Black Square

"Virtual Aircraft. Real Engineering."

Baron Professional User Guide

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

Contents

Introduction

The Baron 58 was introduced in 1969 as an incremental improvement on the already successful Baron 55, which itself was developed from the Travel Air 95. The Baron 58 made use of the Bonanza's fuselage and more modern control surfaces than the Travel Air, creating a solid competitor to the industry's other light twins. Today, the Baron 58 remains one of the few light twins still in production, with over 7,000 aircraft produced. The pressurized Baron is relatively rare, with under 500 aircraft produced, and a time limited airframe. For many business travelers, the 58P represented the perfect cross-country machine, so much so that it was discontinued to promote sales of the King Air 90, the smallest of the King Air offerings.

Black Square's Baron Professional brings you one of the most technically advanced aircraft simulations for Microsoft Flight Simulator, with an advanced reciprocating engine simulation, 100+ possible failures, 12 hot-swappable radio configurations, and the most advanced turbocharger, pressurization, and cabin temperature simulations in MSFS. Black Square's new 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 B58's history. Fly without GPS via a Bendix KNS-81 RNAV system, or with the convenience of a Garmin GTN 750/650 (PMS50 or TDS). Other radio equipment includes KX-155 radios, KLN-90B, GNS 530/430, KFC 150 Autopilot, and an RDR1150XL Weather Radar. A 165+ page manual provides instruction on all equipment, and 45 in-game checklists with control highlighting are included for normal and emergency procedures. **This product includes three airframes**: the normally aspirated B58 of the mid-2000's, the 1984 B58TC, and the pressurized 1985 B58P. Six distinctive interiors and six paint schemes are included from five decades of flying.

Analog Baron Owners: While the panel of the Baron Professional might look familiar, almost all other aspects of the aircraft have been rebuilt with Black Square's current technology and high standards of quality. The major additions include a **custom exterior model**, **custom sound package** from Boris Audio Works, **higher quality materials** with modifications for each model of aircraft, **fine tuned performance tables**, **tablet visualizers** with all the systems required to drive them, **more avionics options**, and the reciprocating **engine simulation that debuted with the Piston Duke**. This expansion of the Analog Baron represents 1,000+ hours of dedication, and roughly a doubling of the aircraft's code complexity. Once you experience Black Square's latest technology in your favorite B58, the difference will be clear!

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.

What's new since the Analog Baron?

Every feature listed below with *NEW* or *IMPROVED* has been added or significantly improved since the Analog Baron was released, but there is even more to discover!

Feature Overview

- **IMPROVED 165+ page manual** with your complete guide to flying the Black Square Baron, including systems guide, tutorials, limitations, performance tables, and electrical schematics
- **NEW Three aircraft in one:** Normally Aspirated B58, Turbocharged B58TC & Pressurized B58P.
- **NEW TABLET INTERFACE!** for configuring options, payload settings, failure management, and real time visualizers for engines, electrical schematics, and environmental systems.
- **NEW physics-based engine simulation** with compression, magneto impulse couplings, blade angle, oil temperature & pressure, cylinder head temperatures, and preheating.
- **IMPROVED Fuel injected engine simulation with fouling, vapor-lock, flooding, and backfires,** even the magneto impulse couplings are simulated and have sound.
- **NEW 12 hot-swappable radios**, configurable via tablet interface. Incl. PMS & TDS
- **IMPROVED 100+ Random, scheduled, or performance triggered failures**, settable via the tablet, including engine damage, compatible with 3rd party UI's and instructor stations.
- **IMPROVED Fully simulated environmental control and pressurization 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. Monitor via the new tablet interface.
- **NEW physics-based sound system.** Sounds like engine starting are not mere recordings, but instead many layered sounds, constructed based on the underlying simulation.
- **NEW propeller hub and unfeathering accumulator**, with feather locking pins.
- **NEW engine preheating** required for cold starts, with heater and ground power cart.
- **NEW voltage-based light dimming,** an immediately recognizable effect to nighttime pilots.
- **NEW gyroscope physics simulation** for electric and pneumatic gyroscopes with precession, and partial failures, based on a coupled quadrature oscillator.
- **NEW magnetic compass effects**, including fields from onboard circuits.
- **NEW 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!
- **NEW KLN-90B vintage GPS.** Download from https://github.com/falcon71/kln90b/releases
- **NEW strobe light system** causes realistic distracting flashes in clouds.

- **NEW St. Elmo's Fire** & static discharge on static wicks in severe weather.
- **IMPROVED KNS-81 RNAV now supports autopilot** with No-GPS configuration.
- **IMPROVED The most advanced turbocharger simulation in MSFS.** Turbocharger sounds reflect the simulated turbine RPM, engine performance is dependent on turbocharger boost, and cabin pressurization is dependent on turbocharger performance.
- **NEW Functional exterior elements (Interactive in MSFS2024) & control locks**: chocks, pitot covers, engine covers, preheater, and ground power cart. Pitot flags blow in the wind.
- **NEW Performance tables** reflect fine tuned aerodynamic and engine cruise performance.
- **Mathematically accurate VOR & ADF signal attenuation and noise degradation.**
- **Physics based instrument needles** bounce and respond to aerodynamic forces.
- **JPI EDM-760 Engine Monitor** with engine leaning optimization "Lean Find".
- Improper engine management will slowly **damage engines to failure**.
- **Completely simulated electrical system**, with 70 circuits, thermal breakers, and failures.
- Carbon Monoxide leaks are possible, and can be detected with the CO detector.
- State saving for fuel, radio selection, radio frequency memory, cabin aesthetics, etc.
- Crew/Passenger oxygen depletes according to pressure altitude, passenger occupancy.
- Ultra-custom dynamic registration number system for livery creators.

Checklists

Over 500 checklist items are provided for 45+ 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 Baron Professional 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.

Flight Dynamics

The Baron Professional features a flight model with performance to match the real world aircraft based on real Starship 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, such as CFD propeller and stall physics, and SU15 improved ground handling and flexible tire physics. Engine damage and fouling produces a rough running engine and decreased performance.

Paint Schemes

The Black Square Baron Professional comes with six paint schemes. The Baron Professional also comes with six interior upholstery packages that represent the aircraft through decades of service. This product makes use of 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	29’11”
Height	9'2"
Wheel Base	7’0"
Track Width	9’7"
Wingspan	37'10” (39’6” with Winglets)
Wing Area	199.0 sqft.
Flight Load Factors	+4.0/-1.3 G’s (+2.0/-1.1 G’s with Flaps Down)
Design Load Factor	150%
Cabin W/L/H	42” x 12’7" x 50"
Oil Capacity	16 U.S. Quarts
Seating	6
Wing Loading	27.6 lbs/sqft
Power Loading	8.45 lbs/hp
Engine	300 HP (224 kW) Continental IO-550-C. Normally aspirated, Fuel-injected, direct-drive, air-cooled, horizontally opposed, 6-cylinder, 550-cubic-inch displacement.
(Turbocharged)	325 HP (242 kW) Continental TSIO-520-WB. Turbocharged, Fuel-injected, direct-drive, air-cooled, horizontally opposed, 6-cylinder, 520-cubic-inch displacement.
Propeller	3-Blade McCauley, Constant Speed, Aluminum, Hydraulically Actuated, 78 inch propeller. Fully fine blade angle of 15.2°, Low pitch blade angle of 55.0°, and feathering angle of 82.5°.
Approved Fuel Grades	Aviation Gasoline Grade 100LL (blue) Aviation Gasoline Grade 100 (green)
Fuel Capacity	Total Capacity: 172 U.S. Gallons (Each Tank: 86 U.S. Gallons) Total Usable: 166 U.S. Gallons
(Turbocharged)	Total Capacity: 202 U.S. Gallons (Each Tank: 101 U.S. Gallons) Total Usable: 196 U.S. Gallons
Electrical System	
Voltage:	28 VDC
Battery:	24V, 12 amp-hour, sealed lead acid battery
Alternators:	28V, 80 amp @ 2,300 RPM, each engine
Pressurization System	3.9 PSI Maximum Pressure Differential Pressurization Rate Controller 150 ft/min to 2,000 ft/min Minimum/Maximum attainable altitude -1,000 ft / 15,000 ft

Aircraft Performance (Normally Aspirated)

Maximum Cruising Speed	198 ktas
Normal Cruising Speed	180 ktas
Economy Cruising Speed	153 ktas
Takeoff Distance	2,345 ft
Takeoff Ground Roll	1,373 ft
Landing Distance	2,428 ft
Landing Ground Roll	1,378 ft
Normal Range	1,013 nm
Maximum Range	1,276 nm
Rate of Climb	1,610 ft/min
Service Ceiling	20,668 ft
Empty Weight	3,120 lbs
Max Ramp Weight	5,520 lbs
Max Takeoff Weight	5,500 lbs
Max Landing Weight	5,500 lbs
Useful Load	2,400 lbs
Usable Fuel Weight	996 lbs
Full Fuel Payload	1,404 lbs
Maximum Operating Temp.	+53°C
Minimum Operating Temp.	-54°C

