Black Square

COMMANDER 114

OPERATIONS MANUAL

For Microsoft Flight Simulator

Published By:
Just Flight

"Virtual Aircraft. Real Engineering."

Black Square Commander 114 User Guide

Please note that Microsoft Flight Simulator must be correctly installed on your PC prior to the installation and use of this Commander 114 aircraft simulation.

Contents

Introduction

The Commander 112 entered the general aviation market in 1972, competing with several other heavyweights in the high performance single engine sector. Beyond its impressive “ramp presence” with a cruciform tail, tall trailing-link landing gear, and slightly forward swept wings, the Commander’s main selling point was its impressive cabin width. At nearly four feet wide, the cabin is ~15% wider than similar aircraft, making it similarly spacious to most six-seat twins. Unfortunately, this large cross-section combined with a 180hp engine yielded somewhat anemic performance. Only four years later, the Commander 114 was introduced, with an improved airframe and a 260hp engine, becoming the most produced single variant of the Commander. Today, the Commander 114 is coveted for its aggressively fast looks, cabin comfort, overbuilt trailing-link landing gear, and impressive useful load.

Black Square’s Commander 114 brings you one of the most technically advanced aircraft simulations for Microsoft Flight Simulator, with an advanced reciprocating engine simulation, 75+ possible failures, 15 hot-swappable radio configurations, and the most advanced turbocharger, and cabin temperature simulations in MSFS. Black Square’s tablet interface lets you configure all options, manage payload, control failures, and monitor engines, electrical schematics, and environmental control systems, all from within the simulator. The failure system allows for persistent wear, MTBF, and scheduled failures for nearly every component in the aircraft.

The 3D gauges are affected by physics, and can even become stuck without engine vibration, requiring a tap on the glass to free them. Radionavigation systems are available from several eras of the 114’s history. Fly without GPS via a Foster RNAV511, or with the convenience of a Garmin GTN 750/650 (PMS50 or TDS). Other radio equipment includes MX-170B radios, KLN-90B, GNS 530/430, System 60-2 Autopilot, and a WX-11 Stormscope. A 150+ page manual provides instruction on all equipment, and 35 in-game checklists with control highlighting are included for normal and emergency procedures.

This product includes two aircraft: the 1977 Commander 114, and also a 114 with an aftermarket turbonormalizing package with aftermarket air conditioning. Six distinctive interiors and ten paint schemes are included from five decades of service.

Black Square’s Commander 114 offers a change of pace in high performance single engine flying, with unique avionics, and all new small airplane features to discover, like airframe resonance, nose gear shimmy, hydraulic landing gear, and MSFS’s first working stormscope.

Primarily analog instrumentation augmented with modern avionics is still the most common aircraft panel configuration in the world. Challenge your piloting skills by flying IFR to minimums with a fully analog panel, and no GPS. You’ll be amazed at the level of skill and proficiency you can achieve to conquer such adversity, and how it will translate to all your other flying.

For more information on this product’s capabilities and a list of all included avionics and equipment, see the extensive operating manual at www.JustFlight.com.

Feature Overview

- **150 page manual** with your complete guide to flying Black Square's Commander 114, including systems guide, tutorials, limitations, performance tables, and electrical schematics
- **Two aircraft in one:** Normally Aspirated Commander 114, and aftermarket Turbonormalized 114 with air conditioning and passenger/crew oxygen.
- **Tablet Interface** for configuring options, payload settings, failure management, and real time visualizers for engines, electrical schematics, and environmental systems.
- **Physics-based engine simulation** with compression, magneto impulse couplings, blade angle, oil temperature & pressure, cylinder head temperatures, and preheating.
- **Fuel injected engine simulation with fouling, vapor-lock, flooding, and backfires,** even the magneto impulse couplings are simulated and have sound.
- **15 hot-swappable radios**, configurable via tablet interface. Incl. PMS & TDS & KLN-90B
- **75+ random, scheduled, or performance triggered failures**, settable via the tablet, including engine damage, compatible with 3rd party UI's and instructor stations.
- **NEW full state saving, with 220+ parameters**. Selectable from only the basics to nearly everything: switches, payload, consumables, avionics, aesthetics, damage, failures, etc.
- **Fully simulated environmental control system** for heating, air conditioning, ventilation, ram air cooling. Cool things off by opening a door, or watch the airplane heat up in the sun.
- **The most advanced turbocharger simulation in MSFS.** Turbocharger sounds reflect the turbine RPM, and engine performance is dependent on boost.
- **NEW rough running engine sounds and effects** for excessively rich/lean mixture, detonation, fouling, cold idle, and engine damage.
- **NEW airframe vibration, resonance, and engine animations** bring the airframe to life.
- **NEW nose gear shimmy** encourages holding yoke back-pressure and careful braking.
- **NEW MSFS's first working stormscope** with plausible lightning depiction for stormcell avoidance works with default and 3rd party weather injection.
- **NEW Foster RNAV511** navigator supports autopilot with No-GPS configuration.
- **Physics-based sound system.** Sounds like engine starting are not mere recordings, but instead many layered sounds, constructed based on the underlying simulation.
- **Gyroscope physics simulation** for electric and pneumatic gyroscopes with precession, and partial failures, based on a coupled quadrature oscillator, with manifold standby system.
- **Instrument needle stiction and friction.** Analog instruments can become sticky without engines running. Tap the glass to free the needles and get a more accurate reading!

- **Voltage-based light dimming,** an immediately recognizable effect to nighttime pilots.
- **Magnetic compass effects**, including fields from onboard circuits.
- **Engine preheating** required for cold starts, with propane heater.
- **Strobe light system** causes realistic distracting flashes in clouds.
- **Functional exterior elements (Interactive in MSFS2024) & control locks**: chocks, pitot covers, engine covers, and preheater. Pitot flags blow in the wind.
- **Mathematically accurate VOR & ADF signal attenuation and noise degradation.**
- **JPI EDM-800 Engine Monitor** with engine leaning optimization “Lean Find”.
- **Completely simulated electrical system**, with 55 circuits, thermal breakers, and failures.
- Carbon Monoxide leaks are possible, and can be detected with the CO detector.
- Crew/Passenger oxygen depletes according to pressure altitude, passenger occupancy.
- Ultra-custom dynamic registration number system for livery creators.

Checklists

Over 300 checklist items are provided for 35+ Normal, Abnormal, and Emergency procedures in textual form in the manual, and in-game, using the MSFS native checklist system with control and instrument highlighting. If it’s in the checklist, it’s settable in the aircraft!

Sounds

Black Square’s Commander 114 features a custom soundset created by Boris Audio Works, recorded from the real aircraft. High quality engine and cockpit sounds will immerse you in the simulation. Sounds like engine starting are not mere recordings, but instead many layered sounds, constructed based on the underlying simulation. New sound layers depict subtle or severe operating conditions, like fouling, damage, and cold cylinders.

Flight Dynamics

The Commander 114 features a flight model with performance to match the real world aircraft based on real 114 owner feedback and in-flight data. Engine and aerodynamic performance should be within 2% of POH values, though no two engines are ever the same. The flight model uses the most up to date features available in MSFS 2020 & 2024, such as the new voxel CFD aerodynamics, CFD propeller, adverse yaw & stall parameters, and flexible tire physics.

Paint Schemes

Black Square’s Commander 114 comes with ten paint schemes and six interior upholstery packages that represent the aircraft through decades of service. This product implements Black Square’s highly customizable dynamic tail number system, which can be configured by livery makers. See the “Custom Dynamic Tail Numbers” section of this manual for more information.

Aircraft Specifications

Length Overall	25’1”
Height	8’5”
Wheel Base	6’11”
Track Width	10’11”
Wingspan	32’9”
Wing Area	152.0 sqft.
Flight Load Factors	+3.8/-1.52 G’s (+2.0/-0.0 G’s with Flaps Down)
Design Load Factor	150%
Cabin W/L/H	47” x 6’3" x 49"
Oil Capacity	8 U.S. Quarts
Seating	4
Wing Loading	20.7 lbs/sqft
Power Loading	12.1 lbs/hp
Engine	260 HP (194 kW) Lycoming IO-540-T4B5D. Naturally aspirated, Fuel-injected, direct-drive, air-cooled, horizontally opposed, 6-cylinder, 540-cubic-inch displacement.
Optional	Aftermarket turbonormalizing package with 18,000ft critical altitude
Propeller	3-Blade Hartzell, Constant Speed, Aluminum, Hydraulically Actuated, 78 inch scimitar propeller. Fully fine blade angle of 13.7°, Low pitch blade angle of 33.4°.
Approved Fuel Grades	Aviation Gasoline Grade 100LL (blue) Aviation Gasoline Grade 100 (green)
Fuel Capacity	Total Capacity: 70 U.S. Gallons Total Capacity Each Tank: 35 U.S. Gallons Total Usable: 68 U.S. Gallons
Electrical System	
Voltage:	12 VDC
Battery:	12V, 28 amp-hour, sealed lead acid battery
Primary Alternator:	14V, 70 amp @ 2,300 RPM
Standby Alternator:	14V, 90 amp (Only included on aircraft with optional A/C)

NOTE: The blowfigures assume the stock 2-blade propeller, as they appear in the POH.

With the 3-blade scimitar propeller, expect the following performance improvements:

- Takeoff 50ft obstacle clearance distance reduced by ~150ft (-7%).
- Climb rates increased by ~50 ft/min (+3%).
- Cruise speeds increased by 2-3kts (+2%).
- Reduced cabin noise levels.

Aircraft Performance (Normally Aspirated)

Maximum Cruising Speed	154 ktas
Normal Cruising Speed	143 ktas
Economy Cruising Speed	116 ktas
Takeoff Distance	2,150 ft
Takeoff Ground Roll	1,390 ft
Landing Distance	1,200 ft
Landing Ground Roll	710 ft
Normal Range	680 nm
Maximum Range	725 nm
Rate of Climb	1,088 ft/min
Service Ceiling	17,400 ft
Empty Weight	1,885 lbs
Max Ramp Weight	3,140 lbs
Max Takeoff Weight	3,140 lbs
Max Landing Weight	3,140 lbs
Useful Load	1,255 lbs
Usable Fuel Weight	409 lbs
Full Fuel Payload	846 lbs
Maximum Operating Temp.	+53°C
Minimum Operating Temp.	-54°C

Aircraft Performance (Turbocharged)

Maximum Cruising Speed	172 ktas
Normal Cruising Speed	164 ktas
Economy Cruising Speed	128 ktas
Takeoff Distance	2,150 ft
Takeoff Ground Roll	1,390 ft
Landing Distance	1,200 ft
Landing Ground Roll	710 ft
Normal Range	700 nm
Maximum Range	800 nm
Rate of Climb	1,100 ft/min
Service Ceiling	25,000 ft
Empty Weight	1,960 lbs
Max Ramp Weight	3,140 lbs
Max Takeoff Weight	3,140 lbs
Max Landing Weight	3,140 lbs
Useful Load	1,180 lbs
Usable Fuel Weight	409 lbs
Full Fuel Payload	771 lbs
Maximum Operating Temp.	+53°C
Minimum Operating Temp.	-54°C

V-Speeds

Vr	66 kts	(Rotation Speed)
Vs	60 kts	(Clean Stalling Speed)
Vso	53 kts	(Dirty Stalling Speed)
Vx	79 kts	(Best Angle of Climb Speed)
Vy	91 kts	(Best Rate of Climb Speed)
Va	118 kts	(Maneuvering Speed)
Vg	82 kts	(Best Glide Speed)
Vfe	109 kts	(Maximum Flap Extension Speed)
Vle	130 kts	(Maximum Landing Gear Extension Speed)
Vno	148 kts	(Maximum Structural Cruise Speed - exceed only in clean air)
Vne	186 kts	(Do Not Exceed Speed)

Engine Limitations

Engine Speed	2,700 RPM
Cylinder Head Temperature	500°F (260°C)
Exhaust Gas Temperature	1650°F (926°C)
Oil Temperature	245°F (118°C)
Oil Pressure	25 PSI (min.) 100 PSI (max.)
Fuel Pressure	9 PSI (min.) 45 PSI (max.)
Manifold Pressure	29.6 inHg

Turbocharger Limitations

Critical Altitude	18,000 ft (varies with throttle and atmospheric conditions)
Turbine Inlet Temperature	1650°F (900°C)
Maximum Turbine RPM	105,000 RPM

DO NOT fully retard throttle above critical altitude. Engine combustion may cease.

NOTE: This aircraft is optionally equipped as a “turbonormalized” aircraft, meaning that the turbocharger and wastegate work together to provide pressurized air at sea-level pressures to the intake manifold. This is in contrast to other turbocharging configurations, which provide air boosted to pressures exceeding 29.9 inHg to the manifold.

Instrumentation/Equipment List

Main Panel

- True Airspeed Indicator
- Sigma-Tek 5000B Attitude Gyro With Warning Flag
- Sigma-Tek 4000H Directional Gyro With Heading Bug
- Bendix/King KEA 130A Altimeter
- TKM MC60 Digital Localizer
- Vertical Speed Indicator
- Bendix/King KI 209 Localizer
- Mid-Continent Turn Coordinator
- ILS 400
- Engine Instrumentation

Avionics

- Collins AMR-350 Audio Panel
- Garmin GTN 750/650 (Com1/Com2)
- Garmin GNS 530/430 (Com1/Com2)
- Bendix/King KLN-90B
- Mid-Continent MD41-328 GPS Annunciator Control Unit
- TKM MX-170B (Com1/Com2)
- Foster RNAV511 Navigation System
- Narco ADF-31
- Narco DME UDI-4
- S-TEC System 60-2 Autopilot
- S-TEC Altitude/Vertical Speed Select Programmer
- JPI EDM-800 Engine Monitor
- 3M WX-11 Stormscope
- Bendix/King KT76A Transponder

Electrical/Miscellaneous

- 30+ Circuit Breakers
- Ammeter & Voltmeter
- Fuel Quantity Indicators
- Vacuum Indicator, Annunciator, and Standby Vacuum System
- Oxygen Pressure Gauge
- Analog Chronometer
- Hobbs Timer
- Carbon Monoxide Detector

Installation, Updates & Support

Installation

You can install this aircraft as often as you like on the same computer system:

1. Click on the ‘Account’ tab on the Just Flight website.
2. Log in to your account.
3. Select the ‘Your Orders’ button.
4. A list of your purchases will appear and you can then download the software you require.
5. Run the downloaded installation application and follow the on-screen instructions

If you already have an earlier version of this software installed, the installation application will detect this and update your existing software to the new version without you needing to uninstall it first.

NOTE: THE FOLLOWING DOWNLOADS ARE OPTIONAL, and not required to enjoy the base functionality of this Black Square aircraft; however, they are highly recommended for the most immersive experience possible.

Installing the PMS GTN 750

1. Go to the following link, and click download for the **FREE GTN 750 Mod.** https://pms50.com/msfs/downloads/gtn750-basic/
2. Move the “pms50-instrument-gtn750” archive (zipped folder) from your browser’s download location (downloads folder by default) to your desktop, and extract (unzip) the archive by right clicking, and selecting “Extract All”.
3. Drag the resulting “pms50-instrument-gtn750” folder into your Microsoft Flight Simulator Community Folder.

   If you don’t know how to locate your MSFS Community Folder, you should be able to find it in one of the following locations, based on the service you used to purchase the simulator.

   For the Windows Store install:

   C:\Users\[YourUserName]\AppData\Local\Packages\Microsoft.FlightSimulator_8wekyb3d8bbwe\LocalCache\Packages\

   For the Steam install:

   C:\Users\[YourUserName]\AppData\Local\Packages\Microsoft.FlightDashboard_8wekyb3d8bbwe\LocalCache\Packages\

Important: Windows 10 by default hides the “AppData” folder, so you will have to go to “View” in the menu of File Explorer, and select “Hidden items” so as to see it.

For the Custom install:

If you used a custom location for your Flight Simulator installation, then proceed there.

For example, you may have set:
E:\Steam\steamapps\common\MicrosoftFlightSimulator\Community

Installing The Working Title GNS 530/430

No additional downloads are required for the Working Title GNS 530/430 and all previous modifications should be removed from your community folder. Some older aircraft may still require a “link” to the new GPS, which can be downloaded from the in-game marketplace for free. This package is not required for the Black Square Commander 114, or any subsequently updated Black Square aircraft.

TDS GTNxi 750 Integration

This aircraft’s GTN 750 unit will automatically detect a valid TDS GTNxi installation and license key, and automatically switch between using the PMS GTN 750 and the TDS GTNxi 750 without any required action by the user.

The TDS GTNxi is available from: **https://www.tdssim.com/tdsgtnxi**

LIMITATIONS:

MSFS native GPS units and native flight planners will not cross-fill from the GTNxi. This could also be seen as an advantage, allowing simultaneous flight plan loading.

NOTE: These are limitations of MSFS and not this aircraft, nor the TDS GTNxi. If and when these issues are resolved, a coordinated effort from the developers of these products will be launched to remove these limitations as soon as possible.

Installing The Falcon71 KLN-90B

1. Go to the following link, and click download for the **FREE KLN-90B Mod.**
   https://github.com/falcon71/kln90b/releases
2. Move the "falcon71-kln90b-vX.XX" archive (zipped folder) from your browser's download location (downloads folder by default) to your desktop, and extract (unzip) the archive by right clicking, and selecting "Extract All".
3. Drag the resulting "falcon71-kln90b" folder into your Microsoft Flight Simulator Community Folder.

   If you don't know how to locate your MSFS Community Folder, follow the instructions in the "Installing the PMS GTN 750/650" section of this manual, above.

Accessing the Aircraft

To access the aircraft:

1. Click on 'World Map'.
2. Open the aircraft selection menu by clicking on the aircraft thumbnail in the top left.
3. Use the search feature or scroll through the available aircraft to find the 'Commander 114' series by Black Square.
4. After selecting the aircraft, use the 'Liveries' menu to choose your livery.

Uninstalling

To uninstall this product from your system, use one of the Windows App management features:

Control Panel -> Programs and Features
or
Settings -> Apps -> Apps & features

Select the product you want to uninstall, choose the 'Uninstall' option and follow the on-screen instructions.

Uninstalling or deleting this product in any other way may cause problems when using this product in the future or with your Windows set-up.

Updates and Technical Support

For technical support (in English) please visit the Support pages on the Just Flight website.
As a Just Flight customer, you can get free technical support for any Just Flight or Just Trains product.

If an update becomes available for this aircraft, we will post details on the Support page and we will also send a notification email about the update to all buyers who are currently subscribed to Just Flight emails.

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Liveries & Custom Dynamic Tail Numbers

This aircraft features Black Square's highly customizable dynamic registration number system. This system allows livery creators to adjust many features of how registration numbers are displayed on the aircraft. The following image shows all the areas on the aircraft where a tail number can be positioned (in blue).

For those interested in creating custom liveries, a custom PANEL.CFG file should be included in the livery package, and referenced via the livery's AIRCRAFT.CFG. In this PANEL.CFG, the [VPainting01] section, specifically the "painting00" can be edited to alter the appearance of the tail number. The parameters between the '?' and the ',' separated by '&', control the tail number. Below is an example tail number configuration, followed by an explanation of all the parameters.

font_color=red&stroke_size=30&stroke_color=black&sv=1&sx=18&sy=41&sr=0&sk=20&ss=250&tv=1&tx=16&ty=8&tr=0&tk=20&ts=225&wv=1&wx=32&wy=20&wr=9&wk=30&ws=150

Each position ("s" = side, "t" = tail, and "w" = winglets) has the following associated variables:

"v" = whether to show the tail number in that position (0=false, 1=true)

"x" = the nose-tail position of the tail number

"y" = the top-bottom position of the tail number

"r" = the rotation of the tail number (will accept decimals)

"k" = shears the tail number, positive values shear top towards tail

"s" = the font size of the tail number

Example "tk=30":   t = tail, k = skew. This will shear the registration on the tail towards the tail of the aircraft by 30 degrees.

These values can be edited live using the Coherent GT Debugger from the MSFS SDK.

Tail Number Positioning:

Side +X -> Forward, -Y -> Up

Tail -X -> Forward, -Y -> Up

Wing -X -> Forward, -Y -> Up

Unlike the default dynamic tail number system, these tail numbers will not automatically resize, so make sure there is room for a full six character registration.

New fonts can be added in livery packages, and any font/outline/shadow color may be selected from the standard JavaScript colors by name, or by Hex Code.

The resolution of the tail numbers can be adjusted with the resolution values at the end of the painting00 entry, and the “size_mm” entry above. Large resolutions may affect performance.

Cockpit & System Guide

Main Panel

True Airspeed Indicator

The Commander 114's airspeed indicator displays indicated airspeed in knots, reference speeds with colored arcs, and true airspeed on an adjustable ring around the instrument. The red radial corresponds to the never-exceed speed. The yellow arc corresponds to the clean-air-only speed, where the lower extent of the arc is the maximum structural cruising speed. The lower extent of the green arc corresponds to the clean configuration stalling speed. The upper extent of the white arc corresponds to the maximum flap operating speed, and the lower extent of the white arc corresponds to the full flap stalling speed.

The airspeed indicator also includes a true airspeed calculator, which can be positioned for pressure altitude and air temperature, much like an E6B flight computer, to produce the true airspeed indicated in the bottom window.

Sigma-Tek 5000B Attitude Gyro With Warning Flag

The 5000B Attitude Indicator is a vacuum powered artificial horizon with a red warning flag, and adjustable attitude bars. Attitude bars are adjusted with the knob at the bottom of the unit.

NOTE: This attitude indicator is equipped with Black Square's highly accurate gyroscope dynamics simulation. Users can experience the multitude of gyroscope dynamics and failures inherent to the operation of these instruments. The partial or complete failure of gyroscopic instruments can surprise pilots and result in catastrophic loss of spatial awareness. For more information on Black Square's gyroscope simulation, see the "Gyroscope Physics Simulation" section of this manual.

Sigma-Tek 4000H Directional Gyro With Heading Bug

The 4000H Directional Gyro is a vacuum powered heading indicator with a manually adjustable compass card and a manually adjustable heading bug. Unlike a heading indicator or HSI that is driven by a remote compass with automatic magnetic slaving, **the 4000H must be set to match the aircraft's magnetic compass before every flight**, and continuously corrected due to gyroscopic drift. To set the compass card, depress the left knob, and rotate it to set the card. The compass card will not rotate effectively until the gyroscope is at speed. The right knob is used to adjust the heading bug, which provides heading reference information to the autopilot.

NOTE: This directional gyroscope is equipped with Black Square's highly accurate gyroscope dynamics simulation. Users can experience the multitude of gyroscope dynamics and failures inherent to the operation of these instruments. The partial or complete failure of gyroscopic instruments can surprise pilots and result in catastrophic loss of spatial awareness. For more information on Black Square's gyroscope simulation, see the "Gyroscope Physics Simulation" section of this manual.

Bendix/King KEA 130A Altimeter

A three pointer precision, encoding altimeter, certified for flight up to 25,000 feet pressure altitude. Kholsman setting is adjusted via the knob in the bottom left corner of the unit. The pilot's altimeter is the encoding altimeter used for the Mode-C transponder output, and to drive the altitude hold function of the KFC 150 autopilot.

TKM MC60 Digital Localizer

This MC60 indicates traditional localizer information using LED's, but was designed to automate some functions, thus easing the workload of VOR navigation. The MC60 possesses a central, green LED to indicate when the lateral navigation signal is valid. Another green LED, marked "GS" indicates a valid glideslope signal. Yellow and red LED's, arranged in a cross, indicate traditional localizer information. Red LED's indicate more than half-scale deviation from the centerline of the signal. To/From information is indicated via two yellow LED's marked "T", and "F". Marker beacon reception is indicated via the three yellow LED's, marked "I", "O", and "Z".

When a navigation receiver is the source for the MC60, the three digit 7-segment display will indicate the omni-bearing selection. Bearing selections are made by rotating the knob on the face of the instrument. In this mode, pressing the "RCP" button will automatically select the reciprocal course to what is shown on the display. Pressing the "Mode" button will illuminate the "TRK" LED, and extinguish all but the green valid LED. In track mode, the display will continuously show the bearing to, or radial away from the station. Pressing the "RCP" button will toggle this selection. Track mode can be thought to be continuously rotating the OBS knob to manually center the course to/from the station, rather than flying along a specific course.

When another navigation source is selected via the switches on the instrument panel, the display will momentarily show "LOC", "GPS", "ETN" (external) to indicate the selected source, with external being reserved for the RNAV navigator. The display will then show the desired track, or selected OBS course for the selected navigation source.

Vertical Speed Indicator

A vertical speed indicator displaying a maximum of +/- 2,000 feet per minute. This instrument will display slipstreaming effects from the turbulent propeller wash passing over the static ports on the rear of the aircraft or on the back of the under-wing pitot mast.

Bendix/King KI 209 Localizer

The KI 209 Localizer acts as a secondary radionavigation source in this aircraft, being permanently driven by the NAV2 VOR radio source. The KI 209 includes both lateral and vertical guidance needles, which can be driven from either a VOR/ILS receiver, or via the GNS 430W or GTN 650. The unit incorporates both vertical “GS”, and horizontal “NAV” red and white “barber pole” flags to indicate when the unit has power, and when the respective navigation source is being received. A single window with white indicators show the traditional to/from VOR indication when a VOR radio source is selected. This unit is not connected to a remote compass, and therefore, must be manually adjusted for the desired course with the omni-bearing-selector (OBS) knob on the unit’s face.

Mid-Continent Turn Coordinator

A DC electric turn coordinator with indicator markings for a standard rate 2-minute turn, a traditional slip indicator, and a red power flag to indicate when the unit is not receiving power.

ILS 400

The ILS 400 is a standalone glideslope, localizer, and marker beacon receiver. Power to the unit is controlled via the rotary knob with integrated switch. The same knob also controls the volume of the audible marker beacon identifier. Pressing the knob will mute or unmute the identifier. Marker beacon reception is indicated with the integrated annunciator lights. ILS frequencies are tuned with the momentary toggle switches on the face of the instrument. The instrument is not connected to any other radio in the aircraft.

Traditional glideslope and localizer information is displayed on the instrument via LED’s. The centermost LED in the diagonal crosshairs is the valid signal indicator. When no signal is received, all LED segments will be illuminated on the face of the instrument. When flying on the instrument landing path, the illuminated bars can be thought to act as arrows, telling the pilot which direction to fly, just like a traditional localizer instrument with physical needles.

Engine Instrumentation

To the right of the pilot's yoke column are two 3-⅛ inch engine instruments. The left instrument is a combined manifold pressure and fuel flow gauge, with the former indicated by the needle marked "M", and latter by the needle marked "F".

NOTE: As the aftermarket turbonormalizing package for this aircraft is "turbonormalizing" and not "turbocharging", the maximum manifold pressure remains the same at around 29.6 inHg, so no different markings are required for this modification. Conveniently, fuel flows are also within the original marked range of the factory model.

To the right of the combined manifold pressure and fuel flow gauge is a tachometer with integrated engine hour meter. The red line indicates the maximum operating RPM of the engine, and the green arc indicates the acceptable cruise RPM range from 2,200-2,700 RPM.

Below these instruments on the pilot's right subpanel are three more engine instruments for indicating cylinder head temperature, oil pressure, and oil temperature. The cylinder head and oil temperature gauges rely on electricity to sense and indicate temperature, while the oil pressure gauge is driven mechanically by an oil line run through the fuselage firewall.

Lastly, an exhaust gas temperature indicator resides above the throttle quadrant, with a fuel pressure gauge below. The red radial on the exhaust gas temperature gauge can be adjusted to create a reference point using the small knob on the face of the instrument.

Avionics

Black Square aircraft have reconfigurable radio panels that allow you to fly with many popular radio configurations from old-school no GPS panels, to modern installations with touchscreen GPS navigators. Unlike legacy Black Square aircraft, the radio configuration is selected via the options page of the tablet interface. The radio selection will be automatically saved and reloaded at the start of a new flight.

NOTE: For more information on radio hot-swapping and selecting an avionics package through the tablet interface, see the “Options Page” section of this manual.

NOTE: The vintage avionics (ADF-31, and DME UDI-4 can also be removed from any panel configuration with the “Hide Vintage Avionics” toggle on the tablet interface’s options page.

Collins AMR-350 Audio Panel

This audio controller is common in older light aircraft, and allows for the control of receiving and transmitting audio sources, and cabin speaker sources. The transmitting channel may be selected with the rotary selector knob on the left of the unit, from the following options: COM 1, COM 2, and External Interphone (EXT). Marker beacon morse identifier reception sensitivity can be selected using the knob on the right of the unit. The unit possesses a single row of three position toggle switches to choose audio receiving sources. Each toggle switch can be positioned in its centered position for no audio, up to send the audio to the cabin speaker, or down to send the audio to the headphones.

Garmin GTN 750/650 (Com1/Com2)

This modern touchscreen GPS is implemented by a 3rd party developer. For installation instructions, and instructions on its use, see the installation section of this manual, or the developer's website. **Both PMS GTN 750/650 and TDS GTNxi 750/650 products are supported.** The aircraft will automatically switch between the installed software with no required user action.

PMS50 GTN 750/650

TDS GTNxi 750/650

NOTE: To switch between PMS and TDS products while the aircraft is loaded, toggle the PMS/TDS switch in the avionics selection section of the tablet interface's options page. For more information on radio hot-swapping and selecting an avionics package through the tablet interface, see the "Options Page" section of this manual.

Garmin GNS 530/430 (Com1/Com2)

This 2000’s era full-color GPS is mostly or partially implemented by a 3rd party developer. For installation instructions, and instructions on its use, see the installation section of this manual, or the developer’s website.

NOTE: To hear an audible radio station identifier, both the small adjustment knob on the GNS must be pressed, and the appropriate NAV receiver switch must be activated on the integrated audio control panel.

Bendix/King KLN-90B

This 1990's era monochrome GPS with limited graphical mapping ability comprises a highly capable GPS unit with many features that are found in modern GPS units for pilots willing to learn the subtleties of the system. This GPS is implemented by a 3rd party developer. For installation instructions, and instructions on its use, see the installation section of this manual, or the developer's website.

NOTE: This GPS does not have integrated COM or NAV radios, and therefore must be used in conjunction with a KX-155 as COM/NAV1.

Mid-Continent MD41-328 GPS Annunciator Control Unit

The GPS Annunciator Control Unit is included to enable the full functionality of the KLN-90B, but retains limited functionality with other GPS units. The NAV/GPS button may be used to control the HSI and autopilot course signal with any GPS unit. The GPS/APR button is used specifically for arming the KLN-90B's approach mode. The OBS/LEG button may be used to toggle OBS mode for any GPS that has this functionality, but is specifically designed to be used with the KLN-90B. The annunciator lights will depict the present modes of operation for any GPS installed.

TKM MX-170B (Com1/Com2)

This 1980's era Com/Nav receiver allows you to control audio and navigation source inputs from two independent communication and navigation antennas, the top controlling the VHF Com radio, and the bottom controlling the VHF Nav radio. The left (yellow) digits are the active frequencies, and the right (red) digits are the standby frequencies. Frequency tuning for both radios is accomplished via the independent MHz and kHz knobs, rather than the familiar dual concentric encoders found on most other radios. The two knobs simultaneously tune either the COM or NAV radio, and pressing the "N-C" button toggles which radio is being tuned. The currently selected radio for tuning is indicated by a red tickmark at the top left of the standby frequency. Pressing the large white button labeled with an arrow will swap frequencies. The large white button labeled "TEST" opens the automatic squelch function of the receiver. The large white button labeled "VC-ID" activates the morse identifier signal from the NAV receiver. The small knobs are used to adjust the volume of the COM radio, and the NAV morse identifier.

Pressing the "25" button will increment the standby COM frequency by 25 kHz by default. In this simulation, the "VT" button is used to toggle between 25 kHz US frequency mode, and 8.33 kHz European mode. When 8.33 kHz mode is selected, a trailing decimal point will be shown in the standby COM display. Pressing the "25" button in 8.33 kHz mode will increment the frequency by 5 kHz. When the last digit of the active or standby COM frequency is a 5 (ex. 122.485), this trailing 5 will be indicated with a tickmark at the top-right of the display in lieu of a sixth digit.

While transmitting, a tickmark is shown at the top left of the active COM frequency. When the "VC-ID" button has been pressed a tickmark is shown at the top left of the active NAV frequency to indicate voice or identifier reception.

