Top Mach Studios, LLC

YF-23A Black Widow II Air Superiority Fighter For Microsoft Flight Simulator 2020 and 2024

User Manual

For Software Release V1.0.X+

Disclaimer – Although the digital aircraft model for which this manual is written resembles its real-world counterpart, neither the model nor this manual can or should be used as a source of real-world information about the operation or maintenance of the corresponding aircraft and is a work of fiction. Additionally, this package is not endorsed by or supported by the Northrop Grumman Corporation or its affiliates, nor by the United States Air Force, the United States Department of Defense, or the government of the United States of America.

IMPORTANT NOTE ABOUT THIS MANUAL:

At the time of the initial 1.0.1 version product release (release date Aug 28 ’25) we were very far along on the first update to the product (and the native 2024 product), which will be follow shortly after 1.0.1 becomes available (and includes even more cool features and a number of minor fixes and improvements). There are a handful of product changes and feature additions documented in this manual, which did not make it into the 1.0.1 product release. If you are using Version 1.0.1 and there is a missing feature or difference in appearance or behavior than what is described in this manual, this is due to the overlap in development and release schedules. 1.0.x will release within 1 to 2 weeks of the 1.0.1 release so the differences should only exist for a matter of days. Thank you for your patience and we apologize for any confusion this may cause in the meantime.

Contents (Click on a subject to navigate there)

The YF-23A Black Widow II Air Superiority Fighter

Brought to you by Top Mach Studios, LLC

Top Mach Studios team has dedicated over a year of research and development to the development of this model for MSFS 2020 and 2024. We are proud to present this highly capable, highly detailed, and highly functional replica of the YF-23 to the MSFS 2020/2024 community. You'll find this aircraft model, our fourth premium quality aircraft model for flight simulation, to be an a true joy to fly in MSFS 2020/2024. We hope you'll have at least as much fun flying the Black Widow as much as we've had making it.

Top Mach Studios:

- Evan Burns – *Lead developer and programmer*
- Aaron Kullman – *Art Direction, Flight physics, programming, vfx, and documentation*
- 3D visual modeling and artwork from 4d Architects and Warped Studios
- Sounds and Sound integration work by Echo19 Studios

Additional thanks and acknowledgements to:

Zak Priest
Brendan Murphy
Our forum moderators and helpers
Our beta tester team

And of course, thank you to the all of those members of the flight simulation community whose enthusiastic support, encouragement, and love of military aviation simulation keep us going. And a special thank you to our families and friends without whose support we couldn't have persevered to make Top Mach Studios and this model a reality.

Minimum Hardware Recommendations

This YF-23A model has high-detail modeling and large, high-resolution textures as well as complex customized flight control and custom coded instrumentation and gauges that may not function well without sufficient computing resources. We highly recommend minimum system specifications that meet or exceed the following:

CPU: 3.2GHz quad core processor or better
GPU: at least 6Gb dedicated video memory, Nvidia 1060 GTX or AMD RX 580 or better recommended
RAM: 16.0Gb minimum
Hard Disk: 11Gb minimum hard disk space required for installation

A dedicated control input device such as a joystick, yoke, or HOTAS type control device with dedicated rudder controls or alternatively an Xbox type compatible controller is strongly recommended, though keyboard flight control inputs are supported..

Installation

The YF-23 model is available in the Microsoft Flight Simulator in-game Marketplace. As such installation is as with any add-on purchased within the marketplace. For support with installation problems we recommend you contact the Marketplace / Xbox support team at Microsoft. *For Xbox customers, you will need to install the Add-On Support Module for the product to work correctly if not already installed.* This is provided by Microsoft and can be downloaded via your content manager if not automatically installed for you. For specific product support, information can be found at the end of this document.

Our Disclaimer About the Model and This User Manual

We've done our best to replicate the YF-23, within the limits of the information available to the public and within the limitations of Microsoft Flight Simulator (MSFS2020/MSFS2024), however, we make no claims, representations, or warranties about the accuracy or validity of any modeled systems or capabilities, or of any statements made about the real-world aircraft. This is not a true-to-life simulator of the YF-23, and any statements or programming choices we've made concerning performance, operations and procedures as incorporated in the model and described herein shall be considered fictional works. This is a "scale" digital model, or replica, of the YF-23, with information used in its creation taken only from published, publicly available sources, and with its only purpose to be as a source of entertainment, exclusively for customers of the MSFS2020/2024 game environment, and is therefore not appropriate or intended for the purpose of training or simulation of real-world YF-23 flight operations or systems familiarization (such as it is, given that the YF-23 is not an operational aircraft). Additionally, this manual should only be used as a guide to using the Top Mach Studios, LLC model of the YF-23 for MSFS2020/2024 and is in no way adequate to serve as a manual or guide to the operation of the real-life YF-23 and its systems, nor is it an adequate source of information for real-world operation and maintenance of any aircraft sub-systems and components. Additionally, neither the YF-23 model, nor this manual are endorsed by or supported by Northrop Grumman, or its subcontractors or affiliates in the development and production of the YF-23, nor by the United States Air Force or the Government of the United States of America.

Software Updates

Top Mach Studios will do its best to keep the product updated and resolve critical bugs as soon as possible. Updates are typically deployed as new installers/packages and will be available through the reseller channel from which you purchased the model. Installation of updates will depend on which point of purchase you used and the nature of the updates and instructions will be provided with each such update.

Warranty and Licensing Information

This SOFTWARE PRODUCT was developed by Top Mach Studios, LLC (TMS) for the individual purchase and use in Microsoft Flight Simulator 2020 / 2024, for an individual customer of Microsoft Flight Simulator 2020/ 2024, for entertainment purposes only. It is not sold and / or licensed for any other purpose. This software is provided by the copyright holders and contributors "as is" and any express or implied warranties, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose are disclaimed. In no event shall the copyright holder or contributors be liable for any direct, indirect, incidental, special, exemplary, or consequential damages (including, but not

limited to, procurement of substitute goods or services; loss of use, data, or profits; or business interruption) however caused and on any theory of liability, whether in contract, strict liability, or tort (including negligence or otherwise) arising in any way out of the use of the software, even if advised of the possibility of such damage. The license holder(s) (you) are solely responsible for determining whether this SOFTWARE PRODUCT is compatible with license holder's computing equipment and other software installed on license holder's equipment. You are also solely responsible for the protection of your equipment and backup of your data, and neither Top Mach Studios nor the reseller partner from whom you purchased this software, will be liable for any damages you may suffer in connection with using this software product.

Our SOFTWARE is licensed to you in accordance with the terms and conditions of the END USER LICENSE AGREEMENT (EULA) you entered when you purchased the software and any related EULA's associated with your license to use Microsoft Flight Simulator 2020 / 2024. You represent and warrant that you will not violate any of the requirements of those agreements and, additionally, you further represent and warrant that:

- You will not, and will not permit others to:

(i) Reverse engineer (including extraction of any 3D or 2D SOFTWARE PRODUCT assets using any means), decompile, disassemble, derive the source code of, modify, or create derivative works from the SOFTWARE PRODUCT, without the explicit prior written permission of TMS, or

(ii) Copy, distribute, or otherwise transfer to any other individual or entity any or all of the content contained in this SOFTWARE PRODUCT without the explicit prior written permission of TMS,

(iii) publicly display, or publicly perform, for any form of compensation or consideration, using the content contained in this SOFTWARE PRODUCT, without the explicit prior written permission of TMS,

(iv) Use TMS's SOFTWARE PRODUCT to engage in or allow others to engage in any illegal activity,

(v) Use TMS's SOFTWARE PRODUCT in a way that will interfere with or damage the operation of the services of any third parties, including Microsoft Corporation and Asobo Studio,

(vi) Sell our SOFTWARE PRODUCT or charge others for use of it or use the SOFTWARE PRODUCT either directly or indirectly for commercial purposes (either for profit or merely to recover your media and distribution costs), whether as a stand-alone product, or as part of a compilation or anthology, or as part of a derivative work without explicit prior written permission of TMS,

(vii) Use our SOFTWARE PRODUCT to engage in any activity that will violate the rights of third parties, including, without limitation, through the use, public display, public performance, reproduction, distribution, or modification of communications or materials that infringe copyrights, trademarks, publicity rights, privacy rights, other proprietary rights, or rights against defamation of third parties.

(viii) claim any sponsorship by, endorsement by, or affiliation with TMS, without explicit prior written permission of TMS.

TMS is the sole copyright holder, with all rights reserved, to the SOFTWARE PRODUCT, notwithstanding those copyrights and trademarks maintained or owned by Lockheed Martin and its affiliates and partners OR by the Government of the United States of America.

A WORD ON SOFTWARE PIRACY:

We ask that you please respect the law and the license agreement and refrain from making illegal copies of this software. We are not a big company – just a handful of us working tirelessly to make cool products – and we've poured our time and money into creating this product. Piracy and illegal copying and distribution of our software is illegal and hurts legitimate paying customers because it takes already limited resources away from us that we need to continually improve our product and develop future products for the flight simulation community. And please keep in mind, the flight simulation community is small and well connected, and we receive notifications of copyright infringements or reverse engineering attempts directly from our customers and fans very quickly.

Model Features and Capabilities

The Northrop/McDonnell Douglas YF-23A is an American single-seat, twin-engine, stealth fighter prototype technology demonstrator designed and submitted by Northrop for the United States Air Force's (USAF) Advanced Tactical Fighter (ATF) demonstration and validation competition, battling Lockheed Martin's YF-22 team for full-scale development and production. Nicknamed "Black Widow II", two YF-23 prototypes were built.

Our YF-23 features many unique and interesting capabilities and we've referenced the publicly available real-world YF-23 utility flight manual to replicate many of the aircraft's unique features. We can say with certainty that there is nothing available for MSFS like this, and the Black Widow II will provide sim pilots of all abilities interesting piloting challenges and many hours of enjoyment.

Significant information about the YF-23A remains classified; in particular, estimated aerodynamic performance and maneuvering capability data. However, we've done our best, utilizing museum displays, the real world YF-23 utility flight manual (available online), photographs, books, videos, graphics, statements by the USAF, test pilots and engineers, and publicly known specifications, to replicate what we know about the YF-23A. In spite of some unavailable information about the real-world aircraft, we've rendered a sophisticated and realistic model of the Black Widow II that's tremendous fun to fly.

We've modeled both real-world prototypes with different performance profiles as well as a hypothetical F-23A operational variant with additional features and performance capabilities. You get all three aircraft models in one package. This user manual describes use and function in all three variants.

Custom-programmed fly-by-wire control system:

- Auto-trim / pitch control
- G-limiter
- Roll and yaw limiters
- High angle of attack performance - controllable beyond 60 degrees AoA
- Computational fluid dynamics for improved aerodynamics and handling
- Highly resistant to departure from controlled flight

- Precision, stable flight control to 65,000 feet and above
- Custom-modeled flight control animations system
- Accurate take-off, approach and landing speeds
- Post-stall aerobatics possible; J-turns, pedal turns, power loops, etc.

Highly Realistic and Immersive Custom Sound Pack from Echo19 Studios

Highly detailed 3D cockpit – nearly 1:1

All displays custom programmed with reference to YF-23A utility flight manual:

- Head-Up Display (HUD)
- HSI screen and moving map for navigation
- Many functional cockpit controls; all cockpit controls are interactive & animated
- Custom canopy reflections and rain effects
- Full featured autopilot, IFR navigation capable
- Engine management controls modeled from flight manual
- Aerial refueling capability
- Complete cockpit lighting in operational variant
- 'Hidden' G3000 Flight planner
- High detail ACESII ejection seat model
- Custom, animated pilot figurine – user customizable display options
- Radar, Tactical display, and FLIR night vision in F-23A variant

Detailed custom-built 3D exterior model:

- 15 liveries included
- Accurate animation sequences for all flight controls
- Highly detailed, fully animated landing gear
- Ordnance bay animations and interior
- F-23A variant includes drop tanks and static weapons
- Custom dynamic vapor and vortex effects
- Custom afterburner and lighting vfx
- Complete exterior lighting systems for F-23A variant
- Custom ground and servicing equipment models

Performance and flight model based on USAF specs:

- Accurate weight and fuel quantities
- Engine model tuned to real-world specs

- Accurate fuel consumption and range
- Exceptional range allows long distance flights
- Mach 2.4+ maximum speed (faster for PAV-2 and F-23A variants)
- Super cruise at Mach 1.4+ at altitude (faster for PAV-2 and F-23A variants)

Other features and included items:

- VR headset compatible
- Ongoing development effort with ongoing upgrades planned

Model Variant Differences

We've included three variants of the YF-23 for your enjoyment, prototype air vehicles 1 and 2 (PAV-1 and PAV-2) and a hypothetical what-if F-23A. We initially considered modeling the F-23A after Northrop drawings of what the F-23A would have looked like, as well as a couple of poor-quality photographs/drawings of the real-world F-23A cockpit simulator that Northrop/McDonnell developed. We ultimately felt the development cost would be prohibitive, resulting in either an entirely separate product or a more expensive one, so we kept our ambitions reasonable and the development time and customer cost lower. Also, since the F-23A was only ever a "paper airplane", we felt that modeling an F-23A from the PAV vehicle design was more conservative and allowed us to develop faster and keep systems and cockpits mostly common. Here are the chief differences from variant to variant:

- PAV-1 had lower engine performance of the two prototypes; the Pratt and Whitney YF119 was a less powerful and slightly smaller prototype version of the F119 that was ultimately installed in the production F-22. As such the PAV-1 had lower performance results during testing. PAV-1 reached a super cruise speed of 1.43M and a maximum tested speed of M1.8 (with afterburner). PAV-1 also had a functional weapon bay system with doors that could be opened for testing during flight. While PAV-1 never carried weapons, the weapon bay and doors were tested for acoustic load and aerodynamic performance at supersonic speeds up to M1.5.
- PAV-2 had an early design of a variable cycle engine from General Electric, the YF120. During testing the aircraft reached publicly stated super cruise speeds of over M1.6, limited by test parameter restrictions, not ultimate engine / aerodynamic performance. GE engineers estimated super cruise speeds up to M1.8 could have been reached in unlimited testing. Maximum speed tested in PAV-2 was M1.72 with afterburner. PAV-2 had a weapon bay that was not designed for in-flight use. We haven't restricted our model in this regard, but be aware of the real-life limitation.
- Our F-23a has the following differences from the PAV-1 and PAV-2 models:
    - Heavier empty and max weights reflecting addition of avionics, structural reinforcement, and weapons carriage capability that would have likely made it into a production aircraft.