Aircraft Performance (Turbocharged)

Maximum Cruising Speed	261 ktas
Normal Cruising Speed	245 ktas
Economy Cruising Speed	166 ktas
Takeoff Distance	2,643 ft
Takeoff Ground Roll	1,555 ft
Landing Distance	2,490 ft
Landing Ground Roll	1,440 ft
Normal Range	1,186 nm
Maximum Range	1,438 nm
Rate of Climb	1,850 ft/min
Service Ceiling	25,000 ft
Empty Weight	4,010 lbs
Max Ramp Weight	6,240 lbs
Max Takeoff Weight	6,200 lbs
Max Landing Weight	6,200 lbs
Useful Load	2,230 lbs
Usable Fuel Weight	1,176 lbs
Full Fuel Payload	1,200 lbs
Maximum Operating Temp.	+53°C
Minimum Operating Temp.	-54°C

V-Speeds

Vr	81 kts	(Rotation Speed)
Vs	84 kts	(Clean Stalling Speed)
Vso	78 kts	(Dirty Stalling Speed)
Vmc	81 kts	(Minimum Controllable Speed w/ Critical Engine Inoperative)
Vx	95 kts	(Best Angle of Climb Speed)
Vy	115 kts	(Best Rate of Climb Speed)
Vxse	102 kts	(Best Single Engine Angle of Climb Speed)
Vyse	115 kts	(Best Single Engine Rate of Climb Speed)
Va	156 kts	(Maneuvering Speed)
Vg	115 kts	(Best Glide Speed)
Vfe	122 kts	(Maximum Full Flap Extension Speed)
Vfa	152 kts	(Maximum Approach Flap Extension Speed)
Vle	152 kts	(Maximum Landing Gear Extension Speed)
Vno	195 kts	(Maximum Structural Cruise Speed - exceed only in clean air)
Vne	223 kts	(Do Not Exceed Speed)

Engine Limitations

Engine Speed	2,700 RPM
Cylinder Head Temperature	460°F (238°C)
Exhaust Gas Temperature	1650°F (900°C)
Oil Temperature	240°F (116°C)
Oil Pressure	30 PSI (min.) 100 PSI (max.)
Fuel Pressure	1.5 PSI (min.) 17.5 PSI (max.)
Manifold Pressure	29.6 inHg / 39.5 inHg (Turbocharged)

Turbocharger Limitations

Critical Altitude	20,000 ft (varies with throttle and atmospheric conditions)
Turbine Inlet Temperature	1650°F (900°C)
Maximum Turbine RPM	125,000 RPM

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

NOTE: The 58TC and 58P are “turbocharged” aircraft, as opposed to a “turbonormalized” aircraft, meaning that the engine is capable of operating at intake manifold pressures greater than that of sea level (29.9 inHg).

Other Operating Limitations

- Do not engage starter for more than 30 seconds in any 4-minute period.
- Do not take-off when fuel quantity gauges indicate in the yellow arc, or with less than 20 gallons in each main tank.
- Maximum slip duration: 30 seconds.
- Do not attempt to fully retract landing gear with manual hand crank handle. Doing so may cause damage to worm gear shaft.
- Avoid cooling cylinders at rates greater than 60°F (33°C) per minute.

Instrumentation/Equipment List

Main Panel

- Glareshield Annunciator Panel
- True Airspeed Indicator
- Bendix/King KI 256 Vacuum Artificial Horizon
- Bendix/King KEA 130A Altimeter
- Bendix/King KI 229 Radio Magnetic Indicator (RMI)
- Bendix/King KI 525A Horizontal Situation Indicator (HSI)
- Vertical Speed Indicator
- Bendix/King KI 206 Localizer
- Mid-Continent Turn Coordinator
- Bendix/King KRA-10A Radar Altimeter
- Engine Instrumentation & Fuel Quantity Indicators
- Standby Copilot Instrumentation

Avionics

- Garmin GMA 340 Audio Panel
- Bendix/King KMA 24 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
- Bendix/King KX-155B (Com1/Com2)
- Bendix/King KNS-81 RNAV Navigation System (incl. Nav3)
- Bendix/King KR 87 (ADF)
- Bendix/King KDI 572R (DME)
- Bendix/King KFC 150 Autopilot
- Bendix/King KAS 297B Altitude Selector
- JPI EDM-760 Engine Monitor
- Bendix RDR1150XL Color Weather Radar
- Garmin GTX 327 Transponder

Electrical/Miscellaneous

- 80+ Circuit Breakers
- Voltmeter & Ammeters
- Bendix/King KA 51B Remote Compass Synchroscope
- Propeller Synchrophaser
- Propeller Amps Indicator
- Instrument Air Indicator
- Deicing Boot Pressure Indicator
- Oxygen Pressure Gauge
- Yoke-Mounted Digital Chronometers

- Hobbs Timer & Carbon Monoxide Detector
- Cabin Pressurization Controller
- Low Thrust 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 Baron Professional, 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 ‘Baron Professional’ 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.

Regular News

To get all the latest news about Just Flight products, special offers and projects in development, subscribe to our regular emails.

We can assure you that none of your details will ever be sold or passed on to any third party and you can, of course, unsubscribe from this service at any time.

You can also keep up to date with Just Flight via Facebook and Twitter.

Liveries & Custom Dynamic Tail Numbers

This aircraft is the first to debut 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

Annunciator Panel

The Baron Professional's annunciator panel consists of twelve annunciator lamps located on the pilot's side glareshield. From left to right, the lamps indicate the following conditions:

- Landing gear is up when flaps are fully extended or throttle is retarded
- Bus voltage is below 24 VDC
- Left or Right Alternator rectified voltage is below ~26VDC
- Left or Right Cowl Flaps are extended
- Air conditioning condenser door in fully extended (ground) position
- Starter is engaged
- Aft door is unlocked
- Deicing boot manifold is pressurized
- Left or Right pitot probe is receiving current
- Windshield heating pane is receiving current

Pressurized 58P Only:

- Door seals are not adequately inflated
- Cabin altitude exceeds ~11,500 feet
- Cabin pressure differential exceeds ~3.9 PSI

To test the glareshield annunciator panel, hold the "ANNUN TEST" push button, located to the left of the left engine magneto switches. To the left of the annunciators enumerated above, there are two red LEDs marked, "ENGINE MONITOR ALARM", which will blink when there is an active alarm on the EDM-760 engine monitor.

Above the artificial horizon is also an autopilot specific annunciator panel, which indicates active autopilot and flight director modes in a different format than on the face of the KFC 150 autopilot itself, which is sometimes preferential for quick reference. This panel includes a red back-course indicator, and red out-of-trim indicator, which illuminates when the aircraft's pitch is more than ten degrees away from the autopilot command pitch. This panel may be tested by depressing the "TEST" button on the face of the KFC 150. All annunciator lights will automatically dim when the panel lighting master switch is activated.

True Airspeed Indicator

The Baron Professional's airspeed indicator displays indicated airspeed in knots, reference speeds with colored arcs, and true airspeed on a white tape through the bottom window. The red marking corresponds to the never-exceed speed. The yellow arc corresponds to the clean-air-only speed, where the lower bounds of the arc is the maximum structural cruising speed. The lower end of the green arc corresponds to the clean configuration stalling speed. The upper end of the white arc corresponds to the maximum flap operating speed, and the lower end of the white arc corresponds to the full flap stalling speed.

Two additional radial marks are relevant to twin engine aircraft operation. The red line indicates Vmc, or minimum controllable speed with a single engine operating, and the critical engine inoperative. The blue line indicates the best single engine operating climb speed. A small white triangle indicates the maximum landing gear extension airspeed, and maximum approach flap setting airspeed. 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.

Bendix/King KI 256 Vacuum Artificial Horizon

A vacuum powered artificial horizon with illuminated decision height indicator, and adjustable attitude bars. Attitude bars are adjusted with the small screw adjustment on the bottom right of the unit's face. When paired with a KFC autopilot, the KI 256 is also capable of driving integrated attitude commend bars via the autopilot's flight director output. The command bars will automatically compensate for the adjusted position of the static attitude bar, and will be hidden from view when not in use.

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.

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.