NOTE: To hear an audible radio station identifier, "VC-ID" button must be toggled, and the appropriate NAV receiver toggle switch must be activated on the AMR-350 Audio Panel.

Foster RNAV511 Navigation System

See the standalone section of this manual for instructions on using the RNAV511, below. All stored radials, and offsets associated with this unit will be automatically saved and recalled at the beginning of a new flight.

NOTE: Since the RNAV511 does not possess its own radio receiver, reception for waypoint 1 and waypoint 2 ground stations comes from ONLY the NAV 1 radio.

NOTE: The autopilot in this aircraft is capable of receiving navigation input from the RNAV511, but will only do so when the no-GPS avionics configuration is selected from the tablet interface. When operating without a GPS, the navigation source selector button and integrated annunciators will read “NAV/RNAV”, instead of “NAV/GPS”. For more details, see the “Flying an RNAV Course with the Autopilot” section of this manual.

Narco ADF-31

The ADF-31 is a 1960’s vintage ADF receiver with a fixed compass card, and analog frequency tuning. The dual concentric knob controls power, modes of operation, and identifier/voice volume. The outer knob with pointer is used to toggle power, and select between voice (REC) and direction finding signal (ADF) modes. Pulling the inner volume knob toggles between voice/identifier reception, and marker beacon reception. Holding the red “TEST” button activates internal test circuitry, which positions the bearing pointer in the 3 o’clock position.

Frequencies are tuned by rotating the “TUNE” knob (with acceleration, for convenience), which rotates the frequency drum in the upper window. This drum presents frequencies in three bands with some overlap. The bands are 190-430 kHz, 420-850 kHz, and 840-1750 kHz. Rotate the selector knob with pointer to select the desired frequency range.

NOTE: While adjusting the frequency via the tuning knob or the range selector knob, the current frequency will be superimposed on the face of the unit to the first decimal place. Since the simulator does not support analog tuning, a precise frequency must be entered, which would not be feasible with the drum alone.

Narco DME UDI-4

The DME UDI-4 is a 1960's vintage DME receiver with a sensitive needle, and adjustable gauge scale. The two large concentric knobs are used to tune the desired frequency. The selector knob is used to toggle power, select between the two distance ranges with overlap (0-35 nm, and 30-100 nm), and DME speed (0-350 kts).

S-TEC System 60-2 Autopilot

The System 60-2 is a relatively simple autopilot, with standard modes of control, which resemble the operation of the default KAP 140 autopilot that many users may be more familiar with. Notably, the unit does not have an autopilot master push button, nor is a flight director connected, meaning that the autopilot is engaged by pressing one of the mode buttons only. The autopilot can be disabled via the yoke-mounted autopilot disconnect push button. In the case of erroneous behavior or trim runaway, the autopilot controller and servo power circuit breakers are located in the center of the instrument panel for easy access.

On the face of the unit, the expected push buttons toggle lateral modes of navigation (HDG, NAV, and REV (backcourse), and the vertical modes of navigation (VS, and ALT). In the upper window, operating modes illuminate in amber, and unit status illuminates in green. In the bottom window, operating conditions illuminate in green, and failure or condition conditions illuminate in amber or red.

When the unit is ready to function, but the autopilot is disengaged, “RDY” will appear in the upper window. If conditions for operation are not met (no trim power, or loss of connection to the turn coordinator), “RDY” will not appear, and “FAIL” will appear in red instead. During normal operation, “CAP” will illuminate in green when the aircraft is approaching the desired lateral course. As the aircraft further approaches the desired course, “SOFT” will illuminate to indicate a reduction in control loop sensitivities to reduce oscillations while maintaining course.

Notable is the absence of an approach arming button, as this unit will automatically engage approach mode when a valid localizer signal is detected, or GPS vertical guidance is provided. When approach and glideslope modes are automatically activated, “APR” and “GS” will illuminate.

On the right of the unit, a blue “UP” button and amber “DN” button can be used to adjust the desired pitch, vertical speed, or captured altitude, depending on the vertical mode of the autopilot. The buttons will illuminate if significant trim input is required to maintain the autopilot’s desired vertical profile. In an aircraft with electric elevator trim control, these buttons might only illuminate briefly during changes to the vertical mode or desired profile.

NOTE: Pressing these buttons will override the selected vertical speed or selected altitude on the Altitude/Vertical Speed Select Programmer. When this happens, the amber negative vertical speed LED on the Altitude/Vertical Speed Select Programmer will flash repeatedly until the thumbwheels of the Altitude/Vertical Speed Select Programmer are manipulated, thus returning authority to the programmer after the momentary intervention.

S-TEC Altitude/Vertical Speed Select Programmer

The Altitude/Vertical Speed Select Programmer consists of seven thumbwheels, one amber LED, and resides at the top of the center instrument panel. The altitude selector is a useful addition to the System 60-2 autopilot, allowing the pilot to select target altitudes and vertical speeds, although the autopilot can function entirely without this unit.

The three black thumbwheels on the left of the unit must be set to the correct barometric pressure in order for the autopilot to capture the correct barometric altitude. The three white thumbwheels are used to select the desired altitude. The black thumbwheel on the right is used to select the desired vertical speed. Vertical speeds from -1,600 to +1,600 fpm may be selected via this wheel, with negative numbers inscribed in yellow, and positive numbers in white. In addition, when a negative vertical speed is selected the amber LED to the right of the thumbwheel will illuminate.

NOTE: Pressing the blue “UP” or amber “DN” buttons on the System 60-2 autopilot will override the selected vertical speed or selected altitude on the Altitude/Vertical Speed Select Programmer. When this happens, the amber negative vertical speed LED will flash repeatedly until the thumbwheels are manipulated, thus returning authority to the Altitude/Vertical Speed Select Programmer after the momentary intervention.

NOTE: In order to use the new vertical speed arming capabilities of this unit, external hardware must be configured to use the L:Vars: “var_AutopilotBaroCalibration_10”, “var_AutopilotBaroCalibration_1”, “var_AutopilotBaroCalibration_01”, “var_PreselectedAltitude_10000”, “var_PreselectedAltitude_1000”, “var_PreselectedAltitude_100”, and “var_PreselectedVerticalSpeed”. If you do not wish to use these events, the functionality of the Altitude/Vertical Speed Select Programmer in this aircraft without vertical speed arming is maintained for use with the native vertical speed hardware events, such as “AP_VS_VAR_INC” or “AP_VS_VAR_SET_ENGLISH”.

JPI EDM-800 Engine Monitor

This engine monitor is a powerful tool for monitoring and managing a high performance aircraft engine, and should be used to its fullest potential to prevent engine damage, increase mechanical longevity, and provide the most efficient cruise flight. See the standalone section of this manual for instructions on using the EDM-800, below.

3M WX-11 Stormscope

This aircraft is equipped with the first functional stormscope in MSFS, which creates a useful depiction of electrical activity around the aircraft, including electrical noise from the aircraft's own systems. Much like the "useful depiction of the surrounding terrain" on the terrain radar of Black Square's Starship, this stormscope is an imperfect implementation of a lightning detector due to the limitations of Microsoft Flight Simulator, but the result is a useful tool that can be used to detect and avoid dangerous storms and electrical activity.

Stormscopes, sometimes called "strike finders" or "lightning detectors" display the bearing and distance to electrical discharges in the vicinity of the aircraft, rather than radar returns from precipitation. While this is arguably less useful than weather radar, the weight and complexity of lightning detection hardware is a fraction of that required for onboard weather radar. This makes stormscopes an attractive alternative for light aircraft. Stormscopes do have the advantage of being able to detect lighting strikes, which radar cannot, and stormscopes do not suffer from radar shadows, which may occlude the true magnitude of a storm system.

A stormscope is capable of detecting ground strikes and intra-cloud lightning several hundred miles away from the aircraft. These strikes appear as singular illuminated dots on the scope screen, placed at the strike's estimated radial and distance from the aircraft. The permanent markings on the screen can be used to read this location information, with the outer ring's distance being equal to the range selected with the right selector knob. The inner ring is one half that distance. The oldest strikes will disappear from the screen first; however, the unit is only capable of displaying a limited number of illuminated dots on the screen, meaning dots will be "recycled" more quickly if there is a very large number of strikes detected.

The rotary selector knob on the left of the unit is used to toggle power to the unit, and select between all-around lightning detection (ON), and only forward looking detection (FWD). When forward-looking mode is selected, no new strikes will appear on the lower half of the screen, but existing strikes will take some time to be "recylced". Due to the limited number of strikes that can be displayed, forward-looking mode effectively doubles the resolution of the imagery, allowing for better defined outlines of the storms in front of the aircraft. Screen brightness is controlled via the small knob at the top-right of the instrument.

To test the unit, press the "TST" button at the bottom of the unit with the 100 nm range selected. If the unit is functioning correctly, a cluster of strikes will appear at 50 nm and and 45° clockwise from the aircraft's heading. Holding the test button for longer will generate more strikes at the test location. The "CLR" button can be used at any time to entirely clear the scope screen of lightning strikes.

To aid in the scope's depiction of nearby storms, this unit can be connected to the aircraft's directional gyroscope via its bootstrapping output. Without a gyroscope connection, it is advisable for the pilot to clear the scope screen after every heading adjustment, or else old strikes will cause apparent "smearing" when viewed with new strikes. With the gyroscope connected, strikes will automatically rotate across the screen for a much improved weather depiction. If the gyroscope signal is not valid, "FLAG" will appear across the screen, and no strikes will be illuminated. To toggle the automatic gyro compensation on and off, press and hold both the "TST" and "CLR" buttons simultaneously. After several seconds, "GYRO ON" or "GYRO OFF" will appear across the screen momentarily.

During the course of normal operation, erroneous dots may appear on the screen that do not reflect any storm activity in the vicinity of the aircraft. These scattered strikes are usually the result of switches or relays being toggled within the aircraft. As the switch or relay makes or breaks contact, a small electrical arc may jump between the contacts. Unfortunately, a 12 volt spark 6-10 feet away from the lightning detector appears similar to a 100,000,000 volt lightning strike 100 miles away from the aircraft. Similarly, very high current and noisy loads within the aircraft, like the starter motor, can cause thick banding across the scope oriented along the field lines generated by the current carrying wire. While it is important to be knowledgeable of these anomalies, they can be cleared using the "CLR" button and are generally not a concern during cruise flight.

Bendix/King KT76A Transponder

The KT76A transponder supports the typical transponder modes of operation; off, standby, on, and altitude reporting mode, which are selected via the rotary knob on the left of the unit. The knob is spring-loaded to return from the test position. The red “IDENT” button is used to trigger the transponder's ident feature when requested by air traffic control. The amber lens above the test button will illuminate whenever the transponder is interrogated by the air traffic control ground hardware, which will vary depending on altitude, and how densely populated the area surrounding the aircraft is. The four rotary knobs under the window of the unit are used to select the desired transponder code.

NOTE: Care should be taken when setting new transponder codes not to accidentally pass through a reserved or emergency code. For this reason, it is best to adjust the code from right to left, thereby avoiding the possibility of hitting an unintentional code beginning with a seven. Alternatively, placing the transponder in standby mode when tuning unfamiliar transponder codes also eliminates this possibility.

Electrical/Miscellaneous

Circuit Breakers

The Black Square Commander 114's circuit breaker panels are located on the copilot's subpanel, with miscellaneous breakers also located on the center of the main instrument panel, and also on the aft bulkhead. The left cluster of circuit breakers on the copilot's subpanel reside on a separate avionics bus, the power to which is controlled via the colocated rocker switch.

Breakers may be pulled or pushed to disable electrical circuits and bus connections within the aircraft. All the corresponding electrical circuits are modeled. The status of the electrical system may be monitored via the volt and amp meters discussed below. In an emergency situation, such as the detection of smoke, acrid burning smells, loss of engine, or alternator failure, all non-essential electrical systems should be switched off, workload permitting.

Ammeter & Voltmeter

To the left of the fuel quantity gauges on the pilot's subpanel, two meters indicate the total load on the aircraft's battery, and the main bus voltage. The ammeter indicates the current in amps being supplied by the battery (negative), or the current being absorbed to charge the battery (positive).

Fuel Quantity Indicators

To the left of the engine ignition switch, there are two fuel quantity indicators. The fuel indicators are marked in fractions, not gallons. Each fuel tank has a capacity of 35 U.S. Gallons, with 34 gal usable. It is imperative to note that the fuel indicating scale is highly non-linear, and only the bottom 27 gallons is "gaugable". By the time the needle has moved halfway across the scale, only one quarter of the usable fuel remains. With this level of inaccuracy, it is best to know how much fuel should be remaining in the tanks based on its rate of consumption, rather than relying on the instruments. The EDM-800's fuel computer is particularly useful for this purpose.

NOTE: Conventional fuel sender units in aircraft are notoriously sensitive to lateral G-force, and how level the aircraft is sitting on the ground. The fuel quantity gauges may appear to indicate incorrectly, as a result, though this is accurate to the real aircraft. Given that this aircraft is also capable of random fuel leaks, fuel levels should be checked prior to takeoff, just as in the real aircraft, when any potential discrepancy exists.

Vacuum Indicator, Annunciator, and Standby Vacuum System

The vacuum indicator shows the vacuum suction generated by the engine-driven vacuum pump on the engine's accessory gearbox. The scale on the gauge indicates the acceptable vacuum range through the aircraft's cruising altitudes. At sea level, the vacuum suction should be near the top of the green arc, above 5 inHg. Above the suction gauge is a red indicating lamp, which illuminates when the vacuum suction is insufficient for safe operation.

This aircraft is equipped with a common standby vacuum system in light aircraft. Rather than having an auxiliary vacuum pump, a pull-handle under the pilot's left subpanel opens a valve to the engine's intake manifold. When engines are operating at anything less than wide open throttle, the manifold pressure is less than the atmospheric pressure, otherwise known as a "vacuum". This pressure is measured by the manifold pressure instrument. This pressure differential can be commandeered as a backup for the mechanically driven vacuum pump, since only a 4-5 PSI differential is required. Since this backup is dependent on engine operation, great care must be taken to ensure sufficient vacuum suction is maintained during critical phases of flight, should this system become a life-saving necessity. In general, the higher altitude at which the aircraft is operating, the greater the reduction of throttle lever position that is required to maintain an adequate vacuum differential. Above 10,000ft, the power reduction required may be untenable with a normally aspirated engine. It is best to begin a descent to lower altitudes if this system becomes required.

Oxygen Pressure Gauge

Present only in the turbonormalized version of this aircraft, an oxygen pressure gauge indicates the oxygen pressure available in the onboard, refillable oxygen cylinder. This gauge is located above the pilot's head, in a recessed area of the overhead ventilation duct, and is illuminated by a post light. This cylinder is normally pressurized to 1,800 - 2,000 PSI when serviced on the ground. Oxygen pressure will deplete as it is consumed by passengers and crew.

To activate the built-in demand-type oxygen regulators for all occupants, pull the adjacent pull-handle into the marked "ON" position. Oxygen will be consumed by the occupants only in accordance with the current pressure altitude of the aircraft, and the weights of the crew members. The oxygen pressure is saved between flights, and can be refilled via the payload page of the tablet interface. When the cabin oxygen system is activated, the sound of pressurized gas flowing through pipes will be audible.

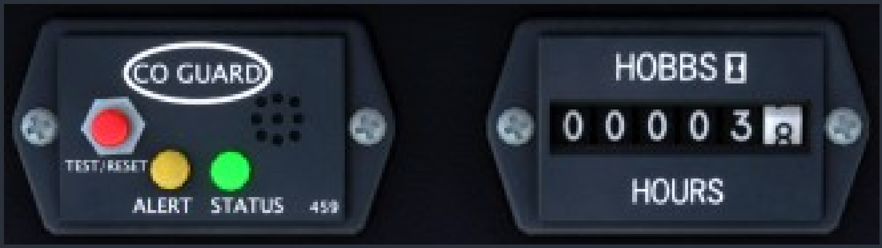
Analog Chronometer

An analog chronometer is located to the left of the airspeed indicator. The large knob is used to adjust the time displayed on the chronometer. Although it will default to the correct local time for every flight, it might be useful to adjust the time to reflect UTC time, or when entering a new timezone. The two concentric center knobs are used to adjust the red minute and hour pointers. These function as manually adjustable stopwatch, countdown, and elapsed time markers.

Hobbs Timer & Carbon Monoxide Detector

The included Hobbs timer in the aircraft runs from when the master switch is activated, to when it is shut off. Indicated in tenths of an hour, this meter should be a reliable source of timing for your logbook recordings, or emergency leg timing in IMC, should you find yourself in a really unusual and dire situation.

Adjacent to the hobbs timer is a carbon monoxide detector.   Carbon monoxide is a potentially deadly gas that results from the combustion of hydrocarbons, such as in an aircraft's internal combustion engine. The gas is odorless, and colorless, making it extremely difficult to detect. To test this carbon monoxide detector, depress the "TEST/RESET" button on the unit. Both the amber and green "ALERT" and "STATUS" lights should illuminate. The detector is battery operated, and the green status light should blink once every few seconds to indicate that the unit is functioning properly. The detector can both fail, and detect an exhaust gas leak via the integrated failures system. If carbon monoxide is detected, a warning tone will sound, and action should be taken immediately.



Lighting Controls

Courtesy Lighting

Several lights in the aircraft are wired to the hot battery bus, meaning they can receive power even when the battery master switch is off. These include the two step lights above both foot steps behind the wings, the baggage compartment light, and the pilot's reading light. The two step lights are activated by pressing either push button above the step, the pilot's reading light is activated by the colocated push button, and the baggage compartment light is activated when the baggage door is opened. All three courtesy lights operate on a three minute timer, after which the lights will be extinguished, regardless of switch state. This prevents the light from draining the aircraft's battery any more than necessary.


Connected to the main electrical bus, and only available when the master switch is in the on position, a single reading light above each seat can be activated by a colocated push button. When the main electrical bus is powered, the pilot's reading light will remain on as long as the push button is depressed.

Panel Lighting

The master panel lighting switch, labeled "INSTR LIGHTS" in the center panel switch panel, is used to activate all panel lighting in the aircraft. Panel light dimming is controlled by three rheostats: two under the pilot's yoke, and one on the copilot's right subpanel. The "INST" knob controls glareshield lighting, which consists of several incandescent bulbs under the glareshield. This knob also controls incandescent subpanel lights, which illuminate the gauges in the pilot's subpanel, and the cabin air controls.

The “AVIONICS” knob controls any integrated lighting sources in the instruments, instrument backlighting, and avionics backlighting. This knob also controls several post lights and smaller instruments throughout the cockpit, like the magnetic compass, and the fuel pressure gauge.

The “CIRCUIT BREAKERS” knob on the copilot’s subpanel illuminates the two clusters of circuit breakers with similar incandescent subpanel lights as the pilot’s subpanel.

Care should be taken to always use the minimum amount of interior lighting necessary to clearly read the instruments in order to preserve crew night vision quality.

Voltage-Based Light Dimming

Black Square’s aircraft now support an advanced dynamic interior and exterior lighting and panel backlighting system that simulates several characteristics of incandescent lighting. Mainly, real world pilots will be intimately familiar with interior lights dimming during engine starting, or becoming brighter when an alternator is switched on. The brightness of the lights in this aircraft are now calculated as the square of the available voltage.

The lights in this aircraft will react to even the smallest changes in the electrical system’s load. For example, a generator failure in flight will result in the dimming of lights. Should a second, or standby generator, not provide sufficient power to support the remaining systems on the aircraft, this is signaled by the dimming of lights in response to even small additional loads, such as exterior lighting. In this reciprocating engine aircraft, the lights will pulse noticeably as the starter motor overcomes the resistance of each cylinder in the engine. The lights will also pulse less noticeable at very low engine RPM, as the voltage regulator struggles to maintain a constant voltage.

The incandescent lights also simulate the dynamics of filaments, creating a noticeably smoother effect to changes in their intensity. This system has the advantage of allowing for easier dimmer setting with L:Vars, and preset configurations when loading the aircraft in different lighting conditions.

Full State Saving

This aircraft now includes full state saving for nearly every parameter. This includes electrical switches, payload, fuel, consumables, avionics, aesthetics, damage, and failures.

The three toggle switches on the tablet interface’s options page allow the user to select which categories of parameters are saved and restored next time the aircraft is loaded. These switches are labeled: "Non-Essential", "Flight Critical", and "Avionics". All three options may be selected independently of each other.

- With no options selected, only critical options are saved, like the radio configuration, damage, failures, and tablet options. Payload and fuel state are always saved/loaded.
- "Non-Essentials" includes anything that does not affect the operation of the aircraft, like interior lights, air conditioning switches, cabin aesthetics, and consumables (like oxygen).
- "Flight Critical" includes all other switches/controls, which may adversely affect the aircraft if set incorrectly, such as electrical, environmental, trim, flaps, fuel valves, etc.
- "Avionics" includes avionics states, frequencies, modes, heading/course/barometer selection, etc.

The system monitors the current phase of flight, so that inappropriate states will not be restored (starting a flight on the runway will not immediately shut down your engines). This means that a flight terminated prematurely will result in sensible defaults the next time the aircraft is loaded, while retaining the rest of the accumulated state. Each parameter possesses a default, which accounts for the phase of flight, and even the time of day, when necessary. With all state saving options de-selected, the aircraft will load in a default state, appropriate to the phase of flight, just as in any other Black Square aircraft.

The several hundred parameter states are saved on a rolling basis, with all states being saved approximately every sixty seconds. The state saving options on the tablet interface are saved immediately, meaning that an option may be selected, and then the flight immediately restarted to achieve a default state.

For more information on state saving settings, see the “Options Page” section of this manual.

Note: Since this aircraft uses the native MSFS state saving library, your changes will only be saved if the simulator is shut down correctly via the “Quit to Desktop” button in the main menu.

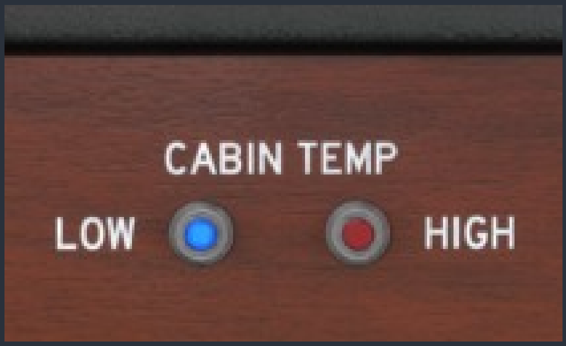
Environmental Simulation & Controls

This aircraft is equipped with a simulated environmental control system, allowing the user to learn the essentials of passenger comfort while operating this aircraft. Cabin temperature is calculated distinctly from outside air temperature. Since the walls of the aircraft are insulated, it will take time for the cabin temperature of the aircraft to equalize with the outside air temperature. The cabin will also heat itself beyond the outside air temperature during warm sunny conditions, and slowly equalize with the outside air temperature after sunset. The cabin climate controls are located on the copilot's subpanel.

Without the need for any aircraft power, the cabin temperature can be partially equalized with the outside air temperature by opening the pilot's side storm window or the cabin doors, and fully equalized by ram air cooling, so long as the airspeed of the aircraft is great enough, and the ram air cabin vents are open. If the aircraft is equipped with the optional air conditioning system, cabin temperature can also be equalized with the use of the air conditioning evaporator fan via the air conditioning panel's "FAN" switch position. The rate at which temperature equalization, active heating, or active cooling can be achieved is influenced by the ram air pressure, and can be supplemented by the air conditioning evaporator fan. Equalization with the ambient air can also be accomplished by opening the four vents in the footwells of the cockpit, which admit air to the cabin through the two screened wing root inlets. The "CABIN VENT" pull handle on the copilot's subpanel acts as a master shutoff for both wing root inlets.

Cabin Temperature Monitoring

A temperature monitoring system is available in this aircraft to monitor cabin temperature, and alert the pilot to when cabin temperatures have become unacceptably hot or cold. The digital LCD temperature display, located below the throttle quadrant, will display temperatures from -99° to 999° Celsius, or Fahrenheit, toggleable with the small blue push button. In addition to this LCD display, two small LED's are located above the pilot's altimeter to indicate when cabin temperatures are unacceptably hot or cold within the pilot's primary field of view, and call their attention to the cabin temperature settings. The "CABIN TEMP LOW" light illuminates when cabin temperatures are below approximately 50°F, or 10°C. The "CABIN TEMP HIGH" light illuminates when cabin temperatures are above approximately 90°F, or 32°C. Both lights will flash alternately when the cabin pressurization altitude exceeds approximately 15,000 ft without supplemental oxygen to indicate a hypoxic cabin.



NOTE: The entirety of the cabin climate state can also be inspected via the cabin page of the tablet interface. For more information on the tablet's cabin page, see the "Cabin Climate Visualizer Page" section of this manual.

Cabin Environmental Controls

Unlike more complex aircraft with automatic environmental control systems, heating and cooling of the Commander 114 is accomplished via a balancing act between heating and cooling sources. On a mild day, simply equalizing the cabin temperature with the outside air temperature with any of the methods listed above may be enough to keep the cabin at a comfortable temperature.

Cabin heating is supplied by an exhaust heat exchanger, or "exhaust shroud" located around the engine's exhaust manifold for the pilot's side cylinders of the normally aspirated engine, or under the crankcase on the turbonormalized engine.

The exchanged air supplied by the exhaust shroud is distributed through the same floor vents as the ram air from the wing root inlets. The amount of heated air supplied to this duct from the exhaust shroud is increased by pulling the "CABIN HEAT" control away from the instrument panel. This is the primary means of raising the cabin temperature by the desired amount. The air supplied from the heat exchanger can be very hot, as the system has the capacity to keep the cabin warm at altitudes in excess of 20,000 ft, where ambient air temperatures can be as low as -60°F (-50°C). Operators should take caution when applying the cabin heat to reduce pilot workload during critical phases of flight, and also to limit the possibility of a cabin fire.

NOTE: Exhaust heat exchangers are notorious for cracking due to extreme temperatures and corrosive combustion byproducts. Should the exhaust heat exchanger become compromised, it may result in poisonous carbon monoxide gas leaking into the cabin. Should carbon monoxide be detected in the cabin with an audible warning, the exhaust heat exchanger should be considered a prime suspect, and the “CABIN HEAT” pull handle should be pushed fully into the instrument panel immediately to isolate the cabin breathing air from the exhaust air. No cabin heating will be available while this knob is pushed in.

While the Commander 114 is not certified for flight into known icing conditions, and therefore is not equipped with deicing boots or windshield anti-icing, the windshield can be partially deiced using the defroster in the event of an unintentional icing encounter. The “DEFROST” pull handle must be pulled away from the instrument panel, and the engine must be running for the windshield to defrost.

Optional Air Conditioning

The turbonormalized variant of this aircraft is equipped with an optional air conditioning package. This package includes a secondary 90A alternator to power the system, electric compressor, evaporator fan, and a small control panel located below the throttle quadrant.

The air conditioning compressor cannot be powered unless the secondary alternator is energized, meaning that the aircraft’s engine must be running. With the alternator offline, a red “LOW VOLT” annunciator will illuminate on the air conditioning panel. The secondary alternator is energized via the “ALTERNATOR #2” rocker switch on the air conditioning panel. This alternator is wired to act as a backup to the main alternator in the event of a failure. If the main alternator has failed, and the secondary alternator is online, pressing the “ALT 2 X-FER” push button will bridge the main electrical bus and the air conditioning bus. The “ALT 2 X-FER” push button will illuminate when the bus tie is closed, and the secondary alternator is supplying power to the main bus.

The air conditioning is activated by placing the large black three-position air conditioning rocker switch in the “COMP” (compressor) position. The blue indicator lamp will illuminate when the air conditioning compressor is running. This position also activates the evaporator fan, which is required to effectively cool the cabin. If only ventilation is required, placing the same switch in the “FAN” position will only energize the evaporator fan. The smaller, two-position white rocker switch controls the evaporator fan speed. Varying the fan speed and toggling the air conditioning compressor is the only way to modulate the amount of cooling the cabin receives.

NOTE: Unlike many aircraft with factory installed air conditioning systems, this installation has no feedback for landing gear position. The air conditioning should be manually disabled before takeoff and landing to ensure best performance and minimize electrical load during critical phases of flight.

Air Conditioning Temperature Effects

When the air conditioner is operating, the load is increased on the engine’s crankshaft. The load is proportional to the differential between the outside air temperature and the desired cabin temperature. This increased load on the engine can cause internal temperatures to increase. Particularly while operating on the ground, the operator should keep an eye on engine temperatures. When the additional load is significant, the engine may cease combustion at idle throttle setting on the hottest days.

Oxygen Duration Table (Hours)

The turbonormalized variant of this aircraft is equipped with a 40 cubic foot, 1850 PSI composite oxygen cylinder.

# of Occupants	10,000 ft	15,000 ft	20,000 ft	25,000 ft
1	13.4	8.9	6.7	5.4
2	6.7	4.5	3.3	2.6
3	4.4	2.9	2.2	1.8
4	3.3	2.2	1.7	1.4

Approximate duration of useful consciousness following a cabin depressurization event:

28,000 ft MSL - 2-1/2 to 3 minutes
25,000 ft MSL - 3 to 5 minutes
22,000 ft MSL - 5 to 10 minutes
18,000 ft MSL - greater than 30 minutes

Reciprocating Engine & Turbocharger Simulation

The piston engine simulation in this aircraft is significantly more complex than most employed in flight simulators. Do not expect the care-free easy operation requiring little expert knowledge that is sufficient for operating the default aircraft. Knowledge of the invisible factors affecting fuel injected engine operation is required to perform a successful start of this aircraft. Additional knowledge is required of turbochargers, as Black Square's fleet employs the most complex turbocharger simulation in Microsoft Flight Simulator.

NOTE: The entirety of this complex engine simulation can be monitored via the engine pages of the tablet interface. For more information on the tablet's engine pages, see the "Engine Visualizer" section of this manual.

Engine Physics Simulation

Cylinder Compression

Unlike a turbine engine, the rotation of a reciprocating engine is not smooth, especially while starting. This is due to the compression in each cylinder imparting significant torque onto the propeller shaft, which must be overcome for the shaft to continue rotating. On the ground, this is most apparent when the starter motor is engaged, or when the engine is shutting down. In the air, the same compression must be overcome for the propeller to start windmilling. When shutting the engine down, it is this torque that forces the propeller to stop in one of several detents every time, often reversing momentarily as it does. Additionally, the propeller shaft must also overcome the resistance of the magnetos to continue rotating. When shutting down, this can cause the propeller to stop suddenly and prematurely, and is signaled with an audible clicking sound from the magnetos. If performing a gear up landing, it may be desirable to rotate the propeller to a position that guarantees the most ground clearance, which can be accomplished with the starter motor.

Starter Motor Torque

Starter motor torque is non-linear, with the motor providing less torque at higher RPM. The maximum power output from the starter motor is also dependent on the battery's current charge level. If you allow the battery charge to diminish greatly due to prolonged use without charging, the engines will become harder to start, as the starter motor will no longer have the power required to overcome the cylinder compression forces. Should this happen in flight, the engine can hopefully be restarted by windmilling. Apparent starter torque can also be reduced in cold weather, due to high oil viscosity, contracted metal components, and poor battery performance. These effects can be mitigated by preheating the engine using the propane heater.

Propeller Blade Position & Feathering

The propeller blade angle of a constant speed propeller is controlled via high pressure oil admitted to a cylinder in the propeller hub, metered by a governor. In a single-engine aircraft, the absence of oil pressure will increase the propeller blade pitch to the fine position, so as to fail safely in the event of a propeller governor failure. As a result, single-engine constant speed propellers will not move to coarse pitch after an engine failure, unlike in a multi-engine aircraft; however, a windmilling propeller produces more drag than a stopped propeller.

It has been suggested that the pilot of a single-engine aircraft should reduce their airspeed after an engine failure to stop the propeller from windmilling in order to extend their theoretical glide range. A windmilling propeller can be locked in place by the compression of the cylinders. A relatively slow airspeed is required to stop the propeller initially, but once it has stopped, the airspeed can be increased considerably before the propeller will start windmilling again. This is now possible to experience with Black Square's engine physics simulation, as the propeller blade angle influences the engine physics simulation by applying torque to the propeller shaft based on the blade angle and apparent wind velocity.