- Drop tanks and weapons can be added to the model allowing for visual weapon display, increased aircraft weight, and increased fuel capacity and longer ferry range; up to 30,000 lbs of fuel will give a range of at least 2,500nm at FL370 or higher at M0.85.
- More powerful engines, allowing a max super cruise speed of 1.9M+ and a maximum speed of well past Mach 2.2. in the game we've reached Mach 2.8 in perfect conditions at around 42000 feet. In the real world there are a variety of considerations in determining an aircraft's ultimate maximum speed and a realistic ultimate allowed maximum Mach number (Mmo) would likely be between M2.2 and M2.5.
- We've made the F-23A a little more maneuverable, able to reach slightly higher angles of attack (over 70 degrees aoa) and with a bit more pitch authority at high alpha than the PAV vehicles. In real-world testing the YF-23 vehicles were not flown above 25 degrees angle of attack, though they were demonstrated in wind tunnel and simulation to reach or exceed 60 degrees angle of attack trimmed. The F-23A is not quite as maneuverable as our F-22, but it will beat just about anything else out there and perform most of the same post-stall airshow type maneuvers as the F-22
- Stronger brakes. PAV-1 and PAV-2 had landing gear systems from the F-18 Hornet, which was a smaller aircraft and as such the braking system was not adequate for heavy / continuous braking. A production aircraft would have had a more capable braking system.
- A third MPCD / MFD display in the cockpit allowing for more display flexibility.
- Additional avionics including a simulated radar system with TSD and HUD integration, moving map display for the TSD screen, and a FLIR-type display.
- Deletion of most of the test equipment switches and interfaces found in the PAV-1 and PAV-2 cockpit models
- A complete cockpit and exterior lighting system. The PAV-1 and PAV-2 aircraft had no night-lighting systems – save for an in-cockpit utility light and two strobing anti-collision lights on the vehicle upper and lower centerline behind the cockpit.

Real World Aircraft Description and Specifications

(Ref. Wikipedia**)**

"The Northrop/McDonnell Douglas YF-23 is an American single-seat, twin-engine, stealth fighter prototype technology demonstrator designed for the United States Air Force (USAF). The design team, with Northrop as the prime contractor, was a finalist in the USAF's Advanced Tactical Fighter (ATF) demonstration and validation competition, battling the YF-22 team for full-scale development and production. Nicknamed "Black Widow II", two YF-23 prototypes were built.

In the 1980s, the USAF began looking for a replacement for its F-15 fighter aircraft to more effectively counter emerging threats such as the Soviet Union's advanced Su-27 and MiG-29 fighters. Several companies submitted design proposals; the USAF selected proposals from Northrop and Lockheed for

demonstration and validation. Northrop teamed up with McDonnell Douglas to develop the YF-23, and Lockheed, Boeing, and General Dynamics developed the YF-22. The YF-23 was stealthier and faster, but less agile than its competitor. After a four-year development and evaluation process, the YF-22 team was announced as the winner in 1991 and developed the F-22 Raptor, which first flew in 1997 and entered service in 2005. The US Navy considered using a naval version of the ATF as an F-14 replacement, but these plans were later canceled due to costs.

After flight testing, both YF-23s were placed in storage while various agencies considered plans to use them for further research, but none proceeded. In 2004, Northrop Grumman used the second YF-23 as a display model for its proposed regional bomber aircraft, but this project was dropped because longer range bombers were required. The two YF-23 prototypes are currently displayed at the National Museum of the United States Air Force and the Western Museum of Flight."

A particularly good book about the YF-23 and the ATF program, if you're interested in more information about the YF-23 is "Air Force Legends Number 220, Northrop YF-23 ATF" by Paul Metz (the Northrop chief test pilot for the YF-23A program).

General characteristics

Crew: 1

Length: 67 ft 5 in (20.55 m)

Wingspan: 43 ft 7 in (13.28 m)

Height: 13 ft 11 in (4.24 m)

Wing area: 950 sq ft (88 m2)

Empty weight: 29,000 lb (13,154 kg) *contractor weight* (without engines – engine weight est. approx. 9500 lbs)

Gross weight: 64,000 lb (29,030 kg) takeoff, 51,320 lb (23,280 kg) combat weight

Powerplant: PAV1: 2 × Pratt & Whitney YF119-PW-100N, PAV2: General Electric YF120-GE-100N afterburning turbofans, 23,500 lbf (105 kN) thrust each (YF119 and YF120) dry, 30,000 (YF119) or 35,000 (YF120) lbf (130 or 160 kN) with afterburner.

Performance

Maximum speed: Mach 2.2, 1,452 mph (1,262 kn; 2,337 km/h) at high altitude

Supercruise: PAV1: Mach 1.43, PAV2: Mach 1.6+, 1,135 mph (986 kn; 1,827 km/h) at altitude (GE engineers est. the YF120 equipped PAV-2 could have reached up to M1.8, but this was not tested)

Range: 2,100 nmi (2,400 mi, 3850 km) ferry

Combat range: 700–800 nmi (810–920 mi, 1,300–1,500 km)

Service ceiling: 65,000+ ft (19,800 m) – highest tested 50,050 feet

g limits: +7.1 g (highest tested – utilizing PAV2, PAV1 was tested to 4.4G)

Wing loading: 67.4 lb/sq ft (329 kg/m2) (54 lb/sq ft at combat weight)

Thrust/weight: 1.09 (1.36 at combat weight) with YF120 engines

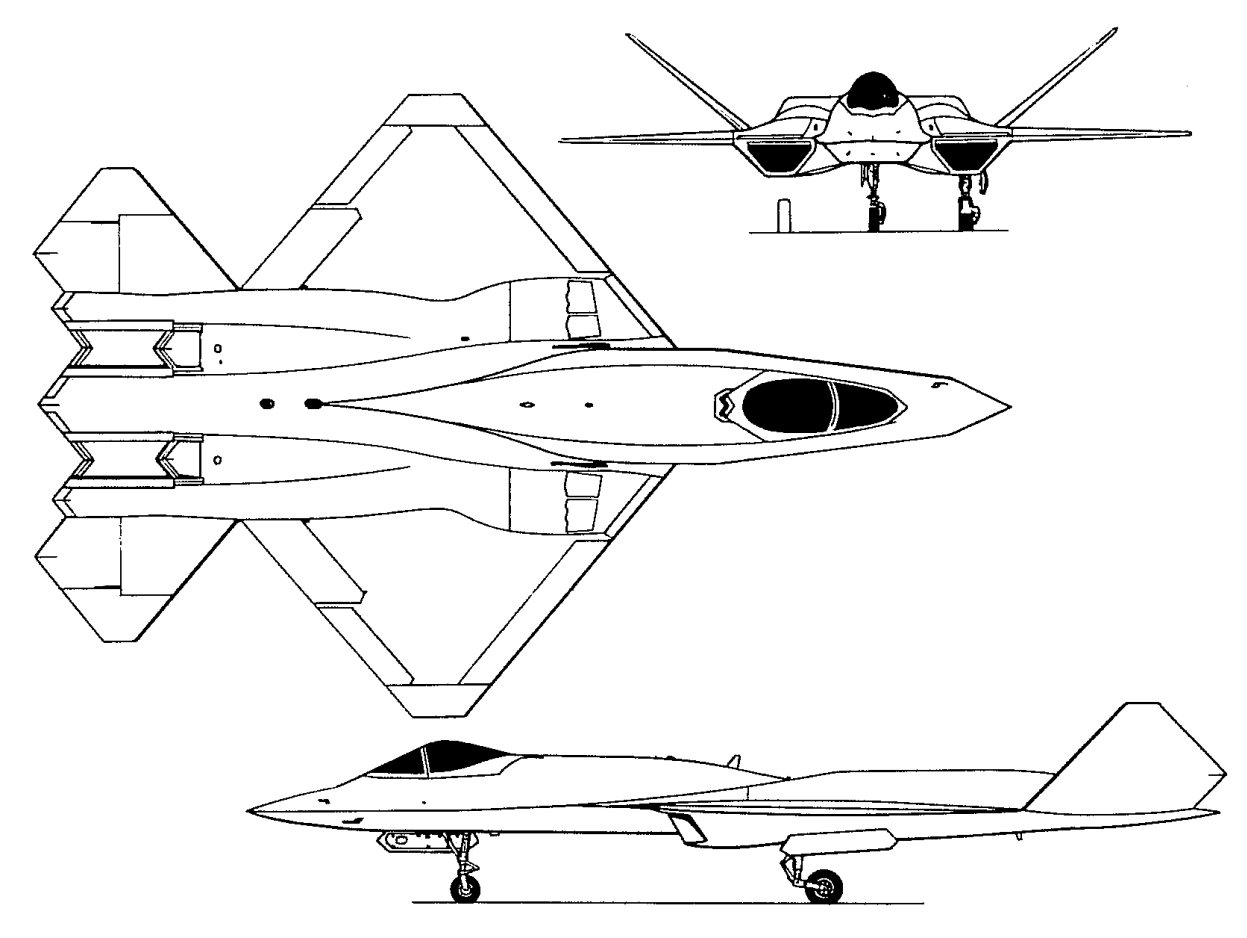
Armament

None as tested but provisions made for:

1 × 20 mm (0.79 in) M61 Vulcan cannon

4 × AIM-120 AMRAAM or AIM-7 Sparrow medium-range air-to-air missiles

2 × AIM-9 Sidewinder short-range air-to-air missiles



NOTAMS (REALLY IMPORTANT INFORMATION) FOR BEST ENJOYMENT OF THIS MODEL – READ THIS BEFORE TAKING OFF

Important concerns or known issues to be aware of before you fly.

Modern flight model
Make sure you have the Flight Model in the game set to “Modern”. We have included an over-ride flag to prevent the model from reverting to “Legacy” performance, but still encourage you to ensure you use the Modern flight model setting to avoid any issues.

No Assistances
The flight model will not perform correctly or handle properly if you have set any of the “Piloting” options under the “Assistance Options” menu to anything other than “Hard”.

No AI Pilot
To achieve the performance characteristics of the model, the flight model and engines performance configurations do not work properly with the AI Pilot option – takeoffs and landings aren’t likely to work. We don’t recommend you try to use these features. Autopilot functions can be used instead to manage the aircraft for long flights or while taking screen shots.

Eyepoint Settings
The model has a small cockpit with a wide field of view setting in the default cockpit camera view to provide best / most realistic visibility out of the window while still being able to see a significant portion of the control panels. As a result, if you have made any prior adjustments to the default Cockpit Camera Height, Horizontal Position, or Zoom (all found under General Options -> Cameras), you may find the default eyepoint to be unusable (in some cases well outside of the cockpit). The default positions, that work best for the model, are 50% for Height, Horizontal Position, and Zoom.

Aerobatics – Independent Rudder Control
To perform several of the aerobatic maneuvers correctly, it is strongly recommended that you have an independent rudder control input. Many control sticks or control pads have or can be configured to use a rudder control option (swivel, rocker switches, L/R buttons, etc…), but we find a set of rudder pedals to be the most effective and realistic way to control rudder inputs.

AMSL vs AMGL – Weather Presets and Engine Performance Bug
There is a bug that appeared after Sim Update 8 (and continues to this day in 2020 and 2024) that effects high performance turbine engines and occurs specifically when using weather presets (this issue is not found with Live weather). This bug degrades engine performance when flying over elevated terrain that is significantly above sea level. Under the Weather menu, Settings -> Altitude Calculation should be set to AMSL and not AMGL, or engine performance will be degraded when flying over higher elevation terrain and you will not achieve maximum performance of the aircraft.

Airspeed Indicator Differences

We have taken great pains to custom program a calibrated airspeed value for all instruments in the cockpit that is highly accurate. However, the game will report inaccurate airspeed when airspeed exceeds supersonic values at intermediate and high altitudes. Therefore, the cockpit KCAS values (as displayed on the HUD or other instruments that show airspeed value) will not match the value shown on the external HUD or other native game airspeed displays – those values will typically be significantly higher (inaccurately so) than what you will see in cockpit. Refer to the speeds reported in the cockpit when you are flying at supersonic speeds and intermediate to high altitudes (above 10,000 feet AMSL).

Angle of Attack Indicator Differences

The standard game angle of attack calculation is limited to around 70 degrees. Above this, the reported value will be incorrect or zero. We have custom programmed a correct angle of attack indicator for our models and this is available in the in-cockpit head up display (HUD) and other in-cockpit displays. When performing high alpha maneuvers, it's best to rely upon the angle of attack indicator in the cockpit and not on the external chase camera HUD or other game native AoA references.

Manual Control Inputs While using Autopilot

In order for the autopilot functions to work, we disable the fly-by-wire module feature while autopilot Master control is activated. We also disable flight control inputs because without FBW features enabled, the controls are extraordinarily sensitive. If you move the stick more than a few degrees in pitch or roll, the autopilot will disengage and you will be restored to manual flight control.

Sound Volume

The external engine sounds are modeled to produce a very high sound output (it's a fighter jet, it's supposed to be LOUD). This can provide a visceral and immersive experience, but be careful to maintain a safe listening volume, particularly when using headphones or other over/in the ear sound output devices to avoid hearing damage. When in the cockpit, it may also be helpful to turn on the Headphone Simulation function to reduce the amount of ambient noise coming through your speakers / headphones when in the cockpit.