Bendix/King KI 229 Radio Magnetic Indicator (RMI)

This RMI has an automatically rotating compass card that is driven via the aircraft's remote compass, and therefore, has no adjustment knob like an ADF. The solid yellow needle of the RMI is permanently driven by the NAV1 VOR navigation source, the same as the HSI source. The hollow green needle of the RMI is permanently driven by the KR 87 ADF receiver. Both needles will point directly to the tuned radio ground station whenever signal strength is sufficient. Since there are no flags on this unit to indicate reception, it is necessary to properly identify the station via its morse code identifier before using the RMI indications as a source of navigation. The RMI will show a red flag when the unit is not receiving power, or the unit is not receiving signal from the remote compass.

Bendix/King KI 525A Horizontal Situation Indicator (HSI)

The KI 525A HSI has an automatically controlled compass card, as opposed to most directional gyroscopic compass units, which can be automatically slaved to magnetic heading, or manually controlled via the remote compass controller. The HSI has two knobs for controlling the heading bug for visual reference, and for autopilot heading lateral navigation mode, and a knob for adjusting the course indicated with the yellow needle in the center of the display. The split yellow needle acts as a course deviation indicator, where the deviation scale depends on the navigation source, and operational mode, such as enroute GPS, or ILS antenna signal. On either side of the unit are normally hidden, yellow, glideslope indicator needles, which come into view when the glideslope signal is valid. Under the yellow course indicating needle, two windows with white indicators show the traditional to/from VOR indication when a VOR radio source is selected. When no navigation source has a valid signal, a red “NAV” flag appears at the top of the display. When no valid signal is received from the remote compass, a red “HDG” flag appears at the top of the display. When the unit is not receiving power, both flags are visible. The HSI in this aircraft can be controlled by either the NAV1 source, or the RNAV source, by selecting with the switch located below the KDI 572R DME display unit.

NOTE: The autopilot will only use the KNS-81 as a navigation source when the no-GPS avionics configuration is selected from the tablet interface. Press the navigation source button to illuminate its “RNAV” annunciator. Use the toggle switch below the HSI to select “RNAV” as the HSI source.

Vertical Speed Indicator

A vertical speed indicator displaying a maximum of +/- 4,000 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.

Bendix/King KI 206 Localizer

The KI 206 Localizer acts as a secondary radionavigation source in this aircraft, being permanently driven by the NAV2 VOR radio source. The KI 206 includes both lateral and vertical guidance needles, which can be driven from either a VOR/ILS receiver, or via the GNS 430W. The unit incorporates both vertical “GS”, and horizontal “NAV” red flags to indicate when the unit has power, and when the respective navigation source is being received. Two windows with white indicators show the traditional to/from VOR indication when a VOR radio source is selected. This unit is not connected to the 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.

Bendix/King KRA-10 Radar Altimeter

The KRA-10 Radar Altimeter displays the height of the belly-mounted radar transducer with respect to the terrain below the aircraft. The yellow indicating needle rests in a vertical "OFF" position when the unit is not receiving power, a valid signal, or when the indicated altitude is below 10 feet. An orange decision height bug can be positioned from 0 to 2,500 feet on the indicating scale with the adjustment knob. When passing the decision height in a descent, the integrated, yellow, decision height indicator will illuminate, as well as the connected indicator on the KI 256 attitude indicator. Be aware that the indicating scale is non-linear.

Engine Instrumentation & Fuel Quantity Indicators

A column of five round-dial engine instruments in the main panel are used to monitor the health of the powerplant. From top to bottom, the gauges are Manifold Pressure (inHg), Propeller RPM (RPM x 100), Fuel Flow (gal/hr), Cylinder Head Temperature (CHT °C), Exhaust Gas Temperature (EGT 20°C/Div.), Oil Temperature (°C), and Oil Pressure (PSI). Some of these instruments are passively driven from the accessory gearbox on the engine, while others are electrically driven; therefore, some will remain functioning with a total loss of electrical power.

The turbocharged version of this aircraft is fitted with different fuel flow and manifold pressure gauge scales than the normally aspirated version. These engines are capable of operating at wide-open throttle manifold pressures of up to 39.5 inHg, and fuel flows approaching 40 GPH.

Under the engine instrumentation, there are two fuel quantity indicators on the subpanel behind the throttle quadrant. The fuel indicators are marked in fractions, not gallons. Each fuel tank has a capacity of 86 U.S. Gallons, with 83 gal usable in the normally aspirated aircraft, and 101 U.S. Gallons, with 98 gal usable in the turbocharged aircraft. The extra 15 gallons of fuel stored in each wingtip cell of the turbocharged variants is not reflected on these instruments. The fuel totalizer function of the EDM-760 can estimate the quantity of fuel remaining before the quantity comes within the range depicted on the fuel gauges. Takeoff is not permitted when either fuel quantity is within the marked yellow arc at the 1/4th level, or approximately 20 gallons.

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.

Duplicate Copilot Instrumentation

Three primary flight instruments are included on the co-pilot's side of the aircraft: an airspeed indicator, artificial horizon, and altimeter.

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. For more information on Black Square's gyroscope simulation, see the "Gyroscope Physics Simulation" section of this manual.

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 previous 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.

Garmin GMA 340 Audio Panel

This audio controller is very common in light aircraft, and allows for the control of both receiving and transmitting audio sources on one panel. In addition, this implementation also supports listening to multiple VHF communication sources at once, and transmitting on both Com1 and Com2 by pressing the “COM 1/2” button. When you want to return to normal operation, press one of the “COM MIC” keys, and the integrated “COM 1/2” button indicator should extinguish.

KMA 24 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 right of the unit, from the following options: Unit off (OFF), Radiotelephone (TEL), COM 1, COM 2, Cabin Interphone (INT), and External Interphone (EXT). The unit possesses two rows of toggling push button selector switches to choose audio receiving sources. The top row is used to select an unlimited number of simultaneous audio sources for the cabin speaker, while the bottom row selects sources for the headphone circuit. Only the bottom row has an effect on the audio source within the simulation.

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.

Bendix/King KX-155B (Com1/Com2)

This 1990's era Com/Nav receiver allows you to control audio and navigation source inputs from two independent communication and navigation antennas, the left side controlling the VHF Com radio, and the right controlling the VHF Nav radio. Frequency tuning increments can be toggled by pulling on the inner knob of the COM side (labeled "PULL 25K"). The small adjustment knob on the Com side of the unit controls receiver volume, and can be pulled to toggle between US and European frequency spacing. The smallest tunable increment in US mode is 25 kHz, and the smallest possible increment in European mode is 8.33 kHz. The COM display will show frequencies with three decimal places when in 8.33 kHz mode, and two decimal places in 25 kHz mode. When the inner frequency adjustment knob on the NAV side is pulled, the same frequency adjustment knob will tune the active NAV frequency, and the standby frequency will be flagged with dashes. Additionally, a small "T" symbol will be displayed between the active and standby COM frequencies whenever the radio is transmitting. The small adjustment knob on the Nav side of the unit controls Nav receiver identifier volume, and can be pulled for an audible identifier tone.

NOTE: To hear an audible radio station identifier, both the small, right adjustment knob on the KX155 must be pulled out, and the appropriate NAV receiver indicator light must be illuminated on the GMA 340 Audio panel.

Bendix/King KNS-81 RNAV Navigation System

See the standalone section of this manual for instructions on using the KNS-81, below. All stored frequencies, radials, and offsets associated with this unit will be automatically saved and recalled at the beginning of a new flight.

NOTE: The autopilot in this aircraft is capable of receiving navigation input from the KNS-81, 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 "VLOC/RNAV", instead of "VLOC/GPS". For more details, see the "Flying an RNAV Course with the Autopilot" section of this manual.

Bendix/King KR 87 ADF

The KR 87 ADF receiver allows for standby ADF frequencies to be selected with the dual concentric rotary knobs on the right of the unit. When tuning a frequency, you will be editing the standby frequency, which can be swapped into the active frequency by pressing the "FRQ <->" push button. The two push buttons to the right of the "FRQ <->" button are for controlling the integrated flight timer. The "FLT/ET" push button toggles between the flight duration timer, which is automatically started when power is applied, and the elapsed time timer, which is started, stopped, and reset with the "SET/RST" push button. The "ADF" push button toggles the receiver's antenna mode between normal operation, and listening to the sense-only antenna (disabling the loop antenna), which makes receiving low signal strength audio-only transmissions easier. The "BFO" push button toggles the unit's beat frequency oscillator, which is used to listen to low signal strength morse code identifiers. A secondary click the power knob will increment the standby frequency by 0.5 kHz, indicated with a dot to the left of the frequency.

Bendix/King KDI 572R DME

This implementation of a KDI 572 behaves similarly to any other Distance Measuring Equipment (DME) receiver, displaying a nautical mile distance to the selected and tuned station, the current speed of the aircraft relative to the selected and tuned station, and a time-to-go until over the station. It should be noted that, like all other DME displays, this one is similarly dependent on being within the VOR service volume, and having good line-of-sight reception of the station. It should also be noted that these distances, speeds, and times, are based on slant-range to the station, not distance along the ground, as one would draw on a map. In order to receive DME information on the KDI 572, the station must be tuned in one of the two navigation radios, the station must be equipped with DME transmitting equipment, the station must have adequate signal strength, and the KDI 572 must have the appropriate navigation source selected via the selector knob mounted on its face.