Engine Preheating

Being lightweight and designed to operate at high temperatures, aircraft engines are more susceptible to damage when started very cold than other engines. This aircraft simulation is equipped with a propane powered heater to preheat the engine before starting. The heater is deployed from the "Exterior Elements" menu on the payload page of the tablet interface. Once ignited, the preheater will heat the engine and its components to around 60-70°F (~35°C) above the ambient temperature in around 10 minutes.

Reciprocating aircraft engines can be destroyed by a single start in extremely cold weather, so preheating should be considered mandatory any time ambient temperatures are below 10°F (-12°C), and recommended any time temperatures are below freezing. When reciprocating engines are started too cold, the resulting temperature differential can crack crankcases, and the increased wear on pistons and cylinders can be severe. Due to the high viscosity of the oil, contracted metal components, and the poor performance of batteries in cold weather, the starter motor may be unable to rotate the crankshaft at sufficient speeds for starting when ambient temperatures approach -25°F (-32°C) without preheating.

Fuel Injected Engine Operation

Fuel injected engines differ most significantly from their carbureted counterparts in their starting procedures. Fuel injected engines can be notoriously difficult to start soon after being shut down due to vapor lock.

Cold Engine Starting

When starting a cold fuel injected engine (cylinder head temperatures within 100°F or 50°C of ambient temperature) the engine should start without difficulty, provided that it has been primed with the electric fuel pump. To quickly prime the engine, place both the throttle and mixture levers in the full forward position. Briefly run the fuel pump for a few seconds only. Prolonged use of the fuel pump will flood the cylinders with fuel. If difficulty persists, try engaging the starter while advancing the throttle partially.

Hot Engine Starting

When the engine has recently been running, hot engine components will vaporize liquid fuel in the fuel injection system, causing back pressure that prevents the injection of new fuel into the cylinders for priming. This is most likely to occur when a hot engine has been sitting for more than 5-10 minutes, and less than an hour or two. Many ill informed pilots have drained their aircraft's battery trying to start a hot engine without the proper procedure.

To start a vapor locked engine, cool fuel from the fuel lines and tanks should be circulated through the fuel injector manifold with the throttle and mixture levers in their fully closed, and cut-off positions. This will have the effect of displacing and condensing the vapor, while not adding additional fuel to the cylinders. After running the fuel pump for 10-20 seconds, if the engine does not start normally, the operation should be repeated once or twice more, depending on the severity of the vapor lock. Attempting this procedure too many times may result in a flooded engine.

Flooded Engine Starting

During starting procedures, if too much fuel is injected into the cylinders by running the fuel pump too long, the engine will no longer start due to an excessively rich fuel-to-air ratio. In mild cases, the engine can be started by advancing the throttle to produce a more favorable mixture; however, this can substantially increase the chances of an engine fire. In severe cases, the engine itself can be used as a pump to remove fuel from the cylinders. Cranking the engine will remove fuel from the cylinders, but may accumulate liquid and gaseous fuel vapors around the exhaust or inside the engine cowling. Unfortunately, light aircraft do not have a convenient way to crank the engine without ignition firing, like turbine engine aircraft do. Should the engine produce a backfire or other ignition source after severe engine flooding, a fire is likely. As a last resort, allowing the engine to sit for an extended period of time will allow fuel to evaporate from the cylinders and alleviate engine flooding.

Backfiring

Backfires occur when the fuel-air charge in a cylinder combusts late in the cylinder's ignition phase, allowing the gasses and the sound of the explosion to escape out the open exhaust valve. This may occur under several different conditions. The most commonly experienced is when the magneto switch is accidentally cycled to the off position and returned to an ignition position when the engine is operating at high RPM. This results in an unburnt charge of fuel remaining in the cylinders and valve body for several full cycles, before a spark is reintroduced to the now overly rich fuel-air mixture. A similar effect can occur when an overly lean mixture is used at high power settings, which stifles ignition until a sub-optimal fuel-air charge is ignited. A backfire is also likely to occur at high power settings when there is significant spark plug fouling present, as the spark produced by the plug, if any, will be too weak to ignite the fuel-air charge.

Spark Plug Fouling

Aviation fuel (Avgas) commonly contains tetraethyl lead to reduce engine knocking, and prevent premature ignition. Unfortunately, this lead can become deposited on interior cylinder surfaces under some conditions. This results in a layer of lead deposits accumulating on the spark plug electrodes, which prevents a spark from developing, or a sufficient spark for optimal ignition. The buildup of lead in the cylinders can happen surprisingly quickly; therefore, proper care is needed on every flight to avoid engine fouling, especially while operating on the ground.

Spark plug fouling can be avoided by leaning the mixture significantly while operating at low cylinder temperatures and low RPM. At sea level, leaning the mixture control halfway may be necessary. Alternatively, keeping engine temperatures warm while on the ground also prevents fouling. As a rule of thumb, an engine RPM of 1,200-1,500 is sufficient to prevent fouling by bringing cylinder head temperatures above ~300°F (120°C).

When spark plug fouling is present, the engine will run rough, and performance will be reduced. To remove lead buildup from the engine, the mixture should be leaned and throttle increased to produce high temperatures in the cylinders above ~750°F (400°C) for a few minutes.

Turbocharged Operation

Owners of other turbocharged aircraft for Microsoft Flight Simulator will be familiar with the inaccurate need to lean the mixture continuously to maintain proper fuel-air mixture while below critical altitude. THIS IS NOT NECESSARY with the turbocharger simulation in this product. This simulation is also substantially more complex than other turbocharger simulations.

Turbocharger Basics

Unlike car engines, which predominantly operate at near sea-level air pressures, aircraft engines may operate at sea-level pressure, and within the upper atmosphere where atmospheric pressure is less than one third of that at sea level. In a normally aspirated aircraft engine, the mixture control is used to maintain a favorable fuel-air ratio throughout these different altitudes. Unfortunately, as the amount of fuel per cylinder is reduced to match the air pressure, so too is engine performance reduced. A turbocharger uses high velocity exhaust gasses from the engine's combustion to compress the atmospheric air to a higher pressure. In the case of a "turbonormalized" engine, the turbocharger and an absolute pressure controller provide consistent sea-level pressure air to the engine until the aircraft reaches critical altitude.

Critical Altitude

Simply put, the critical altitude of a turbocharged engine is the maximum altitude at which the turbocharger can compress the atmospheric pressure air to sea-level pressures. When the aircraft continues to climb beyond this altitude, manifold pressure will begin to drop, and the mixture must be leaned, just as with a normally aspirated engine. Critical altitude is listed in aircraft handbooks as a single altitude in feet; however, critical altitude as described above, is constantly changing throughout the flight.

The book value for critical altitude applies only in standard atmospheric conditions when pressure altitude is equal to density altitude. Otherwise, the critical altitude is based on density altitude, not pressure altitude, as is commonly thought. Additionally, sea-level pressure intake air can only be maintained at the critical altitude at wide open throttle, when the compressor turbine is operating at maximum rated RPM. If the velocity of exhaust gas air is reduced by pulling back on the throttle when the wastegate is fully closed, the turbocharger will no longer be able to maintain sea-level pressure at the manifold. When the aircraft is operating well beyond critical altitude, fully retarding the throttle may even cause the engine to cease combustion. For similar reasons, operators should be aware of the signs of turbocharger failure when operating at very high density altitudes, as a sudden failure of the turbocharger may present as a complete engine failure. Should the turbocharger fail in-flight, the engine may continue to be operated as a normally aspirated engine, but it is recommended that a landing be made at the nearest suitable airport.

Operation Before & During Takeoff

Operating a turbonormalized engine is remarkably similar to operating a normally aspirated engine, as there is no need to manually control a wastegate, or significant worry about overboosting the engine. While on the ground, it's unlikely that any difference will be observed in the turbocharged engine. The mixture should still be leaned during ground operations to prevent spark plug fouling, but placed in the full rich position for takeoff. During engine runup, the sound of the turbocharger will likely be heard, and the manifold pressure will reach the 29.6 inHg redline regardless of density altitude, assuming the turbocharger is operational.

Applying takeoff power is the most likely time to inadvertently cause an overboost, as the oil viscosity may still be high, and slow the operation of the wastegate. When advancing the throttle through the last quarter of its movement, be especially careful to apply power slowly while monitoring manifold pressure.

Operation During Climb & Cruise

The most noticeable difference between a normally aspirated engine and a turbocharged one is the lack of need to adjust the mixture setting during climb. Do not reduce throttle or mixture setting during the initial climb phase. As the absolute pressure controller assures sea-level pressure air is supplied to the intake manifold at wide open throttle, there is no need to adjust the fuel-air ratio with the mixture control until critical altitude has been exceeded, or until the throttle is reduced in the cruise phase. When the aircraft climbs through the critical altitude, manifold pressure will begin to drop, and manual mixture control will be required to maintain desired cruise power.

If a reduced throttle setting is desired during cruise, manual control of the mixture setting may also be required. As the critical altitude is only guaranteed at wide open throttle, a reduced throttle setting may reduce turbocharger RPM to the point where the desired manifold pressure can no longer be maintained. For this reason, it is recommended to assess engine performance after every power adjustment when operating at high altitudes. Using an aid to engine leaning, such as the EDM-800 engine monitor in this aircraft, to precisely set the mixture for best power or best economy cruise can help ensure optimum performance, and increase engine longevity.

NOTE: For your convenience while leaning, the friction lock knob located on the right of the throttle quadrant can be used to increase the fidelity of mixture control adjustments via the mouse wheel. Roll the friction lock clockwise (drag up) to make very fine adjustments to the mixture control.

Operation During Landing & Securing

The approach and landing phases are very similar to normally aspirated engines, except that engine performance may be reduced more than would be expected for a given change in throttle setting when operating at higher altitudes. After exiting the runway, be sure to give the turbocharger enough time to cool at turbine idle RPM before stopping the engine. This is more important in colder ambient temperatures to prevent warping of the turbocharger shaft.

Engine Power Settings (Normally Aspirated)

Shaded areas denote operation at wide open throttle. **All figures at maximum gross weight.**

Take-Off Power (Full Throttle) - 10° Flaps - Standard Day (ISA) No Wind

Press. Alt. (ft)	Man. Press. (inHg)	Engine RPM	Fuel Flow (PPH)	T/O Ground Roll (ft)	50ft Obstacle T/O Dist. (ft)	Rate of Climb (ft/min)
SL	29.6	2,700	135	1,390	2,150	1,090
2,000	27.5	2,700	132	1,690	2,620	930
4,000	25.6	2,700	130	2,220	3,440	790
6,000	23.7	2,700	127	3,110	4,810	620
8,000	21.8	2,700	125	5,610	8,680	510

25 inHg - 75% Maximum Continuous Power - Standard Day (ISA)

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH)	KTAS	Range (nm)
SL	25	2,500	86	147	618
4,000	24	2,500	85	152	644
8,000	22	2,500	77	150	686
12,000	18	2,500	70	142	721
16,000	15	2,500	62	128	715

24 inHg - 65% Maximum Continuous Power - Standard Day (ISA)

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH)	KTAS	Range (nm)
SL	24	2,400	86	137	656
4,000	24	2,400	85	141	675
8,000	22	2,400	76	142	676
12,000	16	2,400	60	132	724
16,000	15	2,400	58	108	655

21 inHg - 55% Maximum Continuous Power - Standard Day (ISA)

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH)	KTAS	Range (nm)
SL	22	2,200	65	126	689
4,000	22	2,200	65	130	705
8,000	22	2,200	64	132	718
12,000	17	2,200	58	127	712
16,000	NA	NA	NA	NA	NA

Cruise Climb - Standard Day (ISA)

Target Alt. (ft)	Man. Press. (inHg)	Engine RPM	Fuel Flow (PPH)	Time to Climb (min)	Fuel to Climb (gal)	Dist. to Climb (nm)
5,000	24.8	2,500	115	6	2	9
10,000	20.5	2,500	110	14	4	23
15,000	16.8	2,500	100	34	9	58
*17,400	15.2	2,500	95	57	15	100

Recommended Climb Airspeeds: 90 kts to 10,000 ft, 85 kts to 16,000 ft, 80 kts to 25,000 ft.

*Applicable to normally aspirated aircraft only when gross weight is less than 2,800 lbs.

NOTE: The above figures assume the stock 2-blade propeller, as they appear in the POH.

With the 3-blade scimitar propeller, expect the following performance improvements:

- Takeoff 50ft obstacle clearance distance reduced by ~150ft (-7%).
- Climb rates increased by ~50 ft/min (+3%).
- Cruise speeds increased by 2-3kts (+2%).
- Reduced cabin noise levels.

Engine Power Settings (Turbonormalized)

Shaded areas denote operation at wide open throttle. **All figures at maximum gross weight.**

Take-Off Power (Full Throttle) - 10° Flaps - Standard Day (ISA) No Wind

Press. Alt. (ft)	Man. Press. (inHg)	Engine RPM	Fuel Flow (PPH)	T/O Ground Roll (ft)	50ft Obstacle T/O Dist. (ft)	Rate of Climb (ft/min)
SL	29.9	2,700	140	1,390	2,120	1,100
2,500	29.9	2,700	141	1,400	2,130	1,100
5,000	29.9	2,700	141	1,410	2,150	1,100
7,500	29.9	2,700	142	1,430	2,170	1,100
10,000	29.9	2,700	142	1,450	2,190	1,100

25 inHg - 75% Maximum Continuous Power - Standard Day (ISA)

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH)	KTAS	Range (nm)
SL	25	2,500	92	150	585
6,000	25	2,500	91	154	609
12,000	25	2,500	90	160	631
18,000	25	2,500	90	172	664
24,000	23	2,500	88	173	667

24 inHg - 65% Maximum Continuous Power - Standard Day (ISA)

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH)	KTAS	Range (nm)
SL	24	2,400	86	141	594
6,000	24	2,400	86	145	607
12,000	24	2,400	86	153	636
18,000	24	2,400	84	165	689
24,000	23	2,400	82	168	698

21 inHg - 55% Maximum Continuous Power - Standard Day (ISA)

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH)	KTAS	Range (nm)
SL	21	2,200	60	128	779
6,000	21	2,200	62	130	771
12,000	21	2,200	65	136	777
18,000	21	2,200	68	147	791
24,000	21	2,200	65	148	798

Cruise Climb - Standard Day (ISA)

Target Alt. (ft)	Man. Press. (inHg)	Engine RPM	Fuel Flow (PPH)	Time to Climb (min)	Fuel to Climb (gal)	Dist. to Climb (nm)
5,000	29.9	2,500	120	5	2	6
10,000	29.9	2,500	122	10	4	12
15,000	29.9	2,500	125	14	6	20
20,000	29.4	2,500	127	23	8	28
25,000	23.9	2,500	122	30	11	37

Recommended Climb Airspeeds: 110 kts to 16,000 ft, 100 kts to 18,500 ft, 90 kts to 25,000 ft.

NOTE: The above figures assume the stock 2-blade propeller, as they appear in the POH.

With the 3-blade scimitar propeller, expect the following performance improvements:

- Takeoff 50ft obstacle clearance distance reduced by ~150ft (-7%).
- Climb rates increased by ~50 ft/min (+3%).
- Cruise speeds increased by 2-3kts (+2%).
- Reduced cabin noise levels.

Gyroscope Physics Simulation

This aircraft is equipped with the most realistic gyroscope simulation for MSFS yet, which simulates many of the effects real world pilots are intuitively familiar with from their flying.

Most recognizable of these effects is the “warbling” of a gyroscope while it is spinning up, such as after starting the aircraft’s engines. This is simulated with a coupled quadrature oscillator, and is not merely an animation. Unlike the default attitude indicators, the attitude indicators in this aircraft are simulated with physics, and their ability to display correct attitude information is dependent on the speed of an underlying gyroscope.

Gyroscope Physics

Gyroscopes function best at the highest possible speeds to maximize inertia. When the gyroscope speed is high, the attitude indicator display will appear to settle rapidly during startup, and is unlikely to stray from the correct roll and pitch, except during the most aggressive flight maneuvers, such as spins. When gyroscope speed is slower than optimal, precession of the gyroscope may cause the display to warble about the correct reading, before eventually settling out on the correct reading, if unperturbed. When gyroscope speed is slow, and well below operating speeds, the forces imparted on it by its pendulous veins, which usually keep the gyroscope upright without the need for caging, can be enough to prevent the gyroscope from ever settling. Gyroscope speeds generally increase to operating speed quickly (within a few seconds), whether electric or pneumatic, but will decrease speed very slowly (10-20 minutes to fully stop spinning).

When these effects are combined, a failed gyroscope may go unnoticed for several minutes while performance degrades. So long as torque is not applied to the gyroscope by maneuvering the aircraft, or turbulence, the attitude display will remain upright. Either when the gyroscope speed gets very low, or when small torques are applied in flight, the display will begin to tumble uncontrollably. This can be extremely jarring to a pilot during instrument flight, especially if the condition goes unnoticed until a maneuver is initiated.

NOTE: All of the above effects are simulated in this aircraft, and both total and partial gyroscope failures are possible.

Pneumatic Gyroscopes

Pneumatic gyroscopes are powered by either positive (“Instrument Air”) or negative (“Vacuum Suction”) air pressure in aircraft. The earliest aircraft attitude gyroscopes were powered by venturi suction generators on the exterior of the aircraft, as this did not require the aircraft to have an electrical system to operate. Later, vacuum pumps, or sometimes positive pressure pumps, were added to the engine’s accessory gearbox to reduce drag on the exterior of the aircraft, and also to supply air to the instruments before takeoff. With a pneumatic instrument air system, the dynamics of an air pump compound the dynamics of the gyroscope itself.

The speed of a pneumatic gyroscope is controlled by the air pressure (positive or negative) available to it from the source (usually a pump in modern aircraft). The pressure the pump can generate is directly proportional to engine shaft RPM. At lower engine RPM, the performance of a gyroscope may noticeably degrade over time. For this reason, some aircraft operators recommend a higher engine idle RPM before takeoff into instrument conditions. This ensures the attitude indicating gyroscopes are spinning as quickly as possible before takeoff. Notable to nighttime and instrument flying, an engine failure means an eventual gyroscope failure. Once the engine is no longer running, the gyroscope performance will begin to degrade for several minutes until it provides no useful information. Some pneumatic attitude indicators are equipped with an “OFF” or “ATT” flag to indicate when gyroscope speed is no longer suitable for use, but many do not.

When a pneumatic pump fails, it is possible for it to experience a complete failure, or a partial failure. A partial failure may cause a slow degradation of gyroscope performance to a level that still provides usable attitude information, but with significant procession and warbling inaccuracies. A complete vacuum failure rarely results in a completely stopped gyroscope and stationary attitude display, however. During a complete failure, there is often a rotating shaft or blade debris in the pneumatic pump housing, and minimal venturi suction effects on a vacuum pump exhaust pipe. These effects may cause the gyroscope to continue tumbling indefinitely while in flight, only coming to a stop when on the ground. This can be distracting during instrument flight, so some pilots prefer to cover up the erroneous information on the attitude display to avoid spatial disorientation.

Electric Gyroscopes

Electrically powered gyroscopes avoid many of the complications of pneumatic powered gyroscopes, but are often only used as backup instrumentation in light aircraft. The internal components of an electric gyroscope often result in a more expensive replacement than an external pneumatic pump, however, and allow for less system redundancy, especially in multi-engine aircraft. A total electrical failure in the aircraft will result in the failure of electric gyroscope information, and often more quickly than a pneumatic gyroscope, due to the additional resistance of the motor windings on the gyroscope. Unlike a pneumatic gyroscope, an electric gyroscope will often settle almost completely after an in flight failure.

Tips on Operation within MSFS

Engine Limits and Failures

When you operate an engine beyond its limits, damage to the aircraft is accumulated according to the severity of the limit exceedance, and the type of limit exceeded. For instance, exceeding maximum allowed cylinder head temperatures will drastically reduce the lifespan of the engine, while a slight exceedance of the maximum governed propeller RPM would not cause an engine failure for quite some time. Keen monitoring of engine parameters via the EDM-800 engine monitor is an essential skill of operating a high performance aircraft. The engine monitor is equipped with alarms, which will illuminate an LED on the glareshield panel to alert you to a potentially dangerous engine condition. If engine parameters are not brought back within limits soon, the engine will fail.

NOTE: The “Engine Stress Failure” option must be enabled in the MSFS Assistance menu for the engine to fail completely.

The following limits are recommended for best engine health. Exceeding these limits will cause engine damage in proportion to the limit departure:

Propeller RPM	2700 RPM
Cylinder Head Temperature (CHT)	500°F (260°C)
Exhaust Gas Temperature (EGT)	1650°F (926°C)
Engine Oil Temperature	245°F (118°C)
Fastest Cooling Cylinder Head	60°F/min (33°C/min)
Turbine Inlet Temperature (TIT)	1650°F (900°C) (Turbocharged Aircraft Only)

Exceeding the engine starter limitations stated in this manual significantly will permanently disconnect the starter from electrical power. Be aware that the Commander 114 does not possess any annunciators pertaining to starter motor overheat, so failure conditions can arise unannounced.

Electrical Systems

The native MSFS electrical simulation is greatly improved from previous versions of Flight Simulator, but the underlying equations are unfortunately inaccurate. Users familiar with electrical engineering should keep in mind that the battery has no internal resistance; however, battery charging rate is correctly simulated in this aircraft, meaning that the battery charge rate in amps is proportional to the voltage difference between the aircraft generators and the battery. Battery charging rate should be kept to a minimum whenever possible, and takeoff limits should be observed.

NOTE: The state of the aircraft’s electrical system can be monitored via the electrical page of the tablet interface. For more information on the tablet’s engine pages, see the “Live Schematic Page” section of this manual.

Battery Temperature

This aircraft is equipped with a realistic battery temperature simulation. The internal resistance of a battery and the contact resistance of the terminals will produce heat when charging or discharging. Battery temperature should be considered particularly after starting, before takeoff, and in the event of an alternator failure. If battery temperature is rising rapidly and the battery is not disconnected from the power source, or the rate of charging reduced, the battery terminals will become damaged and the battery will not be available for use on the remainder of the flight. High battery charging rates are acceptable after startup while the battery is recharging; however, care should be taken while taxiing to avoid overcharging the battery.

Mixture & Fuel Flow

This is the first of Black Square's aircraft to feature MSFS's improved mixture and fuel flow simulation created by Working Title. In previous Black Square aircraft, erroneous fuel flow increases accompanied decreased mixture settings until optimal combustion was reached. This is no longer the case, which allows for much more realistic engine leaning and fuel flow readings for a given mixture setting.

Realistic Strobe Light Bounce

Most light aircraft possess a placard somewhere in the cockpit containing the warning, "turn off strobe lights when operating in clouds or low visibility." While this message may appear a polite suggestion, real world pilots who have ignored this advice will have experienced the disorienting effects of bright strobe lights bouncing off the suspended water particles in surrounding clouds, and back into their cockpit. The strobe lights on Black Square aircraft will now produce this blinding effect while in clouds or reduced visibility. While the disorienting effects are best experienced in VR, photosensitive users should be strongly cautioned against flying into clouds at night with the strobe lights operating.

Third Party Navigation and GPS Systems

There now exist a number of freeware and payware products to enhance or add advanced navigation systems to MSFS. For example, the TDS GTNxi 750/650, the PMS50 GTN 750/650, the Working Title GNS 530/430, and the KLN-90B. Several of these advanced GPS units implement their own autopilot managers out of necessity, with the Working Title GNS being the latest to do so. They may also require the use of their own special variables to be compatible with an aircraft's radionavigation equipment. Accommodating all these different products is not trivial. Black Square's hot-swappable avionics system, and failure system to a lesser extent, have compounded the difficulty.

Users should notice only minor interruptions when switching between GPS units, such as waiting for a GPS to reboot, or an uncommanded autopilot disconnect or mode change. As development continues on these 3rd party products, Black Square will continue to work with the developers to update the fleet, and bring you the most realistic flying experience possible.

Control Locks

Functioning control locks are provided for the pilot's yoke. The control locks can be removed by clicking on them. The control lock is stowed by the copilot's feet on the cabin floor. To access the control locks in their stowed position with a companion occupying the right seat, either just click through the character model, or unload them first via the tablet's payload interface.

Engine & Pitot Covers

Unlike some other Black Square aircraft, it is essential to remove the engine intake and pitot covers before starting the aircraft, as they will not be removed automatically. Engine covers left deployed will rapidly damage the engines, as cooling air is almost completely restricted. Users should suspect that the engine covers have been left installed in response to rapidly rising engine temperatures immediately after starting. The engine intake cover has an attached flag, visible from the pilot's seated position to help avoid catastrophic damage. Engine intake and pitot covers "REMOVE BEFORE FLIGHT" flags can also act as wind indicators.

Headphone Isolation

Simulated active noise cancelling headphones can be toggled by clicking on the pilot's headphone jacks. When the headphone cables are visible, the headphone sound isolation is active. The amount of noise cancellation can be adjusted by scrolling the mouse wheel while hovering over the headphone jack clickspot. The headphone isolation only affects engine and wind noise, allowing you to enjoy subtle sounds and hear interaction feedback without overpowering engine sounds.

Magnetic Compass Effects

This aircraft is equipped with Black Square's new magnetic compass simulation, which filters inputs from the simulation's magnetosphere environment and combines it with the influence of onboard magnetic fields. This means that the magnetic compass will respond more realistically to aircraft movement, and take a realistic amount of time to settle on a new heading.

Complex aircraft have many high power electrical loads onboard that can produce their own magnetic fields, which disturb the compass and produce false readings. The "magnetic compass is erratic when propeller heat is on" placards in the cockpit now have meaning. The largest electrical loads on the aircraft will now cause a deflection in the indicated magnetic heading corresponding to their magnitude, location in the aircraft, and the direction of the field generated relative to the compass' location.

Nose Gear Shimmy

This is the first Black Square aircraft to implement nose shimmy simulation. A phenomenon known to almost all pilots of light aircraft, various forces conspire against the delicate nose wheel systems of tricycle gear aircraft, usually during landing. The more weight that rests on the nose gear, the more likely the steering system is to enter a violent oscillation known as “shimmy”. While this phenomenon is often merely an annoyance, it can be indicative of poor form while handling the aircraft on the runway, and could cause a mechanical failure of the nose gear system.

After landing, it is advisable to increase back-pressure on the yoke, and hold the nose gear above the runway until the minimum possible airspeed, before allowing it to gently contact the runway surface. After all three tires are on the ground, heavy braking may also cause the aircraft’s weight to shift towards the nose, causing shimmy. If shimmy is noticed, the correct response is to apply full back-pressure and reduce braking, if possible. This simulation also includes a resonant frequency, meaning that some ground speeds create a perfect storm for nosewheel shimmy more than others.

Flap Controls

The Commander 114 possesses a common electric flap system with an uncommon control feature. The flap control switch has three positions. In the center position, no power is applied to the flap motor, and the flaps will not move. The switch can be held in the momentary down position to energize the flap motor and lower the flaps. The flaps can be set to any position by holding the switch down for the desired flap deflection. To raise the flaps, the switch must be pulled over an eccentric into the up position, where it will remain until manually positioned back into the center position. In the up position, the flaps will be fully retracted while the pilot’s hand is free to manipulate other controls during busy phases of flight. While a limit switch protects the flap system from surpassing the fully up position, it is considered best practice to return the flap switch to its center position as soon as practical after the flaps are fully retracted.

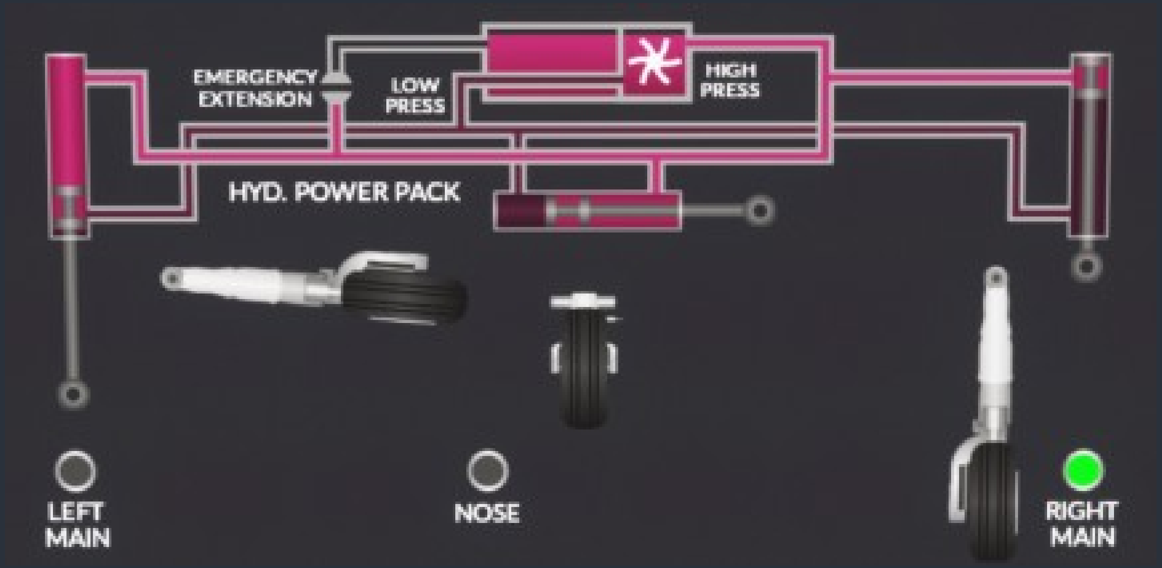
The flap position indicator is notoriously prone to sticking, especially while on the ground. Black Square's needle stiction and friction deliver an authentic experience, sometimes requiring the gauge to be tapped to free the needle and render an accurate flap position reading.

Hydraulic Landing Gear Simulation

This is the first of Black Square's aircraft to implement a hydraulic landing gear simulation of the type most common to light aircraft. Most light aircraft with hydraulically actuated landing gear possess only one loop of hydraulic fluid that feeds all three landing gear actuators. This leads to very distinctive motion exhibited by the landing gear while it is extending and retracting, which is chaotic in nature, and cannot be merely animated. The most noticeable effect of this system to the pilot is that the green landing gear indicator lamps will illuminate or extinguish at unpredictable intervals, and sometimes with long delays between each gear. The rate at which each gear extends or retracts depends on the location of the other two, and the forces experienced by the aircraft in flight.

For a demonstration of the hydraulic landing gear simulation, try raising or lowering the landing gear, and pulling the gear motor circuit breaker halfway through the gear's travel. Then, maneuver the aircraft to watch the hydraulic fluid traverse the system and the gear swing beneath the aircraft.

The status of the hydraulic powerpack and gear system can be monitored from the live schematic page of the tablet interface.



Should the gear motor fail, the red pull handle on the pilot's side of the center console can be pulled out and pushed down to open the emergency gear extension bypass valve. This valve dumps hydraulic fluid from one side of the system back into the reservoir, thereby rapidly lowering the landing gear. For more information on the hydraulic landing gear system, see the "Hydraulic Gear Simulation" tablet annotation in this manual.

Tablet Interface

The Black Square tablet interface is an invaluable resource for the enhanced understanding of complex aircraft systems. The tablet also allows the user to configure all options, manage payload, control failures, monitor engines, electrical schematics, and environmental control systems, all from within the simulator.

To show or hide the tablet, click on the tablet or cabin side wall, beside the pilot's seat. The tablet can be moved around the cockpit by dragging the frame of the tablet.

NOTE: Due to the large amount of information rendered on some pages of the tablet interface, it **may have a noticeable impact on the graphical performance of the simulator on less powerful systems.** This is only a symptom of rendering the graphics, and the rest of the aircraft has been designed to be as frame rate friendly as possible, often outperforming the default aircraft with large glass panel instrumentation. **If you experience this, simply hide the tablet interface when it is not in use, and it will have no further impact on performance.** In testing, the impact of the visualizer has been observed to be **less than 2-3 fps** when open.

Note: For the sake of brevity, not all variations of the engine, cabin, and electrical visualizer pages are pictured in this manual. Wherever possible, the variant with the most features is shown, meaning that other variants will only lack some of the features explained here.

Options Page

Your selections on the options page will be saved and restored next time you load the aircraft.