Auto-trim System

The Black Widow model does not have a manual trim function. The auto-trim system will automatically trim the aircraft pitch even at high angles of attack and will attempt to hold the commanded pitch value in most circumstances. This does not use the separate pitch trim function, but rather operates in a single channel using the primary elevator control. The aircraft can be controlled quite well with pitch control, and trim commands are not supported. If you enter trim, you will find the aircraft will pitch up or down or roll left or right, but the effect is limited and the flight control system will attempt to override the trim commands. To reset trims entered inadvertently (or purposely) you can push the TOT (takeoff trim) button found on the left console of the cockpit.

Lighting System

The PAV-1 and PAV-2 vehicles did not have night lighting systems in the cockpit or exterior of the aircraft. The only lighting in the cockpit is a flashlight found on the right-side console and the only exterior lighting is a flashing anti-collision strobe found on the upper and lower center fuselage. The F-

23A variant includes a complete interior and exterior night lighting system. The lighting system is customized such that the “L” key will not turn on or off lights in a realistic way. It is best to activate lights using the designated switches or controls in the cockpit. Additionally, the landing and taxi lights are programmed to the switch in the cockpit and won’t activate via “L” key as expected. This is so these lights behave more like the real-life counterpart.

Auto-Flaps System

The model does not have a manual flaps system. All flaps settings are controlled automatically depending on airspeed, configuration (landing gear down or up), and angle of attack. There is an emergency flaps override switch on the left console if you desire to manually extend or retract flaps.

G Load Buffet

The game has a built-in high G (gee) load buffet effect that oscillates the pitch controls and elevators up and down when g load exceeds approx. 6 g’s. We have reduced the effect of this “feature” as much as we’ve been able to without degrading aircraft handling and performance, but it’s still noticeable, in particular at high-speeds with the aircraft at “max” G. Perhaps in future revisions we will find complete solution.

A Word on MSFS 2020/2024 Simulation Limitations and Limitations of this Model

Weapons and Combat Situational Awareness Systems: MSFS 2020/2024 is a civilian simulator. Weapons systems and the related avionics aren’t natively supported. As such we don’t simulate weapons systems, other than our custom developed radar and tactical situation displays for display of multi-user and real-time traffic on the MFD and PMFD. Radar warning receivers, functional weapons systems and weapons deployment are not modeled and not permitted for sale in the in-game marketplace. Even if we could, there is little to no public data available describing these systems specific to the YF-23 in any detail because it was never produced as a production fighter aircraft, so any attempt to model these would be conjecture at best. However, for the F-23A variant there are loading options in the MPCD (MFD) configuration menu that automatically adjust the fuel and weight menu to simulate the weight and visual display of missiles and also two optionally displayed external fuel tanks (for which fuel can be added once displayed), but no functionality exists with respect to weapons or weapons deployment.

Cockpit and General Systems Overview

The YF-23 model incorporates a fully custom-built suite of avionics to provide a high degree of functionality with respect to aircraft systems information display, navigation, and automation. We modeled these systems based on the public information available about them including the publicly available YF-23A Utility Flight Manual (which can be downloaded online) and did our best to replicate the look and function of these avionics displays within the limitations of MSFS 2020/2024 and with some limitations based on complexity and use cases for the vast majority of customers. We’ve also added features, for example, a functioning autopilot, that didn’t exist in the real aircraft. This should give the model, from the standpoint of general aircraft management and navigation, similar functionality to most of the native complex aircraft in MSFS 2020/2024, but in a way that is generally more consistent with military systems. However, while this is definitely a go places airplane model, it’s not a procedures simulator and quite a few systems and functions that are found (or presumably found) in the real-world

aircraft aren't represented in this model, both due to the lack of available information about how these are implemented, and the lack of underlying simulator support for modeling these systems.

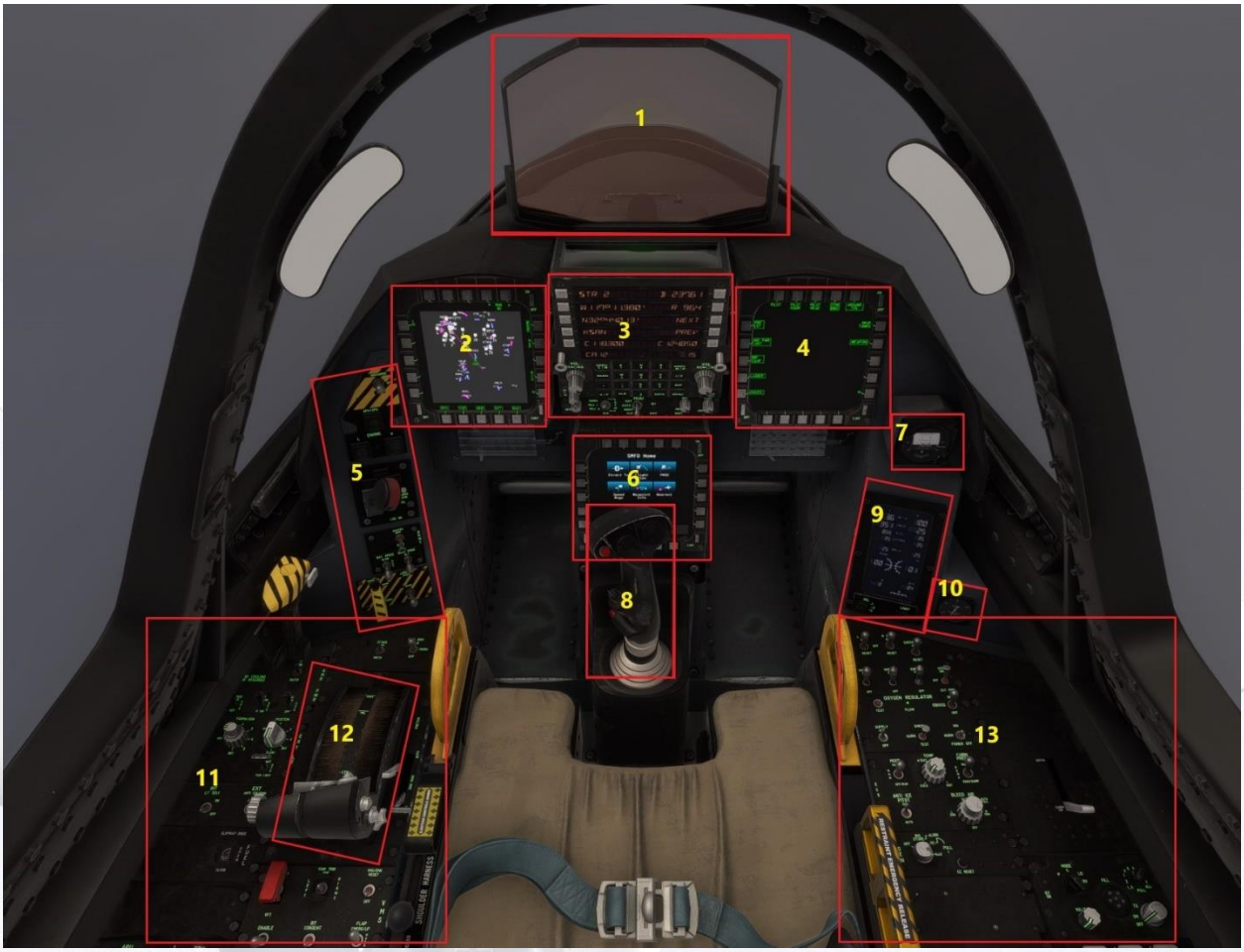
The YF-23 cockpit 3D model is a highly detailed 3D representation of the real-world Black Widow cockpit, modeled from the flight manual, photographs, written descriptions, and illustrations. If it looks a lot like an early F-15E Strike Eagle cockpit, that's because most of the cockpit systems were sourced from the F-15E by McDonnell Douglas Corporation, who was the other principal contracting partner with Northrop for the YF-23 entry into the ATF competition. While not 100% accurate in every respect, we've modeled at a close to 1:1 level of detail as many of the features of the cockpit as we were able to and animated all of the control inputs (switches, knobs, and dials) that are documented in the aircraft flight manual and from photographs and drawings. However, this model does not attempt to replicate a number of the systems and subsystems of the real-world counterpart, in part due to lack of data, and in part due to lack of meaningfulness (for example, the test equipment consoles and test data display systems, have no corollary or meaningfulness in the game). In spite of these purposeful omissions, this model will still provide a highly immersive, realistic, functional, and endlessly entertaining flying simulation experience. The following reference guide will show you where the functional elements of the cockpit are found, where appropriate, how to use them in flight, and key procedures needed to operate the aircraft.

If you are interested in a more thorough guide to the YF-23 systems, we highly recommend you download and review the freely available real-world YF-23A Black Widow II Utility Flight Manual. There you can find a wealth of information pertaining to the operation of the real YF-23 aircraft.

A Note About Using this Manual:

IMPORTANT: Throughout this user manual, whenever an object (switch, knob, lever, button, etc…) is not specifically numbered or described it means that it does not have a function or trigger an event in the game. All objects in the cockpit are generally animated (with a handful exceptions), but not all perform a function or trigger an event.

YF-23A Cockpit Overview



Welcome to the YF-23 pilot's front office. This is a high-level summary of the key components of the cockpit. The above diagram is from the F-23A which has a larger number of features. The YF-23 PAV1 and PAV2 differences are noted below. Each section of the cockpit will be described in more detail within this user guide.

1. Head Up Display (HUD)

2. MPCD (Multi-Purpose Color Display) 1 / Left

3. Up Front Controller (UFC

4. MPCD (Multi-Purpose Color Display) 2 / Right

5. Left Auxiliary Console

6. MPCD (Multi-Purpose Color Display) 3 / Lower (F-23A variant only)

7. Backup Attitude Indicator

8. Flight Control Stick

9. Secondary Flight Data Display

10. Cabin Pressure Altitude Gauge

11. Left Console

12. Throttle Quadrant

13. Right Console

YF-23 PAV-1 and PAV-2 Cockpit Overview and Differences

The real-world YF-23 cockpit had three different test equipment and recording control sub-panels on the left console of the cockpit (2) and had a test data LCD screen mounted below the UFC (1). We've modeled these in the PAV-1 and PAV-2 cockpit. The test data LCD screen is used to display the G1000 flight planning interface. The test data and test control switches are non-functional, but are animated / interactive. There was also a thermal cooling / heating garment called a jerkin, that was worn by test pilots – control for that is found on the right console. We've modeled that for the PAV1 and PAV2 aircraft and omitted for the F-23A. The PAV1 and PAV2 aircraft also had no light lighting systems (cockpit or exterior) and didn't include a third MPCD, as we have for the F-23A variant.

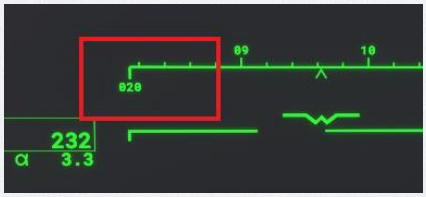
Head Up Display (HUD)

The Head Up Display provides the pilot with substantial information about the aircraft performance, attitude, position, and navigational references without having to look down into the cockpit. For this model, we've developed a fully customized HUD based on the information available about the HUD included in the real-world YF-23.

1. Pitch ladder (in increments of 5 degrees pitch up or down)

2. Aircraft Heading Tape

3. Course or heading selection bug (small tick mark below the heading tape) derived from the autopilot NAV or HDG mode selection. If bug is outside the range of the heading tape a small numeric indicator will show in the end of the tape that is the closer turning angle to the target heading.



4. Aircraft current heading carat

5. Knots Calibrated Airspeed (KCAS). Primary airspeed indicator for the aircraft

6. Angle of Attack indicator in degrees (positive or –negative)

7. Waterline Marker (Aircraft Pitch Reference Symbol): Shows where the aircraft nose is pointed. The difference between the Waterline Marker and the Flight Path Marker will equal the aircraft angle of attack and sideslip.

8. Autopilot current altitude target as set in the autopilot menu.

9. Barometric altitude (above sea level) in 10s of feet

10. Flight Path Marker – shows the direction/vector of travel of the aircraft relative to the ground. A small vertical line will display above the flight path marker when the aircraft is above or below the target angle of attack when the aircraft is on approach and landing gear is down. Target angle of attack for final is 10 degrees AoA. If angle of attack is too low, a vertical line will appear above the climb/dive marker. If angle of attack is too high, a vertical line will appear below the climb/dive marker. When speed brake is extended, a trapezoidal shape will display on top of the flight path marker

10A. Artificial horizon indicator

11. Glideslope and localizer crosshairs – shows deviation from localizer / glideslope path

12. Course deviation indicator (CDI): Appears when a course selection is made in autopilot system tied to a navigation signal (GPS, TACAN, VOR, etc…)

13. Vertical velocity (climb or dive rate) in feet per minute.

14. Radar altimeter (altitude above ground level - AGL)

15. Current Mach number (fraction or multiple of the speed of sound).

16. Bank angle indicator

17. Current steerpoint number, bearing, and distance in NM

18. Current G (gee) level (airframe load factor).

18A. Maximum g load attained during the current flight

19. Bank angle pointer and combination slip indicator

20. Estimated time to go to steerpoint based on groundspeed (hours:minutes:seconds)

21. Status of weapons system arming switch (SAFE or ARMED)

Head Up Display – ILS

During ILS landing using an ILS landing beacon the following symbology will display:

1. Glideslope indicator. Fly toward the arrow to establish on glideslope
2. ILS crosshairs (when centered as crosshair, shows if on slope and localizer – vertical and horizontal)
3. Flight path marker with angle of attack target indicator. In this reference, angle of attack is too low.
4. CDI – shows lateral guidance – needle will center when on localizer
5. Identifier, bearing, and range of tuned localizer

UFC (Up Front Control Panel)

The Up-front control panel or UFC, provides quick access to a wide array of functions and information about the YF-23. We've modeled, where reasonable / possible the UFC functionality as closely as we can to the real YF-23, based on the information contained in the YF-23 utility flight manual. We've added or modified certain functions within the UFC to improve ease of use and functionality within MSFS 2020/2024.