Selecting “HLD” mode will hold the current DME frequency and information on the unit, while allowing the user to change the tuned NAV frequencies on the NAV1 or NAV2 radios. This can be useful for some specific instrument approaches. This unit’s state will be automatically saved and reloaded at the start of the next flight.

Bendix/King KFC 150 Autopilot

The KFC 150 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. The unit has an autopilot master push button, and can be disabled via the yoke-mounted autopilot disconnect push buttons. Along the row of push buttons, the autopilot’s mode selections include, flight director, altitude hold mode, heading hold mode, lateral navigation mode, approach coupling mode, and back course mode. A test button is included on the face of the unit to test the autopilot annunciators, and perform a self-test of the KFC unit. When in altitude hold mode, an “UP DN” rocker switch located on the left of the init is used to adjust the selected altitude by increments of 100 feet. Alternatively, when in pitch hold mode, the same rocker switch can be used to increase or decrease the pitch holding reference by increments of one degree. The KFC 150 is designed to be used with the KAS 297B altitude and vertical speed selector.

The flight director on the KI 256 attitude indicator can be activated and deactivated via the “FD” button on the KFC 150. The flight director can also be deactivated via the red autopilot disconnect buttons on either yoke. In the real aircraft, this push button has two stages of activation. For your convenience, this feature is approximated with two presses of the button. The first press will deactivate only the autopilot master, allowing the user to hand-fly the aircraft. The flight director and relevant modes will remain engaged. Upon pressing the disconnect button a second time, the flight director will also be disengaged. When the autopilot master is disengaged after the first press, all autopilot modes can still be selected on the KFC 150, which will apply to the command bars, just as if the autopilot was still flying the aircraft itself.

Bendix/King KAS 297B Altitude Selector

The KAS 297B resides on the main instrument panel, above the pilot's altimeter. The altitude selector is an integral part of the KFC 150 autopilot system, allowing the pilot to select target and alert altitudes, as well as vertical speeds. The unit's dual concentric rotary encoder can be used to select target and alert altitudes by default, and can be used to select vertical speeds when the inner knob is pulled out. The outer knob will adjust both quantities in 1,000 ft(/min) increments, and the inner knob will adjust both quantities in 100 ft(/min) increments. When the knob is pulled, "FT/MIN" will illuminate on the display, as opposed to just "FT" when in altitude selection mode. When adjusting vertical speed, two small arrows to the left of the set rate indicate whether the desired vertical speed is a climb or a descent.

When the autopilot is transitioning between vertical speed hold mode and altitude hold mode to capture the desired altitude, "CAPT" will illuminate on the display. When approaching the desired altitude within 1,000 feet, or departing the set altitude beyond 300 feet, "ALERT" will illuminate on the display, and an audible tone will be heard. Pressing the altitude hold mode button on the KFC 150 will cancel any currently set altitudes in the KAS 297B, insert the current barometric altitude, and begin to level the aircraft to hold the shown altitude. Whenever a change in vertical speed occurs by means other than the concentric adjustment knobs, such as via the KFC 150 rocker switch, or when using external hardware, the vertical speed will be displayed momentarily for two seconds if the unit is otherwise displaying the selected altitude.

When adjusting vertical speed, the aircraft will remain level at the currently captured altitude until vertical speed mode is activated. Pressing the "VS ENG" button when the vertical speed is displayed will begin a climb or descent at the currently selected vertical speed. Pressing "VS ENG" when the selected altitude is displayed will synchronize the target vertical speed with the aircraft's current vertical speed and being a climb or descent. If the climb or descent is in the direction of the selected altitude, altitude capture will automatically be armed. Alternatively, pressing the "ALT ARM" button when either value is displayed will toggle altitude capture arming mode. When altitude capture is armed, pressing "VS ENG" when either value is displayed will begin a climb or descent with the selected vertical speed.

NOTE: In order to use the new vertical speed arming capabilities of this unit, external hardware must be configured to use the HTML events: “kas297b_VsButton”, “kas297b_ArmButton”, “kas297b_1000_INC”, “kas297b_1000_DEC”, “kas297b_100_INC”, and “kas297b_100_DEC”. If you do not wish to use these events, the original functionality of the KAS 297B in this aircraft without vertical speed arming has been maintained for use with the native vertical speed hardware events, such as “AP_VS_VAR_INC” or “AP_VS_VAR_SET_ENGLISH”.

JPI EDM-760 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-760, below.

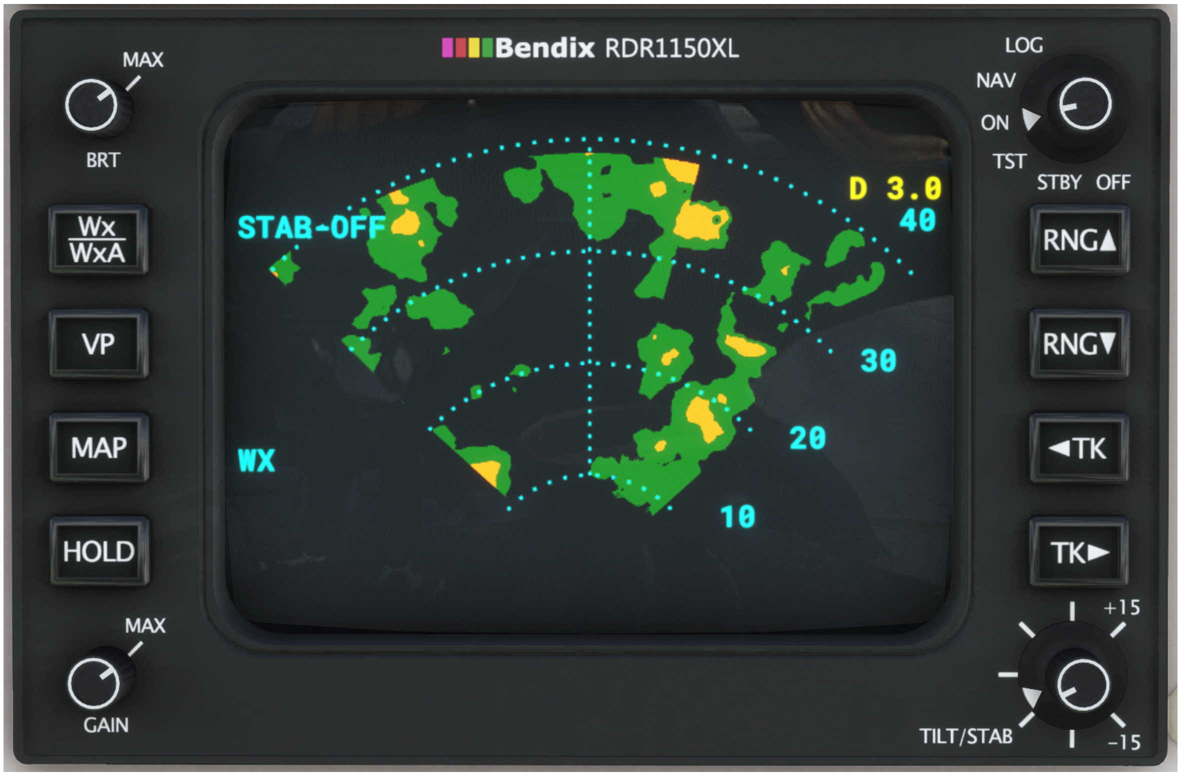
Bendix RDR 1150XL Color Weather Radar

This implementation of the Bendix RDR 1150XL has six selectable modes via the mode select knob in the upper right-hand corner of the unit. When cycled through the “OFF” mode, the unit will perform a self-test upon startup, and will annunciate if signal is not received from the aircraft’s external weather radar transceiver unit.

In “STBY” mode, the unit is in a safe standby mode, which does not energize the radar transmitter. It is recommended that the unit be placed in standby mode whenever the aircraft is operating on the ground to avoid injuring ground personnel, or sensitive equipment on other nearby aircraft. In this mode, the unit will annunciate “STAND BY” in yellow in the center of the radar arc.