1. Primary Avionics Selection

The primary avionics choice will occupy the role of the COM1 and NAV1 radios. This selection could limit the available choices for secondary and tertiary avionics selections. When a GPS is selected as the primary avionics choice, it will always be the unit driving the MC60 localizer and autopilot. This selection will be saved and recalled at the start of your next flight. As opposed to other Black Square aircraft, the RNAV511 is given its own selection. This is the only selection for which the RNAV 511 will drive the MC60 localizer and autopilot.

2. Secondary Avionics Selection

The secondary avionics choice will occupy the role of the COM2 and NAV2 radios. This selection could limit the available choices for tertiary avionics selections. When a GPS is selected as the secondary avionics choice, it will only drive the MC60 localizer and autopilot if no GPS is selected as the primary avionics selection, and the capability exists for the secondary choice. For example, a secondary PMS50 GTN 650 or TDS GTNxi 650 will drive the autopilot and localizer if the MX-170B is selected as the primary radio. This selection will be saved and recalled at the start of your next flight.

3. Hide Vintage Avionics Switch

The Narco ADF-31 and Narco DME UDI-4 can be hidden, and sometimes replaced by a factory installed glovebox by activating this switch. This change takes effect immediately, and will be saved and recalled at the start of your next flight.

4. PMS50 GTN / TDS GTNxi Switch

To switch between the PMS50 and TDS offerings of GTN GPS units, toggle this switch. This selection will be saved and recalled at the start of your next flight.

5. Confirm Avionics Selection

Your avionics selection will only take effect once you have pressed the confirm button. Once pressed, the button will display a series of messages while the avionics are reconfigured. This takes a few seconds, and should not be interrupted due to the complexity of new avionics software. The autopilot will be disengaged when this change takes effect. Once the change is complete, the confirm button will remain grayed out until you make a change to your avionics selection with the buttons above.

6. State Saving Options

This aircraft now includes full state saving for nearly every parameter. The three toggle switches on this page allow you to choose which categories of parameters are saved and restored next time you load the aircraft. These switches are labeled: "Non-Essential", "Flight Critical", and "Avionics". All three options may be selected independently of each other.

For complete information on the new full state saving system, see the “Full State Saving” section of this manual.

7. Options List

The scrolling options list contains all configuration options for the aircraft. Your selections will be saved and recalled at the start of your next flight.


Options
Payload
Engine
Elec
Cabin
Failures
Avionics Selection
Primary
Secondary
MX 170B
MX 170B
1
2
KLN 90B
GTN 650
GNS 530
Hide Vintage
GTN 750
3
4
PMS50 GTN
TDS GTNxi
5
Confirm
6
State Saving
Non-Essential:
Flight Critical:
Avionics:
Options
VR Tablet Static Position
7
Cloud Strobe Effect

Payload Page

NOTE: Using the payload configuration tools in this tablet interface is optional.

You may always use the simulator's native payload and fuel interface, though the two may be desynchronized when the aircraft is first loaded. This is a simulator limitation.

1. Payload Data

This text area contains real-time weight and balance information, as well as range and endurance estimates. The toggle switch above the payload data block can be used to switch units from gal/lbs to L/kg. The maximum gross weight will appear in red when it exceeds limits.

2. Exterior Actions

The buttons in this list execute actions pertaining to the exterior of the aircraft, such as opening doors, and refilling the oxygen cylinder. All cabin doors and baggage compartment doors can also be opened from the inside of the aircraft without the tablet interface. If a door fails to open, its operation is being impeded by the aircraft's condition, such as airflow around the aircraft, or the cabin pressurization. The oxygen cylinder can also be refilled via the weather radar display.

3. Fuel Stations

Each fuel tank in the aircraft is represented by a fuel block. Each block depicts the current fraction of the tank that is filled in the color of the fuel type appropriate to the aircraft, the total gallons or liters of fuel in the tank, and the weight of the fuel. Below each block is the name of the tank, and its maximum capacity. The quantity of the fuel in the tank can be adjusted with the up and down buttons, or the simulator's native payload interface.

4. Payload Stations

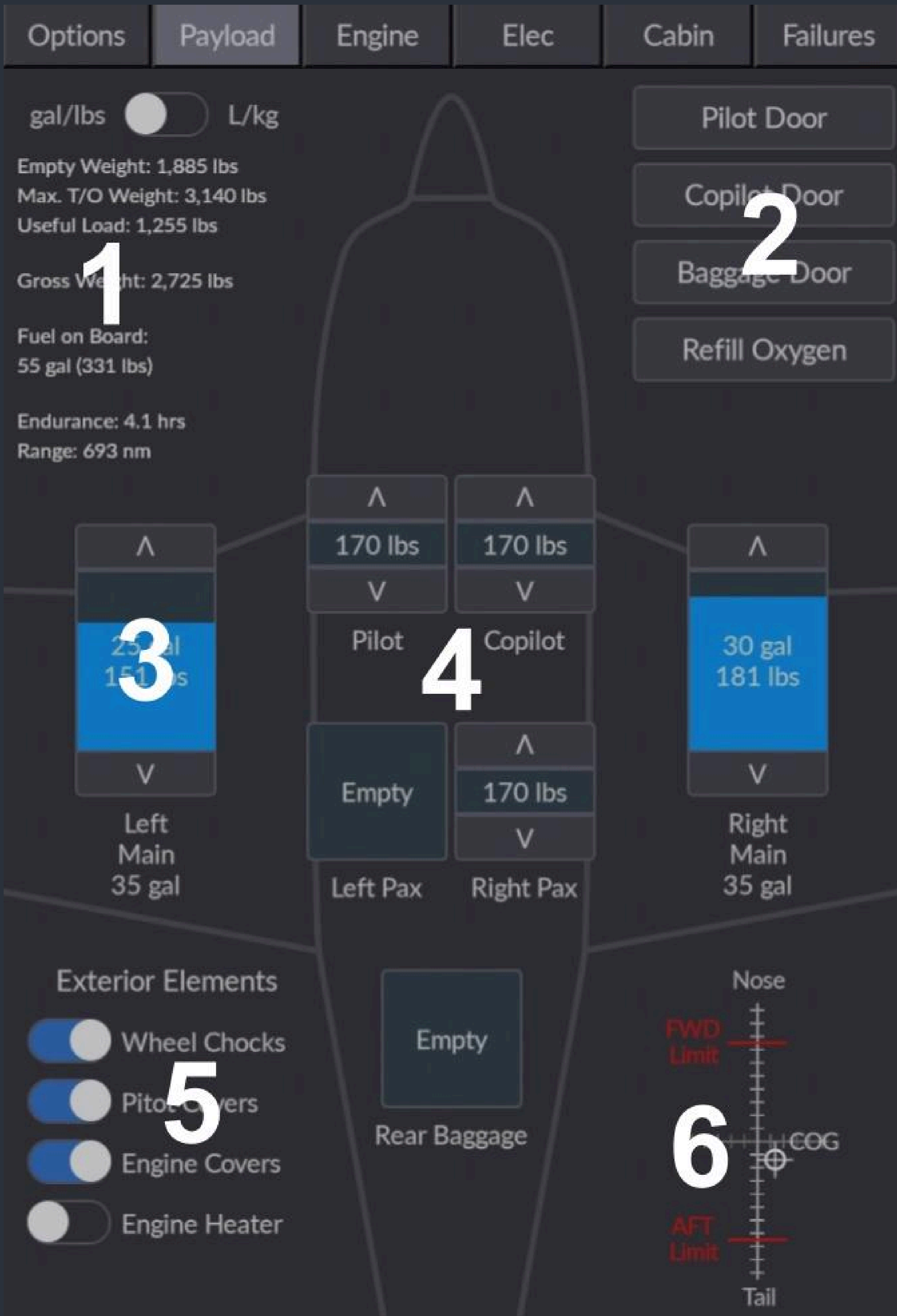
Each payload station in the aircraft is represented by a payload block. When occupied by passengers or cargo, each block shows the current weight of the station in its center. Clicking in the center of the block will toggle the payload between empty, and the default station weight. The weight of the payload station can be adjusted with the up and down buttons, or the simulator's native payload interface.

5. Exterior Elements

The toggle switches in this list control the visibility of exterior elements around the aircraft, such as wheel chocks and engine covers. The functioning wheel chocks can also be toggled by clicking on the stowed wheel chocks in the aircraft cabin.

6. Center of Gravity

This relative depiction of the center of gravity limitations can be used to assess the balance of your payload. When the aircraft's center of gravity exceeds the lateral or longitudinal limits, the crosshair will turn red.


Options
Payload
Engine
Elec
Cabin
Failures
gal/lbs
L/kg
Empty Weight: 1,885 lbs
Max. T/O Weight: 3,140 lbs
Useful Load: 1,255 lbs
Fuel on Board:
55 gal (331 lbs)
Endurance: 4.1 hrs
Range: 693 nm
Pilot Door
Refill Oxygen
1
2
3
4
5
6
170 lbs
170 lbs
Pilot
Copilot
30 gal
181 lbs
Left
Main
35 gal
Empty
170 lbs
Left Pax
Right Pax
Right
Main
35 gal
Exterior Elements
Wheel Chocks
Engine Covers
Engine Heater
Empty
Rear Baggage
Nose
FWD
Limit
COG
AFT
Limit
Tail

Engine Visualizer Page

While the engine visualizer does not depict every operating parameter of the engine, as this would be a nearly impossible task, it depicts many of the parameters and conditions designed by Black Square that were previously invisible to users. This visualizer is probably most helpful for reliably starting the engine, but also for troubleshooting failures.

Cold Engine

This is how the engine visualizer will appear when the aircraft is first loaded on the ground.

1. Repair Engine

Clicking the Repair Engine button will reset only the engine's core condition, which can be observed on the adjacent engine condition bar. This action requires confirmation. Resetting the engine condition will not perform any of the actions performed by the column of buttons on this page, such as clearing the cylinders of fuel, or recharging the battery. The engine condition can also be reset via the legacy weather radar systems display.

2. Engine Condition

The engine condition is represented by a percentage of total engine health. When the engine's condition reaches 0%, a catastrophic failure will occur, and the engine will become inoperable. When the engine condition falls below 20%, the engine's performance will begin to suffer, making further degradation likely if power is not reduced immediately. The engine condition can be reset using the adjacent Repair Engine button, or the legacy weather radar systems display.

3. Inactive Battery

The battery's capacity is displayed as a percentage of total amp-hours remaining. Batteries should generally not be discharged below 70-80% of their total capacity, unless they are specially designed "deep-cycle" batteries. When the battery is not connected to the main bus of the aircraft, it will appear grayed out.

4. Cowl Flap Indicator

The cowl flap indicator shows the current position of the engine's cowl flaps. When the cowl flaps are flush with the bottom of the fuselage, they are in the fully closed position.

5. Crankcase & Crankshaft

The crankcase of the engine contains the crankshaft, piston rods, oil galleries, and above it, the fuel distributor manifold. The crankshaft and piston rods will blur as the engine speed increases, but they do not change color with any temperature.

6. Pistons & Cylinders

When standing still, the pistons are numbered for each cylinder. The firing order for this engine is 1-4-5-2-3-6. Each cylinder possesses two spark plugs (top and bottom), one intake valve, and one exhaust valve. The cylinders on the right side of the engine (1-3-5), receive their top spark plug excitation from the left magneto, and the bottom plugs from the right magneto. The cylinders on the left side of the engine (2-4-6), receive their top spark plug ignition from the right magneto, and the bottom plugs from the left magneto. As the cylinders warm their color will change from blues and greens, to ambers and reds. The cylinder heads' absolute temperatures can be monitored on the EDM-800 engine monitor. For more information on EDM-800, see the "Using the JPI EDM-800 Engine Monitor" section of this manual.

7. Oil Pumps & Lines

A mechanical oil pump attached to the engine's accessory gearbox provides oil pressure only when the crankshaft is turning. As oil is circulated through the engine's galleries, a brown slug of oil will move down the lines depicted on the engine visualizer. The speed at which oil permeates the engine is determined by the oil's viscosity. Oil viscosity is determined mostly by temperature. The color of the oil depicts its temperature. Dark browns indicate very cold and viscous oil.

8. Fuel Pumps & Lines

Fuel is drawn from the lowest point in the fuel tanks from the suction of an engine driven fuel pump, or an electric pump. The total quantity of fuel in the tanks is indicated by the level of fuel in the "tanks" hopper. Be aware that this is the total quantity of fuel on board, not the tank that is currently feeding the engine. Animated dashes indicate the rate at which fuel is moving through the pressurized lines towards the fuel injector servo on the throttle body.

9. Exhaust Gas Parameters

The engine visualizers for this aircraft contain one or three exhaust gas parameters: Exhaust Gas Temperature (EGT), Exhaust Gas Volume in Cubic Feet per Minute (CFM), and Exhaust Gas Velocity (EGV) in miles per hour.

10. Induction Air Controls

Ambient air enters the induction system through filters at the bottom right of the visualizer. This air is always at the same temperature and pressure as the air surrounding the aircraft. Alternatively, induction air can enter through the alternate air intake, should the primary intake or filter become obstructed.

When ambient pressure and temperature ram air reaches the turbocharger with the engine running, it is pressurized before entering the rest of the intake system. After the turbocharger, a small relief valve protects the intake system from overpressurization if the throttle is closed rapidly while the turbocharger is spinning at high RPM.

11. Engine Condition Reset Buttons

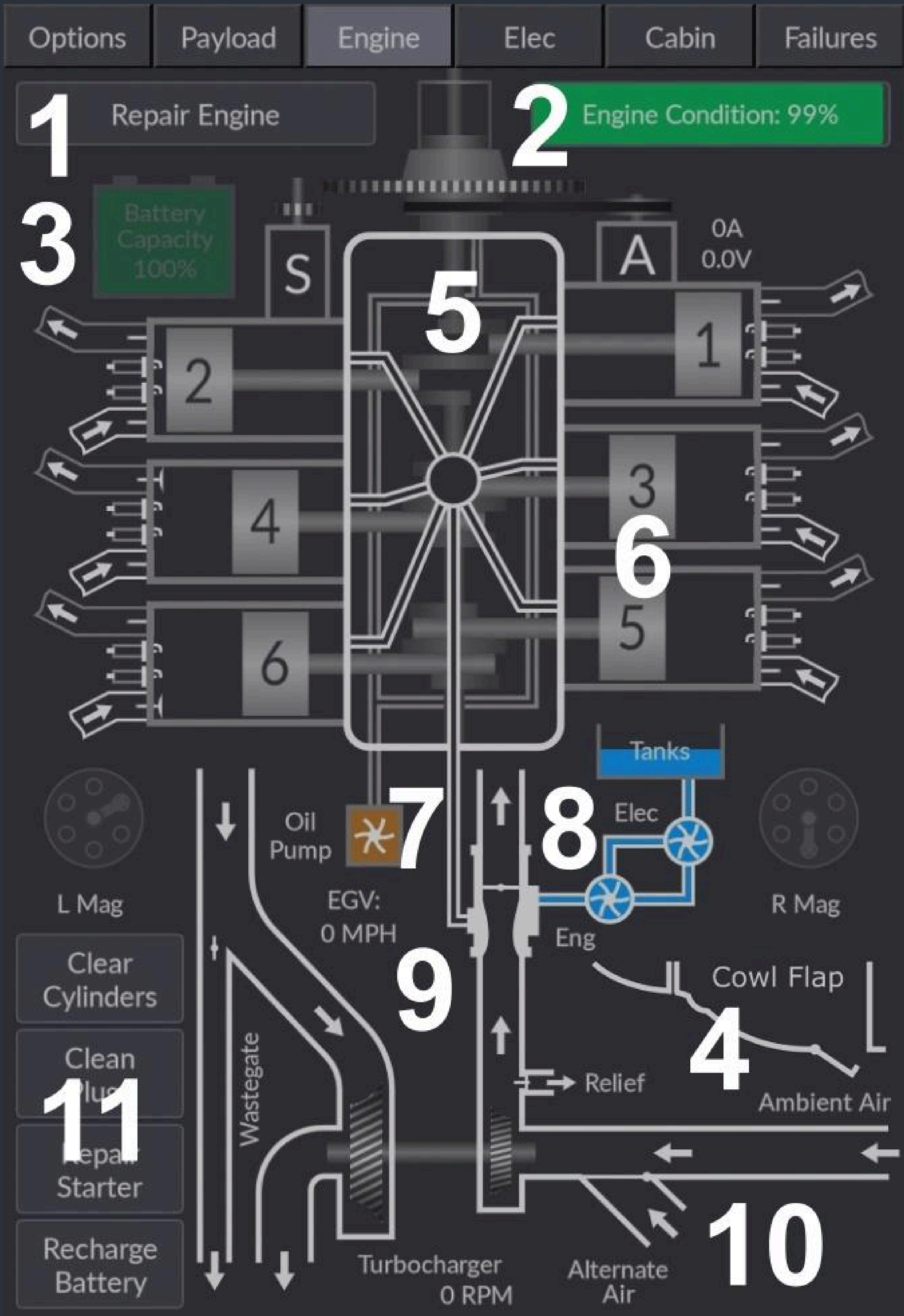
These buttons will not reset the engine's overall condition, but instead will reset individual elements of the engine's operating condition that may have become damaged or inoperable due to mismanagement, as opposed to failure.

The Clean Cylinders button will remove all fuel from the cylinders and fuel lines, and remove all fuel vapor from the fuel lines.

The Clean Plugs button will remove all fouling from the spark plugs which can prevent ignition.

The Repair Starter button will reconnect the starter with the aircraft's electrical system, and set the starter's casing to the ambient temperature. The starter may become disconnected from the electrical system due to overuse, which results in a high temperature.

The Recharge Battery button will fully recharge the battery, set its internal temperature to the ambient, and reconnect it with the hot battery bus. The battery may become disconnected from the hot battery bus if it is charged or discharged too quickly, which results in high temperatures.


Options
Payload
Engine
Elec
Cabin
Failures
1
Repair Engine
2
Engine Condition: 99%
3
Battery Capacity 100%
S
A
0A
0.0V
5
1
2
3
4
6
5
6
Tanks
7
Oil Pump
8
Elec
L Mag
EGV:
0 MPH
R Mag
Eng
9
Cowl Flap
Clear Cylinders
Clean Plugs
11
Repair Starter
Wastegate
Relief
4
Ambient Air
Recharge Battery
Turbocharger
0 RPM
Alternate Air
10

Starting Engine

This engine visualizer is most useful for diagnosing difficulties while starting the engine. The primary difficulties usually encountered while starting fuel injected engines are vapor lock, and the amount of liquid fuel in the lines, and fuel vapor in the cylinders. For more information on starting fuel injected engines see the “Fuel Injected Engine Operation” section of this manual.

1. Propeller Hub

Atop the flywheel in this visualizer is the propeller hub cylinder and piston. When the piston is at the bottom of the cylinder, the propeller is in its fully fine position. The piston’s position is controlled by engine oil pressure, metered by the propeller governor. While starting from cold, there is no pressurized oil in the propeller hub, but a powerful spring holds the piston down and the blades in their fully fine position.

2. Battery Temperature

Here, the battery can be seen connected to the main electrical bus. The exterior casing of the battery will change color to indicate the temperature of the battery’s terminals and electrodes. When the battery is cold, the casing color will be gray. As the battery warms the color will change from blues and greens, to ambers and reds. For more information on battery charging and temperature, see the “Battery Temperature” section of this manual.

3. Starter Motor in Use

When the starter motor is in use, the interior body of the starter will be depicted in green. Should the starter fail, it will turn red. When power is applied to the starter, a powerful solenoid pushes the starter gear into the flywheel gear to rotate the crankshaft. The exterior casing of the starter will change color to indicate its temperature. When the starter is cold, the casing color will be gray. As it warms the color will change from blues and greens, to ambers and reds.

4. Spark Plug Fouling

When the spark plugs become fouled with carbon and lead deposits, they will either produce a weak spark, or no spark at all. These deposits can be removed operationally, assuming they are not too severe. For the best practices to avoid fouling, and how to remove it, see the “Spark Plug Fouling” section of this manual. If fouling has become so severe that the engine cannot run at the temperatures required to remove the fouling, use the Clean Plugs button on this page to restore all the spark plugs to their original condition. The quantity of spark plug fouling is depicted here by the amount of red showing in the interior volume of the plug. Bottom spark plugs are usually fouled more than top plugs, because oil and combustion residue settle to the bottom of the cylinders with gravity.

5. Early Ignition

While starting, it can be useful to see when a cylinder fires, as this means the conditions required for the continuous combustion needed to start the engine are present. Here, we can see a cylinder expelling hot exhaust gasses through its exhaust valve, and the spark plug having just fired, despite some considerable fouling.

6. Fuel in Cylinders

The most crucial aspect of fuel injected engine starting is the amount of fuel vapor in the cylinders. The fuel lines must be fully pressurized before sufficient fuel can be found in each cylinder. The amount of fuel vapor in the cylinders is depicted by the blue gradient, here. There must be at least some fuel in the cylinders for a successful start, but not so much that the engine becomes flooded. In the screenshot below, this would be a generous amount of fuel for a normal start, and may require some additional cranking.

7. Fuel & Vapor in Lines

When the electric or engine driven fuel pumps run with the throttle open and the mixture above cutoff, fuel will flow from the tanks into the distributor manifold, then outwards to the cylinder heads. As the fuel lines are pressurized, a slug of fuel will travel from the throttle body out to the cylinders. Dashed lines indicate the rate of fuel flow. Not until this slug reaches the cylinders will they begin to fill with fuel.

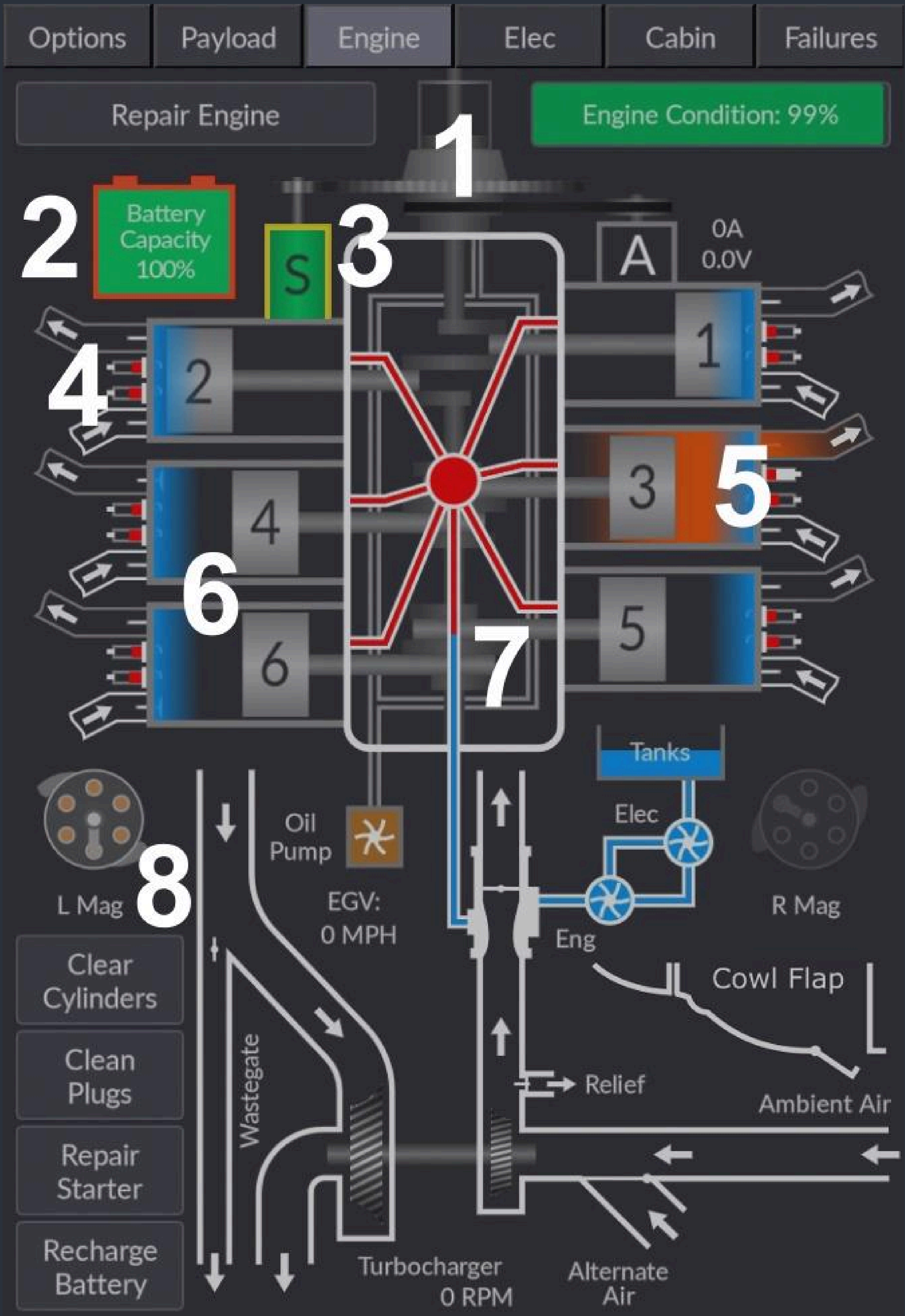
Usually when an engine is shut down, the heat in the cylinders will begin vaporizing fuel in the lines, causing back pressure that can prevent the flow of liquid fuel to the cylinders. This is called vapor lock. It is the bane of many fuel injected aircraft pilots who do not know how to manage it. For information on when vapor lock is likely to occur, and how to alleviate it, see the “Hot Engine Starting” section of this manual for more information. Vapor lock back pressure is depicted here by the red slug, working backwards from the cylinders towards the throttle body.

8. Magneto & Impulse Coupling

When a magneto is grounded by the ignition switch, it will appear grayed out. Here, only the left magneto is ungrounded, as is the typical starting configuration for aircraft engines. Magnetos may also become grounded or ungrounded by way of failures, which are simulated.

The magneto wiper is a rotating internal mechanism which connects the magneto coil to the right spark plug at the right time, as the engine rotates. Here, the wiper contacts copper pads, positioned around the periphery of the magneto.

Around the outside of the magneto are the impulse coupling flyweights, which will only be visible when the engine is starting. These weights snap in and out as the engine rotates at low RPM, delaying the ignition of each spark plug, and increasing the angular velocity of the magneto’s rotor to produce larger sparks. These also make a characteristic snapping sound while the starter is cranking, and when the engine is coming to a stop.


Options
Payload
Engine
Elec
Cabin
Failures
Repair Engine
Engine Condition: 99%
1
2
Battery Capacity 100%
S
3
A
0A
0.0V
4
2
1
5
3
4
6
5
6
7
Tanks
Elec
Oil Pump
L Mag
8
EGV:
0 MPH
Eng
R Mag
Clear Cylinders
Clean Plugs
Repair Starter
Recharge Battery
Wastegate
Cowl Flap
Relief
Ambient Air
Turbocharger
0 RPM
Alternate Air

Running Engine

While the engine is running, the engine visualizer is best used for monitoring temperatures, component failure, and the intake manifold valve positions.

1. Propeller Hub

Unlike the cold engine example above, here the propeller hub is slightly filled with pressurized oil from the engine. As the propeller control lever is pulled towards the low RPM position, more oil will be metered into the propeller hub, and the blades will move towards their coarse position.

2. Alternator

Like the starter motor, the alternator's internal volume will appear green when it is operating, and red when it has failed. The alternator also has text to indicate the present output voltage and current load on the alternator.

3. Cylinder Temperatures

With the engine running, we can see intake air flowing into each cylinder through the intake valves, and hot exhaust gasses exiting through the exhaust valves. Each spark plug can also be seen firing continuously, or so it would appear. This is merely because each spark plug is firing around 25 times per second, which approaches the refresh rate of the tablet screen.

The color of the exhaust gas and cylinder head temperatures follow the same logic as the other elements discussed above. As they warm, the colors will change from yellows and oranges, to reds and magentas. Magenta should be considered dangerously hot for any equipment depicted in this engine visualizer. Here, the number four cylinder is running moderately warmer than the rest. Some variation in cylinder head temperature is normal, and may even change with the pitch of the aircraft, or direction of crosswinds. The cylinder heads' absolute temperatures can be monitored on the EDM-800 engine monitor. For more information on EDM-800, see the "Using the JPI EDM-800 Engine Monitor" section of this manual.

4. Backfire

A cylinder may backfire under several abnormal conditions, which are enumerated in the "Backfiring" section of this manual. When a cylinder backfires, combustion of fuel vapors and hot gasses takes place outside the cylinder, in its exhaust manifold. Backfiring is depicted here as red-yellow gasses rapidly expand out of the cylinder's exhaust valve.

5. Oil Pumps & Lines

While dark brown oil in the galleries indicated very cold and viscous oil, red indicates oil that is too hot. The oil has a large normal operating temperature span, throughout which its color will be the brown seen below. Here, the engine driven oil pump can also be seen running.

6. Magnetos

Once the engine is running and the ignition switch is released from the “start” position and returns to the “both” position, both magnetos will supply high voltage pulses to each spark plug in turn, assuming there are no magneto grounding failures. The wiper has blurred with the speed of the engine, and the impulse coupling flyweights have retracted.

7. Exhaust Manifold

When the engine is running, the exhaust manifold is filled with hot exhaust gasses, which are the average temperature of all the cylinders’ exhaust gasses. The exhaust gas temperature colors are the same as those described for each cylinder, above.

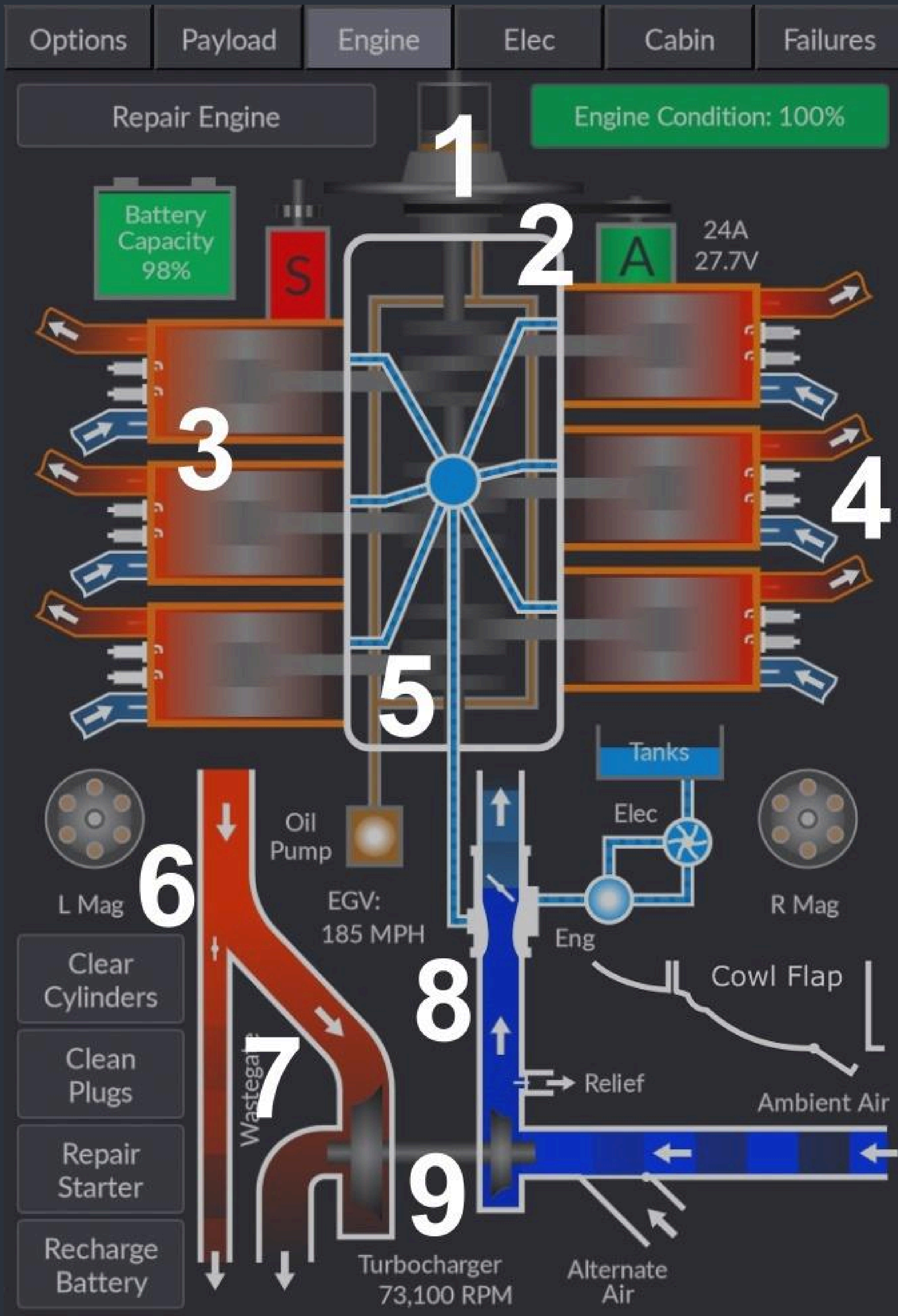
In the case of a normally aspirated aircraft, this exhaust gas will immediately be directed overboard. For turbocharged aircraft (as depicted below) most of this exhaust gas flows into the turbocharger, while some is diverted overboard. The diversion of this gas is controlled by the oil pressure actuated wastegate, and absolute pressure controller. When the engine is operating near sea level, the engine would overboost if all the gas was allowed to flow through the turbocharger, so the wastegate is fully opened, allowing some gas to bypass the turbocharger. As the aircraft climbs towards the critical altitude, the wastegate closes. For more information on turbochargers, wastegates, and critical altitude, see the “Turbocharged Operation” section of this manual.

