200	2,000	1,800
+7	80	—	—	—	—
+4	7	66	61	54	—
+2	66	61	57	50	43
0	60	55	51	45	39
- 2	53	49	45	40	35
-4	45	42	38	34	30

Above +7 Boost (High Power):

Boost lb./sq.in.	R.p.m.	gals./hr.
+ 15	3,000	130
+12	2,850	105

CHANGES OF TRIM

Gear Up: Causes Nose up

Gear Down: Causes Nose down

Flaps Up: Causes Nose up

Flaps Down: Causes strong Nose Down

The engine has a tendency to cause a slight yaw and roll at higher power settings – this should be managed via the rudder bias (trim) knob. Observe the sideslip gauge to assist you with setting the rudder trim correctly. You should aim to center the sideslip gauge with the trim knob as much as possible.

Navigation

MAGNETIC COMPASS

The magnetic compass does not require pilot input in the current build of the Spitfire and will align itself correctly in level flight.

It is located behind the flight stick on the front dash.

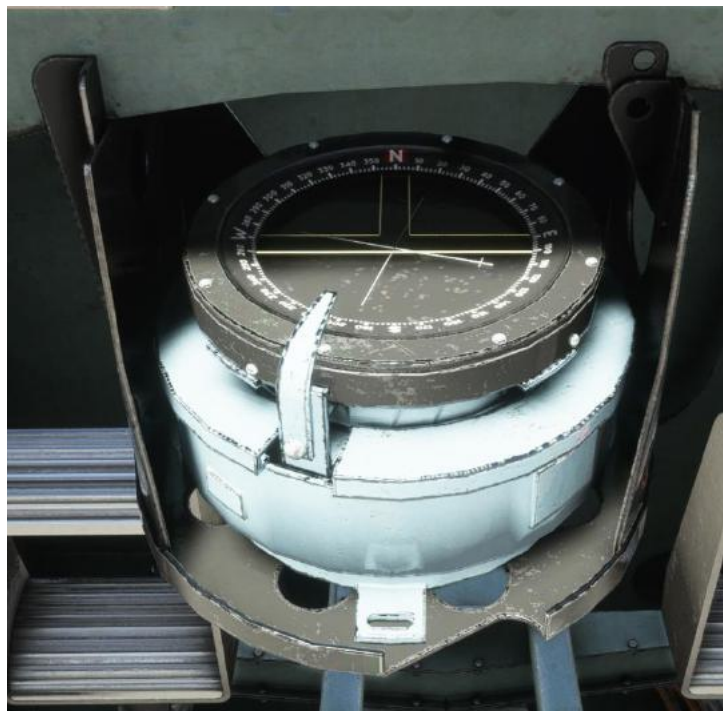
PRIMARY COMPASS

Use the metal lever tab to lock/unlock the compass. Rotate the compass ring to align the cross head of the pointer (which always points to North) with the 'North' indicator on the ring. Lock it in place, and read your heading from the top/front of the compass. Note that you must constantly realign the compass ring after turning in order to get an accurate reading.

Verify your compass reading by checking against the Magnetic Compass.

The Compass is highly prone to Parallax Error when aligning, so be sure to check that the pointer is parallel with the yellow boxes.

In the Picture below, you can see the compass is aligned correctly as the cross pointer is aligned with North on the outer ring.



You can find a more in-depth video guide here, made by DreamsofWings in early 2018 for the A2A Spitfire Simulation - as the compass is the same in our simulation, the exact same principles apply:

<https://www.youtube.com/watch?v=YdDvh5zPUWI>

Support & FAQ

FAQ

Why can't I see my Spitfire in the Aircraft selector?

Please check that you have extracted the downloaded zip file into the 'Community' section of your MSFS installation. It may be necessary to restart the simulator. If you are still having issues, please also verify that you purchased the correct version of the Spitfire from our website, not the X-plane 11 version.

My Engine starter won't work?

Please check that you have electrical power to the aircraft – you can check the gear indicator for illumination as a simple power check. The Battery switch has been fused with the gear indicator light switch, which is located next to the throttle. It is automatically switched ON when the throttle is moved forwards past about 30%.

My Engine spins but won't ignite properly?

Check that you have properly pressurized the fuel via the wobble pump or booster pump – the Low-Pressure Fuel Light should be extinguished, indicating that the fuel is pressurized sufficiently. After this, ensure the engine is primed sufficiently with the priming lever (if in doubt, go for 5+ strokes). Be sure to engage both the Booster Coil AND the starter (this can be done easily by using the clickable section in between the starter buttons).

Why can't I move the fuel primer?

Ensure that you have unlocked it first, by using the scroll wheel to rotate the primer.

My engine died suddenly?

At altitudes above 12'000ft, you should have the Fuel Pressurization Cock set to ON. This prevents the fuel from vaporizing in the tank; if you forget to turn it on your engine will die at high altitudes from fuel starvation.

Another potential cause could be an engine overheat – if your engine temperatures are exceeding their limits (100 & 135 degrees), the engine will seize up and fail. Be sure to follow operating limits to avoid overheat failures.

Finally, check that you have adequate fuel, and that fuel is available to the engine (check fuel shutoff and external tank selectors).

CONTACT US

For help, support or questions feel free to contact us on any of these channels!

Discord: <https://discord.gg/KwTK7Mk3Tm>

Website: [FlyingIron Simulations](#)

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Forum: [Microsoft Flight Simulator Forums](#)