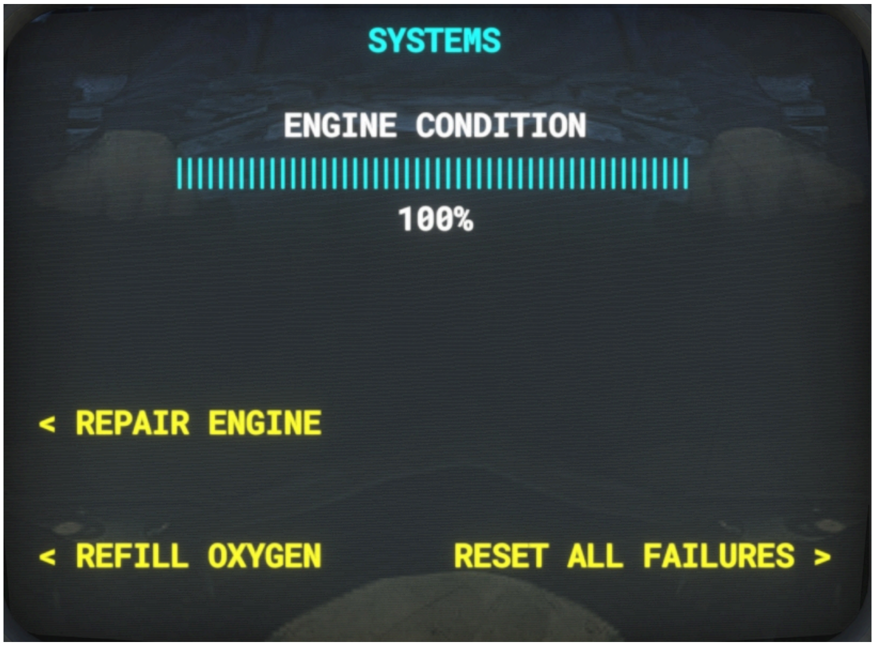
In “TST” mode, the unit will continuously display a sweeping test signal from the radar unit, which should subtend the full horizontal radar arc, and contain concentric arcs of magenta, red, yellow and green. The “RT FAILURE” flag will also display in cyan.

The “ON” mode is the normal mode of operation for this unit. In “ON” mode, the radar will display precipitation and severe turbulence in the above color spectrum, within the radar arc on the screen. The range of the display can be adjusted with the “RNG ^”, and the “RNG v” push buttons. Nautical mile distances are displayed adjacent to the range rings on the radar display. By pressing the “VP” button, the unit can be toggled between horizontal and vertical profile modes, which are annunciated in the upper left-hand corner of the display. The “<TK” and “TK>” buttons can be used to pan the radar transceiver to the right or left, and the “TILT” knob can be used to tilt the radar transceiver up or down. The position of the radar transceiver is annunciated on the display in yellow, but there is no effect on the underlying weather radar simulation. Lastly, “BRT”, and “GAIN” knobs on the left of the unit can be used to control the brightness and gain of the radar respectively. “NAV” and “LOG” modes are not implemented yet in this unit. This unit’s state will be saved automatically and reloaded.



This aircraft is equipped with an underlying software system that is capable of triggering a failure of almost any simulated aircraft system, either determined by the Mean Time Between Failure (MTBF) of each component, or at a scheduled time. Failures are configured via the tablet interface, discussed in the "Tablet Interface" section of this manual. The "NAV" and "LOG" pages of this weather radar interface have been replaced with quick access shortcuts for accessing the failure and engine condition options in this aircraft.

On the NAV page, you will be presented with a segmented bar graph indicating the current engine condition. Using the keys on the weather radar bezel indicated by the YELLOW text and accompanying arrows, you can reset engine conditions to 100% and restore all of their components to working order, refill the oxygen cylinder, or recharge the batteries.



On the LOG page, you will be presented with the current number of active failures. This can be useful if you wish to be alerted of new failures without having the tablet interface open, since the weather radar sits just within the forward view of the pilot. Pressing the corresponding button on the weather radar's bezel to reset all failures, will reset all the currently active failures.

Garmin GTX 327 Transponder

The GTX 327 transponder supports the typical transponder modes of operation; off, standby, on, and altitude reporting mode. This transponder also has a VFR preset button, which will automatically set the transponder code to your region's VFR flight code (such as 1200 in the United States). The unit is also equipped with an ident button for responding to ident requests from air traffic control. Pressing the "FUNC" button will cycle through the unit's function modes, which are as follows:

1. Pressure Altitude (in flight levels)
2. Flight Timer (triggered by weight-on-wheels sensor)
3. Outside Air Temperature & Density Altitude
4. Count Up Timer
5. Count Down Timer

Timers can started and stopped by pressing the "START/STOP" button, and the time can be cleared/reset with the "CLR" button.

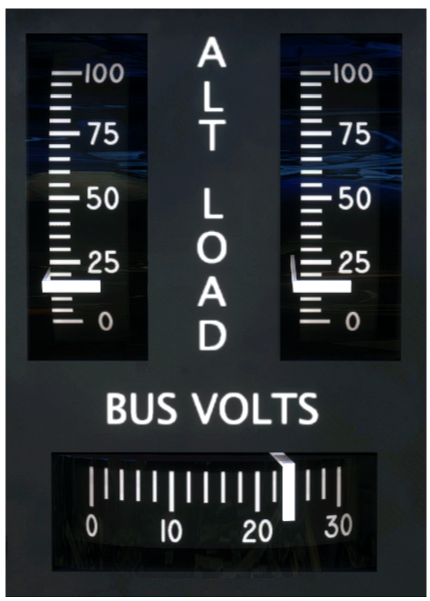
Electrical/Miscellaneous

Circuit Breakers

The Baron Professional's circuit breaker panels are located on the cockpit sidewall to the left of the pilot's seat, and under the copilot's subpanel. The latter of the two panels resides on a separate avionics electrical bus. 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. The last circuit breaker to the right on the avionics panel is a relay that connects the avionics bus to the aircraft's main electrical bus.

Voltmeter & Ammeters

Under the fuel quantity gauges on the center subpanel, two meters with vertical scales indicate the total load on the aircraft's two alternators. Another meter with a horizontal scale indicates the bus voltage. The ammeters indicate current (in percent of maximum) being supplied by each alternator. The voltmeter indicates the voltage of the aircraft's main bus from 0V to 30V.

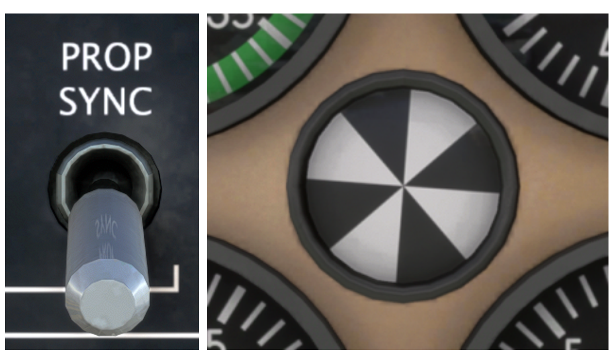


Bendix/King KA 51B Remote Compass Synchroscope

This aircraft contains a Bendix/King remote compass, and remote compass controller with integrated synchroscope. The purpose of a remote compass is to supply several instruments, autopilots, or navigation systems with a reliable source of magnetic compass direction that is continuously correcting for gyroscopic drift. This is accomplished by integrating a fluxgate magnetometer's sensing of magnetic direction with a larger gyroscope than could fit within the housing of a single panel-mounted instrument. This remote compass erects to the correct magnetic heading when powered on, and will automatically correct for gyroscopic drift throughout the flight when the remote compass controller's mode switch is placed in the "SLAVE" position. In this mode, the integrated synchroscope should display a white line, centered between the stationary + and - markings. Should the position of the remote compass become unreliable, such as during flight through magnetic disturbances or over the earth's poles, the remote compass can be placed in a manual mode by placing the mode switch in the "FREE" position. In this mode, the input of the magnetometer will be ignored, and the unit will behave like a normal directional gyroscope. The position of the remote compass can be advanced in one direction or another by holding the remaining switch on the remote compass control in either the clockwise ("CW") direction, or the counter-clockwise ("CCW") direction. In this mode, the synchroscope will show the set compass position's deviation from the detected magnetic heading.

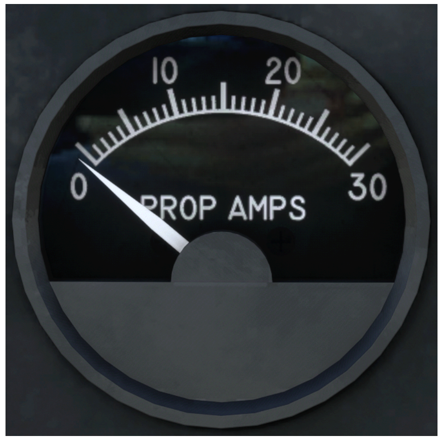
Propeller Synchrophaser

Since the Baron Professional is equipped with a propeller synchronizer, it is also equipped with a visual synchrophaser on the main panel. The synchrophaser is a small disk with alternating black and white wedge marks. When one propeller is spinning faster than the other, the disk will rotate in the direction of that propeller; counterclockwise for the left engine, and clockwise for the right engine.