8. Intake Manifold

The gasses in the intake manifold are color-coded not for temperature, but pressure. Fully saturated, bright blue indicates sea level pressure. Darker blues indicate higher pressures, and greens and yellows indicate lower than sea level pressures. Seen here, the throttle butterfly valve limits the amount of pressurized intake air admitted to the intake manifold, and the engine pulls a vacuum above the throttle valve. This is measured as the manifold pressure.

9. Turbocharger (Turbonormalized Variant Only)

The turbocharger RPM is shown below the intake and exhaust turbines. See the “Turbocharged Operation” section of this manual for more information on turbocharger operation.


Options
Payload
Engine
Elec
Cabin
Failures
Repair Engine
Engine Condition: 100%
1
Battery Capacity 98%
S
2
A
24A
27.7V
3
4
5
Tanks
Oil Pump
Elec
L Mag
6
EGV:
185 MPH
R Mag
Eng
Clear Cylinders
8
Cowl Flap
Clean Plugs
7
Wastegate
Relief
Ambient Air
Repair Starter
9
Recharge Battery
Turbocharger
73,100 RPM
Alternate Air

Live Schematic Page

The live schematic in the tablet interface is an almost identical recreation of the static schematic in the “Overview Electrical Schematic” section of this manual. For more information on the enhanced electrical simulation of this aircraft, also see the “Electrical Systems” section of this manual.

1. Active & Inactive Equipment

When a circuit component, such as a starter motor, is inactive, it will be grayed out.

2. Circuit Breakers

Circuit breakers will show their red collar when the breaker has been tripped by excessive current. The breaker can be reset manually by clicking on the tripped breaker in the cockpit. If the breaker has tripped due to a failure, it will trip again soon, assuming the circuit is still under load and producing heat. For more information on the circuit breaker layout and power distribution logic, see the “Circuit Breakers” section of this manual.

3. Switches

Toggle switches control whether a circuit is open or closed. Wherever possible, the switches in the live schematic will be oriented so that the head of the toggle switch points towards the direction of current flow when it is in the on position.

4. Buses & Circuit Connections

An electrical bus is any point in an electrical system at which multiple circuits, or other buses, attach. They are often solid pieces of conductive metal to which many wires attach, though they can also be purely conceptual, and used to aid your understanding of the system.

Connections between circuit elements and buses are depicted with solid lines and “hop-overs” wherever two lines must cross without making contact. In this live schematic, buses and circuit connections receiving any voltage from the battery or alternators are highlighted in green, and are otherwise red. For the sake of readability, some circuit connections appear in red when no apparent switch isolates that part of the circuit from normally powered buses. For example, the circuit connection from the main bus to the alternator power switch remains red, even when the main bus is powered.

Logic or signal connections, which do not carry any meaningful current, are depicted as dashed lines. For example, in this aircraft, the flap control switch sends a signal to the flap controller, which directs high current power to the flap motor.

5. Voltmeter

Voltmeters measure the electrical potential between two points in the aircraft's electrical system. Here, the direct current (DC) voltmeter measures the voltage between the main bus, and the chassis (ground) of the aircraft. As opposed to current measuring devices, voltmeters are depicted beside the point at which they measure voltage, or across two points between which the potential is measured, rather than as in-line devices.

6. Loadmeters

The load meters in most light aircraft do not indicate the total load required of the aircraft's electrical system for all of its electrical equipment. Instead, the loadmeters indicate the load on each generator. This will always be a positive number, as opposed to ammeters in aircraft that can be used to observe battery charge and discharge rates. As opposed to voltmeters, current measuring devices are depicted as in-line with their load, rather than as point measurements.

7. Circuits

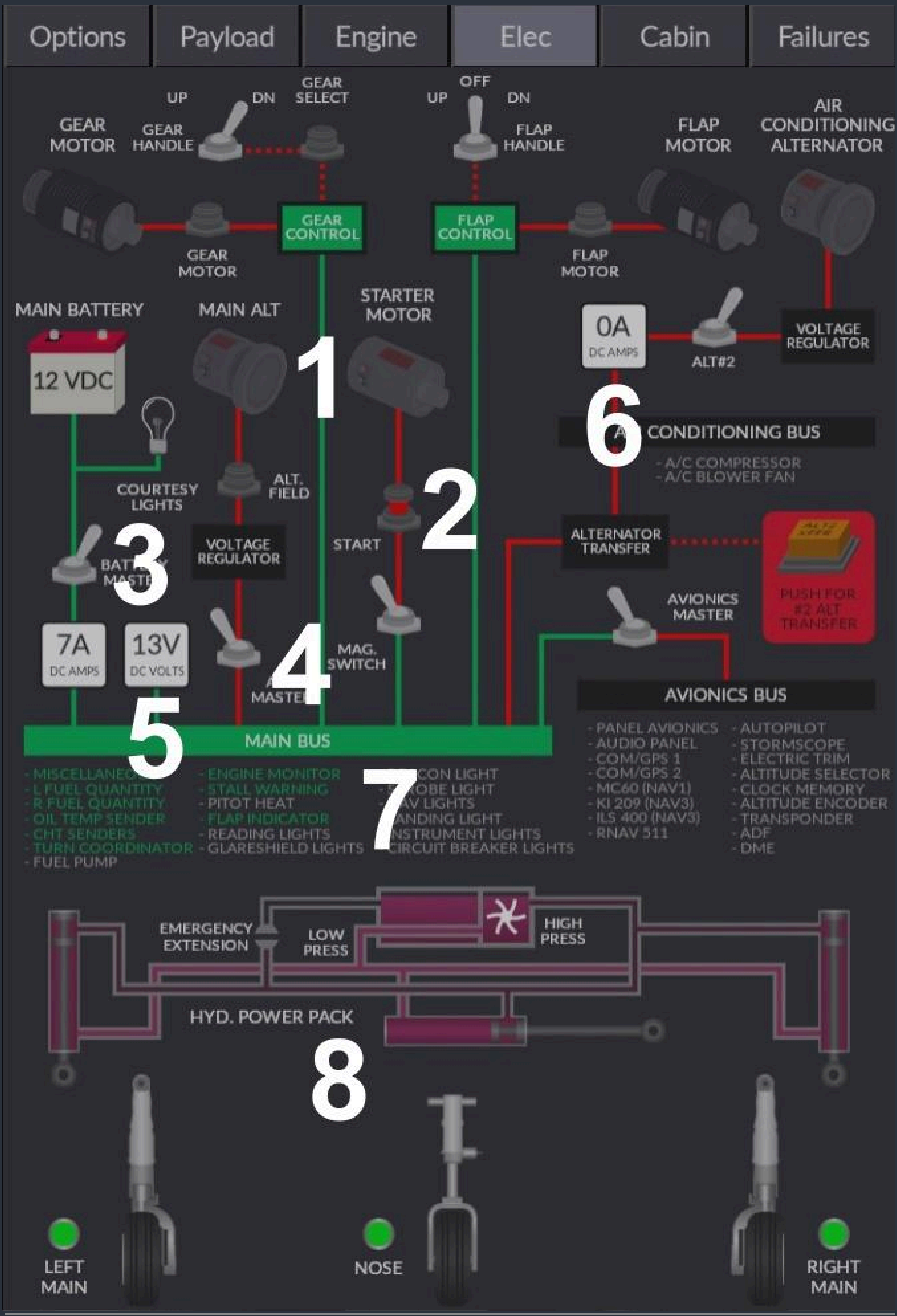
Each circuit for an individual piece of equipment in the aircraft is represented on this schematic. When the circuit is in use and powered, its name will be highlighted in green. Otherwise, the name will be grayed out.

8. Hydraulic Gear Simulation

This is the first Black Square aircraft to feature a hydraulic landing gear simulation, which is designed to produce the very recognizable characteristics inherent to this system. For more details on the simulation, see the "Hydraulic Landing Gear Simulation" section of this manual.

Depicted in this live schematic is the hydraulic reservoir, hydraulic pump, high and low pressure lines, hydraulic actuators, emergency extension bypass valve, and the landing gear position. When the powerpack is energized, the hydraulic pump develops pressure to either raise or lower the gear. The more brightly colored hydraulic fluid indicates the direction of flow within the system. The emergency extension valve opens the high pressure side of the system (used for retraction) to the reservoir, allowing the pressure currently holding the gear up to bleed off, thus lowering the gear. At the bottom of the screen, the position of the three landing gear struts are indicated by motion graphics. The green indicator lamps mirror those in the cockpit. When combined with the motion graphics, these allow the status of the gear system to be monitored entirely from either the inside or the outside of the aircraft.

Note: Counterintuitively, the main landing gear actuators fully extend to retract the main gear, while the nose gear is extended by the actuator fully extending. This is simply a design choice in the landing gear's mechanical system. This action can be observed on the exterior model of the aircraft.


Options
Payload
Engine
Elec
Cabin
Failures
GEAR MOTOR
UP
GEAR HANDLE
DN
GEAR SELECT
OFF
UP
DN
FLAP HANDLE
FLAP MOTOR
AIR CONDITIONING ALTERNATOR
GEAR CONTROL
FLAP CONTROL
GEAR MOTOR
FLAP MOTOR
MAIN BATTERY
MAIN ALT
STARTER MOTOR
12 VDC
1
0A
DC AMPS
ALT#2
VOLTAGE REGULATOR
6
CONDITIONING BUS
- A/C COMPRESSOR
- A/C BLOWER FAN
COURTESY LIGHTS
ALT. FIELD
2
3
VOLTAGE REGULATOR
START
ALTERNATOR TRANSFER
PUSH FOR #2 ALT TRANSFER
AVIONICS MASTER
7A
DC AMPS
13V
DC VOLTS
4
MAG. SWITCH
AVIONICS BUS
5
MAIN BUS
- PANEL AVIONICS
- AUDIO PANEL
- COM/GPS 1
- COM/GPS 2
- MC60 (NAV1)
- KI 209 (NAV3)
- ILS 400 (NAV3)
- RNAV 511
- AUTOPILOT
- STORMSCOPE
- ELECTRIC TRIM
- ALTITUDE SELECTOR
- CLOCK MEMORY
- ALTITUDE ENCODER
- TRANSPONDER
- ADF
- DME
- L FUEL QUANTITY
- R FUEL QUANTITY
- OIL TEMP SENDER
- CHT SENDERS
- FUEL PUMP
- ENGINE MONITOR
- STALL WARNING
- PITOT HEAT
- FLAP INDICATOR
- READING LIGHTS
- GLARESHIELD LIGHTS
7
CON LIGHT
OBE LIGHT
AV LIGHTS
ANDING LIGHT
NSTRUMENT LIGHTS
CIRCUIT BREAKER LIGHTS
EMERGENCY EXTENSION
LOW PRESS
HIGH PRESS
HYD. POWER PACK
8
LEFT MAIN
NOSE
RIGHT MAIN

Cabin Climate Visualizer Page

With many other high performance aircraft having automatic climate control systems, understanding the function of more manual systems is essential to reduce pilot workload during critical phases of flight.

Heating Cabin

When the desired cabin temperature is warmer than the outside ambient air, heating is provided by an exhaust heat exchanger or "exhaust shroud". For more information on the environmental control systems, see the "Environmental Simulation & Controls" section of this manual.

1. Exhaust Air Heat Exchanger (Exhaust Shroud)

Attached to the left exhaust manifold of the normally aspirated version of this aircraft, or below the crankcase on the turbonormalized variant, is an exhaust heat exchanger or "exhaust shroud". This heat exchanger takes ambient temperature ram air and heats it to potentially very high temperatures for cabin heating. The hotter the exhaust gas temperature, the greater the heating potential.

2. Cabin Heat Valves

The cabin "CABIN HEAT" pull handle, located on the copilot's left subpanel, actuates two slide valves to control how much heating air from the exhaust air heat exchanger is admitted to the cabin. Pulling the "CABIN HEAT" pull handle away from the instrument panel will send progressively more heating air to the cabin. This air is directed to each seating location through the same ducts as the ram air from the wing root ram air vents. For more information on these footwell vents, see the "Wing Root Ram Air Vents" annotation, below. For more information on controlling the cabin temperature, see the "Cabin Environmental Controls" section of this manual.

3. Windshield Defroster Valves

The defroster valves direct heating air from the exhaust air heat exchanger towards the aircraft's windshield. Pulling the "DEFROST" pull handle away from the instrument panel opens the normally closed valves.

4. Wing Root Ram Air Vents

At the root of each wing, a screen-covered intake sources ram air for the cabin and avionics cooling. The ducts and vents used to deliver ram air from the wing root are shared with the heating air system. When heating is desired, the "CABIN VENT" pull handle should be pulled away from the instrument panel. This prevents the cooler, ambient ram air from defeating the heating system.

5. Footwell Air Vents

Within the cabin, both heating and ambient ram air enter the cabin through the adjustable direction D-shaped vents in the footwells of each seating area. These vents are opened and closed by moving the small lever on their aft sides. These vents can generally remain open, and are mainly designed for different passenger preferences, as both ram air and heating air are controlled by separate pull handles on the copilot's subpanel.

6. Target Cabin Temperature

The target cabin temperature will be displayed any time there is an active source of heating or cooling air entering the cabin. When the cabin is left to passively heat or cool itself with ambient air or solar heating, the displayed target temperature will be "None". For information on how to set the target temperature with active heating and cooling sources, see the "Cabin Environmental Controls" section of this manual. If there is a condition that prevents this target temperature from being achieved (such as the engine not running fast enough to energize the air conditioning alternator to run the compressor), the target temperature will be shown in red.

7. Main Cabin Volume & Vents

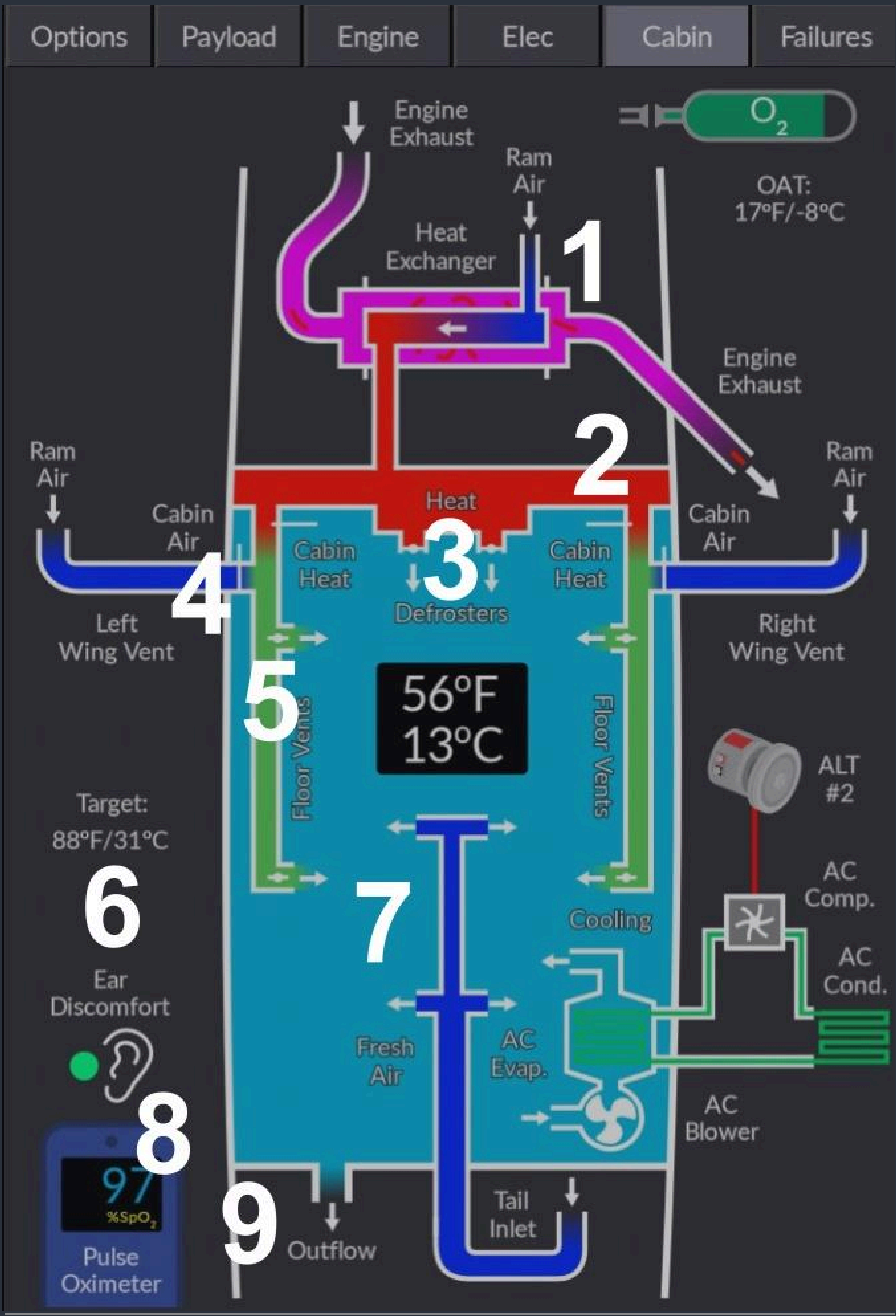
The temperature of the main cabin, and all ducts and vents in the visualizer, can be estimated from the same absolute temperature scale used elsewhere in this tablet interface. Dark blues are the coldest, greens and yellows are moderate, and reds and magentas are the hottest. The cabin's current temperature is shown in Fahrenheit and Celsius at the bottom of the visualizer.

8. Ear Discomfort Index

Ear discomfort is a frequent consideration while operating both pressurized and unpressurized aircraft. The colored dot in this visualizer gives some sense of ear discomfort due to pressure equalization between the outer ear and the middle ear. While everyone's physiology is different, rates of climb/descent in excess of 700 ft/min will create noticeable discomfort if the middle ear pressure is not consciously equalized through the eustachian tubes. For those accustomed to flying in light aircraft, climb/descent rates of 1,500 ft/min are a routine affair. However, rates of 3,000 ft/min or greater will be considerably uncomfortable for most occupants without ample flying or scuba diving experience.

9. Outflow Port

Cabin air is allowed to flow freely out a covered port on the pilot's side of the fuselage, just behind the rear cabin bulkhead. This helps promote fresh airflow through the cabin.



Options
Payload
Engine
Elec
Cabin
Failures
Engine Exhaust
O2
Ram Air
OAT: 17°F/-8°C
Heat Exchanger
1
Engine Exhaust
2
Ram Air
Ram Air
Heat
Cabin Air
Cabin Air
3
Cabin Heat
Cabin Heat
4
Defrosters
Left Wing Vent
Right Wing Vent
5
56°F 13°C
Floor Vents
Floor Vents
ALT #2
Target: 88°F/31°C
AC Comp.
6
7
Cooling
AC Cond.
Ear Discomfort
Fresh Air
AC Evap.
8
AC Blower
97 %SpO2
Pulse Oximeter
9
Outflow
Tail Inlet

Cooling Cabin

When the desired cabin temperature is below the outside ambient air temperature, cooling is provided by the vapor cycle cooling system, more commonly known as an air conditioner. For more information on the environmental control systems, see the “Environmental Simulation & Controls” section of this manual.

1. Oxygen Cylinder

The pressure of oxygen in the cylinder (a surrogate for the quantity remaining) is indicated by the green volume in the cylinder. This quantity can be refilled on the payload page of the tablet interface. The valve to the left of the cylinder, here seen in the closed position, depicts the position of the oxygen valve, controlled via the pull handle above the pilot’s head.

2. Cabin Heat Valves

The exhaust air heat exchanger is more than capable of defeating any cooling provided by the air conditioning system, so the cabin heat valve must be set to the fully cold position by pushing the “CABIN HEAT” pull handle into the instrument panel in order to cool the cabin.

3. Main Cabin Volume & Vents

The temperature of the main cabin, and all ducts and vents in the visualizer, can be estimated from the same absolute temperature scale used elsewhere in this tablet interface. Dark blues are the coldest, greens and yellows are moderate, and reds and magentas are the hottest. The cabin’s current temperature is shown in Fahrenheit and Celsius at the bottom of the visualizer.

4. Target Cabin Temperature

When air conditioning is desired, the target cabin temperature text can be useful for determining whether all conditions are met for active cooling. If the air conditioning switch is in the compressor position, but a condition exists that precludes the cooling of the cabin (such as the engine not running fast enough to energize the air conditioning alternator), the target temperature will be shown in red. For information on how to manage temperatures with active heating and cooling, see the “Cabin Environmental Controls” section of this manual.

5. Air Conditioning Compressor & Condenser

The air conditioning system (also known as the vapor cycle cooling system), is powered by an electrically-driven compressor via a secondary belt-driven alternator. This compressor will only function when the RPM of the engine is high enough to support the substantial electrical load, at which point the compressor will indicate with green on this visualizer, and the impeller will begin to rotate.

6. Air Conditioning Blower & Air Conditioning Evaporator

Cooling of the cabin is accomplished with an air conditioning evaporator, through which recirculated cabin air flows from the baggage area. The insulated lines of the vapor cycle cooling system will change color to indicate that the system is operating. The air conditioning blower blower fan can be used to accelerate passive and active cooling while on the ground with the “CABIN VENT” valve open. When the air within the cabin is cooler than the air outside, the “CABIN VENT” valve can be closed. The maximum cooling achievable by the evaporator is primarily influenced by the evaporator fan speed. Increasing the fan speed will increase the cooling potential. If more fine control of the cabin temperature is required, then some combination of heat and ram air must be used.

7. Pulse Oximeter

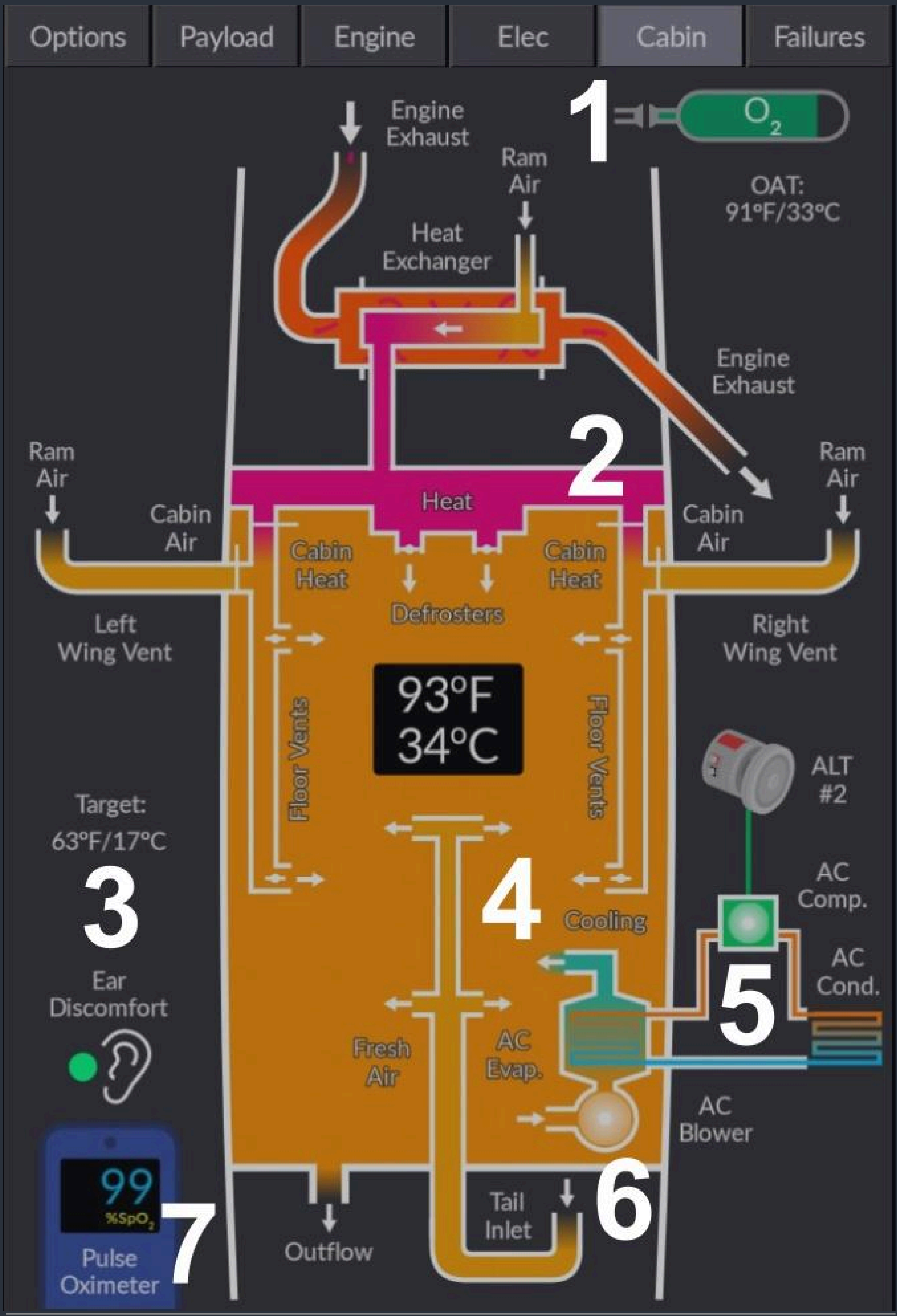
Loss of conscientiousness and impaired cognitive functioning in low oxygen environments does not happen instantaneously. Except in the case of the most severe decompression events, oxygen must leave the blood supply in order for hypoxia to take effect. This process can take over an hour at lower cruising altitudes, or a few seconds at high altitude. Use the pulse oximeter to monitor the concentration of oxygen in the pilot’s bloodstream. If the concentration becomes too low, decrease the cabin pressurization altitude, descend if the cabin is unpressurized, or open the oxygen valve to use supplemental oxygen.

Generally speaking, 98% oxygen saturation (SpO_2) is normal at sea level for a healthy adult.

The recommended, and legally required, altitudes for supplemental oxygen use of around 12,000 - 14,000 feet correspond to an SpO_2 of roughly 90-92% for exposure under 60 minutes.

An SpO_2 below 90% results in cognitive impairment, possibly detrimental to flight safety.

An SpO_2 below 80% can lead to incapacitation after exposure of just a few minutes.


Options
Payload
Engine
Elec
Cabin
Failures
Engine Exhaust
1
O_2
Ram Air
OAT:
91°F/33°C
Heat Exchanger
Engine Exhaust
Ram Air
Cabin Air
2
Heat
Ram Air
Cabin Air
Cabin Heat
Cabin Heat
Defrosters
Left Wing Vent
Right Wing Vent
Floor Vents
93°F
34°C
Floor Vents
ALT #2
Target:
63°F/17°C
3
4
AC Comp.
Cooling
5
AC Cond.
Ear Discomfort
Fresh Air
AC Evap.
AC Blower
99
%SpO_2
Pulse Oximeter
7
Outflow
Tail Inlet
6

Failures Page

This aircraft is equipped with an underlying software system that is capable of triggering a failure of almost any simulated aircraft system, in response to the users mismanagement of the aircraft, at appropriately timed random (MTBF) intervals, or within a scheduled window of time. These failures are managed through the failures page of the tablet interface. A list of all possible failures is provided below in the “List of Possible Failures” section of this manual. Failures are saved between flights, leaving you to discover what failed on the previous flight during your before flight checklists.

MTBF Failures

In Mean Time Between Failure (MTBF) mode, the user can set custom failure probabilities in the form of a mean time between failure time in hours. While real world electromechanical components follow an exponentially decaying failure probability after their fabrication, this would be inconvenient for users of virtual aircraft, since it would subject new users to high component mortality rates just after purchasing the product; therefore, the probability of component failure is constant throughout aircraft operation. This means that the probability of failure can be considered to be exactly the mean at all times.

While many of these failures may be randomly generated, they will feel like an authentic system failure (which are essentially random in real life), because they will only fail while the system is in use, and at a rate appropriate to the real world system.

1. Restore Defaults & Reset All Failures

The Restore Defaults button can be used to reset all MTBF times to their default value. As adjustments to MTBF times are saved and restored for the next flight, this action requires a confirmation to complete. For instructions on adjusting the MTBF time for individual components see point 6, below. The reset all failures button can be used to reset all currently active failures at once. For instructions on triggering individual failures, see point 7, below.

2. MTBF / Scheduled Mode Switch & Show Only Active Failures

Use the MTBF / Scheduled Mode switch to toggle between the two modes of operation for the failure system. The Show Only Active Failures switch can be used to filter the results of the scrolling failure list to only those that are currently active. This also applies to the results of the search function.

3. Global Failure Rate Slider

The global failure slider is used to control the global failure rate, indicated by the text below the slider. The maximum allowable rate is 1000 times real-time. All MTBF and scheduled failures can be disabled completely by positioning the slider all the way to the left, until “Failures Off” appears below the slider. The global failure rate multiplies the probability of random failures occurring while in MTBF mode, but does nothing in scheduled failure mode.

For Example, if a specific failure is expected to occur once in every 5,000 hrs of flight time, a global failure rate of 1000x, will result in this failure occurring roughly once in every 5 hrs of flight time instead. Settings between 10x and 50x are recommended to add a little excitement to your virtual flying experience, as many hundreds of hours can be flown at 1x real-time failures without encountering a single failure, while settings above 250x almost guarantee multiple failures per flight.

4. Active Failures

The current number of active failures can be seen at all times below the global failure rate slider. This number is also shown on the systems page of the weather radar display so that the number of current failures can be monitored from the cockpit without the tablet visible.

5. Search Failures

All failures shown in the scrolling list are searchable. Click in the search window and start typing to search. The text entry mode should deactivate automatically a few seconds after you stop typing. When the "show only active failures" option is selected, the search will only return results among the currently active failures.

6. Adjust MTBF

Upon loading the aircraft for the first time, default MTBF values will be displayed for each system, which are representative of their real world counterparts in accordance with published NASA guidelines whenever available. These failure probabilities can be modified by pressing the left and right arrow buttons beside the MTBF value. The minimum allowable MTBF is 100 hrs, and the maximum is 1,000,000 hrs. If adjusted from the default, the selected MTBF time will be saved and restored on the next flight.