UFC Interface Overview (Menu Page 1 Shown):

1. Bingo Fuel entry area
2. Current Steerpoint and steerpoint menu page select
3. Tacan entry and tacan page entry button.
4. Transponder frequency entry area
5. Barometric pressure entry area
6. Flight envelope alert configuration page select
7. Comm1 frequency entry area
8. Comm2 frequency entry area
9. Scratch pad. Use keypad to enter a value here. Enter the value by pressing button next to value you desire to change. When a menu option has dual function: data entry field or page select, entering a value into scratch pad and then pressing button next to data entry field will enter the value. Pressing button next to entry field without a value in the scratch pad will open the page.
10. Comm1 volume
11. Comm2 volume
12. UFC Display brightness knob
13. HUD brightness knob
14. Keypad – here is information about specific sub-functions of keypad buttons:

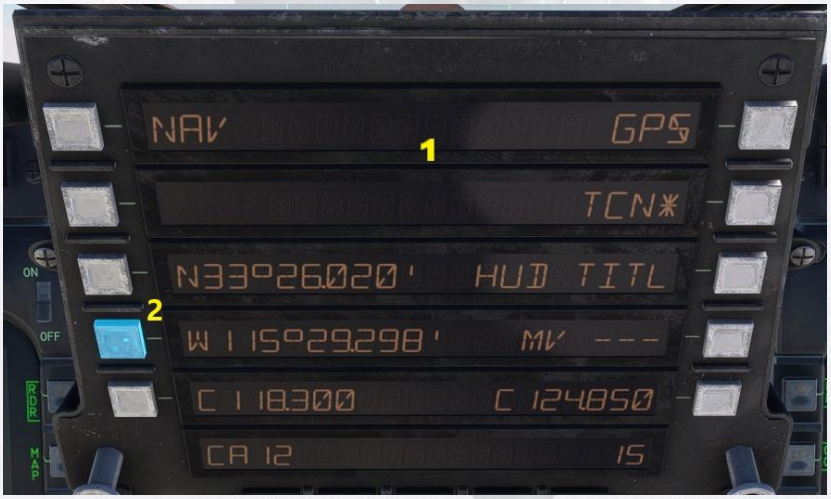
- A/P button opens the autopilot menu
- Data button opens the Data page
- Menu button, pressing this button cycles between Menu 1 page and Menu 2 page

- To enter a negative value, press SHF button and then the 0 key. The SHF button can also be used to select the alternate key value (non-numeric) for a given keypad button.
- Other buttons have no function in this UFC.

UFC MENU PAGE 2:

1. Nav Radio entry area (only one nav radio is equipped in the YF-23 model – the real aircraft had no civilian nav radio capability)
2. PP-INS opens the Present Position – INS page.

UFC PP-INS Page:



1. Navigation guidance source selection – push button next to the three source options to control HSI, autopilot navigation sources. This can also be controlled from within the Autopilot page menus.

2. Present position latitude and longitude

UFC TACAN Page:

Accessed from Menu 1 page

1. TACAN channel
2. TACAN band (toggles X or Y band)
3. Enter TACAN Program page (non-functional data page that would normally provide information about the TACAN channel facility – game limitation)

UFC Envelope Page:

Changing/updating values in this table adjusts the trigger point for the Envelope Crew Alerting System message “Envelope” which is accompanied by a tone and illumination of the Master Caution/Warning alert button.

- CAS = airspeed limit

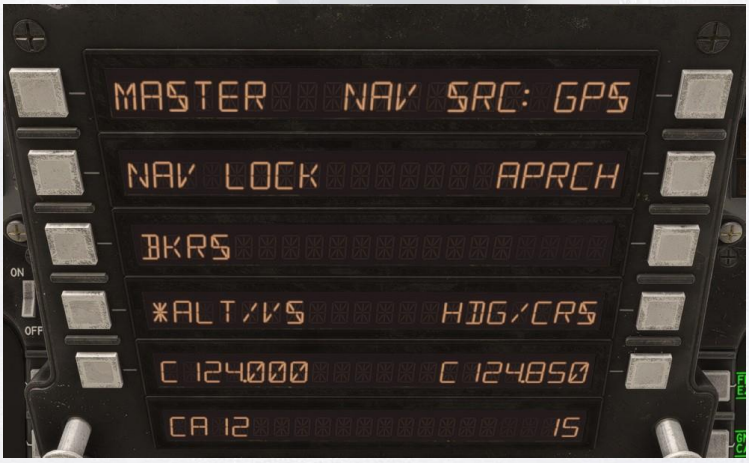
- AFT center of gravity limit
- M = Mach number limit
- G Lim = Positive G load limit
- AOA = Angle of Attack limit
- CG = non-functional – static
- AOSS = non-functional – static
- WT = non-functional – static weight limit

UFC Steer points Page:

Cycles through the steer points for a flight plan entered into the flight planning computer or loaded from the main lobby.

1. Steer point number, bearing, latitude and longitude, and range
2. Cycles to next or previous steerpoint in the list
3. Steerpoint facility ICAO ID abbreviation.

UFC Autopilot Page:



This page is accessed by pressing the A/P button the UFC keypad and opens the autopilot menu. The YF-23 did not have an autopilot installed, but we added one with standard autopilot options for convenience. Stable autopilot envelope in the game (we use the game's underlying native autopilot software) is up to 600 knots indicated airspeed and around 60,000 feet. Outside of these two parameters we've encountered instability in the autopilot system ability to maintain stable flight.

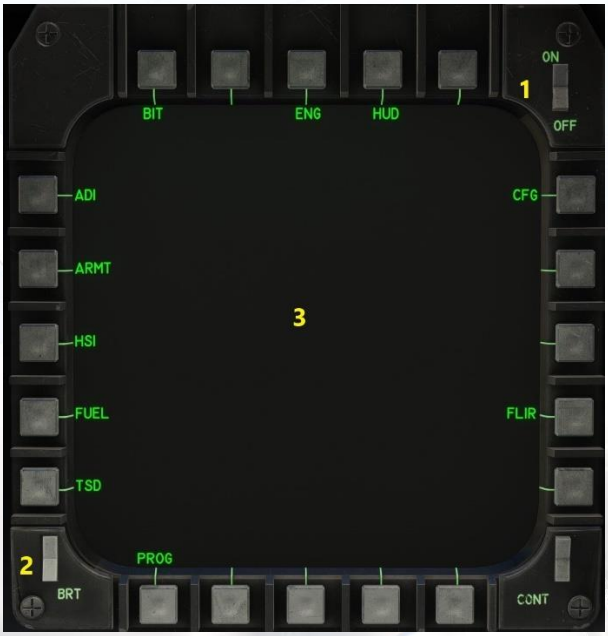
- Master – activate or deactivate autopilot. Moving the control stick will automatically disable the autopilot as well.
- NAV SRC – selects the navigation source for the NAV LOCK or APPRCH hold modes and also affects the HSI and HUD data display and functions.
- BKRS selects back course hold option for localizers
- ALT/VS – opens the altitude and vertical speed hold menus.
- HDG/CRS: opens the Heading hold, target heading, or course / OBS target menu

UFC Data Page:

1. Radar Altimeter (AGL) altitude
2. Current steer point (and opens steer points page)
3. Current wind aloft bearing and speed
4. Current steer point bearing and distance
5. True airspeed knots
6. Estimated Time of Arrival for current steer point (local time)
7. Ground speed knots
8. Current UTC time

Multi-Purpose Color Display (MPCD) Overview:

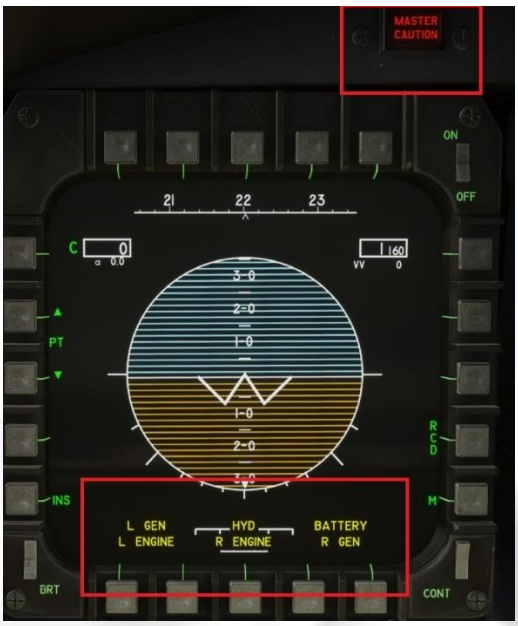
The Multi-Purpose Color Display provides a variety of flight, systems, performance, and tactical display information in 2 x full color 7-inch display screens (3 x screens for the F-23A variant). Each MPCD has independent control of display objects, brightness, and power controls.



Each MPCD has 20 push buttons, a power switch (1), and a brightness control (2). The following items are included and have a function in this model and will be described in more detail below:

- CFG: Configure your model with various display options like pilot, ground equipment, weapons, etc…
- ADI: Attitude and Direction Indicator
- ARMT: Armament page (mostly relevant to the F-23A variant as the PAV1 and PAV2 models don't have armaments)
- HSI: Horizontal Situation Indicator for navigation
- FUEL: Fuel page with fuel state by tank
- TSD: Tactical Situation Display (contains radar system simulation in the F-23A variant)
- BIT: Built in Test system (multiple pages – all static)
- ENG: Engine data page
- HUD: Repeats HUD display from the main HUD glass
- FLIR: Simulates a forward looking infrared view of the world around the aircraft
- PROG: non-functional placeholder for MPCD display prioritization found in real aircraft

MPCD Crew Alerting System (CAS) Display:



CAS Alerts (advisories, cautions, warnings) are found in the MPCD 1 – left side MPCD screen and will display at the bottom of the current page, overriding other display information. Up to six alerts will be displayed in priority order. If one or more alerts is active and not acknowledged the master caution / warning button will illuminate. Pressing this button will clear the light and silence any aural alerts, but the CAS message will stay in the MPCD until resolved. A list of CAS messages present in this model can be found near the bottom of this user manual.

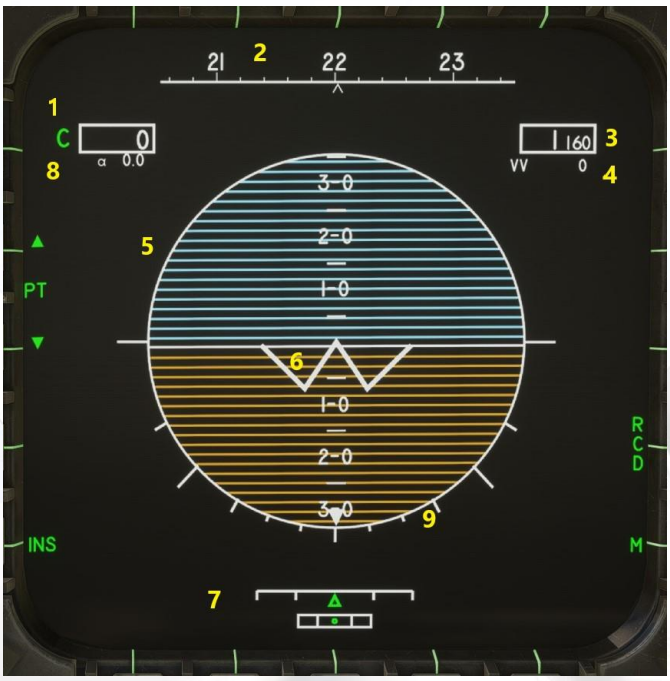
MPCD CFG Page:

Here is a list of the display options and conditions for display:

- Pilot: displays or hides pilot figurine in the cockpit view. Pilot is always displayed from exterior view except when aircraft is cold and dark with electrical system off
- Pilot Visor: Toggles pilot visor up or down

- Pilot Head: Hides or displays pilot's head when inside the cockpit view. Default is off so it does not interfere with cockpit view
- Tow Bar: Toggles display of this object. Only displays when aircraft engines and APU are off and aircraft is stationary.
- Ground Tug: Toggles display of this object. Only displays when aircraft engines and APU are off and aircraft is stationary.
- Fire Extinguisher: Toggles display of this object. Only displays when aircraft engines and APU are off and aircraft is stationary.
- Ground Power Cart: Toggles display of this object. Only displays when aircraft engines and APU are off, aircraft is parked at a game designated parking apron spot, and aircraft is stationary AND the aircraft main utility battery is switched into EXT PWR position.
- RBF Equip: Toggles display of these objects. Only displays when aircraft engines and APU are off and aircraft is stationary.
- Tow Bar: Toggles display of this object. Only displays when aircraft engines and APU are off and aircraft is stationary AND canopy is open.
- Chocks: Toggles display of these objects. Only displays when aircraft is parked at a game designated parking apron spot AND aircraft is stationary.
- Drop Tanks: F-23A variant only. Displays drop tank models, adds the weight of the tanks and pylons to the aircraft and permits loading of fuel into the drop tanks via the fuel and weight menu. If drop tanks are removed, the weight and any fuel contained is removed.
- Weapons : F-23A variant only. Displays weapon models in the weapon bay and adds their weight to the aircraft. Removing the weapons hides them and removes weight from the aircraft.

MPCD ADI Page:



The ADI provides essential flight data and is a useful supplement to the Head up Display.

1. Calibrated Airspeed (KCAS)
2. Heading tape with heading bug showing current aircraft heading
3. Barometric altitude in feet
4. Vertical Velocity (climb or dive rate) in feet per minute
5. Artificial Horizon – blue is sky, orange/brown is the earth
6. Waterline marker and pitch ladder
7. Slip and rudder indicator
8. Angle of attack indicator
9. Bank angle indicator

MPCD ARMT Page:

Displays status of weapons and ordnance bay doors

1. Quantity and status of weapons on board (for PAV1 and PAV2 always displays 0 and Standby). When Master Arm switch is in Armed position, weapon status will display RDY (ready).
2. Status of Master Arm switch (found on left aux console)
3. Weapon selection. Push button above each weapon type or select via weapon select switch on pilot facing side of the engine 2 throttle lever.
4. Weapon door status (open or closed)

MPCD HSI Page

Primary navigation display providing top-down view of the airspace from a navigation perspective.