Propeller Amps Indicator

The propeller ammeter gauge indicates the flow of current to the propeller hubs during deicing. Nominal current when cycling is 20-25 amps.



Deicing Boot Pressure Indicator

Deicing pressure for the aircraft's inflatable deicing boots is supplied by a mechanical instrument air pump on each engine. This is the same air source used to power the gyroscopic flight instruments, and the standby door seal system in the pressurized model. This gauge indicates the pressure in PSI being admitted to the deicing boots, and will cycle as the automatic deicing boot controller cycles the pressurized air to the different zones of the aircraft. The pressure will be a few PSI less when operating the deicing boots in manual mode, as this activates all deicing zones at once. The pressure will be further reduced while the standby door seal valve is open.

Instrument Air Indicator

The instrument air indicator shows the regulated air pressure generated by the two engine-driven air pumps. The scale on the gauge indicates the acceptable pressure 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. Since dual engine failure in a twin engine aircraft is very unlikely, there is no additional electric standby instrument air pump. At the bottom of the gauge, there are two red incandescent indicator bulbs to indicate when a source of instrument air has become inoperable. These indications should be checked during engine starting.

Oxygen Pressure Gauge

On the copilot's subpanel in the normally aspirated version of this aircraft, a gauge indicates the oxygen pressure available in the onboard, refillable oxygen cylinder. This cylinder is normally pressurized to 1,850 - 2,150 PSI when serviced on the ground. Oxygen pressure will deplete as it is consumed by passengers and crew, when activated. To activate the built-in demand-type oxygen regulators for all occupants, pull the green oxygen supply handle on the pilot's subpanel out to the 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 "SYSTEMS" page on the weather radar, or 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.

Yoke-Mounted Digital Chronometers

On each yoke, there is a digital chronometer capable of displaying two different clock modes, and one timer mode, cycled through with the “SELECT” push button. The two clock modes are Universal Time (“UT”), and Local Time (“LT”), each in 24-hour format. The Elapsed Time (“ET”) mode is a count-up stopwatch, controlled via the “CONTROL” push button. The maximum displayable time in Elapsed Time mode is 99 minutes and 59 seconds. The mode of these chronometers will be automatically saved and restored at the beginning of a new flight.

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.

Cabin Pressurization System

The cabin pressurization is controlled via several switches and push-buttons on the co-pilots subpanel, and a dial behind the throttle quadrant. The selector dial consists of two offset control knobs. The small knob at the bottom left controls the cabin climb/descent rate from between approximately 150 ft/min to 2,000 ft/min. A position approximately one third of the knob's full rotation from the counterclockwise stop should produce a desirable climb rate of around 700 ft/min. The larger, centrally located knob controls the destination cabin altitude by rotating a scale visible through the plastic window above the knob. The upper scale of this rotating card (labeled “CABIN”) is used to set the desired cabin altitude from -1,000 ft to 15,000 ft. The lower scale (labeled “ACFT”) rotates with the upper scale and depicts the approximate aircraft pressure altitude at which the pressurization controller will no longer be able to maintain the desired cabin pressure.

For example, when the upper scale is set to 8,000 ft at the small black index mark on the plastic window, the inner scale will read approximately 19,900 ft at the same black index mark. This means that the pressurization controller will be able to maintain a cabin pressure equivalent to 8,000 feet pressure altitude until the aircraft reaches 19,900 feet pressure altitude. If the aircraft continues climbing without an adjustment being made to the pressurization controller, the cabin altitude will begin climbing beyond the desired 8,000 feet. If the cabin pressure differential becomes negative, or increases beyond 3.9psi, the electric dump valve will activate, rapidly dropping the pressure differential. The electric dump valve can be disabled by pulling the “CABIN PRESS” circuit breaker.

To the right of the cabin pressurization controller dial are two push-buttons, and two toggle switches relating to cabin pressurization control. The top toggle switch has two positions, “PRESS” and “DUMP”. When cabin pressurization is desired, this switch should be placed in the “PRESS” position. Cabin pressure should always be dumped using this switch after landing, and before opening cabin doors, or cockpit windows. Pressing the colocated “TEST” button will bypass the weight-on-wheels sensor, allowing the cabin to pressurize while on the ground, which is required for the pressurization ground checks.

Below, another two-position toggle switch, labeled “PRESS”, activates the aircraft’s inflatable door seals, which are required for pressurized operation. In the event of a primary door seal pressurization failure (indicated by the red “DOOR SEAL” glareshield annunciator), the door seals may also be pressurized by either instrument air source supplied by the engines. To pressurize the door seals in the event of a primary failure, leave the door seal mode switch in the “PRESS” position, and pull the “door seal standby system” lever on the pilot’s subpanel away from the instrument panel. Press and HOLD the red “STANDBY” push-button on the door seal panel to momentarily inflate the door seals. If the “DOOR SEAL” glareshield annunciator extinguishes, the standby system has successfully inflated the door seals to an acceptable pressure (around 16 PSI). If high altitude flight is continued, the door seal annunciator light will illuminate again as pressure is slowly lost in the door seal system. Press the momentary push-button again to reinflate the door seals, and consider descending to an altitude that does not require pressurization as soon as practical.

NOTE: Door seal pressure can be monitored on the cabin visualizer page of the tablet interface. The pressurization of the door seals will also reduce cabin wind noise, which can be used as a secondary indicator of the door seal pressure.

Three additional glareshield annunciators are included in the pressurized version of the Baron Professional. One is the aforementioned “DOOR SEAL” annunciator, which indicates when a failure is detected in the primary door seal pressurization controller loop. An amber “CABIN ALT” annunciator indicates when the cabin is at pressure altitudes in excess of approximately 11,500 ft. Lastly, a red “CABIN DIFF” annunciator indicates when an exceedance of the 3.9 PSI maximum cabin differential pressure is imminent.

At the bottom of the pilot’s subpanel, to the left of the door seal standby air valve lever, are two pull handles labeled “CABIN PRESS AIR SHUTOFF”. Unlike the normally aspirated version of this aircraft, which derives no breathing air from either powerplant, the pressurization system uses regulated air from each turbocharger to pressurize the cabin. In the event of a fire, carbon monoxide leak, or other hazardous condition, it may become necessary to isolate an engine from the breathable air in the cabin by pulling these handles away from the instrument panel. They can also be used to test the pressurization supply air of each engine during the ground pressurization test, to ensure that both are working properly.

In order to prevent the cabin doors from being opened when the aircraft is pressurized, each door has a pressure differential activated locking mechanism. In the event that this locking mechanism becomes compromised, preventing the doors from being opened, each door is equipped with a pressurization lock bypass handle. Pulling this handle out and away from the door will defeat the pressurization lock, allowing the door to be opened, regardless of cabin pressure. If the doors will not open when the aircraft is on the ground and secured, follow the “Cabin Door Will Not Open” checklist before assuming the pressurization lock is not functioning properly to avoid a potentially damaging depressurization.

NOTE: As the Baron Professional's pressurization system derives its pressurized air from the aircraft's two turbochargers, the maximum attainable inflow pressurization is dependent on turbocharger RPM, just as is the intake manifold pressure. If the throttles are reduced while operating at very high pressure altitudes, turbocharger RPM may no longer be sufficient to sustain cabin pressurization. Check valves will prevent the rapid depressurization of the cabin, but leaks in the system will allow pressurized air to escape that cannot be replaced. This will likely be accompanied by a more severe than expected reduction in engine performance for the amount of throttle adjustment. For more information on managing turbochargers during high altitude operation, see the turbocharger operation section of this manual.

Low Thrust Detector

This aircraft is equipped with a now-rarely known system to aid in the identification of a failed engine during emergency procedures, or anticipate the incipient failure of a functioning engine. The low thrust detector system consists of two curved pitot tubes mounted in the propeller wash of each engine, a digital signal processing microcomputer, and several indicator LED's. When the thrust being produced by one engine falls slightly below the other, an amber LED will illuminate on the main instrument panel above the engine instrumentation to indicate that an engine failure or partial power loss may be imminent on the low thrust side. The low thrust detector is capable of detecting small variations in thrust, so false positive indications of partial engine failure can be expected during aggressive leaning. When the thrust of an engine falls significantly below the other, a blinking red LED will illuminate to indicate a complete engine failure. Users familiar with engine-out emergency procedures will immediately see the utility of this system, and the enhanced safety it offers by mitigating the chances of incorrectly identifying the failed engine.