7. Instantaneously Fail or Reset Failure

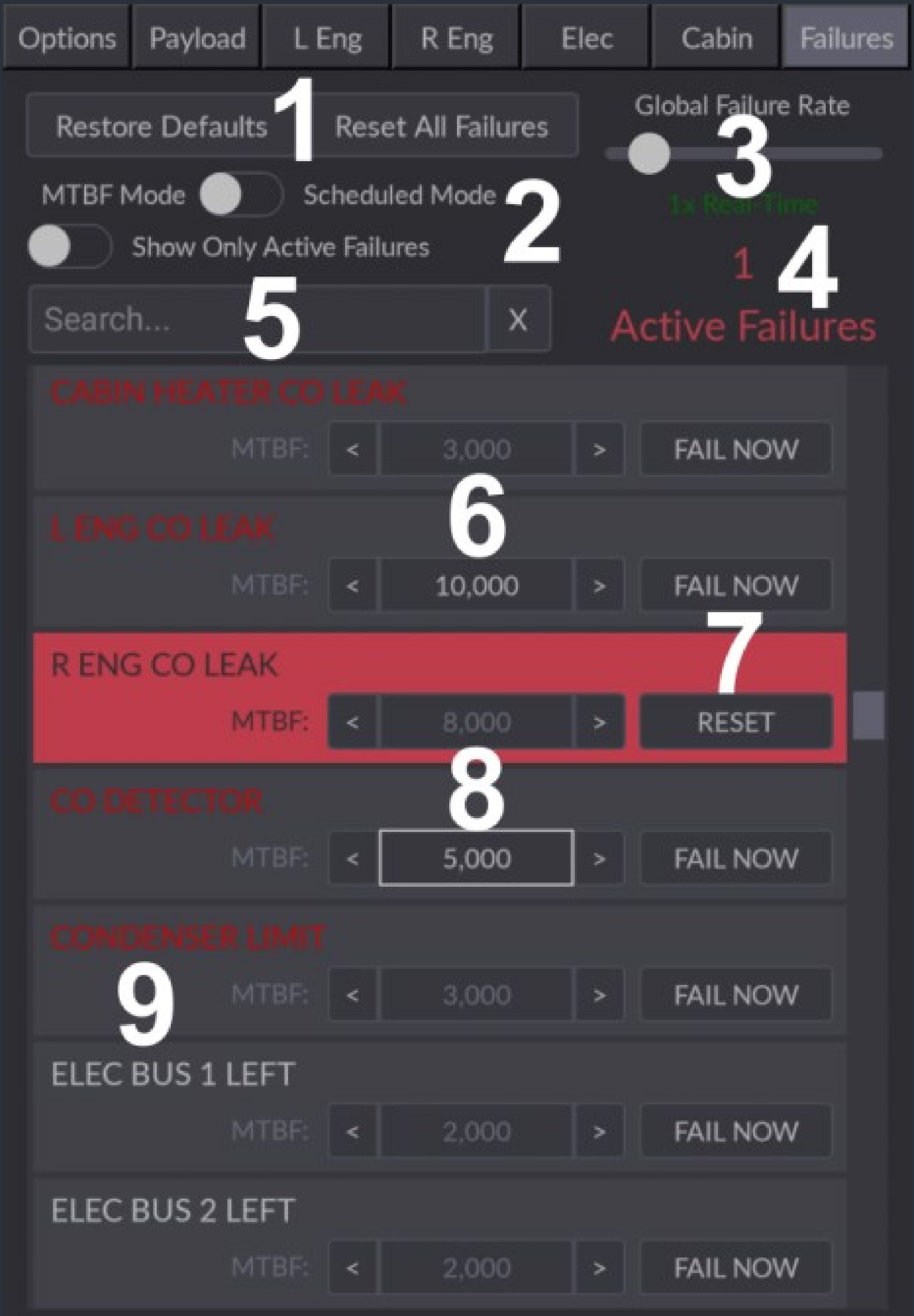
After being triggered by any means, individual failures can be reset by pressing the "RESET" button. Failures can also be triggered manually in this mode by pressing the "FAIL NOW" button.

8. Restore Default MTBF

Clicking on the displayed MTBF value will restore it to the default for that specific component. When the button is grayed out, the component's MTBF is already set to the default value.

9. Failure Names & Color Codes

Failures are color coded into groups. Magenta is used for catastrophic engine failures, red for major systems failures, white for power distribution failures, and cyan for circuit breaker protected electromechanical failures. The failure names as they appear in this list can be used to trigger the failures via any 3rd party software or hardware interface that is capable of sending HTML (H:Events) to the simulator. See the "Failure System HTML Interface" section of this manual for more information.


Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
Restore Defaults
1
Reset All Failures
Global Failure Rate
3
1x Real-Time
MTBF Mode
Scheduled Mode
2
Show Only Active Failures
1
4
Active Failures
Search...
5
X
CABIN HEATER CO LEAK
MTBF: 3,000 FAIL NOW
6
L ENG CO LEAK
MTBF: 10,000 FAIL NOW
7
R ENG CO LEAK
MTBF: 8,000 RESET
8
CO DETECTOR
MTBF: 5,000 FAIL NOW
CONDENSER LIMIT
9
MTBF: 3,000 FAIL NOW
ELEC BUS 1 LEFT
MTBF: 2,000 FAIL NOW
ELEC BUS 2 LEFT
MTBF: 2,000 FAIL NOW

Scheduled Failures

In scheduled failures mode, individual failures can be scheduled to occur within a specific time window after the present time. Failures have a constant probability of occurring between the two times shown, and will occur only after the failure has been armed. This allows for variability in scenario training, while ensuring that a given failure occurs in the desired phase of flight.

1. Restore Defaults & Reset All Failures

The Restore Defaults button can be used to reset all scheduled failure windows to the default. This action requires a confirmation to complete. For instructions on adjusting the scheduled failure time window for individual components see point 6, below. The Reset All Failures button can be used to reset all currently active failures at once.

2. MTBF / Scheduled Mode Switch & Show Only Active Failures

Use the MTBF / Scheduled Mode switch to toggle between the two modes of operation for the failure system. The Show Only Active Failures switch can be used to filter the results of the scrolling failure list to only those that are currently active. This also applies to the results of the search function.

3. Global Failure Rate Slider

The global failure rate has no effect on the rate of failures in the scheduled failure mode; however, it will prevent all failures from occurring when placed in the “No Failures” position.

4. Active Failures

The current number of active failures can be seen at all times below the global failure rate slider. This number is also shown on the systems page of the weather radar display so that the number of current failures can be monitored from the cockpit without the tablet visible.

5. Search Failures

All failures shown in the scrolling list are searchable. Click in the search window and start typing to search. The text entry mode should deactivate automatically a few seconds after you stop typing. When the “show only active failures” option is selected, the search will only return results among the currently active failures.

6. Adjust Time Window

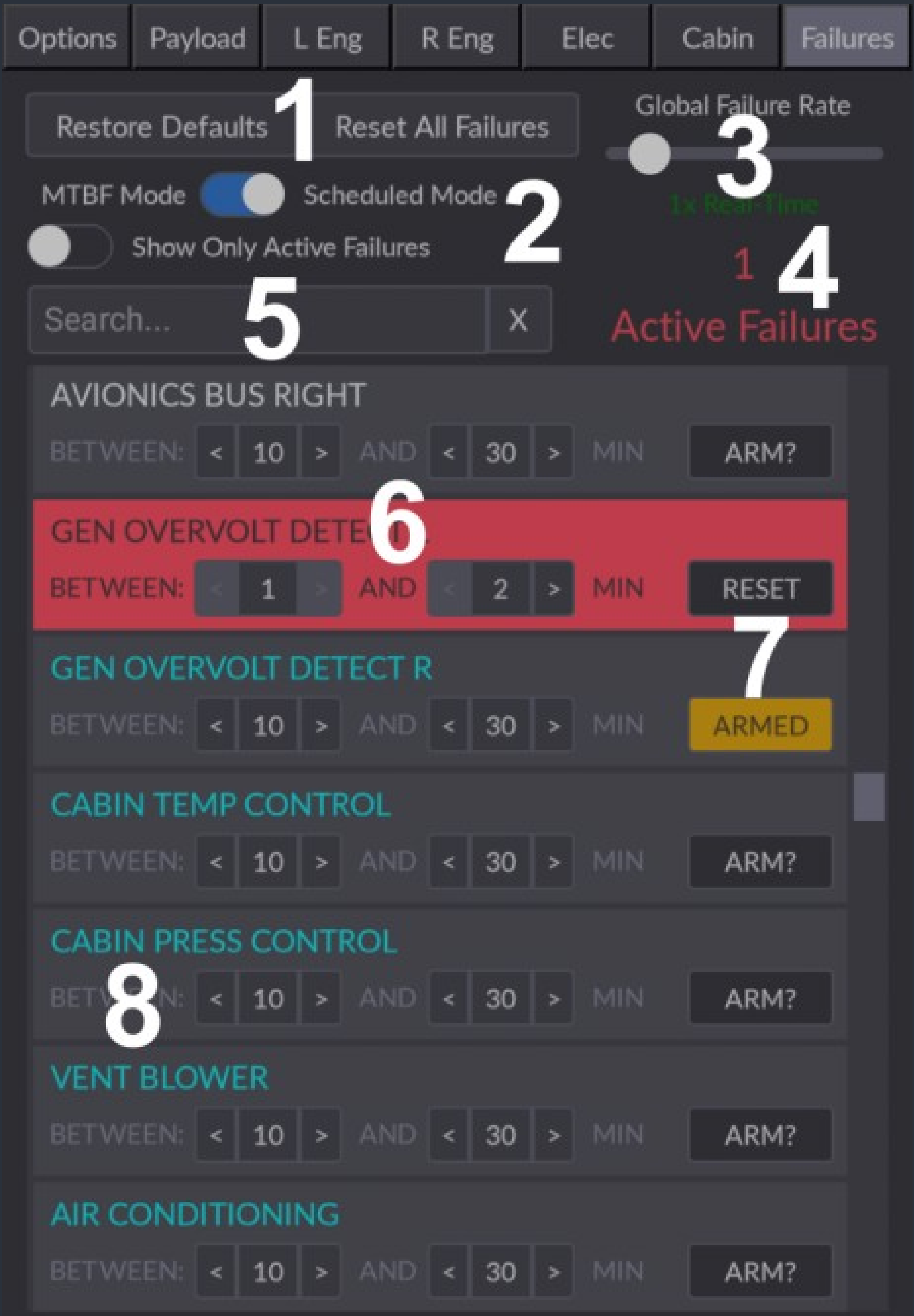
The time window in which a specific failure will occur can be adjusted with the arrow buttons beside the “after” and “before” times. These times are expressed in minutes. The minimum time after which a failure will occur is one minute, and the maximum time before which a failure will occur is ninety minutes. When the time cannot be adjusted up or down as it would exceed the minimum or maximum, or when it is constrained by the other time, the adjustment buttons will be grayed out.

7. Arm or Reset Failure

Clicking the “ARM?” button will arm the failure with the currently selected time window. Once armed, this button will appear in yellow, with the text “ARMED”. Clicking the button again anytime before the failure has occurred will disarm the failure. After the failure has occurred, the button will read “RESET”, and clicking the button will reset the failure, returning it to an unarmed state.

8. Failure Names & Color Codes

Failures are color coded into groups. Magenta is used for catastrophic engine failures, red for major systems failures, white for power distribution failures, and cyan for circuit breaker protected electromechanical failures. The failure names as they appear in this list can be used to trigger the failures via any 3rd party software or hardware interface that is capable of sending HTML (H:Events) to the simulator. See the “Failure System HTML Interface” section of this manual for more information.


Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
Restore Defaults
Reset All Failures
Global Failure Rate
1x Real-Time
MTBF Mode
Scheduled Mode
Show Only Active Failures
Search...
X
1
Active Failures
AVIONICS BUS RIGHT
BETWEEN: 10 AND 30 MIN
ARM?
GEN OVERVOLT DETECT
BETWEEN: 1 AND 2 MIN
RESET
GEN OVERVOLT DETECT R
BETWEEN: 10 AND 30 MIN
ARMED
CABIN TEMP CONTROL
BETWEEN: 10 AND 30 MIN
ARM?
CABIN PRESS CONTROL
BETWEEN: 10 AND 30 MIN
ARM?
VENT BLOWER
BETWEEN: 10 AND 30 MIN
ARM?
AIR CONDITIONING
BETWEEN: 10 AND 30 MIN
ARM?
1
2
3
4
5
6
7
8

Failure System HTML Interface

To facilitate users who wish to initiate failures instantaneously via an external software interface, such as an instructor station, webpage, or tablet interface, access has been provided into the failure system using MSFS's HTML events. Any software that is capable of sending HTML events (also known as H:Vars), is capable of triggering failures without any additional configuration. These failures will appear in the in-cockpit weather radar interface discussed above, and can be reset from the same interface, or by sending the same HTML event again.

This interface allows users to create and share profiles for popular 3rd party interface applications to trigger and reset failures, or even mimic more complex emergency scenarios. Popular software capable of sending HTML events to MSFS include:

- Air Manager
- Axis and Ohs
- Mobiflight
- SPAD.neXt
- FSUIPC
- Many other SimConnect-based interfaces

To trigger or reset any failure in any Black Square aircraft, simply send an HTML event with the prefix "BKSQ_FAILURE_", and the exact name of the failure as it appears in the in-cockpit weather radar interface with spaces replaced by underscores.

For example, to trigger or reset a failure named "L FUEL QTY", the HTML event would be:

>H:BKSQ_FAILURE_L_FUEL_QTY

Depending on your programming environment, be sure to check the exact syntax needed to trigger HTML events. Some graphical programming environments may require you to omit the leading ">" from the event, while others may require this ">" to be expressed as ">", such as in reverse polish notation.

List of Possible Failures

Major System Failures

ENGINE FAILURE
ENGINE FIRE
TURBOCHARGER
TURBOCHARGER BEARING

L MAGNETO
R MAGNETO
L MAGNETO GROUNDING
R MAGNETO GROUNDING
IGNITION SWITCH GROUND
MAIN ALTERNATOR
AC ALTERNATOR
PROP GOV
ENG DRIVEN OIL PUMP
ENG DRIVEN FUEL PUMP
VACUUM PUMP
VACUUM PUMP PARTIAL
PITOT BLOCKAGE
STATIC BLOCKAGE
L BRAKE
R BRAKE
L FUEL LEAK
R FUEL LEAK
GEAR INDICATOR N
GEAR INDICATOR L
GEAR INDICATOR R
CO LEAK
CO DETECTOR
PILOT DOOR LATCH
COPILOT DOOR LATCH
BAGGAGE DOOR LATCH
OXYGEN LEAK

Breaker Protected Failures

STARTER MOTOR
FLAP MOTOR
FLAP INDICATOR
GEAR MOTOR
GEAR SELECTOR WARNING
PANEL MISCELLANEOUS
STALL WARNING
CYLINDER TEMP
OIL TEMP
VOLTAGE REGULATOR
ALTERNATOR FIELD
ENGINE MONITOR
FUEL QUANTITY L
FUEL QUANTITY R
TURN COORDINATOR
FUEL PUMP
PITOT HEAT
BEACON LIGHT
NAV LIGHTS
LANDING LIGHTS
STROBE LIGHT
INSTRUMENT LIGHTING
AVIONICS LIGHTING
CIRCUIT BREAKER LIGHTS
PILOT READING LIGHT
READING LIGHTS
STEP LIGHTS
BAGGAGE LIGHT
AVIONICS PANEL
COM 1
COM 2
MC60 NAV 1
KI209 NAV 2
ILS400 NAV 3
RNAV511
ADF 31A
DME UDI4
TRANSPONDER
STORMSCOPE
AUDIO PANEL
ALTITUDE ENCODER
CLOCK MEMORY
ALTITUDE SELECTOR
AP CONTROLLER
AP PITCH TRIM
AC COMPRESSOR
AC BLOWER

Miscellaneous Systems

Audible Warning Tones

This version of the 114 comes equipped with several warning tones to alert the operator to important configuration changes, or potentially dangerous situations. These tones can be disabled by pulling the circuit breaker for the respective tone's underlying warning system. These tones are as follows:

- Autopilot Disconnect Tone: Whenever the autopilot is disconnected via the autopilot master push button, the control yoke mounted disconnect buttons, or automatically disconnects when overpowered, a warning beep will sound.
- Stall Warning Horn: When the aircraft is within approximately 5-10 knots of stalling speed, a constant buzzer warning horn will sound.
- Gear Configuration Warning Horn: When the throttle lever is reduced below approximately 20% of its travel, or the flaps are placed in their landing configuration, and the landing gear has not been deployed, a ringing bell (like a telephone) will be heard.
- Carbon Monoxide Detector: When an engine or its exhaust systems becomes compromised, it is possible for poisonous gas to leak into the cabin of the aircraft. When this colorless, odorless, gas is present, a beeping alarm will sound. The alarm will continue to sound as long as the gas is present. Follow the checklists for Carbon Monoxide leaks, and close (push) the cabin heating pull handle immediately.
- Engine Cooling Ticking: The ticking sound an engine makes after shutdown while it cools and contracts is modeled in this simulation. This sound can be used to roughly estimate when temperatures are high enough in the engine cowling to vaporize fuel and contribute to vapor lock.

NOTE: Have you ever noticed that the wind sound in all other MSFS aircraft is erroneously based on true airspeed rather than indicated airspeed? This makes wind noise during high altitude cruise far too loud. It's likely the result of there being no persistent indicated airspeed simulation variable that is not affected by pitot-static failures. All Black Square aircraft now have wind sounds based on indicated airspeed, which makes them much more enjoyable to fly at high true airspeed.

VOR & ADF Signal Degradation

Unlike in the real world, navigation receivers in Microsoft Flight Simulator produce only ideal readings. Signal strength is not affected by distance, altitude, terrain, or atmospheric conditions. When a station is out of range, the signal is abruptly switched off. This is unrealistic, and does not give the feel of navigating with the physical systems of the real aircraft.

All Steam Gauge Overhaul and Standalone Black Square aircraft solve this problem by providing variables for VOR and ADF indications with distance and height above terrain based signal attenuation and noise. This noise is mathematically accurate for the type of signal (phased VHF for VOR, and MF for NDB), and adheres to the international standards for station service volumes. Combined with the two-pole filtering and physics of the instrument's needles in the cockpit, this creates a very convincing facsimile of the real world instrument's behavior. The To-From indicators of the VOR instruments will even exhibit the fluttering that is characteristic of the "cone of confusion" directly over the ground-based stations that pilots are taught to recognize during instrument training

Engine Normal/Abnormal Operation Soundscape

This Black Square aircraft features several new "sound layers", which combine to produce subtle or pronounced changes to the engine sounds based on operating conditions.

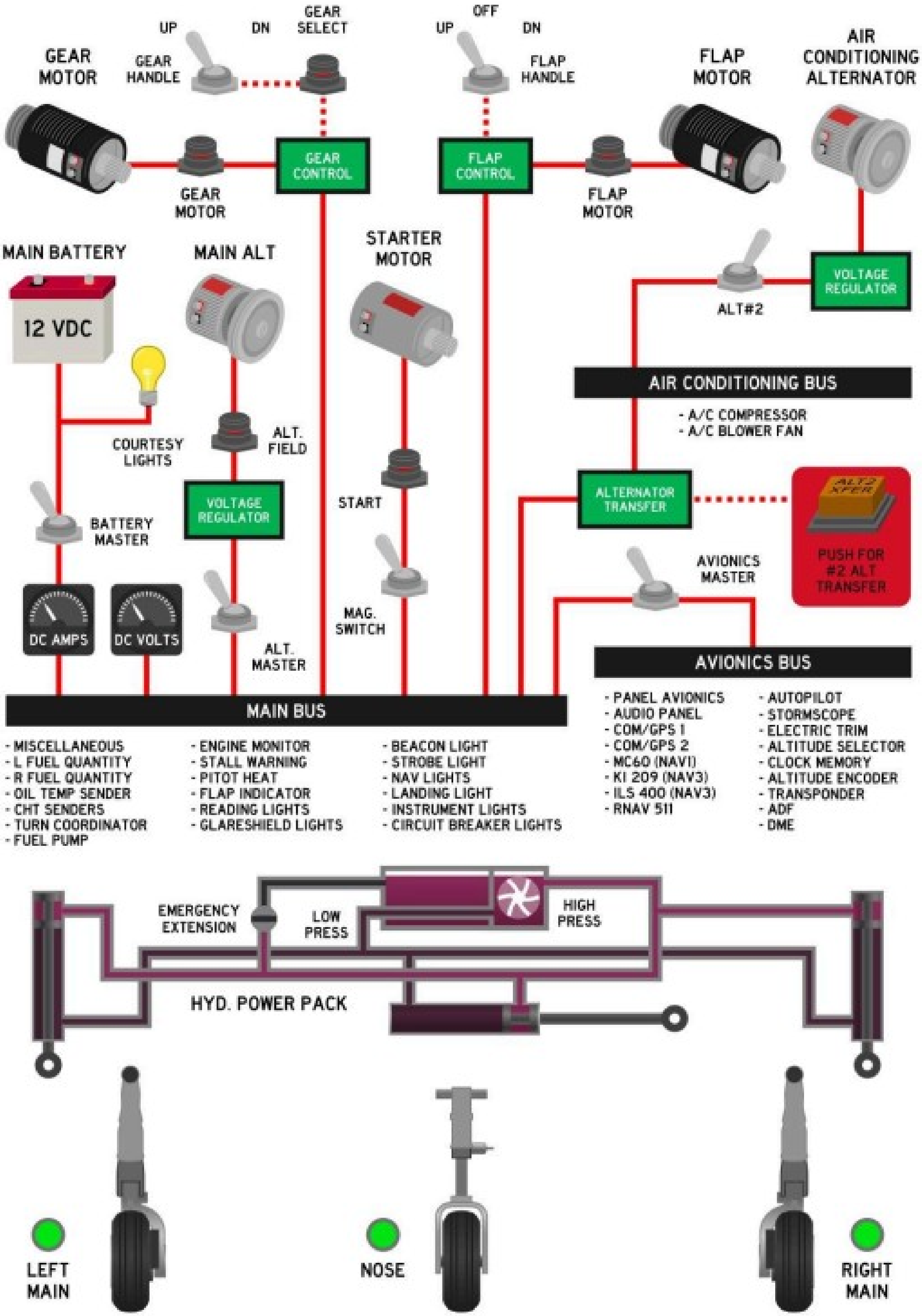
This includes conditions such as: viscous oil, cold cylinders, overheating cylinders, sparkplug fouling, incomplete combustion, knocking, detonation, mechanical damage, engine failure, ceased engine, engine fire, turbocharger bearing failure, and cracked exhaust shrouds.

Overview Electrical & Hydraulic Landing Gear Schematics

The Commander 114's electrical system is simple, consisting of only two main buses, as is typical for aircraft of similar size. The turbonormalized aircraft incorporates a third bus for powering the air conditioning system. This third bus can be used to power the other two in the event of an emergency.

Black Square's Commander 114 also is the first to feature a hydraulic gear simulation, which can be monitored from the Live Schematic page of the tablet visualizer. For more information on the hydraulic gear simulation, see the "Hydraulic Landing Gear Simulation" section of this manual.

NOTE: The aircraft's electrical system can be monitored via the electrical page of the tablet interface, where a schematic nearly identical to this one is presented. For more information on the tablet's engine pages, see the "Live Schematic Page" section of this manual.


GEAR MOTOR
GEAR HANDLE
UP
DN
GEAR SELECT
OFF
UP
DN
FLAP HANDLE
FLAP MOTOR
AIR CONDITIONING ALTERNATOR
GEAR CONTROL
GEAR MOTOR
FLAP CONTROL
FLAP MOTOR
MAIN BATTERY
12 VDC
MAIN ALT
STARTER MOTOR
ALT#2
VOLTAGE REGULATOR
AIR CONDITIONING BUS
- A/C COMPRESSOR
- A/C BLOWER FAN
COURTESY LIGHTS
ALT. FIELD
START
ALTERNATOR TRANSFER
ALT2 XFER
PUSH FOR #2 ALT TRANSFER
BATTERY MASTER
VOLTAGE REGULATOR
AVIONICS MASTER
DC AMPS
DC VOLTS
MAG. SWITCH
ALT. MASTER
AVIONICS BUS
MAIN BUS
- MISCELLANEOUS
- L FUEL QUANTITY
- R FUEL QUANTITY
- OIL TEMP SENDER
- CHT SENDERS
- TURN COORDINATOR
- FUEL PUMP
- ENGINE MONITOR
- STALL WARNING
- PITOT HEAT
- FLAP INDICATOR
- READING LIGHTS
- GLARESHIELD LIGHTS
- BEACON LIGHT
- STROBE LIGHT
- NAV LIGHTS
- LANDING LIGHT
- INSTRUMENT LIGHTS
- CIRCUIT BREAKER LIGHTS
- PANEL AVIONICS
- AUDIO PANEL
- COM/GPS 1
- COM/GPS 2
- MC60 (NAV1)
- KI 209 (NAV3)
- ILS 400 (NAV3)
- RNAV 511
- AUTOPILOT
- STORMSCOPE
- ELECTRIC TRIM
- ALTITUDE SELECTOR
- CLOCK MEMORY
- ALTITUDE ENCODER
- TRANSPONDER
- ADF
- DME
EMERGENCY EXTENSION
LOW PRESS
HIGH PRESS
HYD. POWER PACK
LEFT MAIN
NOSE
RIGHT MAIN

Using the RNAV511 Navigation System

The Concept

When most pilots hear the acronym “RNAV”, they probably think of the modern RNAV, or GPS approach type, or precision enroute navigation for airliners; however, long before this type of navigation, there was the onboard RNAV computer. This 1980’s era piece of early digital computer technology allowed pilots to fly complex routes with precision away from traditional ground-based radionavigation sources, such as VOR’s and NDB’s, and fly much shorter routes as a result. As the technology improved, even an early form of RNAV approaches became possible. Before GPS, the onboard RNAV computer allowed for GPS-like flying in a sophisticated package of digital electronics, marketed towards small to mid-size general aviation aircraft.

How it Works

To understand how the RNAV computer works, consider the utility of being able to place a ground-based VOR antenna anywhere you like along your route. If your destination airport does not have a radionavigation source on the field, you could simply place one there, and fly directly to or from it. You could also place an antenna 10 miles out from a runway to set up for a non-precision approach. You could even place an antenna on the threshold of a runway, set your HSI course to the runway heading, and fly right down to the runway with lateral guidance; in fact, this is how an ILS receiver works. The RNAV511 Navigation System allows the user to “move” a virtual VOR antenna anywhere they like within the service volume (area of reliable reception) of an existing VOR antenna.

“Moving” a VOR

To “move” a VOR antenna to somewhere useful, we must know how far from the tuned VOR station we would like to move it, and in what direction. These quantities are defined by a nautical mile distance, and a radial upon which we would like to move the antenna. For example, to place a virtual VOR 10 miles to the Southwest of an existing station, we would need to enter the station's frequency, a displacement radial of 225°, and a displacement distance of 10.0 nm. Once we have entered this data into the RNAV computer, the resulting reading from this new virtual VOR station will be indicated on our localizer in the same manner as any other VOR, assuming the localizer source selector switch is set to "RNAV", and not "NAV1/GPS". This means that you can rotate omni-bearing selector knob to any position you like, to fly to/from from the new virtual station on any radial or bearing, so long as you stay within the service volume of the tuned VOR station.

Data Entry

Now that you understand the basics of RNAV navigation, let's learn how to enter the data from above into the RNAV511. Firstly, the RNAV511 does not have its own navigation receivers. Instead, waypoint 1, and waypoint 2 (left and right sides of the unit) are driven by the NAV1 receiver in the aircraft, whether this be the MX-170B's, GNS 530, or GTN 750. The first step to flying an RNAV course is tuning the required frequencies in the navigation radio. Once the navigation radio is tuned, the desired radial and distance offsets can be entered using the sixteen thumbwheels on the RNAV551. The radial and distance thumbwheel pair on the left of the unit pertains to waypoint 1, and the right pair pertains to waypoint 2. If invalid data is momentarily entered on the thumbwheels (such as radials greater than 360°), the unit's 7-segment displays will flag with dashes.

NOTE: The data entered into these thumbwheels will be saved and recalled on your next flight.

Modes of Operation

Pressing the large push button labeled "RNAV ON" will apply power to the unit. As configured in this aircraft, the "RNAV ON" button can be left depressed at all times, as it mainly exists to allow "passthrough" for navigation signals in other aircraft configurations.

The second large push button, labeled "VOR DME" toggles the RNAV511's 7-segment displays between RNAV mode (unpressed), and VOR DME mode (pressed). In RNAV mode, the left display shows the bearing to the virtual VOR, and the right display shows the distance in nautical miles. When the VOR DME button is pressed, these displays show the radial upon which the aircraft sits, and the distance from the actual tuned VOR station. The state of this button has no effect on the lateral deviation information displayed on the connected localizer.

While holding the small black "KTS MIN" button, the 7-segment displays will show the calculated slant speed of the aircraft relative to the virtual VOR, and the minutes until arriving at the virtual VOR station.

The unit possesses one navigation radio input, and two sets of thumbwheels so that one set can be used for standby data entry while the other is in use. The waypoint in use is selected by pressing the illuminated cylindrical push buttons at the top of the unit. The currently active waypoint's corresponding button will illuminate when it is active.

Other Possible Uses

Another possible use for the RNAV Navigation System is simply determining your distance away from an arbitrary point within a VOR service volume. This can be useful for many applications, such as ensuring that you remain clear of controlled airspace, or a temporary flight restriction (TFR). It could also be used for maintaining a certain distance away from a coastline, or flying circles around a target on the ground. A further possible use for the RNAV Computer is enhanced VOR "Fencing", such as for avoiding special use airspace, military operations areas, international airspace borders, or Air Defense Identification Zones (ADIZ), or descent planning, or radionavigation switchover points. Finally, one of the most useful applications of the RNAV System is in establishing holding patterns. Before GPS, holding pattern entry and flight could be even more confusing than it already is today. With an RNAV computer, a holding point entry waypoint can be placed anywhere, and flown around like there is a purpose-placed ground-based transmitter at the entry point.

Flying an RNAV Course with the Autopilot

The autopilot will only use the RNAV511 as a navigation source when no-GPS is selected as COM1. Toggle the "LOC SRC" (localizer source) rocker switch to view RNAV deviation on the MC60 localizer, and press the "NAV GPS" button on the MD41 to select RNAV deviation as the autopilot source, indicated by an adjacent "RNAV" annunciator in green. Then, select the desired course with the MC60's omni-bearing select knob.

Recommended Skills

1. Direct Route Navigation
2. Parallel Flight along Airways
3. Location & Distance from Waypoints
4. Enhanced Geo-Fencing
5. Maintaining Distance from Ground Points
6. Holding Pattern Entries
7. Fly a Rectangular Course

Direct Flight to Airport Tutorial

Lastly, as a first illustration of the power within the RNAV navigator, follow these steps to fly from any location within the chosen VOR service volume directly to an airport of your choosing without the need for any colocated navigational aid.

1. Locate the nearest VOR station to your desired destination, and its frequency, radial, and distance from the destination airport. While other station frequencies, radials, and distances can be found on approach, arrival, and departure charts, the easiest place to start is often with a mobile app or website that lists nearby stations along with other airport information. Examples include: ForeFlight, Garmin Pilot, FltPlan Go, SkyVector.com, and Airnav.com. These radials and distances can also be calculated

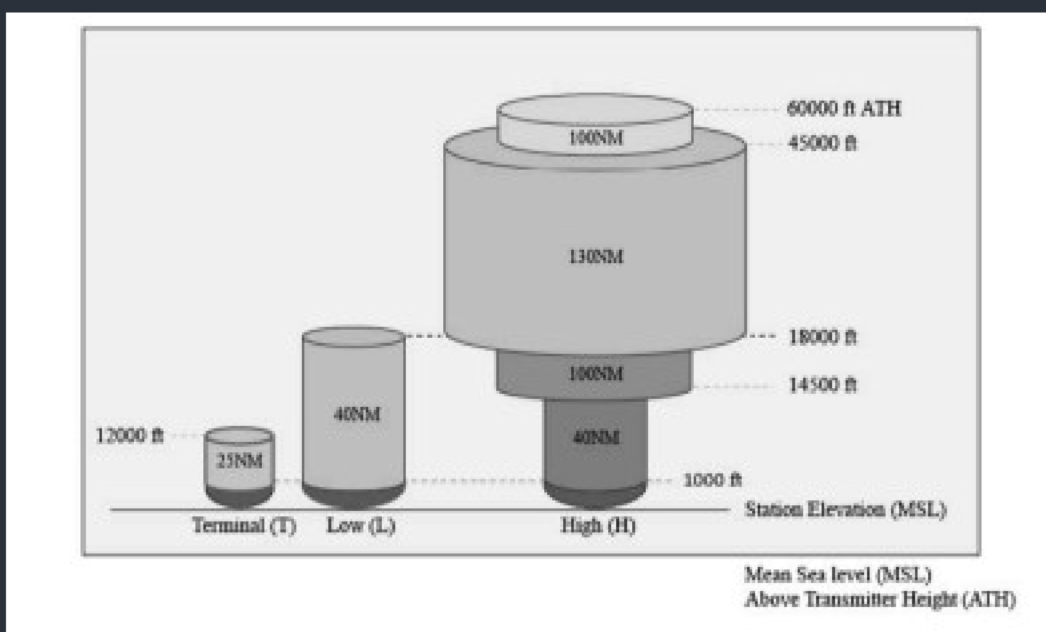
during preflight planning by hand with a plotter, or with most flight planning software applications. In this case, we will use SkyVector.com to search for a destination airport, in this case, Beverly Airport in the US state of Massachusetts.