The above image shows the HSI when tuned to an ILS beacon (with NAV mode selected in the UFC) and a TACAN channel is also tuned. Contains the following elements:

1. Heading selection can be adjusted in one degree intervals up or down here, or by entering a value in the HDG entry in the Autopilot menu
2. Current local time
3. Map range
4. Barometric altitude
5. Course selection can be adjusted in one-degree intervals up or down here or by entering a value in the CRS entry in the Autopilot menu
6. Bearing of the ILS repeater (in NAV mode the pointer will point to the tuned VOR or LOC/ILS facility)
7. Course arrow showing the selected course heading.
8. Aircraft reference symbol (also note the diamond just inside the compass rose indicating current heading) and Course deviation indicator or CDI, shows the offset from the course selection
9. Bearing and range to the VOR or LOC/ILS repeater
10. Heading bug – shows the heading selection on the compass rose
11. TACAN information – shows tuned TACAN channel, current radial and range to the facility
12. Pushing NAV reveals a list of map display options to declutter the HSI display screen.
13. Aircraft current ground speed in knots

HSI Page - VOR

Tuned to a VOR and with NAV source set to “NAV” in UFC, you’ll see the following items:

1. Course select – adjust in one-degree increments up or down in the HSI or adjust in the A/P menu
2. Bearing to the repeater
3. Current heading pointer
4. Aircraft symbol and CDI showing offset from course selection
5. Bearing and Range to the VOR repeater (range available if distance measuring equipment is available)

HSI Page - TACAN

To display TACAN information for a tuned TACAN channel, press TCN button on lower left corner. Tuned to a TACAN channel with NAV source set to “TCN”, you’ll see the following items:

1. Bearing pointer showing bearing to the TACAN facility
2. Course selection allowing you to adjust course and point to the current radial as needed
3. TACAN channel
4. TACAN current radial and range to the facility

HSI Page - GPS

With a flight plan entered into the G1k or entered via the Game navigation log or EFB, and NAV source switched to “GPS” in the UFC, you will see the following items:

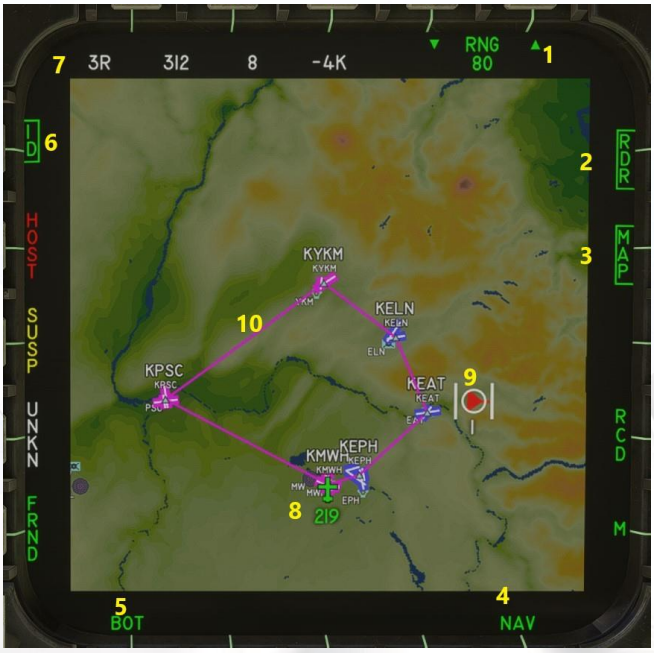
1. CDI showing offset from flight plan path
2. Current heading (Course selection is not possible while GPS nav source is selected)
3. 3 bearing and range to the next waypoint
4. Bearing and range to a tuned navigation radio beacon (in addition to the bearing and range provided by the flight plan)

HSI FUEL Page:

The HSI Fuel page displays the following elements:

1. CONT - Displays the fuel system manual tank transfer and mgmt. control menu options (all static but reflect real world display accurately)
2. Total fuel on board including external tanks in pounds
3. Current aircraft center of gravity
4. Bingo fuel setting (configurable from UFC)
5. 6 aircraft internal fuel tank volumes – arrows are a graphical reference to tank levels in addition to fuel weight in pounds
6. External fuel tanks (drop tanks) will display if drop tanks equipped in F-23A

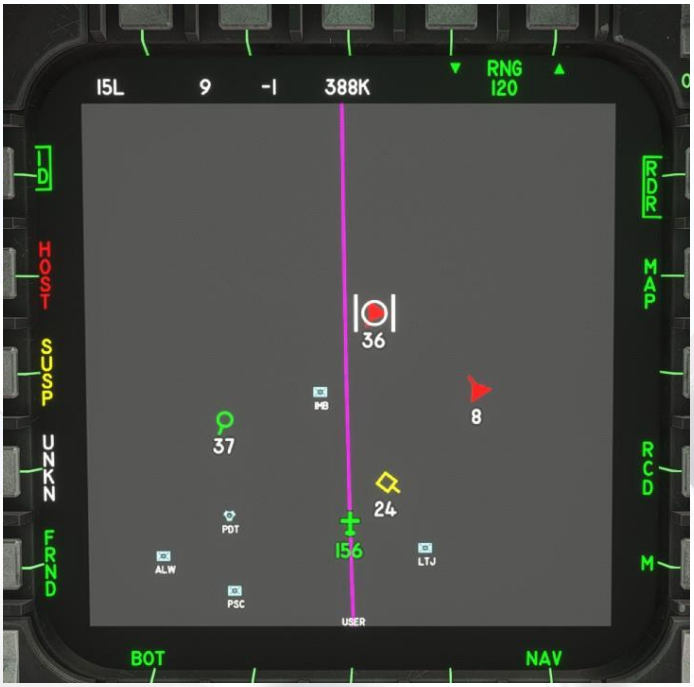
MPCD TSD Page:



Shown here is the TSD found in the F-23A. Here is a description of the primary TSD elements:

1. Map / display range control
2. Hide or display radar contacts / tracks (F-23A only)
3. Map terrain display (F-23A only – coming in next product update)
4. NAV selection shows a declutter hide / display for airports and navigation aid symbols on the TSD (same as found in the HSI).
5. CTR / BOT Switches between centered own-aircraft reference and display near bottom of TSD display.
6. Hide or show radar contact identification / label options (F-23A only)
7. Locked Radar contact telemetry (also displayed in more detail in HUD) – F-23A only
8. Current own-aircraft reference position and heading
9. Locked contact showing altitude, ID'd / labeled as hostile with target selection frame bounding the contact
10. Current flight plan flight path (magenta line)

MPCD - TSD RADAR Overview:



The TSD / RADAR page shows a top down view of the air space which can be configured to radar contacts in the F-23A. The YF-23 didn't carry a radar set but for the F-23A variant we've included our custom integrated radar gauge system. How to use:

- The radar screen displays positional information on air contacts for data from Multiplayer, or real-time live traffic.
- Radar displays contacts across a maximum azimuth of -60 deg to 60 deg (120 degrees total beam angle) from the left and right of the aircraft nose / reference symbol in the display.
- Beam originates from the location of the aircraft reference graphic and extends forward of the aircraft position.
- Top edge of the screen is the selected range (max of 500 – game aircraft track data is limited to approx. 100 nm)
- Once designated using the target designator options, friendly aircraft will continue to be tracked and displayed outside of the radar block zone to simulate Data Link communications (like Link16) and maintain awareness of your wingmen or friendlies as long as they are within display range (TSD is limited to 500 nm range).
- Double click on a contact to bug it, then double click again to promote it to an active track (locked and displaying telemetry). It can be a little tricky to select targets and you may need to try a few times (esp. at larger map zoom ranges).
- A locked contact will also show in the HUD with a directional helper that shows as a square box shape when the contact is within the HUD display aspect angle and a square box with an X through it when outside the HUD aspect angle. If you fly toward the locked target box you will center the target in the HUD.

- Telemetry data will also display in the lower right corner of the HUD and at the bottom of the TSD screen. Telemetry data includes, Aspect angle, contact heading, contact altitude, contact range from your aircraft, true airspeed, and closure rate (the relative speed between your aircraft and the contact).

- Right click a contact to demote the tracked contact. If no contacts are presently locked, a right click will remove/demote all bugged aircraft.
- Tracks will persist for between 10 and 30 seconds on the radar and TSD screens even once the beam is moved away from a track. The radar system emulation has programming to predict a track's position even after the beam has stopped illuminating it.
- To designate a track as hostile, suspect, unknown, or friendly, using your mouse pointer, single click on a selected track / contact and then select one of the four options in the ID menu on the left side of the MPCD using the select buttons. To change a designation, click the cursor over the contact again and select the new designation.

Radar System Limitations

We employ the game's traffic data API to generate the tracks / contact data. There are some game specific limitations to the data displayed on the radar screen.

- The effective range at which tracks can be displayed is a little over 100NM. Game API limitation.
- For PC customers, the minimum distance a contact can be tracked / displayed is around 5NM or a little less (approx.. within visual range) at which point the radar screen will stop displaying track information. To reacquire the track, you'll need to increase distance to the aircraft. Game API limitation.
- For Xbox customers, AI and real-time traffic tracking can be a challenge due to low data refresh rates from the API. Tracking at longer ranges (greater than 25nm) is possible, but once you close on a contact to less than about 20-25nm, it can be difficult to impossible to maintain radar contact or lock. Also, the denser the scenery or the more resources are being used to run the game, the less likely you will be to see traffic tracks displayed on the radar / TSD screens; the

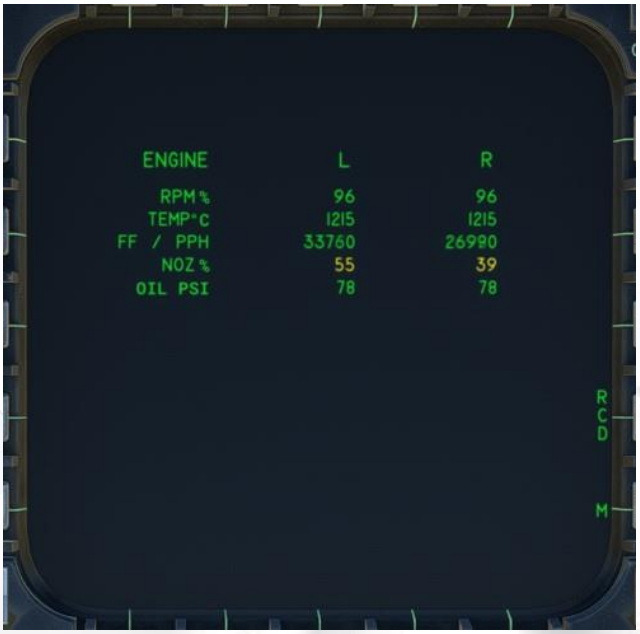
game culls or removes unnecessary data to free up resources. Multiplayer traffic radar tracking has fewer limitations and performs more like you'd see for PC (see above).

- With the exception of position and altitude and a randomly generated ID, the rest of the telemetry data is calculated by our software. This is a very complex set of mathematical calculations and the game does create some limitation around these, particularly in the calculation of closure rate, which can display values as much as 10% - 15% lower than actual with the delta increasing with increased closure velocity.
- If you leave the session, pause, or minimize the game, your track designations will be lost/cleared.
- At present this system does not support Sim-connect derived data and as such it will not display tracks/contacts when in, for example, VATSIM, or other third party mediated connections.

MPCD BIT Page:

The MPCD Built In Test pages are static displays of systems used in the real aircraft to perform maintenance and live flight diagnostics and testing of aircraft systems. We've chosen not to model these systems due to complexity and lack of support within the game for this functionality. However, we've modeled a number of the BIT pages for your enjoyment:

MPCD ENG Page:



The MPCD Engine page shows key engine parameters including second stage (N2) turbine RPM percentage, Exhaust gas temperature in degrees C, Fuel flow in 10s of pounds per hour, engine nozzle percentage of total aperture, Oil pressure in pounds per square inch.

MPCD HUD Page:

Repeats the display information seen on the primary Head Up Display Screen for heads down visibility.

MPCD FLIR Page (F-23A Only):

The MPCD FLIR Page (F-23A variant only) emulates a forward-looking infrared view of the area forward of the aircraft. In this implementation we make use of the game's synthetic vision visualization of the virtual world and as such is not able to display buildings, trees, 3d models, and other objects; only landforms (3D terrain) and objects mapped onto the ground (airports, roads, rivers, bodies of water, etc…) will display. Regardless of limitations, this is still a very useful tool for navigating in low visibility or for night flying, but will not help prevent collisions with non-terrain 3D objects, so use caution! The visual display also contains a few elements of the primary HUD to assist with heads down navigation. Included in the display are:

1. Airspeed
2. Heading of the FLIR sensor (FLIR view can be moved by mouse click and drag on the screen to point the FLIR sensor around the aircraft). When centered, will align with aircraft heading.
3. Barometric Altimeter
4. Pitch ladder and artificial horizon
5. Flight Path Marker
6. Centers the FLIR sensor view to the forward position

G1000 Flight Planner Interface

Not found in the real YF-23, but for customer convenience, we've embedded the Garmin 1000 style flight planning widget into the Test Data Display screen of the PAV1 and PAV2 variants and in the lower MPCD of the F-23A. To access in the F-23A, press the G1K option in the lower MPCD display. To exit press the lower right hand button on the MPCD (1 in the image here). In the YF-23 press the DATA ON button on the center Flight Test Data display unit to hide or show the G1k screen. Brightness control is the Contract control knob (2). The interface is a touch screen style interface.

Secondary Flight Display

A display screen found on the lower right auxiliary console (lower right side of the main display panel) that provides supplementary information about aircraft systems and performance. Additionally, a cabin pressure altitude gauge accompanies the SFD. The SFD has two pages, described here.

SFD 1 Information:

1. N2 RPM %
2. Exhaust Gas Temperature in Celcius
3. Fuel Flow in thousands of pounds per hour (max display value 40,000)
4. Engine oil pressure - PSI
5. Fuel temperature C
6. Engine nozzle aperture percentage
7. Total Fuel onboard (thousands of lbs)
8. Center of gravity MAC
9. Slip indicator
10. SFD display screen selector
11. SFD brightness
12. Cabin pressure altitude gauge.