Lighting Controls

Cabin Lighting

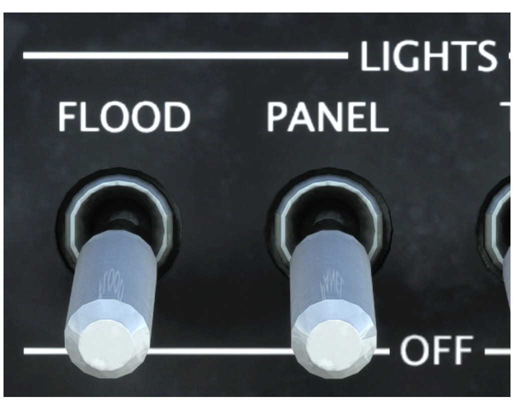
Cabin reading lights for each seating position can be turned on and off via the overhead push buttons over each seat. Ensure that cabin lighting is turned off during all flight and ground operations, as light bleeds from the cabin into the cockpit area, diminishing the quality of crew night vision. Keep in mind that incandescent, DC, cabin lighting presents a significant drain on the aircraft battery during operation. Use of cabin lighting should be kept to a minimum when the aircraft battery is the only source of electrical power.

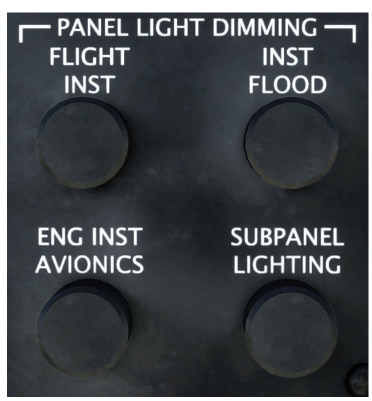
Panel Lighting

Panel lighting is controlled by two toggle switches on the pilot's subpanel, "PANEL" and "FLOOD", and four rheostats on the copilot's subpanel. The "FLOOD" switch corresponds to the "INST FLOOD" rheostat, and controls the blue-green indirect glareshield lighting. The "PANEL" switch corresponds to the other three panel lighting rheostats. The "FLIGHT INST" rheostat controls the intensity of the flight instruments' integrated lighting, or panel-mounted lighting stems for all flight instruments. The "ENG INST AVIONICS" rheostat controls the intensity of the engine instruments' integrated lighting, and the integrity lighting of the aircraft's avionics. Lastly, the "SUBPANEL LIGHTING" rheostat controls the intensity of the panel's electroluminescent integrity lighting. In order for a lighting system to be illuminated, its associated switch must be in the on position, and its rheostat turned clockwise to the desired lighting intensity.

Cockpit Lighting

In addition to the overhead cabin lighting, each yoke possesses a "MAP OAT COMPASS" toggling push button of similar style to the overhead cabin light switches. On the pilot's yoke, this button will control three lights: a stem light to illuminate the outside air temperature gauge, integrated lighting in the magnetic compass, and a map reading light on the underside of the yoke, which is focused at the pilot's knees. On the copilot side, this switch will only control the yoke-mounted reading light.





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.

State Saving

This aircraft implements "selective" state saving, meaning that not all variables are saved and recalled at the next session, but some important settings are, primarily to enhance the user experience. Of primary interest, the radio configuration is saved, as well as any preset frequencies/distances/radials/etc that are entered into radio memory. Many radio and switch settings are also saved for recall, including cabin environmental controls, and the state of other cabin aesthetics, such as sun visors, armrests, and windows. No action is required by the user to save these configurations, as they are autosaved periodically. The state of switches that affect the primary operation of the aircraft, such as battery switches, de-icing, etc, are not saved, and are instead set when the aircraft is loaded based on the starting position of the aircraft. Engine health and oxygen pressure are saved between flights, and can be reset via the tablet interface, or the "SYSTEMS" screen on the Weather Radar.

Fuel tank levels will be restored from the last flight whenever a flight is loaded with the default fuel levels. Due to a currently missing feature in MSFS, payload and passenger weights cannot be restored in the same method, although the code has been implemented to do so.

Whether or not the engine covers, pitot covers, and wheel chocks are deployed when loading the aircraft on the ground is controlled via the "Load with Covers & Chocks Deployed" option on the tablet's options page.

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 pilot'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. Cabin temperature can also be equalized with the use of the electric vent blower centrifugal fan mounted in the tail of the aircraft, or forward of the instrument panel in the pressurized variant. 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 combustion heater fan, air conditioning evaporator fan, or centrifugal vent blower fan.

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 above the copilot's airspeed indicator, 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 airspeed indicator 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.

Be aware that the electric ventilation systems increase the load required from the current power source substantially, and therefore should be used predominantly while under power, or when external power is supplied to the power distribution bus.

Cabin Environmental Controls

Unlike more complex aircraft with automatic environmental control systems, heating and cooling of the Baron Professional 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. On warmer days, use of the air conditioner will be necessary. Placing the air conditioning control switch in the "A/C" position will not begin cooling the cabin by itself. The left engine must be running at a sufficiently high RPM to engage a centrifugal clutch (~1,200 RPM), and the air conditioning condenser must be deployed. The air conditioning blower will automatically turn off when the landing gear is retracted, and the fresh air knob should be opened to allow the evaporator coils sufficient airflow for cooling. When cooling the cabin, the position of the fresh air knob and A/C blower switch are used as the primary means of setting the desired cabin temperature. Opening the fresh air valve while in flight, or increasing the speed of the air conditioning blower while on the ground, will increase the maximum cooling potential of the air conditioning system.

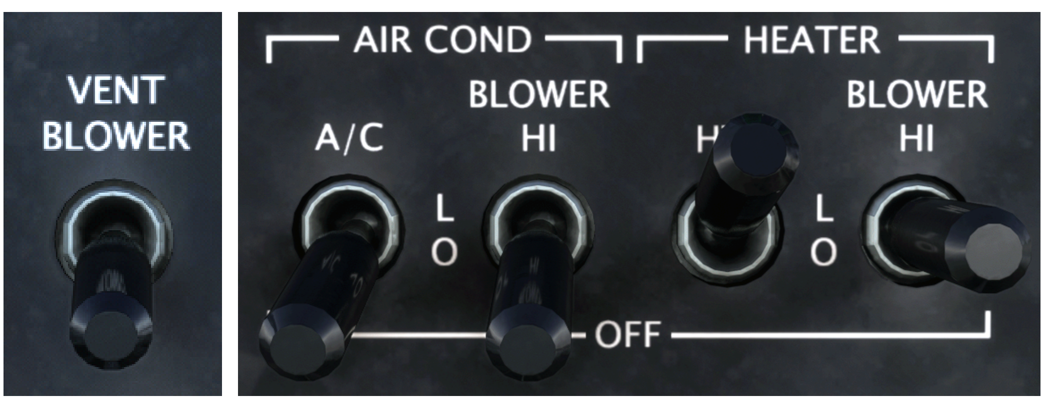
In the pressurized model of the aircraft, all air conditioning air is recirculated, and the air conditioning blower fan is not disabled when the landing gear is retracted, such that the operator can still control the desired amount of cooling. The intercooler air scoops on top each engine nacelle also open to further cool the pressurization supply air.

Cabin heating is supplied by a combustion heater, located under the floor of the nose baggage compartment, which exhausts through the pilot's side of the fuselage, outboard of the nose gear doors. When operating without the engines running, this heater's ignition and blower is clearly audible when it starts and stops. The combustion heater is ignited with the "HTR" switch on the pilot's right subpanel. A blower fan provides air to the combustion heater, sourced through a duct on the pilot's side of the aircraft's fiberglass radome. The combustion heater will consume fuel from the left tank only at a rate of approximately one-half gallon per hour when operating.

NOTE: The combustion heater will only operate in the unpressurized version of this aircraft if the "CABIN AIR VENT" slide handle is more than halfway towards the "ON" position to prevent dangerous overheating of the combustion heater. To fully open the ram air valve, slide the handle located under the main circuit breaker panel forward, towards the nose of the aircraft.