Nearby Navigation Aids

ID	Name	Freq	Radial / Range		ID	Name	Freq	Bearing / Range	
LWM	LAWRENCE	112.50	154°	12.3	**OW**	STOGE	397	198°	29.4
BOS	BOSTON	112.70	029°	14.0	**MJ**	FITZY	209	302°	31.9
NZW	SOUTH WEYMOUTH	133.40	017°	26.1	**ESG**	ROLLINS	260	005°	38.4
MHT	MANCHESTER	114.40	145°	26.3	**CO**	EPSOM	216	323°	39.9

In the fourth block of data, we are presented with four nearby VOR stations (on the left), all providing good coverage to Beverly Airport. To assess whether or not a VOR provides good service to your destination, reference the following chart for VOR service volumes published by the Federal Aviation Administration. For the vast majority of VOR stations, reception will be acceptable within 40 nm of the station while in-flight, and is usually the only volume worth considering for low altitude general aviation flights.

For this example, we will choose the nearest VOR at Lawrence Airport, (LWM). This VOR has a frequency of 112.50 Mhz, a radial to Beverly Airport of 154°, and a distance of 12.3 nm. These are all three pieces of data that we need to fly directly to Beverly.



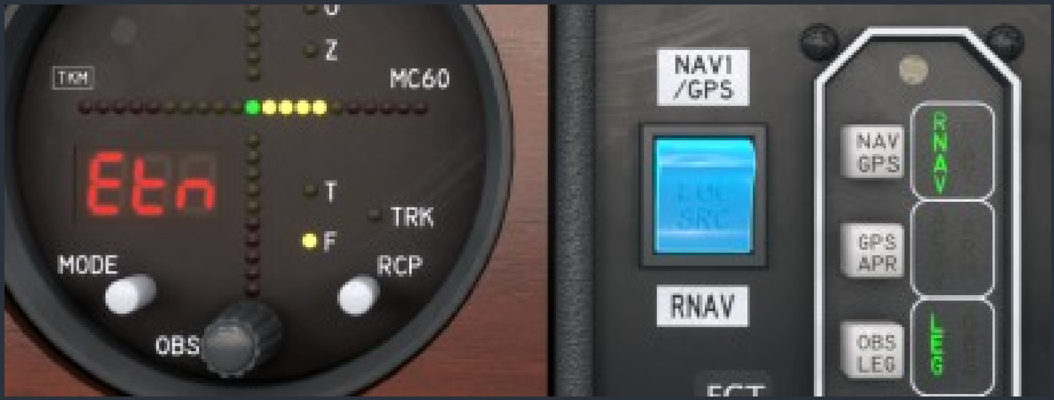
2. First, we will use the rotary knobs on the NAV1 MX-170B (or any other NAV1 navigation unit) to tune the desired frequency of 112.5 Mhz. For tips on using the MX-170B, see the “TKM MX-170B (Com1/Com2)” section of this manual.

3. Once our desired frequency has been set we will enter our radial and offset information into the RNAV511. Rotate the four leftmost thumbwheels one at a time to enter the radial 154.0. The black thumbwheels are whole digits, while the white thumbwheels are tenths of a digit.

4. When our desired radial is set, enter our desired distance offset of 12.3 nm into the four distance thumbwheels using the same method as above.

5. Data entry is now complete. Make sure the "VOR DME" push button is not depressed, so the RNAV bearing and distance information we're interested in will show on the 7-segment displays.

6. Lastly, make sure the "LOC SRC" rocker switch is set to RNAV; otherwise, we will not see the RNAV information displayed on the localizer.



7. To fly directly to the displaced VOR waypoint at our destination airport, simply rotate the omni-bearing selector (OBS) knob on your localizer, as you would to fly to a VOR, and follow the CDI needle with a TO indication. Countdown the distance and time remaining until arriving at your destination on RNAV511's 7-segment displays. When you have arrived, the TO/FROM indication will reverse, and DME distance will approach zero, just like with a conventional VOR receiver. Even at distances of 40 nm away from the actual VOR station, this system is usually precise enough to place your route of flight inside the airport perimeter fence at your destination.

8. To check your position relative to the actual VOR station you are receiving at any given time, toggle the "VOR DME" push button. The 7-segment displays will now show your actual distance from the VOR station, and the radial upon which the aircraft sits. Toggle the "VOR DME" button again to return to viewing RNAV waypoint information.

Using the JPI EDM-800 Engine Monitor

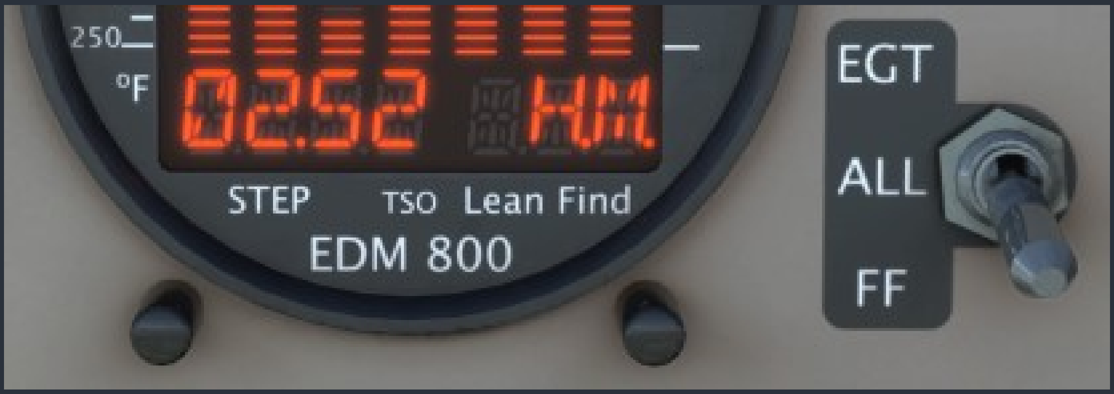
The Black Square Commander 114 is equipped with the most complete implementation of the EDM-800 engine monitor to appear in a flight simulator. The EDM-800 is one of the more common pieces of engine monitoring equipment found in general aviation aircraft, and is often underestimated in its power and utility due to its compact size. Aircraft owners would be wise to fully understand the information at their fingertips via the unit's trend monitoring to increase engine longevity and detect changes that may result in a catastrophic failure. In normal operation, the efficient and safe operation of a high performance engine is one of the most important skills that a pilot should learn when advancing from a simple training aircraft to a more complex long-distance cruising aircraft. For a complete understanding of the unit's functionality, please see the "More Information on Operation" section of this manual for training videos and operating manuals. The EDM-800 has two push buttons that provide all control of the unit; however, several functions require pressing both buttons at once. This is accomplished in MSFS via an invisible button at the bottom of the unit's bezel, between both buttons. The single engine EDM-800 is very similar in appearance and operation to the twin engine EDM-760, which is featured in the Baron Professional and Piston Duke.

Static Displays

Upon startup, the EDM-800 will perform a self-test and illuminate every segment of the display. At the top of the unit will be a static 7-segment display indicating the approximate horsepower produced by the engine. To the right of this static display will be either a “C” or “F” to indicate the temperature units that will be displayed. To toggle between units, press both of the unit’s control buttons at once. Below these static displays is one more static display with numerals 1-6, for each cylinder of the aircraft, and a final letter “T”, if the aircraft is turbocharged. These are column headers for each cylinder’s temperature bar, which will be discussed below. Lastly, two 14-segment displays at the bottom of the unit will display many different types of information, units, alarm ID’s, and more.

Data Display

When the unit is powered on, the data display will be in manual mode for 10 minutes, at which time, it will enter automatic mode. In manual mode, the user can cycle through all available data by tapping the “STEP” button. To cycle through data in the opposite order to save oneself the trouble of cycling through all the data again, hold the “STEP” button for three seconds. To enter manual mode, tap “STEP” at any time. To enter automatic mode, tap “LEAN FIND” and then tap “STEP”. When data associated with a particular cylinder is being displayed, a dot below that cylinder’s header number will be displayed. When oil temperature or turbine inlet temperature (TIT) (in turbocharged aircraft only) is being displayed, a dot will be shown above the last column on the right. These conventions also apply in automatic mode, and when an alarm is being displayed. A switch to the right of the unit marked “EGT, ALL, FF”, allows the user to switch between groups of data to be displayed in automatic and manual modes. A summary of these groups, their data, and units follows.



Select Switch	Description	Example		Requirements
EGT, ALL	Main Bus Voltage	25.7	BAT	None
EGT, ALL	Outside Air Temp.	75	OAT	None
EGT, ALL	Induction Air Temp.	150	IAT	Turbocharger
EGT, ALL	Compressor Discharge Temp.	400	CDT	Turbocharger
EGT, ALL	Carburetor Temp.	-28	CRB	Carburetor
EGT, ALL	Difference between hottest and coldest CHT.	52	DIF	None
EGT, ALL, FF	Propeller RPM and Manifold Pressure	2520	23.8	None
ALL, FF	Fuel Remaining	41.6	REM	None
ALL, FF	Fuel Required to next GPS waypoint	12.1	REQ	Compatible GPS
ALL, FF	Fuel Remaining at next GPS waypoint	29.5	RES	Compatible GPS
ALL, FF	Nautical Miles per Gallon	11.5	MPG	Compatible GPS
ALL, FF	Time to Empty (endurance in hours.minutes)	02.35	H.M.	None
ALL, FF	Fuel Flow Rate	16.1	GPH	None
ALL, FF	Total Fuel Used since unit startup	11.8	USD	None
EGT, ALL	EGT & CHT (cycles through all cylinders)	1412	392	None
EGT, ALL	Turbine Inlet Temp. & Fuel Flow	1465	16.1	Turbocharger
EGT, ALL	Oil Temp.	161	OIL	None
EGT, ALL	Fastest Cooling Cylinder Head (°/min)	-25	CLD	None

Temperature Columns

When the unit is in manual or automatic mode, the majority of the display will be occupied by the seven temperature columns. The six cylinder columns have two modes of operation, percent view, and normalized view. The unit defaults to percent view at startup, and normalized view can be activated by holding the “LEAN FIND” button for three seconds, which will illuminate “NRM” to the left of the horsepower display. In percent view, each column’s height represents that cylinder’s exhaust gas temperature (EGT) from one-half redline value, to redline value. The same scale applies to the turbine inlet temperature or oil temperature being displayed in the seventh column. Each of the six cylinder columns can also display cylinder head temperature (CHT), on a fixed Fahrenheit scale, inscribed on the bezel of the unit, from 250°F to 450°F. The CHT will be displayed by either a single lit segment in the column when

EGT is below CHT, or a single unlit segment when EGT is greater than CHT. When this scale is ambiguous, such as when the CHT and EGT column heights match, the single segment will blink continuously. In the normalized view, each column's height is set to exactly half of the total available column height, and all changes in EGT are displayed relative to the temperature they possessed when you activated the normalized view. Percent view should be used for most normal operation, and normalized view should be used during power level changes in-flight, and when troubleshooting a problem. The seventh column will display the oil temperature on a percent scale only when a turbocharger is not installed, otherwise, TIT will be displayed with the column, and oil temperature will be displayed as the single segment. The results of activating normalized view can be seen below.

Lean Find Mode

Tapping the "LEAN FIND" button will activate Lean Find mode, an intelligent engine leaning optimization feature that will help you optimally lean the engine's mixture for best power, or best economy. When Lean Find mode is activated, "LEAN R" will be shown in the data display by default to indicate that the selected leaning method is rich of peak (ROP). To select lean of peak (LOP) leaning, hold both control buttons for three seconds until "LEAN L" is shown. This is the only time the leaning method can be toggled.

Both methods of leaning begin by “pre-leaning” the engine to approximately 50°F (28°C) EGT rich of peak on any cylinder. After waiting for temperatures to stabilize, begin leaning the engine. When a dot begins flashing above one of the cylinder columns to indicate the hottest cylinder, Lean Find mode is now armed, and an approximately 15°F (8°C) increase of average EGT has been observed.

NOTE: For your convenience while leaning, the friction lock knob located on the right of the throttle quadrant can be used to increase the fidelity of mixture control adjustments via the mouse wheel. Roll the friction lock clockwise (drag up) to make very fine adjustments to the mixture control. Use of this feature, or hall-effect based hardware controls, will be almost necessary for accurate leaning while at high density altitudes.

Leaning Rich of Peak

Leaning “Rich of Peak”, as the name suggests, means operating the engine at mixture settings richer than peak EGT, usually in search of the most power from the engine. This is also known as “leaning for best power”, and can increase power by as much as 15% from peak values.

After completing the pre-leaning procedure above, continue leaning the mixture until one entire column begins flashing, and “LEANEST” is shown on the data display. This means that the peak EGT for the first cylinder to peak has been detected. Afterwards, the left side of the data display will show degrees relative to peak. Negative numbers indicate a mixture setting richer than peak. This configuration can be further monitored by pressing the “LEAN FIND” button, which will show the EGT of the first cylinder to peak, and the fuel flow relative to peak. Positive fuel flows indicate operating rich of peak.

The final step is to enrich the engine’s mixture setting to the desired EGT for best power cruise. At cruise power settings, this point is approximately 50-100°F (28-56°C) below peak EGT for best power. Keep in mind that this lower EGT results from a higher mixture setting, as opposed to LOP operation. This can be accomplished in either display mode, either by adjusting the raw EGT value, or by the relative EGT offset from peak. For rich of peak operation, the relative EGT should be negative, and the relative fuel flow should be positive. To return to automatic mode, tap “STEP” once.

Leaning Lean of Peak

Leaning “Lean of Peak”, as the name suggests, means operating the engine at mixture settings leaner than peak EGT. This results in significantly lower fuel consumption, and extended range. This is also known as “leaning for best economy”, and can decrease fuel consumption by as much as 30% from peak values, for only a 5-10% loss in airspeed.

After completing the pre-leaning procedure above, continue leaning the mixture until one entire column begins flashing, and “RICHEST” is shown on the data display. This means that the peak EGT for the last cylinder to peak has been detected. The bar graph in LOP mode is shown in the form of a descending histogram to differentiate it from ROP mode. The left side of the data display now will show degrees relative to peak. Positive numbers indicate a mixture setting leaner than peak. This configuration can be further monitored by pressing the “LEAN FIND” button, which will show the EGT of the last cylinder to peak, and the fuel flow relative to peak. Negative fuel flows indicate operating lean of peak.

The final step is to lean the engine’s mixture setting to the desired EGT for best economy cruise. At cruise power settings, this point is approximately 25-50°F (14-28°C) below peak EGT for best economy. Keep in mind that this lower EGT results from a lower mixture setting, as opposed to ROP operation. This can be accomplished in either display mode, either by adjusting the raw EGT value, or by the relative EGT offset from peak. For lean of peak operation, the relative EGT should be positive, and the relative fuel flow should be negative. To return to automatic mode, tap “STEP” once.

NOTE: While lean of peak operation is generally accepted as a good method to reduce fuel burn and increase engine longevity, most engine manufacturers only provide guidance for rich of peak operation. This means that the performance data in the aircraft’s operating handbook will most closely be reflected by rich of peak operation. It should also be noted that excessively lean mixtures can cause the engines to run rough, or become damaged. Lastly, it is more important to remember to enrichen the mixture during descent when operating lean of peak, as the mixture may become too lean for combustion otherwise.

Alarms

The EDM-800 is constantly monitoring all available engine and fuel flow parameters, and will activate an alarm to warn the operator of a potentially dangerous situation. When an alarm is activated, regardless of the current operational mode, the data display will show one of the alarm codes and associated values enumerated below, and blink continuously. An engine monitor alarm LED will also illuminate and flash continuously on the glareshield annunciator panel. To cancel the active alarm for ten minutes, tap the “STEP” button. To cancel the active alarm for the duration of the flight until the engine monitor is rebooted, hold the Lean Find button for three seconds. Since many simultaneous alarm conditions may exist at once, each alarm has a priority, allowing the most severe condition to be displayed first. The following list of alarm codes is listed in priority order, with the most severe condition listed first.

Description	Example	Low Limit	High Limit
High Cylinder Head Temp.	552 CHT		450 °F / 230 °C
High Exhaust Gas Temp.	1685 EGT		1650 °F / 900 °C
High Oil Temp.	240 OIL		230 °F / 110 °C
High Turbine Inlet Temp.	1781 TIT		1,650 °F / 900 °C
Low Oil Temp.	86 OIL	90 °F / 32 °C	
High Cylinder Head Cooling Rate	-84 CLD	-60 °F/min / -33 °C/min	
High Exhaust Gas Temp. Difference	587 DIF		500 °F / 280 °C
Battery Voltage (24V system)	23.4 BAT	24.0V	32.0V
Battery Voltage (12V system)	11.6 BAT	12.0V	16.0V
High Manifold Pressure	33.2 MAP		32.0 inHg
Low Fuel Quantity Remaining	LO FUEL	10 gal	
Low Endurance Remaining	LO TIME	45 min	

Normal Checklists

*Turbonormalized Model Only

Before Starting Engine

Preflight Inspection	Complete
Control Lock	Remove
Seats & Seatbelts	Secure
Cabin Doors	Latched
Parking Brake	Set
Avionics Master	Off
Circuit Breakers	All In
Electrical Switches	All Off
Alternate Static Air	Normal
Landing Gear	Down
Alternate Air	Push (Off)
*Oxygen Pressure	1550-1850 psi
Elevator Trim	Neutral
Rudder Trim	Neutral
Emergency Gear Valve	Handle Up
Throttle	Closed
Propeller	High RPM
Mixture	Full Rich
Cowl Flaps	Open
*Standby Alternator	Off
*Air Conditioner	Off
CO Detector	Test
Fuel Selector	Both
Beacon Light	On
Standby Vacuum	Push (Off)
Pitch Trim	Off
Battery Master	On
Voltmeter	11V Minimum
Fuel Quantities	Check

Engine Start (Cold)

Mixture	Full Rich
Propeller	High RPM
Throttle	Full Open
Fuel Pump	On for 2-3s
Fuel Flow	Greater than 5 GPH
Fuel Pump	Off
Throttle	Open 1/4in
Propeller Area	Clear
Starter	Engage
Throttle	800-1000 RPM

Engine Start (Hot)

Mixture	Cut-Off
Propeller	High RPM
Fuel Pump	On for 10-20s
Fuel Pump	Off
Mixture	Full Rich
Throttle	Full Open
Fuel Pump	On for 2-3s
Fuel Flow	Greater than 5 GPH
Fuel Pump	Off
Propeller Area	Clear
Starter	Engage
Throttle	800-1000 RPM
If No Start...	Repeat

Engine Start (Flooded)

Mixture	Cut-Off
Propeller	High RPM
Throttle	Full Open
Propeller Area	Clear
Starter	Engage
Throttle	Reduce Until Start
Mixture	Full Rich
Throttle	800-1000 RPM

After Starting

Oil Pressure	Increase in 30s
Alternator	On
Ammeter	Charging
Voltmeter	13-16V
Engine Instruments	Check
Lights	As Required
Avionics	On
Stormscope	On
Altimeter	Set
Directional Gyro	Set to Magnetic
Cabin Vent & Heat	As Desired
*Air Conditioning	As Desired
Mixture	Lean for Taxi
Parking Brake	Release
Brakes	Check
Nose Wheel Steering	Check

Runup

Parking Brake	Set
Flight Controls	Free & Correct
Flaps	Fully Cycle
Elevator Trim	Neutral
Rudder Trim	Neutral
Mixture	Full Rich
Throttle	2000 RPM
Check Magnetos	175 RPM Drop Max
Exercise Propeller	To 300 RPM Drop
Alternate Air	Test
Gyro Suction	Green
Throttle	Idle
Engine Persists	600-700 RPM
Standby Vac	Pull On
Vacuum Section	Note Increase

Standby Vac	Push Off
Pitch Trim	On
Electric Trim	Exercise
Heading Bug	30 Degrees Left
Autopilot Heading	Engage
Yoke Movement	Observe
Heading Bug	30 Degrees Right
Yoke Movement	Observe
Autopilot Disconnect	Press Off
Elevator Trim	Set Takeoff
Fuel Selector	Both
Windows & Doors	Closed
Altimeter	Set
Autopilot Barometer	Set
Departure Altitude	Set
Vertical Speed	Set Positive
Directional Gyro	Set to Magnetic
Takeoff Heading	Set
Panel Lights	Dim for Takeoff
Parking Brake	Release

Normal Takeoff

Fuel Pump	On
Mixture	Max Power
Flaps	10 deg
Landing Light	On
Strobe Lights	On
*Air Conditioning	Off
Transponder	ALT Mode
Throttle	Full Power
Propeller RPM	2700
Engine Instruments	Check
Landing Gear Up	No Rwy Remain
Flaps	Retract at 70kts
Autopilot	Engage

Max Continuous Power

Airspeed	91 kts
Throttle	Full Open
Propeller	2700 RPM
Mixture	Max Power
Cowl Flaps	As Required
*Air Conditioning	Off
*Oxygen	As Required
Engine Performance	Monitor

Normal Climb

Airspeed	100-120 kts
Throttle	25 inhg
Propeller	2500 RPM
Mixture	Max Power
Cowl Flaps	As Required
*Air Conditioning	As Desired
*Oxygen	As Required
Engine Performance	Monitor

Cruise

Cowl Flaps	As Required
Throttle	15-24 inhg
Propeller	2200-2700 RPM
Fuel Pump	Off
Landing Light	Off
Fuel Selector	Maintain Balance
Lean Mixture	LOP or ROP
Cabin Vent & Heat	As Desired
*Air Conditioning	As Desired
Engine Performance	Monitor

Descent

Cowl Flaps	Closed
Throttle	Reduce
Mixture	Enrichen
Engine Performance	Monitor

Approach

Seats & Seatbelts	Secure
*Oxygen	Off
Fuel Selector	Both
Fuel Pump	On
Landing Light	On
*Air Conditioning	Off
Cowl Flaps	As Required
Mixture	Max Power
Flaps	20 deg
Airspeed	80 kts

Landing

Propeller	High RPM
Mixture	Max Power
Flaps	35 deg
Landing Gear	Down & Locked
Airspeed	71 kts min.
Autopilot Disconnect	Press

Balked Landing

Mixture	Max Power
Propeller	2700 RPM
Throttle	Full Open
Cowl Flaps	Open
Airspeed	69 kts min.
Engine Instruments	Check
Landing Gear Up	No Rwy Remain
Flaps	Retract at 70kts

After Landing

Flaps	Up
Cowl Flaps	Open
Fuel Pump	Off
Lights	As Required
*Air Conditioning	As Desired
Cabin Vent & Heat	As Desired

Shutdown & Securing

Parking Brake	Set
Avionics	Off
Electrical Equipment	All Off
Throttle	Closed
Propeller	High RPM
Mixture	Cut-Off
Magnetos	Off
Alternators	Off
Battery Master	Off
Fuel Selector	Off
Parking Brake	Release
Control Locks	Install

Instrument Markings & Colors

Manifold Pressure:
10.0-35.0 inHg

Propeller RPM:
2200-2700 RPM (GREEN)
2700 RPM (RED)

Fuel Flow:
0-26.0 gal/hr
~28.5 gal/hr (RED)

Cylinder Head Temperature:
200-500 °F (GREEN)
500 °F (RED)

Exhaust Gas Temperature:
1,200-1,650 °F
1,650 °F (RED)

Oil Temperature:
100-160 °F (YELLOW)
160-245 °F (GREEN)
245 °F (RED)

Oil Pressure:
25 psi (RED)
25-60 psi (YELLOW)
60-100 psi (GREEN)
100 psi (RED)

Main Fuel Quantity:
0 lbs / 0 gal (MINIMUM)
163 lbs / 27 gal (MAXIMUM)

Fuel Pressure:
9 psi (RED)
9-45 psi (GREE)
9-45 psi (RED)

Oxygen Pressure:
0-1850 psi

Vacuum Suction:
4.5 inHg (RED)
4.5-5.2 inHg (GREEN)
5.2 inHg (RED)

Ammeter:
-70-70 amps

Voltmeter:
10-16 volts
16 volts (RED)

Airspeed Indicator:
SEE V-SPEEDS

Abnormal & Emergency Checklists

*Turbonormalized Model Only

Engine Fire (Ground)

Mixture	Cut-Off
Fuel Selector	Off
Master Switches	Off
Magnetos	Off
Magnetos	Off

Engine Failure (Takeoff)

Throttle	Closed
Braking	Maximum
Flaps	Up
Mixture	Cut-Off
Fuel Selector	Off
Master Switches	Off

Engine Failure (In Flight)

Airspeed	82 kts
Fuel Pump	On
Alternate Air	Pull (On)
Fuel Selector	Fullest Tank
Magnetos	Check Both
Mixture	Full Rich
Throttle	Open 1/2in
Starter	Engage
Engine	If No Restart...
Fuel Pump	Off
Favorable Landing Site	Select

Rough Running Engine

Fuel Pump	On
Mixture	Rich then Lean
Magnetos	Check Both
Alternate Air	Pull (On)

Engine Fire (Flight)

Mixture	Cut-Off
Fuel Selector	Off
Master Switches	Off
Magnetos	Off
Cabin Heat & Defrost	Off
Engine	Do Not Restart
Airspeed	Maximum (Vne)

Starter Does Not Disengage

Master Switches	Off
*Standby Alternator	Off
Mixture	Cut-Off
Magnetos	Off

Emergency Descent

Landing Gear	Down
Flaps	Up
Throttle	Idle
Propeller	High RPM
Bank	45 deg
Airspeed	187 kts

Maximum Glide

Landing Gear	Up
Flaps	Up
Cowl Flaps	Close
Propeller	Low RPM
Airspeed	82 kts
Air Conditioning	Off

Electrical Smoke or Fire

Master Switches	Off
*Standby Alternator	Off
Electrical Switches	All Off
Cabin Vent & Heat	All Off
Oxygen System	Activate
Emergency Descent	Initiate
Observe	If No Fire...
Avionics	Off
Master Switches	On
Restore Power	Circuit by Circuit
Cabin Vent	As Desired
Windows	Open

Carbon Monoxide Detected

Cabin Vent & Heat	All Off
Oxygen System	Activate
CO Detector	Reset
CO Alarm	If Persists...
Throttle	Closed
Mixture	Cut-Off
Propeller	Low RPM
Magnetos	Off
Windows	Open
Cabin Air	Full Open
Nonessential Equipment	Off

Alternator Failure

Alternator Switch	Cycle
Circuit Breakers	Check In
*Ammeter	If still negative...
*Air Conditioning	Off
*Standby Alternator	On
*Alternator Transfer	Push
Ammeter	If still negative...
Nonessential Equipment	Off
Land	As Soon as Practical

*Turbocharger Failure

Observe	If No Fire…
Throttle	Advance
Manifold Pressure	If Still Low…
Restart Engine	If Necessary…
Mixture	Lean Max Power
Land	At Nearest Airport

Vacuum Suction Failure

PUMP INOP Annun	If Illuminated...
Standby Vac	Pull On
PUMP INOP Annun	If Extinguished…
Throttle & Handle	Adjust For…
Vacuum Suction	Green

Severe Icing Encounter

Pitot Heat	On
Cabin Heat & Defrost	Pull On
Propeller	High RPM
Cowl Flaps	Closed
Ice Build-Up	Monitor
Alternate Static Air	On

Autopilot Failure or Trim Runaway

Autopilot	Disconnect
Autopilot Circuit Breakers	Pull Off

Door Open In Flight

Airspeed	80 kts
Windows	Open
Overhead Latch	Open
Open Door	Slam Shut
Overhead Latch	Close
If unable	to secure door...
Increased Drag	Anticipate
Land	As Soon as Practical

Landing Gear Failure to Retract

Circuit Breaker	Check In
Emergency Gear Valve	Check Handle Up
Landing Gear	Cycle Switch
If unable	to retract gear...
Landing Gear	Down
Gear Position	Verify Lights
Land	As Soon as Practical

Landing Gear Failure to Extend

Circuit Breaker	Check In
Landing Gear	Cycle Switch
Gear Position	Verify Lights
If unable	to extend gear...
Landing Gear	Down
Airspeed	80 kts
Rudder Trim	Neutral
Emergency Gear Valve	Push Down
Gear Position	Verify Lights

No Power Landing

Fuel Selector	Off
Mixture	Cut-Off
Magnetos	Off
Flaps	As Required
Landing Gear	Down & Locked
Alternators	Off
Battery Master	Off

More Information on Operation

Black Square aircraft are created by an avid pilot who believes that every switch, knob, and button should be interactable, and the user should be able to follow real world procedures without compromising results from the simulation. This aircraft was designed and tested using real world handbooks and procedures, and leaves little to the imagination in terms of functionality. For the most immersive experience, it's recommended that you seek out manuals, handbooks, checklists, and performance charts from the real aircraft represented in this simulation. Although this aircraft and simulation is not suitable for real world training, and should not be used for such, every effort has been taken to ensure that the simulation will represent the real aircraft until the fringe cases of instrument flying, or system failure.

In the case of this particular product, additional resources are available online for the real world counterparts of these units. There are comprehensive video tutorials for the EDM-700/800 on Youtube. You will find one complete overview of the instrument under the title of **"EDM 700 and 800 Video Toutorial"** [sic]. A complete **"Pilot's Operation Manual" to the ETM Engine Trend Monitor** can be found on the Shadin Avionics website. Additionally, the **"KLN-90B Pilot's Guide"** is also available on Bendix/King's website.

Hardware Inputs & Outputs

A nearly complete list of input and output variables and events is provided below for home cockpit builders. If this list is not enough to accomplish the amount of interactivity you are looking to achieve in your home cockpit, anything is possible with a little code. Nothing in any Black Square aircraft is "hard coded", or made inaccessible behind encrypted or compiled files. If you have further questions, contact Just Flight Support, or reach out to me directly in the Just Flight Community forums, where I will be happy to help.