SFD 2 Information:

1. Barometric altitude, thousands of feet
2. Current Calibrated Airspeed
3. Hydrazine percent remain (static – part of EPU system)
4. Aircraft Total Air Temperature (degrees C)
5. Aircraft Mach Number
6. Hydraulic system pressures
7. First stage (N1) turbine percentage
8. Angle of Attack (Alpha)
9. Pitch angle (degrees up or down)
10. Bank angle (negative left, positive right)
11. Side slip (Beta)
12. Slip Indicator

Cabin Pressurization System

We've modeled the cabin pressurization system faithfully to the real aircraft. So long as the cabin pressure switch is on and ECS system is functioning, the cabin pressure will maintain about 8,000 feet cabin altitude until reaching 23,000 feet aircraft altitude. Above this altitude the cabin pressure will slowly decrease, maintaining a differential of 5 PSI. At about 70,000 feet, cabin pressure altitude will go above 25,000 feet and a cabin pressure alert will display. If cabin pressure is dumped, an alert will display. If oxygen system is not on when above 10,000 feet cabin pressure altitude an OXY alarm and alerts will be triggered. You can monitor the Cabin pressure altitude from the gauge noted in the Secondary Flight Display section above. A minor game bug: if the canopy is opened after landing, or opened multiple times while aircraft is taxiing, the cabin pressurization system doesn't engage and no pressurization will be simulated.

Left Auxiliary Console

Left Auxiliary Console contains several important controls

1. Landing gear status indicator lights. Green = down and locked. Red = in transit / not safe. Off = retracted
2. Landing gear control handle. Illuminates red when gear in transit or if gear warning is active
3. Armament system master arm switch (will show status on HUD and in ARMT page)
4. Weapon bay door speed control switch. 10 seconds on slow, 5 seconds medium, 2.0 seconds normal
5. Weapon bay door switch (opens and closes the weapon bay door)
6. Emergency landing gear extension switch – drops landing gear in gear emergencies
7. Fire warning and extinguisher panel. Lights will come on if engine fire failure is triggered in-game. No other function enabled at present.

- ITT shows the interstage turbine temperature in degrees Celsius and is a key temperature measurement for the engine.
- The Nozzle position gauge shows the relative position of each engine exhaust nozzle, which opens and closes depending on the throttle setting. The nozzle gauge will turn yellow when afterburner is engaged.
- Oil temperature is displayed in degrees C.
- Fuel flow per engine is displayed in pounds per hour.

Page displays fuel loading, total weight, fuel flow, and bingo/joker fuel settings.
Bingo and Joker fuel settings are managed from the right TMFD or the Fuel menu under the UFC OTHR page.

Left Console

The left console contains a number of flight and system critical controls (F-23A left console shown in this section):

1. APU switch (required for engine starts)
2. Engine starter switch. Can start either engine Left engine or right engine by switching back and forth. Will lock into position during start of an engine and return to center / become available for other engine start when N2 RPM reaches 53% for the respective engine.
3. EPU control. EPU functionality is not modeled at this time, but if EPU is not in Auto position after aircraft start a CAS message will display.
4. Aerial refueling slipway. Open will open the refueling door. ORRIDE position will take on fuel if your aircraft is 8000<alt<35000 feet and 180<speed<325 knots.
5. Anti-collision light. For PAV-1 and PAV-2 activates the strobe lights on the upper and lower fuselage behind the cockpit. For F-23A activates strobes from the wing tip lighting clusters
6. Formation light switch (F-23A only)
7. Landing and taxi lighting switch (F-23A only)
8. Position lighting switch (F-23A only) includes 4 brightness levels and a flash option
9. Parking brake / anti-skid switch. CAS messages will appear if this is active or out of position
10. Autothrottle switch. Very simple system – system will attempt to hold aircraft airspeed at the time it is turned on. Restores manual throttle control when switched off. DOES NOT respond to in-game keybinds; it only works via interaction with the switch in the model.

11. Ejection seat arming switch. Up is safe / disarmed. Down is armed. CAS message will alert if the switch is in the disarmed position
12. Engine 1 fuel valve control lift – press to start fuel to engine when starter is active for Eng 1
13. Engine 2 fuel valve control lift – press to start fuel to engine when starter Is active for Eng 2
14. Speed brake switch. Forward is retracted, aft is extended (a symbol will appear in HUD when speed brake extended and sound effect can be heard)
15. Weapon select switch. Switches between GUN, SRM, MRM and updates in the ARMT page.
16. Emergency flap switch. Norm should be used for most operations. Force flaps up or down if needed.
17. TOT = Takeoff Trim switch. This switch neutralizes any trim inputs you have made or that may be made by the autopilot system. Glows green for three seconds when pressed.
18. IFF master switch: Low / Norm = normal transponder behavior. Emerg – sets transponder code 7700 and mode 3 transponder

PAV1 and PAV2 Left Console

As noted elsewhere in the manual, the YF-23 does not have lightings systems and includes a variety of test equipment control switches. Test control systems are inoperable in this model but animations/interactions work. The controls noted above work the same for the PAV-1 and PAV-2 but omit the lighting controls.

Right Console

The right console contains critical equipment interfaces. F-23A right console shown in this section. Functional elements are described below:

1. Left and right generators. Should be in the on position for all phases of flight and prevent battery drain.
2. Utility battery. Forward for battery, aft for external power source (will only function if on a parking apron spot)
3. Emergency battery (must be on during operations)
4. Oxygen system power
5. Oxygen system mode (leave in norm for normal operations)
6. Oxygen supply. If oxygen supply or system power are disabled when above safe cabin altitude an alert and aural alarm will sound and the OXY annunciator light under the right glare shield will light.
7. Cabin Pressure switch. If placed in RAM/DUMP will trigger an alert and the cabin pressure will quickly drop to ambient pressure.
8. ECS mode switch. Must be on for environmental control system to function
9. Bleed Air – REQUIRED for engine starts and for all ECS functions. Generally advised to leave in BOTH position for normal operations.
10. Anti-ice system: leave in auto or on position – system is always active when aircraft powered
11. Console and main panel flood light controls (F-23A only)
12. Main panel backlight (F-23A only)
13. Side console panel backlight (F-23A only)
14. Flashlight – two modes, white, and red – flashlight can be swiveled to light different areas of cockpit
15. Defog / cabin air lever. Changes sound effects

PAV 1 and PAV 2 Right Console

Functions identically to the right console in the F-23A (described above), however the cockpit lighting controls are not found in the PAV-1 and PAV-2 (there were none) and includes a thermal control system for the test pilot insulating jerkin (worn under the helmet and flight suit).

Canopy Switch

As in the real aircraft, the canopy switch is tucked away on the forward face of the forward structural members on the right side of the cockpit and can be hard to find. It's a three position switch that raises, holds, or closes the canopy. Here is its location:

Aerial Refueling

When the Slipway switch is placed in the “Slipway Override” position, the aircraft fuel quantity will increase so long as the aircraft is flown within the following parameters:

- Altitude maintained between 8,000 ft. AMSL and 35,000 ft. AMSL.
- Airspeed is maintained between 180 and 325 KIAS.

Fuel will be on-boarded at a rate of 1,100 gallons per minute (approx. 7,400 pounds per minute), which approximates the typically maximum refueling rate from the boom of USAF refueling aircraft. If drop tanks are enabled, both the internal fuel and drop tank capacity will be refilled. If drop tanks are not selected, only internal fuel will be loaded.

When the Slipway switch is placed in the open position an AAR Ready message will appear on the MPCD and on the HUD. When in ORRIDE and if the aircraft is within parameters the alert will clear while the aircraft takes on fuel.

Fly-By-Wire System Notes

A unique feature of this model is the custom programmed fly by wire module that governs the flight control system for the aircraft including pitch rate, roll, yaw, g-limiter, and a variety of other control laws that enhance and improve controllability. Without it the aircraft becomes very difficult to control and/or can be over-controlled very easily, resulting in airframe stress or loss of control. This system is always on and provides stable handling in all flight regimes.

Basic Procedures / Checklists

To a certain extent you can follow the procedures found in the real world YF-23 utility flight manual, which have made available separately for your reference and are too long and too detailed to include in this product manual. There are a variety of systems and interactions that we've elected not to model for various reasons, and/or that are not supported by MSFS. However, all cockpit switches, knobs, and levers are interactive, so you can play along in large measure if you wish. Checklists are found on page 2-1 of the YF-23 Utility Flight Manual, which we've made available on our Discord.

However, here is a basic startup checklist so you can get the plane started up quickly from cold and dark:

- Hold Brake – check ON
- Util Battery – ON (or EXT PWR)
- Emergency Battery – Check On
- Interior Lighting Controls (F-23A only) / Flashlight – as needed
- Oxy Supply and Power – On
- Oxy Mode - Norm
- CFG menu in MPCD - configure desired ground equipment and pilot display
- Remove RBF and other ground objects not needed during start
- Select Drop Tank and Weapons preference (F-23A only)
- Enter flight plan and configure other pre-flight data entries in planning widget and UFC as desired.
- APU – ON / READY
- L GEN / RGEN switches ON
- Canopy – Closed
- BLEED AIR Knob – BOTH
- ENGINE CRANK – RIGHT
- Wait for RPM to reach 20% and then engage finger lift on throttle 2 (FUEL CUTOFF ENG 2) to start right engine
- When RPM above 53% for Engine 2 (or vice versa if starting engine 1 first), ENGINE CRANK – LEFT
  Wait for RPM to reach 20% and then engage finger lift on throttle 1 (FUEL CUTOFF ENG 1) to start left engine
- Anti-Collision lights – ON
- Exterior lighting controls (F-23A only) – as needed
- APU – OFF when engines at stable idle
- Weapon Bay – Close (aircraft spawns cold and dark with bay open)
- EPU – Auto
- Cabin Press – On
- ECS Mode - Auto
- Ejection Seat Arming Lever – ARMED
- Anti-Ice/Pitot – Check AUTO / ON
- Taxi Light (F-23A only) – ON
- Set other switches and knobs as desired
- Hold Brake – Norm (OFF)
- Press Takeoff Trim TOT button to reset any trims prior to takeoff

CREW ALERTING SYSTEM REFERENCE

This is a draft list of crew alerting system reference information. These messages will appear in the left side MPCD and some alerts will display on the HUD. We'll update this as we refine this list. For the CAS messages we've modeled, we referenced the real world utility flight manual the Warning and Caution advisory analysis can be found on page 3-5 of that manual.

ALERTING MESSAGE TEXT	Trigger Point	I, W, C	Display On HUD?	SPECIFIC VOICE ALERT
HOLD BRAKE	Parking Brake On	Info	No	
BBW OFF	Antiskid Switch not in NORM	Info	No	
ANTISKID	Antiskid Switch not in NORM, or emergency brake selected	Info	No	
L BLEED	1-55 Alert comes on when BLEED AIR CONTROL Switch in OFF or RIGHT position	Caut	No	
R BLEED	1-55 Alert comes on when BLEED AIR CONTROL Switch in OFF or LEFT position	Caut	No	
FLAPS	Actuating Manual Override	Info	No	
L ENGINE	Malfunction or Failure 1-26 (Off)	Caut	No	
R ENGINE	Malfunction or Failure 1-26 (Off)	Caut	No	
LH OVHT	Engine overspeed and/or too fast, too hot, or fire	Caut	No	Aural: WARNING OVERTEMP LEFT
RH OVHT	Engine overspeed and/or too fast, too hot, or fire	Caut	No	Aural: WARNING OVERTEMP RIGHT
ENVELOPE	Exceeds values set in Envelope Menu of UFC: Mach, Angle of Slip, Angle of Attack, G	Caut	No	Tone Plays
CG	CG Outside paramerts set in envelope menu	Caut	No	
BINGO	When total fuel is below set Bingo value	Caut	Yes	Aural: BINGO FUEL
FIRE	Engine or AMAD fire or Overtemperature	Caut	Yes	Aural: WARNING ENGINE FIRE LEFT or WARNING ENGINE FIRE RIGHT 3-8
OXY	Oxygen System Failure > 10kft	Caut	No	Aural: THREAT WARNING
HYD	If hydraulic integrity below 100%	Caut	No	
CANOPY	Canopy Open or Canopy Switch not in "Stop" position	Caut	No	
CABIN ALT	Cabin Pressure above 25,000 MSL	Caut	No	
FUEL ASYM	Asymmetrical wing fuel distribution (500 lbs)	Caut	No	
FUEL LOW	< 1100 lbs - Tank 1 < 900lbs - Tank 2	Caut	Yes	Aural: WARNING FUEL LOW
L GEN	Left Generator Failure/Off	Caut	No	
R GEN	Right Generature Failure/Off	Caut	No	
BATTERY	Emergency, utility or one of two VMS batteries malfunction	Caut	No	
EJECT SEAT	Displays when not armed	Caut	No	
GEAR UP	If gear is not down and locked when below 7500 feet MSL, < 175kcas and descending more than 200 feet/minute	Caut	No	
AAR RDY	AAR Doors Open	INFO	No	
RAM AIR	RAM AIR SCOOP open	CAUT	No	
EPU NOT ARM	Knob not in Auto or ON	Info	No	

Aircraft Handling and Performance Notes, Limits, and Game Settings:

Pitot Heat and Anti-Icing Equipment: Always on when the electrical system is running. You do not need to manually activate or deactivate these systems during flight.

Landing gear extension and speed limit: 260 KCAS – above this speed gear will not extend. At 310 KCAS the landing GEAR UNSAFE warning CAS message (crew alerting system) will come on. Reduce speed and retract gear.

Speed Limits: We have custom coded a highly accurate simulation of calibrated airspeed (KCAS) indication in response to the changes made in Sim Update 5, which introduced significant inaccuracies in reported airspeed values above the speed of sound and at high altitudes. This coding change is reflected in the cockpit instruments; *however* this is not reflected in the exterior Chase Camera HUD mode, and indicated airspeed will be significantly over-stated at high altitudes and supersonic speeds. The aircraft's overspeed warning is set by within the Envelope menu in the up-front controller; by default it is set to 600 knots and M1.8 which were the real world test limits for the YF-23 ATF program and an Envelope message and tone will come on at when the airspeed reported by the in-cockpit instruments reaches the limits you've set. A realistic maximum speed limit with no test program restrictions would be M2.2 and/or 800 Knots calibrated airspeed. These aircraft models, particularly PAV-2 and the F-23A can easily and rapidly exceed these limits. Be mindful of your speed and thrust setting. We've also included some aircraft heating warnings that come on when the aircraft temperature exceeds 242 degrees C. This is the thermal limit publicly stated for the F-22 Raptor (though in practice speeds are kept below this limit) and is reached at about Mach 2.6 at altitude. In case you were wondering, at 40,000 feet and in ISA conditions, the model will reach up to about Mach 2.8 if you ignore the overspeed warnings.

G-Limiter: The simulated fly by wire system (if active) won't allow overstresses to the point of destroying the aircraft; the G-limiter will normally keep the aircraft under +10 Gs and -3.5Gs. But that doesn't mean the aircraft or the pilot is meant to be stressed to these limits with abandon. Don't bend the frame and the maintenance depot will thank you. In real world testing, PAV-1 was limited to 4.4G and PAV-2 to 7.1G. They were rated to 9G but never tested to that limit.

Flaps System: Flaps in the real-world YF-23s were automated in normal operation and adjusted depending on the aircraft configuration, speed, and pilot inputs. All flaps settings are controlled automatically depending on airspeed, configuration (landing gear down or up), and angle of attack. There is an emergency flaps switch on the left console if you decide to override the automatic flaps system.

During takeoff, the flaps setting will increase automatically as ground speed increases – lowering both the leading-edge flaps and the trailing edge flaps to their optimum position for takeoff. Once airborne, as the aircraft speed increases, trailing and leading-edge flaps deflection will decrease. When landing gear is raised, the trailing edge flaps will retract and be locked in place and only the leading-edge flaps will deflect as airspeeds decrease and angle of attack increases. Trailing edge flaps operate as flaperons during normal flight and are also employed as part of the speed braking and yaw system.

During approach and landing, once the landing gear is lowered, the flaps will be lowered into optimum position as aircraft reaches target angle of attack (target AoA for landing is 10 degrees aoa).

Emergency procedures: We've made no real attempt to simulate or replicate emergency procedures for the Black Widow. You could refer to the real-world YF-23 Utility Flight Manual if you'd like to attempt to simulate emergencies. However, there are a variety of CAS messages that will display in the left TMFD status and alerts page and, if a warning (a serious issue needing immediate attention) on the HUD. Additionally, the APU can be activated in the event of an engine out situation to maintain hydraulic systems pressure for flight controls and landing gear extension / retraction. With engines out and no APU, you will have no control of the aircraft.

Rudder Limits and Control Sensitivity: Rudder deflection is disabled above approximately 550 knots indicated airspeed and maneuvers like the knife edge pass can be performed. However, at present there is no mechanism in the flight model system to offset roll induced by rudder input, so you will find you will need to provide some aileron deflection to counter yaw induced roll, especially at lower airspeeds. Yaw damping is automatic – there is no need to turn yaw damping on or off in this model.

GAME SETTINGS NOTE 1: Regarding rudder input controls, if you use rudder pedals or any other rudder input controller we strongly recommend you set your rudder sensitivity curve (found in the game Controls Options menu) setting to somewhere between -20 and -30 for your rudder input control curve. The rudder input in the game, at default settings, is very touchy or twitchy, and reducing the sensitivity curve will provide a much more easily managed rudder input and yaw control for all aircraft.

GAME SETTINGS NOTE 2: Do not enable (or turn off if already enabled) the Take-Off Auto-Rudder option under the Assistance menu. Enabling this function may cause oscillation around the yaw axis at airspeeds above 600 knots indicated, although we've taken steps to reduce this effect with adjustments to the flight model. Auto-rudder is also not a realistic control setting for the aircraft. If you must enable this function, make sure to disable it after takeoff (and re-enable just before your approach and landing) to avoid this problem.

Aileron / Roll Control Sensitivity: The model is highly responsive in the roll axis and some sim pilots may find the default control sensitivity "twitchy" and find fine aileron control modulation difficult when in normal flight mode. If you find this to be the case we recommend a setting of between -20% and -30% for both positive and negative deflections for Axis-X (or whatever Axis correlates to aileron input for your controller) under the Sensitivity menu for your control stick or yoke (found under the Controls Options).

Takeoff and Approach Mode: When landing gear is extended, the simulated fly by wire system switches to a takeoff and approach mode that reduces roll and pitch rates by about 35% for more deliberate and docile handling.

Takeoff, Approach, and Landing: There are no verifiable references that we've found for the F-23A's various V speeds or the procedures for these phases of flight. Regardless, takeoff, approach, and landing is a straightforward affair, and the flight control system in this model makes it all a lot easier.

Takeoff: For fully loaded (full fuel and internal weapons storage) takeoffs, apply max military (non-afterburning) or higher thrust. Rotate gently between 125 to 135 knots (this will come very quickly at maximum power) and pull the nose up to no more than 10 degrees on the pitch ladder. Do not initiate

the rotation at lower speeds or you may cause a loss of lift, tail strikes, and potentially damage or destroy the aircraft. Do not pull hard or jerk back on the stick as the aircraft has a very powerful pitch control response even at low speeds and you can easily over-rotate the aircraft and cause a tail strike. For reference, the maximum pitch angle allowed is 12.5 degrees nose up attitude when wheels are on the ground or a tail strike may occur. Fully loaded (with external fuel and stores), the aircraft should lift off at approximately 170 knots at sea level ISA conditions (higher speed for hotter temperatures and lower for colder temperatures, as with all aircraft). Immediately retract the gear as soon as you have a confirmed positive rate of climb to avoid over-speeding the landing gear; the aircraft accelerates very quickly once airborne. As the aircraft takeoff weight decreases, the aircraft will have progressively lower rotation speeds and liftoff speeds, but the same take-off methodology should be used. In most cases you will want to retard the throttles shortly after takeoff to maintain your target climb profile speed and avoid over-accelerating. Flaps are automated and will deploy as the aircraft increases speed toward rotation and takeoff speeds. Trailing edge flaps will retract automatically when the landing gear is raised. Leading edge flaps are automated and will extend based on angle of attack and speed.

Approach and landing: We don't have much information or guidelines for initial approach and pattern speeds, but we assume these would be similar to the F-15 series of fighters given the lift vs. weight ratio, general aerodynamic configuration, and twin-engine configuration. Flaps are automatically deployed when landing gear is extended and will reach full deflection once you are at or near the target Angle of Attack. Final approach and landing should be done while maintaining approximately 10 degrees angle of attack (AoA) all the way to the runway, with minimal need to execute a touchdown flare. On final, this is best accomplished in this model by keeping the nose between 6 to 9 degrees on the pitch ladder, and maintaining enough power to sustain your target AoA; this will result in a descent rate of between 400 and 500 feet per minute. If you use a lower angle of attack on final approach and landing, keep the pitch attitude shallower and speeds higher, but keep in mind this just wears out tires and brakes faster and will increase landing distances needed. In particular for PAV-1 and PAV-2, which had undersized brakes, keeping touchdown speeds low and using aerobraking will reduce rollout distance and wear on aircraft parts. As with any high-performance, high-speed aircraft, ensure you have adequate time and distance to establish a stabilized approach with gear down, proper angle of attack, and stable thrust settings well before attempting to land. This is a fast, heavy airplane with a very large wing, and it can be quite difficult to guide it to the touchdown markers if you are approaching too fast/slow, too high/low, or otherwise lined up incorrectly and not stabilized on approach. If you don't have it right, it's always better to execute a go around than to force a landing and cause possible damage the aircraft and/or the pilot. To help with maintaining the correct approach angle of attack, there is a small indicator line on the left side of the flight path marker that will appear when landing gear is down, that will extend above or below the horizontal cross line the marker when you are above or below the target AoA. Keep this marker on the line and you will be holding 10 degrees AoA.

Adjust your thrust to keep the aircraft at the target angle of attack – don't chase the angle of attack with pitch changes – at the correct approach speed and power settings, the nose will typically be kept pitched up between 6 and 9 degrees on the climb pitch ladder to maintain the target AoA. The

shallower the pitch angle maintained, the higher the speed needed to execute a landing at safe rate of descent. Approach and landing speeds will vary considerably depending on aircraft weight, air temperature, and if adjusting for wind gusts. At typical landing weight (post-mission with less than 10% internal fuel and minimal stores), this can usually be achieved at around 120 to 130 KCAS, but the best method is to maintain whatever combination of speed and pitch angle results in the target angle of attack for final approach and landing – this is how the USAF trains its pilots. So long as you maintain the correct angle of attack and a stable approach you should not have to manage the approach and landing based on any preset airspeed.

Landing and Landing Roll-out: Upon touchdown, retard the throttles to idle, deploy the speed brake and keep the nose up at around 10 degrees on the pitch ladder to bleed off speed (do not exceed 12.5 degrees pitch up). Once the aircraft has decelerated to below 100 knots the nose will automatically drop toward to the runway; apply wheel brakes once the nose wheel is on the ground. Retract speed brakes once groundspeed is below 30 knots.

Cruise Profile and Range: The YF-23 / F-23A has two very powerful and thirsty engines. Its two engines can *each* consume close to 100,000 pounds of fuel per hour at maximum thrust and sea level. Without a close eye on fuel state and throttle setting, you can find yourself running low on fuel at an alarming rate, especially flying at low altitudes and high throttle settings. Even with an economical approach to throttle management, the two GE or P&W engines consume a lot of fuel. Fortunately, the YF-23 and the F-23 carry a lot of fuel, and the F-23 can carry an additional 8000 lbs of fuel in drop tanks The stated ferry range is around 2100+ nm with on internal fuel and with a external fuel load a range of up to 2600 nm is possible. That's a long time sitting on an ejection seat!. As with most turbine aircraft, the optimum cruise profile makes use of thin, cold air. At least for this model, best cruising altitudes are between 36,000 and 43,000 feet – starting lower when fully loaded with fuel and slowly climbing higher as fuel is burned off. Target cruise Mach number at these altitudes for this model is between 0.85 and 0.88 Mach, optimizing lift vs. drag, and the optimum cruise angle of attack will be between 2 and 3 degrees AoA. Climbing to cruise altitude burns a lot of fuel; expect to burn about 6% to 8% of a full fuel load, or about 2,500 pounds of fuel, to reach your initial cruise altitude, even using conservative fuel management. Best climb speed is between 300 and 350 knots until intercepting cruise Mach number (at which point, continue climbing while maintaining the cruise Mach number) and you'll want to get to high altitude as quickly as possible with that speed and without engaging afterburning thrust. Use of afterburner for any phase of flight will exact a significant range penalty. You can monitor your fuel consumption, estimated range, and endurance via the *fuel* submenu in the UFC.

Supersonic Cruise: Another unique capability and an interesting topic for the YF-23 when it comes to aircraft range and performance is the ability to "supercruise". This concept generates a lot of confusion and misguided information about the aircraft's capabilities. The YF-23A was designed to accelerate to and maintain supersonic flight, at a target Mach number of 1.5, without having to use afterburning thrust, through a combination of optimized aerodynamics and high dry-thrust engines optimized for supersonic performance. This results in a far greater endurance at supersonic speeds than when using afterburner, and because the aircraft carries its offensive weapons stores internally, it is

aerodynamically much more efficient than other aircraft that carry stores externally (which can limit performance to subsonic speeds, even with afterburning). However, just because the aircraft can cruise at supersonic speeds, doesn't mean this is as efficient as cruise flight at subsonic speeds. At optimal altitude, the aircraft still burns almost twice as much fuel per mile flown at Mach 1.6, at or near MIL thrust settings, as it does at Mach 0.85. This is due to unavoidable supersonic drag penalties and engine efficiency decreases as the aircraft enters the supersonic flight regime. For this reason, even in the real world, the aircraft does not routinely "cruise" supersonically, unless training for or simulating combat profiles. It's stated, however, that where speed was critical, a production F-23A with its large internal fuel fraction could have performed most of a high altitude air superiority mission at around Mach 1.4 with a combat radius of at least 600 nautical miles – very impressive. Combined with stealthy design and coatings, this capability would have provided the F-23A with exceptional survivability due to its ability to enter and exit a highly contested battle space very quickly and with a reduced chance of interception. The high speed also improves the kinematics of its weapons – both range and impact performance. In addition to these advantages, the use of supercruise rather than afterburning to reach and maintain supersonic speeds also reduces heat signatures and the radar reflection from afterburner flame plumes which would otherwise greatly increase the chance of detection.

Maneuvering Notes: The aircraft turn rate becomes G-limited by the flight control system G-limiter between 300 and 340 KCAS (maxing out at around 9.5Gs) and the rate of turn will slow as speed increases once the plane becomes G limited. At Max thrust, with the power and lift available in this model, at low altitude (less than 10,000 AMSL) the aircraft can accelerate, gaining airspeed, in a maximum G (9+ G's) turn once speed is above approx. 400 KCAS and can maintain 9+ G's indefinitely (until the fuel is exhausted). At maximum thrust and 50% internal fuel (12,000 lbs or less), the aircraft can sustain a 3G+ turn at 45,000 feet while supersonic.

Camera Settings: We recommend turning off camera shake in the Camera settings under General Options. At high angles of attack, and with the maneuvers this aircraft can perform, you won't be able to see the instrumentation or outside views as well with your "head" bobbing up and down – unless you like having that additional challenge.

Custom Cameras: These can be found in the in-session Cameras Widget under Cockpit → Instrument, and under Showcase → Fixed Camera. These should help with visualization of parts of the cockpit and for some fun with different views of the aircraft in flight. Enjoy.