Inputs

Exterior & Cabin Element Variables

Description	**Variable**	**Range**
Yoke Control Locks	L:bksq_controlLocks	Boolean
Pitot Covers	L:bksq_PitotCovers	Boolean
Engine Covers	L:bksq_EngineCovers	Boolean
Wheel Chocks	L:bksq_WheelChocks	Boolean
Tablet Visibility	L:bksq_TabletVisible	Boolean
Tablet Horizontal Position	L:var_efb_rot_x	-1 - 1
Tablet Vertical Position	L:var_efb_rot_y	-1 - 1
Pilot Door	L:bksq_PilotDoor	Boolean
Copilot Door	L:bksq_CopilotDoor	Boolean
Pilot Door Overhead Latch	L:bksq_PilotDoorLocked	Boolean
Copilot Door Overhead Latch	L:bksq_CopilotDoorLocked	Boolean
Pilot’s Window	L:bksq_stormWindow	Boolean
Baggage Door	L:bksq_BaggageDoor	Boolean

Primary Control Variables

Description	**Variable**	**Range**
Mixture Lever	K:MIXTURE1_SET - OR - L:BKSQ_MixtureLeverPosition_1	0 - 100 -OR- (0 - 1)
Friction Lock (mixture adjust speed)	L:var_FrictionLock	0 - 100
Hide Pilot's Yoke	L:XMLVAR_YokeHidden1	Boolean
Hide Copilot's Yoke	L:XMLVAR_YokeHidden2	Boolean
Insert Ignition Key	L:bksq_MagnetoKeyInserted	Boolean
Ignition Switch	K:MAGNETO1_INCR/DECR - OR - L:BKSQ_IgnitionPosition_1	0 - 5
Cowl Flaps	RECIP ENG COWL FLAP POSITION:1	0 - 100
Carbon Monoxide Detector Test	L:var_CoTest	Boolean
Alternate Induction Air Handle	L:var_AlternateAirHandle	0 - 100
Standby Vacuum Pull Handle	L:var_StandbyVacuumHandle	0 - 100
Emergency Gear Extension	L:var_EmergencyGearExtension	Boolean
Alternator Transfer Button	L:var_AcAlternatorTransferButton	Boolean
Pitch Trim Servo Power Switch	L:var_PitchTrimPower	Boolean
Fuel Selector	A:FUEL TANK SELECTOR	0, 1, 19, 20
Fuel Selector Off Animation	L:var_FuelSelectorOffSide	Boolean
Fuel Selector Thumb Stop	L:var_FuelStopDown	Boolean

Lighting Control Events & Variables

Description	**Variable**	**Range**
Navigation Lights	K:TOGGLE_NAV_LIGHTS	
Strobe Lights	K:STROBES_TOGGLE	
Beacon Lights	K:TOGGLE_BEACON_LIGHTS	
Landing Light	K:LANDING_LIGHTS_TOGGLE	
Master Panel Lighting Switch	L:bksq_MasterPanelLights	Boolean

Avionics Lights Dimmer	L:var_AvionicsLightingKnob	0 - 100
Glareshield Lights Dimmer	L:var_InstrumentLightingKnob	0 - 100
Circuit Breaker Lights Dimmer	L:var_CircuitBreakerLightingKnob	0 - 100
Pilot Cabin Reading Light	L:var_LIGHTING_Push_Cockpit_1 L:var_ReadingLightOn 180 >L:var_ReadingLightTimer	
Copilot Cabin Reading Light	L:var_LIGHTING_Push_Cockpit_2	Boolean
Passenger Cabin Reading Light	L:var_LIGHTING_Push_Cockpit_3	Boolean
Passenger Cabin Reading Light	L:var_LIGHTING_Push_Cockpit_4	Boolean
Wing Step Lights	L:var_StepLightsOn 180 >L:var_StepLightsTimer	
Baggage Lights	L:var_BaggageLightOn 180 >L:var_BaggageLightTimer	

Environmental Control Variables

Description	**Variable**	**Range**
Oxygen Flow Valve	L:var_OxygenHandle	0 - 100
Cabin Heat Valve	L:var_CabinHeatHandle	0 - 100
Cabin Vent Valve	L:var_CabinVentHandle	0 - 100
Defroster Valve	L:var_DefrosterHandle	0 - 100
Pilot Footwell Air Valve	L:var_FootwellVent_FL	0 - 100
Copilot Footwell Air Valve	L:var_FootwellVent_FR	0 - 100
Left Passenger Footwell Air Valve	L:CabinFloorVent_BL	0 - 100
Right Passenger Footwell Air Valve	L:CabinFloorVent_BR	0 - 100
Air Conditioning Mode Switch	L:var_AirConditionerModeSwitch	0 - 2
Air Conditioning Fan Switch	L:var_AirConditionerFanSpeedSwitch	Boolean

Instrument Variables

Description	Variable	Range
Localizer Source Switch	L:var_LocSourceSwitch	Boolean
Directional Gyro Heading	L:var_DirectionalGyroHeading	0 - 360
Directional Gyro Push to Adjust	L:var_gyroAdjustMode	Boolean
Increase Directional Gyro Heading	K:GYRO_DRIFT_INC	
Decrease Directional Gyro Heading	K:GYRO_DRIFT_DEC	
True Airspeed Calculator	L:var_TrueAirspeedKnob	4.30 - 69.85
Cabin Temperature Display Unit	L:var_CabinTempUnitMode	Boolean
EGT Reference Radial	L:var_EgtReferenceKnob	0 - 100

Primary Control Events Events

Description	Event
Battery Master	K:BATTERY1_SET
Main Alternator	K:TOGGLE_ALTERNATOR1
Standby (Air Conditioning) Alternator	K:TOGGLE_ALTERNATOR2
Avionics Master	K:AVIONICS_MASTER_1_SET
Pitot Heat	1 >K:PITOT_HEAT_TOGGLE
Fuel Pump	K:FUEL_PUMP
Alternate Static Air	K:TOGGLE_ALTERNATE_STATIC

Instrument Events

Description	Variable
Autopilot Master	K:AP_MASTER
Autopilot & Flight Director Disengage	K:AUTOPILOT_DISENGAGE_TOGGLE
Autopilot Heading Mode	K:AP_PANEL_HEADING_HOLD
Autopilot NAV Mode	K:AP_NAV1_HOLD
Autopilot Approach Mode	K:AP_APR_HOLD
Autopilot Backcourse Mode	K:AP_BC_HOLD
Autopilot Altitude Hold Mode	K:AP_ALT_HOLD
Autopilot Go-Around Mode	K:AUTO_THROTTLE_TO_GA
VLOC/GPS (when using GNS 530)	K:TOGGLE_GPS_DRIVES_NAV1 (H:AS530_CDI_Push)
Toggle COM1 Receive	K:COM1_RECEIVE_SELECT
Toggle COM2 Receive	K:COM2_RECEIVE_SELECT
Toggle COM3 Receive	K:COM3_RECEIVE_SELECT
Toggle NAV1 Receive	K:RADIO_VOR1_IDENT_TOGGLE
Toggle NAV2 Receive	K:RADIO_VOR2_IDENT_TOGGLE
Toggle ADF Receive	K:RADIO_ADF_IDENT_TOGGLE
Toggle DME Receive	K:RADIO_DME1_IDENT_TOGGLE
Toggle Marker Receive	K:MARKER_SOUND_TOGGLE
Marker Sensitivity and Test Knob	L:var_AmrBeaconSelectKnob (0 - 2)
Altimeter Baro Increase	K:KOHLSMAN_INC
Altimeter Baro Decrease	K:KOHLSMAN_DEC

Avionics Variables & Events

Not all variable and event names are listed here for multiple instances of avionics. For instance, to control a GTN 650, just replace “GTN750” with “GTN650”, or “H:AS530_1_MENU_Push” with “H:AS430_1_MENU_Push”. For communications radios, change the index to the corresponding radio, such as “K:COM1_VOLUME_INC” to “K:COM2_VOLUME_INC”. For Black Square aircraft with multiple GNS 530 units installed, increment the index, as well, such as “H:AS530_1_DRCT_Push” to “H:AS530_2_DRCT_Push”.

PMS50 GTN

Description	Variable or Event
Volume Knob Set	L:GTN750_Vol
Volume Knob Increase	H:GTN750_VolInc
Volume Knob Decrease	H:GTN750_VolDec
Home Button	H:GTN750_HomePush
Direct-To Button	H:GTN750_DirectToPush
Inner Knob Increase	H:GTN750_KnobSmallInc
Inner Knob Decrease	H:GTN750_KnobSmallDec
Knob Push	H:GTN750_KnobPush
Outer Knob Increase	H:GTN750_KnobLargeInc
Outer Knob Decrease	H:GTN750_KnobLargeDec

TDS GTNxi

Description	Variable or Event
Volume Knob Increase	L:TDSGTNXI750U1_LKnobInc
Volume Knob Decrease	L:TDSGTNXI750U1_LKnobDec
Home Button	L:TDSGTNXI750U1_HomeKey
Direct-To Button	L:TDSGTNXI750U1_DTOKey
Inner Knob Increase	L:TDSGTNXI750U1_RKnobInnerInc
Inner Knob Decrease	L:TDSGTNXI750U1_RKnobInnerDec

Knob Push	L:TDSGTNXI750U1_RKnobCRSR
Outer Knob Increase	L:TDSGTNXI750U1_RKnobOuterInc
Outer Knob Decrease	L:TDSGTNXI750U1_RKnobOuterDec

Working Title GNS 530

Description	**Variable or Event**
COM Volume Knob Increase	K:COM1_VOLUME_INC
COM Volume Knob Decrease	K:COM1_VOLUME_DEC
NAV Volume Knob Increase	K:NAV1_VOLUME_INC
NAV Volume Knob Decrease	K:NAV1_VOLUME_DEC
Radio Knob Push	H:AS530_1_LeftSmallKnob_Push
Radio Inner Knob Right	H:AS530_1_LeftSmallKnob_Right
Radio Inner Knob Left	H:AS530_1_LeftSmallKnob_Left
Radio Outer Knob Right	H:AS530_1_LeftLargeKnob_Right
Radio Outer Knob Left	H:AS530_1_LeftLargeKnob_Left
GPS Knob Push	H:AS530_1_RightSmallKnob_Push
GPS Inner Knob Right	H:AS530_1_RightSmallKnob_Right
GPS Inner Knob Left	H:AS530_1_RightSmallKnob_Left
GPS Outer Knob Right	H:AS530_1_RightLargeKnob_Right
GPS Outer Knob Left	H:AS530_1_RightLargeKnob_Left
Direct-To Button	H:AS530_1_DRCT_Push
Menu Button	H:AS530_1_MENU_Push
Clear Button Short	H:AS530_1_CLR_Push
Clear Button Long	H:AS530_1_CLR_Push_Long
Enter button	H:AS530_1_ENT_Push
COM Swap Button	H:AS530_1_COMSWAP_Push
NAV Swap Button	H:AS530_1_NAVSWAP_Push
NAV Ident Button	H:AS530_1_ID

CDI Button	H:AS530_1_CDI_Push
OBS Button	H:AS530_1_OBS_Push
Message Button	H:AS530_1_MSG_Push
Flightplan Button	H:AS530_1_FPL_Push
VNAV button	H:AS530_1_VNAV_Push
Procedure Button	H:AS530_1_PROC_Push

KLN90B

Description	**Variable or Event**
Brightness Knob Increase	H:KLN90B_Brt_Inc
Brightness Knob Decrease	H:KLN90B_Brt_Dec
Power Knob Push/Pull	H:KLN90B_Power_Toggle
Left Knob Outer Right	H:KLN90B_LeftLargeKnob_Right
Left Knob Outer Left	H:KLN90B_LeftLargeKnob_Left
Right Knob Outer Right	H:KLN90B_RightLargeKnob_Right
Right Knob Outer Left	H:KLN90B_RightLargeKnob_Left
Left Knob Inner Right	H:KLN90B_LeftSmallKnob_Right
Left Knob Inner Left	H:KLN90B_LeftSmallKnob_Left
Right Knob Inner Right	H:KLN90B_RightSmallKnob_Right
Right Knob Inner Left	H:KLN90B_RightSmallKnob_Left
Right Knob (Scan) Push/Pull	H:KLN90B_RightScan_Toggle
Left Cursor Button	H:KLN90B_LeftCursor_Toggle
Right Cursor Button	H:KLN90B_RightCursor_Toggle
Message Button	H:KLN90B_MSG_Push
Altitude Button	H:KLN90B_ALT_Push
Direct Button	H:KLN90B_DCT_Push
Clear Button	H:KLN90B_CLR_Push
Enter Button	H:KLN90B_ENT_Push

MD41 Approach Arm Button	H:KLN90B_ApprArm_Push
MD41 OBS Button	K:GPS_OBS
MD41 VLOC/GPS Button	K:TOGGLE_GPS_DRIVES_NAV1
MD41 Test Button	L:var_md41Test

RNAV511

Description	**Variable or Event**
RNAV Power Button	A:CIRCUIT SWITCH ON:43
RNAV VOR DME Button	L:var_Rnav511_VorSwitch
RNAV Waypoint Buttons	L:var_Rnav511_ActiveWaypoint (0 = Left, 1 = Right)
RNAV Radial Thumbwheels Left	L:var_Rnav511_Radial_100_L L:var_Rnav511_Radial_10_L L:var_Rnav511_Radial_1_L L:var_Rnav511_Radial_01_L
RNAV Radial Thumbwheels Right	L:var_Rnav511_Radial_100_R L:var_Rnav511_Radial_10_R L:var_Rnav511_Radial_1_R L:var_Rnav511_Radial_01_R
RNAV Distance Thumbwheels Left	L:var_Rnav511_Distance_100_L L:var_Rnav511_Distance_10_L L:var_Rnav511_Distance_1_L L:var_Rnav511_Distance_01_L
RNAV Distance Thumbwheels Right	L:var_Rnav511_Distance_100_R L:var_Rnav511_Distance_10_R L:var_Rnav511_Distance_1_R L:var_Rnav511_Distance_01_R
RNAV Knots Minutes Button	L:var_Rnav511_KtsMinButton
RNAV Test Button	L:var_Rnav511_TestButton

MX-170B

Description	**Variable or Event**
MHz Knob Increase	H:MX170_1_Knob_MHz_INC
MHz Knob Decrease	H:MX170_1_Knob_MHz_DEC
KHz Knob Increase	H:MX170_1_Knob_kHz_INC
KHz Knob Decrease	H:MX170_1_Knob_kHz_DEC
25 KHz Increment	H:MX170_1_Button_25kHz
COM/NAV Select (“N-C”)	H:MX170_1_Button_NavComSelect
Toggle European Frequency Spacing	H:MX170_2_Button_PresetEdit
NAV Volume Increase	K:NAV1_VOLUME_INC
NAV Volume Decrease	K:NAV1_VOLUME_DEC
COM Test (unsquelch) Botton	L:var_MX170_2_TestButton
NAV Ident Toggle	K:RADIO_VOR1_IDENT_TOGGLE
COM Swap Button	K:Mx170ComSwapButton_1
NAV Swap Button	K:Mx170NavSwapButton_1

MC60 Localizer

Description	**Variable or Event**
OBS Knob Increase	H:MC60_OBS_INC
OBS Knob Decrease	H:MC60_OBS_DEC
Mode Button	H:MC60_Mode
Reciprocal Button	H:MC60_Reciprocal

ILS 400

Description	Variable or Event
Toggle ILS Ident Receive	K:RADIO_VOR3_IDENT_TOGGLE
ILS Volume Increase	K:NAV3_VOLUME_INC
ILS Volume Decrease	K:NAV3_VOLUME_DEC
MHz Switch Increment	K:NAV3_RADIO_WHOLE_INC
MHz Switch Decrement	K:NAV3_RADIO_WHOLE_DEC
kHz Switch Increment	K:NAV3_RADIO_FRACT_INC_CARRY
kHz Switch Decrement	K:NAV3_RADIO_FRACT_DEC_CARRY

Narco ADF-31

Description	Variable or Event
Power and Mode	L:var_AdfMode
ADF Volume Increase	K:ADF_VOLUME_INC
ADF Volume Decrease	K:ADF_VOLUME_DEC
Frequency Range Selector Knob	L:var_AdfFrequencyRange
Direct Frequency Tuning	L:var_Adf31_kHz
Momentarily Superimpose Frequency	8 >L:var_AdfTuningDisplayTimer
Test Button	var_AdfTestButton

Narco DME UDI-4

Description	Variable or Event
Outer Knob	L:var_Dme190_MHz
Inner Knob	L:var_Dme190_kHz
Power and Mode	L:var_DmeMode

KT76A Transponder

Description	Variable or Event
Transponder Mode	A:TRANSPONDER STATE:1
Ident Button	K:XPNDR_IDENT_ON
Transponder Interrogation Light	L:var_TransponderReply
Transponder Digit 1 Increment	K:XPNDR_1000_INC
Transponder Digit 1 Decrement	K:XPNDR_1000_INC
Transponder Digit 2 Increment	K:XPNDR_100_INC
Transponder Digit 2 Decrement	K:XPNDR_100_INC
Transponder Digit 3 Increment	K:XPNDR_10_INC
Transponder Digit 3 Decrement	K:XPNDR_10_INC
Transponder Digit 4 Increment	K:XPNDR_1_INC
Transponder Digit 4 Decrement	K:XPNDR_1_INC

WX-11 Stormscope

Description	Variable or Event	Range
Power and Mode	L:var_StormScopeMode	0 - 2
Screen Brightness	L:var_StormScopeBrightness	0 - 100
Scope Range	L:var_StormScopeRange	0 - 3
Test Button Short Press	H:bksq_StormScope_Test_Short	
Test Button Long Press	H:bksq_StormScope_Test_Long	
Clear Button Short Press	H:bksq_StormScope_Clear_Short	
Clear Button Long Press	H:bksq_StormScope_Clear_Long	
Both Buttons Short Press	H:bksq_StormScope_Both_Short	
Both Buttons Long Press	H:bksq_StormScope_Both_Long	

EDM 800 Engine Monitor

Description	Variable or Event	Range
Mode Switch	L:var_JpiMode	0 = TEMP, 2 = FF
Left Button Short	H:bksq_JpiButton_1_L_Short	
Left Button Long	H:bksq_JpiButton_1_L_Long	
Right Button Short	H:bksq_JpiButton_1_R_Short	
Right Button Long	H:bksq_JpiButton_1_R_Long	
Short Press Both Buttons (Temp Unit)	L:var_JpiTempUnit	0 = °F, 1 = °C
Long Press Both Buttons	H:bksq_JpiButton_1_B_Long	

Altitude/Vertical Speed Select Programmer

Description	Variable or Event	Range
Barometric Calibration Thumbwheels	L:var_AutopilotBaroCalibration_10 L:var_AutopilotBaroCalibration_1 L:var_AutopilotBaroCalibration_01	0 - 9
Altitude Select Thumbwheels	L:var_PreselectedAltitude_10000 L:var_PreselectedAltitude_1000 L:var_PreselectedAltitude_100	0 - 9
Vertical Speed Select Thumbwheels	L:var_PreselectedVerticalSpeed	-16 - 16
Vertical Speed Condition LED	L:var_AltitudeSelectorNegativeVs_EM_readonly	Boolean

Outputs

Since the Black Square Commander 114 has many custom underlying simulations beyond that of the native simulator, the following variables should be used to access what would normally be a simulator-level value. If the quantity you are interested in does not appear in this list, it is safe to assume it should be accessed via the native simulator variable.

Aircraft & Engine Variables

Description	Variable	Units
Manifold Pressure	L:BKSQ_MANIFOLD_PRESSURE_1	inHg
Propeller RPM	L:BKSQ_PROP_RPM_1	RPM
Fuel Flow	L:BKSQ_FuelFlow_1	GPH
Oil Pressure	L:BKSQ_OIL_PRESS_1	PSI
Oil Temperature	L:BKSQ_OIL_TEMP_1	CELSIUS
Exhaust Gas Temperature	L:BKSQ_EGT_1	CELSIUS
Cylinder Head Temperature	L:BKSQ_CHT_1	CELSIUS
Left Fuel Quantity	A:FUEL TANK LEFT MAIN QUANTITY	GALLONS
Right Fuel Quantity	A:FUEL TANK RIGHT MAIN QUANTITY	GALLONS
Vertical Speed Needle	L:BKSQ_VerticalSpeed_1	FPM
Turn Coordinator Ball	L:BKSQ_TurnCoordinatorBall	0 - 100
Magnetic Compass (with field error)	L:BKSQ_MagneticCompassHeading	0 - 100
Suction Pressure	L:BKSQ_SUCTION_PRESSURE	inhg
Oxygen Pressure	L:var_oxygenPressure	PSI
Nose Gear Locked Indicator	L:var_GearIndicatorNose_readonly	Boolean
Left Gear Locked Indicator	L:var_GearIndicatorLeft_readonly	Boolean
Right Gear Locked Indicator	L:var_GearIndicatorRight_readonly	Boolean

Radio Navigation Variables

While these variables may seem redundant, Black Square aircraft incorporate a signal degradation system, and physics based needles. Even the TO-FROM flags exhibit non-boolean behavior for a more realistic experience.

Description	Variable	Range
Localizer 1 CDI LED’s	L:var_MC60_CDI	-127 - 127
Localizer 1 Loc Valid LED	L:var_MC60_LocValid	Boolean
Localizer 1 Track Mode	L:var_MC60_TrackMode	Boolean
Localizer 1 To LED	L:var_MC60_To	Boolean
Localizer 1 From LED	L:var_MC60_From	Boolean
Localizer 1 Glideslope LED’s	L:var_MC60_GSI	-127 - 127
Localizer 2 Glideslope Valid LED	L:var_MC60_GsValid	Boolean
Localizer 2 CDI Needle	L:BKSQ_LOC_2	-127 - 127
Localizer 2 CDI Flag	L:BKSQ_LOC_2_FLAG	Boolean
Localizer 2 TO Flag	L:BKSQ_LOC_2_TO_FLAG	0 - 100
Localizer 2 FROM Flag	L:BKSQ_LOC_2_FROM_FLAG	0 - 100
Localizer 2 Glideslope Needle	L:BKSQ_GLIDE_2	0 - 100
Localizer 2 Glideslope Flag	L:BKSQ_LOC_2_GS_FLAG	Boolean
ILS Valid LED	L:var_Ils400Power	Boolean
ILS CDI LED’s Left	L:var_Ils400_CDI_L	-127 - 0
ILS CDI LED’s Right	L:var_Ils400_CDI_R	0 - 127
ILS Glideslope LED’s Up	L:var_Ils400_GSI_U	-127 - 0
ILS Glideslope LED’s Down	L:var_Ils400_GSI_D	0 - 127
ADF Needle	L:BKSQ_adfNeedle	0 - 360
ADF Frequency Tuning Drum	L:var_Adf31_DisplayDrumAnimPos	0 - 100
DME Scale Mode	L:var_DmeMode	0 - 2
DME Needle	L:BKSQ_dmeNeedle	0 - 100
RNAV CDI Needle	L:BKSQ_RNAV_CDI_Degraded	-127 - 127

RNAV CDI TO Flag	L:BKSQ_RNAV_TO_Degraded	0 - 1
RNAV CDI FROM Flag	L:BKSQ_RNAV_FROM_Degraded	0 - 1
RNAV Bearing Pointer	L:BKSQ_RNAV_BRG_Degraded	0 - 360
RNAV DME Distance Output	L:var_RNAV_DME	0.0 - 999.9
RNAV DME Speed Output	L:var_RNAV_DMESPEED	0.0 - 999.9
RNAV Waypoint Button	L:var_Rnav511_ActiveWaypoint	0 = Left, 1 = Right

Annunciator Lights

The over 100 annunciators and indicator lamps in this aircraft are also accessible to home cockpit builders and 3rd party UI creators. There are too many to list here, but they can all be located in the Commander114_INT.XML. Search for “BKSQ_DIMMABLE_ANNUNCIATOR” to find them all. Each one is accessible via an L:Var named according to the “NODE_ID” of the annunciator in the XML file, following the pattern (L:var_**#NODE_ID#**_readonly, bool).

For example, the low voltage annunciator NODE ID is “GSA_LowBusVolts”, therefore…

The low voltage annunciator L:Var is (L:var_**GSA_LowBusVolts**_readonly, bool).

Frequently Asked Questions

How do I open/close the tablet interface?

Click the back of the tablet **between the pilot’s seat and the wall** of the cabin. Click the same area to close the tablet. The tablet can be moved by dragging its frame in lock or legacy interaction modes. For advanced users, the tablet position can also be set manually using L:var_efb_rot_x, L:var_efb_rot_y, and L:var_efb_dist.

How do I change which avionics/radios are installed?

The current avionics configuration is selected on the **options page of the tablet interface**. Once you’ve chosen your avionics, click the confirm button. Wait a few seconds for the change to take effect. For more information, see the “Tablet Interface” section of this manual.

How do I choose between the TDS and PMS GTN 750?

The current avionics configuration is selected on the **options page of the tablet interface**. The “PMS50 - TDS” toggle switch selects which GPS provider is used for the GTN 750/650. For more information, see the “Tablet Interface” section of this manual.

Why does the aircraft crash if I open the cockpit window?

Turn off “Aircraft Stress Damage” in the MSFS realism settings menu. This is the case for almost every addon aircraft with opening doors. The simulator interprets an open door as a catastrophic failure of the airframe. Unfortunately, the door states are also used to control sound insulation in the cabin, so they cannot be easily ignored by the developer.

Do I have to use the tablet interface to set fuel & payload?

Absolutely not. If you prefer to use the native fuel/payload interface, you may always do so. Be aware that, due to a core simulator bug, the native payload interface may become desynchronized with the actual state of the aircraft. This has no effect on operation, and making any change will resynchronize the native interface.

Why is the autopilot behaving strangely, not changing modes, showing HDG/NAV simultaneously, or not capturing altitudes?

This is indicative of GPS addon incompatibility. Please make sure that you have updated all the avionics packages that you are using, including the TDS GTNxi 750, PMS50 GTN 750, and that you do not have any outdated packages. **No additional packages should be required for the autopilot to work correctly** with the various GPS choices. The product is tested with ONLY the TDS GTNxi 750, and freeware PMS50 GTN 750 installed. Please see the “Third Party Navigation & GPS Systems" section of this manual for more information.

Why does the mixture behave strangely in the turbocharged version, and I cannot bind it to hardware controls?

Microsoft Flight Simulator's turbocharger simulation has been significantly flawed for several generations. This aircraft has a custom turbocharger that fixes nearly all of these issues, and is much more realistic, as a result. To make these changes, the new "Input Event" system is used to intercept hardware and key-bindings for the mixture control axis. Please make sure that your hardware bindings are using the Key Events, such as "K:MIXTURE1_DECR_SMALL", or "K:MIXTURE1_SET" to set the mixture, and NOT setting either "A:GENERAL ENG MIXTURE LEVER POSITION:1", or "B:FUEL_Mixture_1_Set". Alternatively, setting **"L:BKSQ_MixtureLeverPosition_1" from 0-100 will also work to set the mixture axis.**

Why can't I start the engines?

The Black Square Commander 114 simulates many features of real world fuel injected engine operation that some users may not be familiar with. Understanding the checklists for hot, cold, and flooded engine starts should provide a successful engine start. Recall that fuel injected engines must be primed with an electric fuel pump before starting, and may succumb to vapor lock after recently running. Flooded engines will also be difficult to start, requiring an advanced throttle setting to produce a combustible air-to-fuel ratio. **Check the engine visualizer in the tablet interface** for a graphical representation of these many invisible factors of engine starting.

Why do my engines always fail or lose health?

It is very easy to mismanage high performance reciprocating engines. Be sure to watch the engine instrumentation and EDM-800 engine monitor for alarms. **When a limit is being exceeded, the alarm code will flash on its screen.** see the "Reciprocating Engine & Turbocharger Simulation" section of this manual for more information.

Why can't I enable the autopilot?

This aircraft has a toggle switch that controls power to the autopilot servo motors. Make sure the toggle switch to the right of the master switches, labeled **"PITCH TRIM" is in the on position**. Additionally, check the "SERVOS" circuit breaker on the center main panel to make sure power is available to the autopilot servo motors.

Why is the GTN 750 GPS or KLN-90B GPS screen black?

Make sure you have the PMS GTN 750 or TDS GTNxi 750 installed properly in your community folder. **The free addon can be obtained for free from the following link**.

> **https://pms50.com/msfs/downloads/gtn750-basic/**

Make sure you have the Falcon71 KLN-90B installed properly in your community folder.

The free addon can be obtained for free from the following link.

https://github.com/falcon71/kln90b/releases

For more detailed Installation instructions see the “Installation, Updates & Support” section of this manual.

Why do some switches not work, or avionics logic seem broken?

This is almost always caused by default control binding of hardware peripherals, especially the Honeycomb yoke and throttle system. Due to how the electronics in these peripherals work, they often “spam” their control events, or set them, rather than toggle them. In either case, this can interfere with the operation of more complex aircraft, such as this one. Either create a control binding profile for this aircraft that does not attempt to send control inputs in the same manner as you would for default aircraft, but instead use the suggested method for this aircraft, or seek advice on using 3rd party hardware binding software, such as Axis and Ohs, SPAD.neXt, and FSUIPC.

Can the autopilot track RNAV511 RNAV waypoints?

Yes! By the nature of how the RNAV511 autopilot coupling has been implemented, it cannot conflict with other GPS sources of navigation; therefore, the RNAV511 can only drive the autopilot’s NAV mode in the no-GPS avionics configuration. For more information, see the “Using the RNAV511 Navigation System” or the “Foster RNAV511 Navigation System” section of this manual.

Why is the state of my aircraft and radios not saved/recalled?

In order for the MSFS native state saving to work correctly, you must **shut down MSFS correctly** via the main menu, by clicking “Quit to Desktop”, NOT by pressing the red “X” on the application window, or otherwise terminating the application window.

Why does the engine not fail when limits are clearly exceeded?

The engine will not fail immediately upon limit exceedances, as is true of the real engine. Different engine parameters contribute differently to reducing the health of the engine. The **“Engine Stress Failure” option must also be enabled in the MSFS Assistance menu** for the engine to fail completely. Engine condition can be monitored via the engine pages of the tablet interface, or on the “SYSTEMS” page of the weather radar display.

Why do screens flicker at night when adjusting lighting intensity?

This is a long standing bug in MSFS with some graphics settings and hardware. It happened rarely in MSFS 2020, but constantly in MSFS 2024. **Disabling NanoVG from the “Experimental”** menu in General Settings will stop the flickering in MSFS 2020. (Black Square products do not use legacy XML gauges.) **Using the “Legacy” interaction mode in MSFS 2024** will also eliminate the flickers, as they are caused by the blue control highlight.

Why does pitch control seem overly sensitive in MSFS 2024?

For some reason, control reactivities appear to be much higher by default in MSFS 2024 than MSFS 2020. Since this will affect all aircraft, try changing your hardware sensitivities in the controls menu by clicking the gear icon beside your hardware input device.

Change Log

v1.0 - Initial Release (after public preview build)

New Features:

- **Completely new full state saving system** with 220 parameters, using JavaScript state saving, rather than state.cfg. See the “Full State Saving” section of this manual for more information on the system, and the “Options Page” section for how to configure the system.
- **Added new gauge glass material for MSFS 2024** to introduce more cubemapped reflections while preserving most surface imperfections. This hopefully strikes a good balance for users who miss the more vibrant reflections of MSFS 2020, and those who find MSFS 2024’s reflections too distracting.
- **Added disabled visual state to tablet options switches** (greyed out), like engine/pitot covers/chocks to provide feedback when these options are not available.

Bug Fixes:

- **Fixed slow ignition key physics simulation** for some users on MSFS 2024.
- Tweaked gauge card texture to appear darker under new MSFS 2024 glass material.
- Adjusted manual flap switch deployment speed and reduced number of discrete flap settings to three to prevent stuck switch and sound anomalies in MSFS 2024.
- Adjusted glareshield lighting to eliminate bleed on to glareshield washers and screws in MSFS 2024.
- Fixed incorrect material parameters on door hinges for some liveries.
- Fixed glass polygon slightly extending beyond flap gauge bezel.
- Fixed live schematic main bus voltage, which was polling the wrong variable.
- Angle of wheel chocks and preheater adjusted to better align with ground.
- Added missing backlighting to transponder.

Credits

Black Square Commander 114	Nicholas Cyganski
Publishing	Just Flight
Console Testing	Just Flight Testing Team
Audio	Boris Audio Works
Liveries	Ryan “ryanbatc” Butterworth
	Tim "TimHH" Scharnhop
Manual	Nicholas Cyganski
Selected Digital Photography & First Look Video	David Ames

Dedication

I’ve used my many dedications to thank family, mentors, teachers, and legends of aviation. In comparison, it seems rather nebulous to thank a group of unnamed close friends. However, our direct peers are often how we center ourselves, define ourselves, and humble ourselves. Most recently, I’ve found great solace in knowing that my friends since childhood are experiencing the same emotions that come with the gentle weight of passing years, both joyous and sorrowful. I believe that family and purpose anchor one to life’s defining pillars, while friends support the moments in-between. There are those who have listened to me describe the smallest detail of programming avionics, yet inexplicably come back for more. Others have helped test aircraft, or proofread publications. To my dearest friends: I cannot predict where life will take us, but I am ever-thankful for your perplexing ability to tolerate my ramblings.

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ALSO AVAILABLE
Black Square
BLACK SQUARE'S STARSHIP
For Microsoft Flight Simulator
Just Flight
Black Square
LACK SQUARE'S TBM 850
For Microsoft Flight Simulator
Just Flight
Black Square
PISTON DUKE
For Microsoft Flight Simulator
Just Flight
Black Square
RBINE DUKE
For Microsoft Flight Simulator
Just Flight
Black Square
BONANZA PROFESSION
For Microsoft Flight Simulator
Just Flight
Black Square
BARON PROFESSIONAL
For Microsoft Flight Simulator
Just Flight
Black Square
REAL TAXIWAYS UNITED STATE
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