A note about Frame Rate and Performance: The aircraft model handles best if you can maintain a frame rate of at least 20 frames per second. Below this and you may start to see some mild oscillation or other effects of the FBW system attempting to keep up with the processing cycles on your computer. In very dense scenery or with your graphics sliders maxed out, this may become more noticeable. The aircraft is still very fly-able, but you may see less smoothness in the performance.

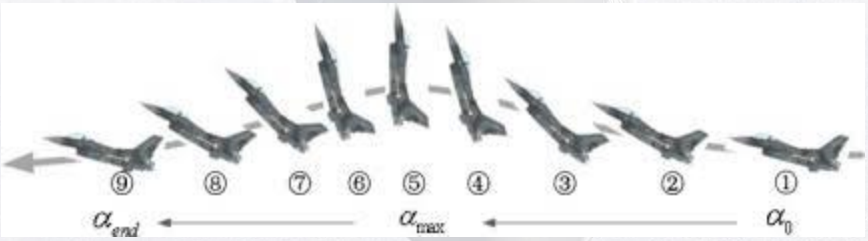
Aerobatic Flight And Maneuvering

While never tested, Northrop simulated high alpha capability that was very similar to that demonstrated by the YF-22. The huge and powerful ruddervators were supposed to be able to provide controllable flight at 60 degrees angle of attack. The F-22 will still have better capability at the very limits of the post stall envelope, but our YF-23 and F-23A are capable of performing many of the incredible and seemingly impossible maneuvers almost as well as the F-22.

Top Mach Studios has made a substantial effort to model aerodynamic stability and control authority to perform maneuvers in the post-stall or high alpha flight regime. The model will perform most of the maneuvers you can perform in our F-22 model, albeit a little less adroitly. Below is an explanation of maneuvers and some general guidelines for how to perform them. To perform these maneuvers properly, you will need rudder input controls that are independent of pitch and roll controls. A set of rudder pedals would be ideal, but twist controls on joystick or separate rudder buttons on a controller should be sufficient.

Configuration: For all maneuvers described below we tested with a clean aircraft (no weapons or other stores), and approx. 12,000 pounds fuel on board. A high wind component could also affect maneuver stability so caution is advised in high wind situations. You will need to make some adjustments if the aircraft is heavier (more speed, more altitude may be needed), and if aircraft is lighter, you may have some more leeway with respect to speed and altitude.

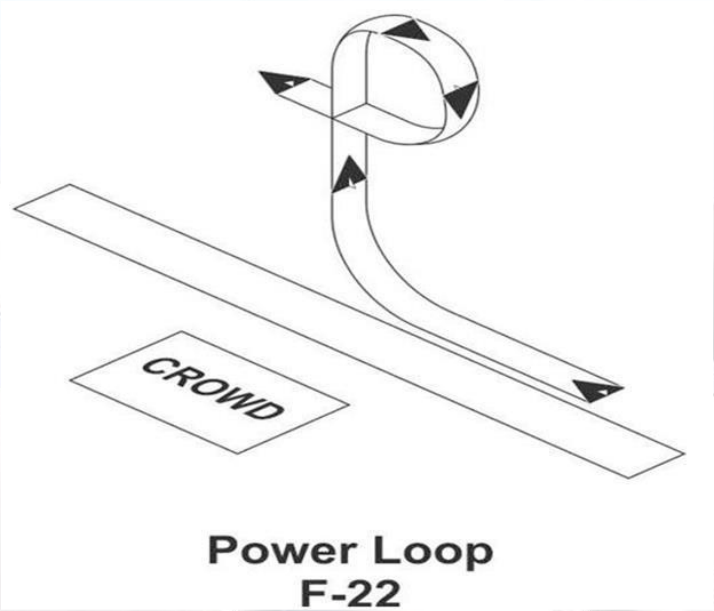
Cobra:



Begin with altitude at least 500 AGL. In level flight (nose and wings level with horizon), with airspeed of approx. 250 knots and max power, make a medium to hard pull into the vertical, pushing the angle of attack approaching at or above 70 degrees. As soon as the nose is pointing at the vertical, initiate a full forward stick movement to push the nose back down to level with the horizon – don't allow airspeed to bleed off too much or you will run out of available control authority to finish the pushover portion of the

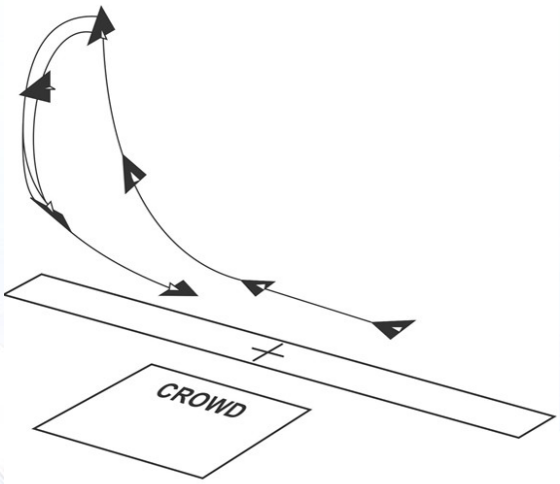
maneuver – the pushover maneuver should not be delayed more than one or two seconds once you have the nose in the vertical.

Power Loop:



Altitude at least 1500 AGL. Enter maneuver with nose and wings level with horizon. With airspeed of approx. 300 to 330 knots and max power, make a hard pull allowing the plane to pull all the way through the vertical, into the inverted, and back around until you are back level and upright (a vertical 360 degree loop). Maintain enough stick back pressure all the way through the maneuver to keep angle of attack of between 45 and 65 degrees, releasing only when the nose reaches level with the horizon. Maintain max power to facilitate recovery from post-stall and maintain nose level with horizon.

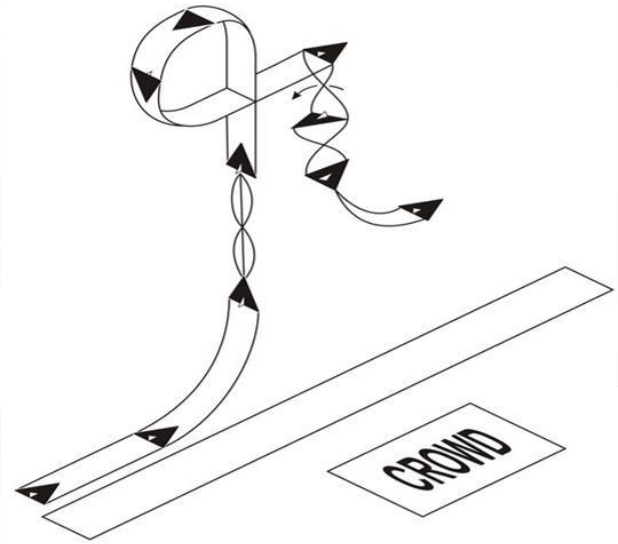
J-Turn:



J-Turn
F-22

In the YF-23 this maneuver requires some altitude - at least 3000 AGL – to ensure room to recover. Maintain Max thrust for the duration of the maneuver. From nose and wings level with horizon, with airspeed of between 100 (can be a little less) and 180 knots, initiate a medium to hard pull into the vertical (at least 60 degrees nose up or higher). Making sure to keep the back stick pressure all the way through the maneuver to maintain high angle of attack, as the nose approaches the vertical and angle of attack exceeds 60 degrees, push rudder and aileron to full deflection in the direction of the desired yawing movement (right rudder right stick to go right, vice versa for left), again, maintaining stick back pressure for the entirety of the maneuver. The aircraft will perform something like a hammerhead maneuver and the nose will yaw from the positive vertical to the negative vertical (and beyond if you continue to maintain control pressure). When the nose reaches the negative vertical (90 degrees down) release all stick inputs to arrest the maneuver. Allow the aircraft to build some airspeed (at least 100 to 150 knots) and begin a gentle pull to bring the nose level with the horizon taking care to keep angle of attack below 35 degrees to avoid excessive sink rate and maintain roll authority during recovery. It’s best to practice from a higher altitude first to get the feel for this.

Pedal Turn:



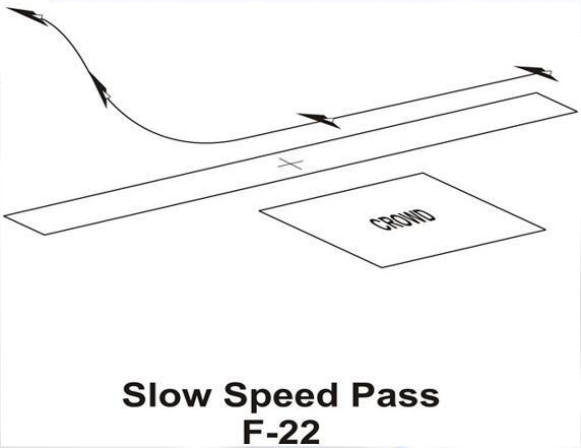
Pedal Turn
F-22

This maneuver is similar to the J-Turn in execution but is done with the aircraft nose level with the horizon and angle of attack between 60 and 70 degrees (falling in a flat attitude, slightly nose down, almost straight down). It will look like a controlled flat spin when executed correctly. The easiest way to enter the maneuver is to climb vertically (nose at 80+ degrees vertical) with no roll or yaw input while maintaining Max thrust, targeting airspeed of approximately 250 to 300 knots. At 5000 feet AGL or higher, initiate a hard pull (maintaining between 35 and 50 AoA), bringing the aircraft around a 270 degree arc (3/4 of a high alpha loop) bringing the aircraft upright with nose level or slightly above the horizon as you begin the maneuver entry. As you near level with the horizon, pull back the throttle from max thrust to Mil power or less and continue to maintain stick back pressure to maintain a high angle of attack and nose level or slightly below the horizon. The KCAS airspeed indicator on the HUD should read 0 and the angle of attack at least 60 degrees. Without delay and while maintaining stick back pressure, enter full aileron and rudder input in the desired direction of the spin. The aircraft will begin to spin slowly around the Z (yaw) axis as long as you maintain stick back pressure and rudder and aileron input in the desired direction of spin. Continue the maneuver for a 360-degree rotation. Maintain angle of attack at or above 60 degrees to maintain nose slightly below the horizon. Adding throttle will decrease angle of attack (increasing airspeed), reducing throttle will increase angle of attack (reducing airspeed). Loss of altitude is rapid and you must ensure that you *begin* your recovery at no less than 2500’ AGL or you risk ground impact. To recover, release all stick and rudder input – to arrest unwanted spin/yaw momentum you can provide a small amount of rudder opposite the direction of spin. Increase throttle to max power and initiate recovery by gaining speed and pushing the nose down to bring angle of attack back below 36 degrees alpha.

Reverse the Pedal Turn Spin: For a bit more of a challenge, you can attempt to reverse the direction of spin. To do so, reduce power further, maintain some stick back pressure and reverse the aileron and

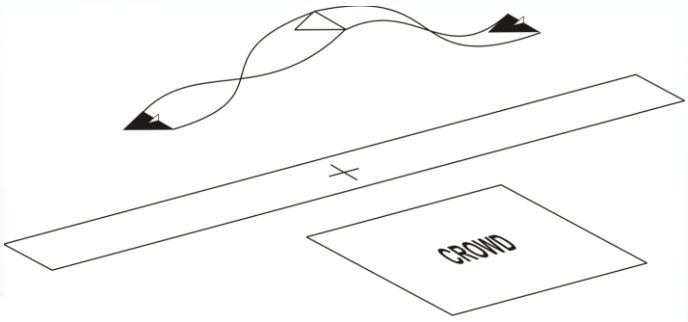
rudder inputs while keeping airspeed close to 0 and angle of attack between 75 and 85 degrees. The nose may balloon a bit when this happens and you may find the nose will slice a bit through the horizon (adjust stick back pressure to keep nose as level with horizon as you can), but will eventually stabilize as long as angle of attack above 80 degrees is maintained. You'll need to start the hard pull over from the vertical to execute the maneuver at least 1000 feet higher than you would for the standard 360 degree pedal turn.

Slow Speed (High Alpha) Pass:



In air show demonstrations, the aircraft is brought to a low speed and around 900 feet AGL as the aircraft flies the show line (parallel to the crowd line). The aircraft is slowed, and while slowing is pitched up to approximately 35 degrees nose high and airspeed maintained at approximately 65 knots KCAS with altitude staying at 900' AGL. Thrust level will be at or near Mil power to hold this attitude. The angle of attack should be maintained at approx. 36 degrees and not allowed to increase above 40 degrees AoA to prevent unwanted sink rate or decreased above this resulting in climb away. The trick with this maneuver is to maintain consistent airspeed, angle of attack, and altitude to keep the aircraft in a stable attitude. It may be necessary to use small amounts of aileron input to keep the aircraft from yawing off from the desired attitude. To exit the maneuver, apply Max thrust until angle of attack is restored to less than 20 degrees AoA, push nose over to return to level flight and then reduce throttle avoid over-acceleration.

Loaded Roll:



Loaded Roll
F-22

Perform at least 1000 feet AGL. To initiate the loaded roll, bring airspeed to approx. 200 Knots KCAS and then advance throttle to Max thrust while pitching the nose up from level with horizon until angle of attack is around 30 to 35 degrees. Do not exceed this angle of attack or you will lose too much roll authority. Initiate a roll with a moderate amount of aileron input while maintaining enough stick back pressure to keep the angle of attack above 28 degrees throughout the roll (but no more than about 36 degrees). Recover after a 360 degree roll, reduce angle of attack and return the aircraft to level flight – reduce throttle to avoid over-acceleration out of the maneuver.

Contact and Support Information

For support with your purchase, download, and installation, please contact the reseller channel from which you purchased the product.

For support with model features, bugs, or other related issues, please contact us on our Discord server via the Support channel.

Top Mach Studios Online Resources:

Web Site: www.topmachstudios.com

Discord: https://discord.gg/uqpvKjZC6t

Facebook: https://www.facebook.com/TopMachStudios

Youtube: https://www.youtube.com/channel/UCla-LVq4xGHcuK6yQFCu1qw

Email non-support related inquiries to:
devs@topmachstudios.com