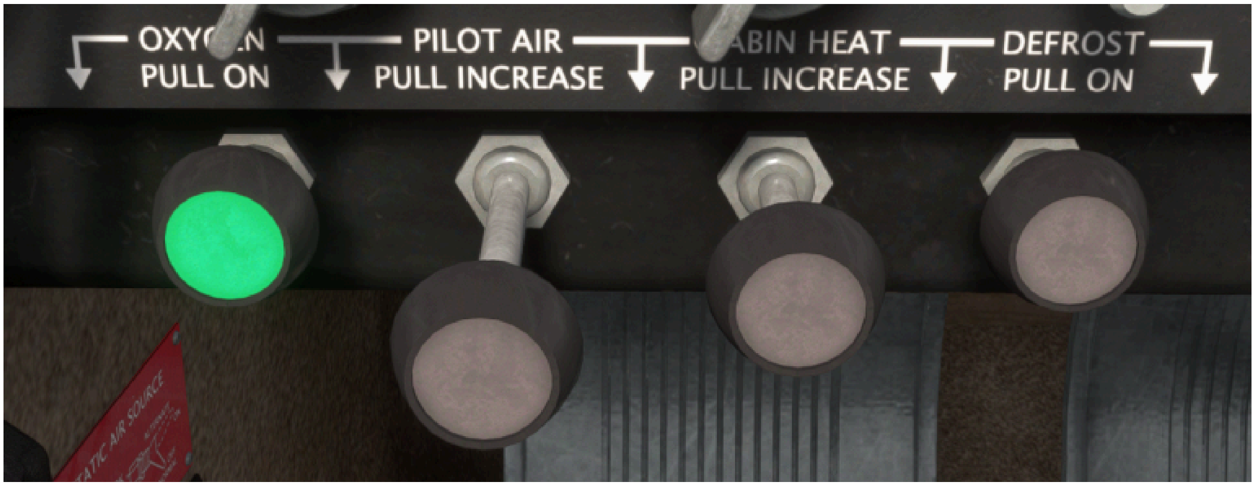
NOTE: A combustion heater is a gasoline powered furnace, and a notoriously dangerous piece of aircraft equipment. Should the combustion heater become compromised, it may result in poisonous carbon monoxide gas leaking into the cabin. Should carbon monoxide be detected in the cabin with an audible warning, the combustion heater should be considered a prime suspect, and its use should be discontinued immediately.

The exchanged air supplied by the combustion heater is distributed through the heating air ducts, which can admit heat to the cabin through the windshield defrosters, pilot air vent, and copilot air vent. The amount of heated air supplied to this duct from the combustion heater 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.



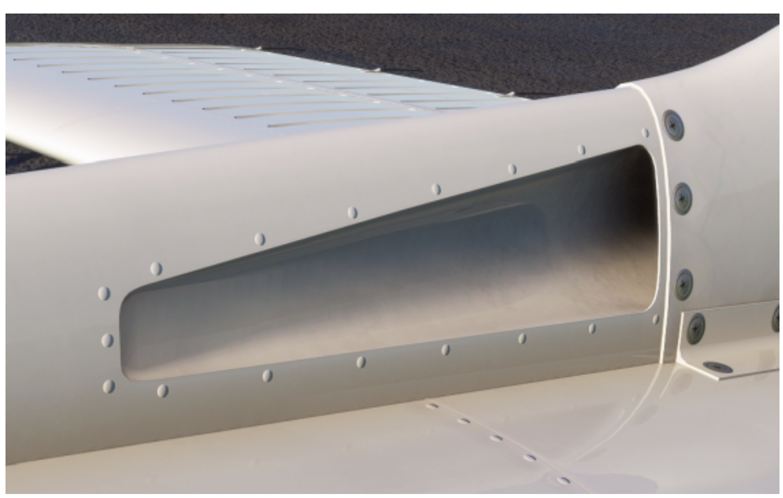
The air supplied from the combustion heater can be very hot, as the system has the capacity to keep the cabin warm at altitudes in excess of 20,000 ft, where ambient air temperatures can be as low as -60°F (-50°C). Operators should take caution when applying the cabin heat to reduce pilot workload during critical phases of flight, and also to limit the possibility of a cabin fire. The rate of heating is controlled via the cabin vents and heater blower, as with equalization and air conditioning. The heater blower fan is automatically disabled when the gear is retracted, and all air required for heating is supplied through the ram air intake in the nose of the aircraft.

NOTE: Both the air conditioning and heater blower fans can be operated independently of the air conditioning and combustion heater; however, each fan will operate at the low speed setting whenever its respective “A/C” or “HTR” switch is in the on position.



While the Baron Professional is equipped with deicing boots and a hotplate for windshield anti-icing, the windshield can be partially deiced using the defroster in the event of a primary system failure. The “DEFROST” control knob must be pulled away from the instrument panel, the “CABIN HEAT” knob must also be pulled out, and the combustion heater must be operating.

Fresh air for the unpressurized variant’s cabin is sourced from a NACA duct on the pilot’s side of the extended dorsal fairing. When the overhead “FRESH AIR” knob in the cockpit is rotated counterclockwise towards the open position, ram air is admitted into the cabin through this vent. This air can be used to cool the cabin passively, or supply air to the air conditioning evaporator coil to increase its efficiency.



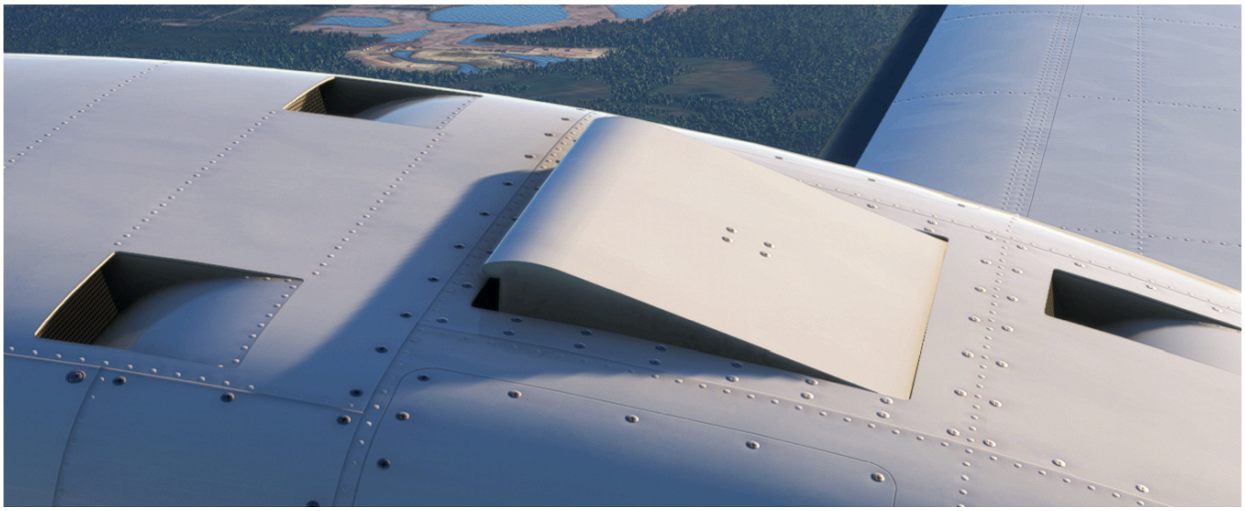
In unpressurized models of this aircraft, stale cabin air is exhausted through a port just aft of the rear cabin bulkhead on the pilot's side of the aircraft to promote fresh air ventilation in the cabin.

Air Conditioning Condenser Scoops

The Baron Professional is equipped with electromechanically actuated air conditioning condenser scoops on the top of the left engine nacelle in the unpressurized aircraft, and both engine nacelles in the pressurized model. When the air conditioner is not in use, the doors are fully stowed to minimize drag. When the air conditioner is used in flight, the doors are only partially extended. When the air conditioner is activated and the landing gear is extended, the condenser doors are fully opened to provide better cooling during ground operations. The air conditioner should be turned off and the door retracted before takeoff to ensure maximum climb performance. The additional drag produced by the air conditioner condenser scoop will rob the aircraft of several knots when in cruise flight, but could produce as much as 10 knots worth of drag should the door become stuck in the fully extended position during flight.

Left: fully extended - ground position   Right: partially extended - flight position

The pressurized model of the aircraft also has a door on the right engine nacelle, even though the vapor cycle cooling system’s condenser coil is only housed within the left engine nacelle. This right door is used to provide additional cooling airflow over the cabin pressurization air intercooler, so that warm pressurization air from the turbochargers does not counteract the efforts of the air conditioning system.



Above: pressurization intercooler door, partially extended - flight position

An annunciator on the glareshield annunciator panel marked “AC DOOR” indicates when the air conditioning condenser door is fully extended into the ground position. Should this annunciator illuminate in flight with the landing gear retracted, the air conditioner should be disabled in an attempt to retract the condenser door.

Air Conditioning Temperature Effects

When the air conditioner is operating, the load is increased on the left 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. The temperature increase is proportional to the airflow through the engine nacelle, which is influenced by the condenser scoop’s position. Particularly while operating on the ground, the operator should keep an eye on engine temperatures. Since the condenser door can become stuck in this aircraft simulation, a fully closed condenser door on the ground could cause dangerously high engine temperatures. During low airspeed climbs or while operating at low altitudes, the additional load on the engine may be significant enough to cause differential performance. This should be compensated for by use of differential mixture control. Increasing the mixture setting of the left engine will help keep the engine cool. When the additional load is significant, the left engine may cease combustion at idle throttle setting on the hottest days.

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 multi-engine aircraft, the absence of oil pressure will reduce the propeller blade pitch to the feathered position, but only when the oil pressure is reduced quickly; otherwise, counter-weighted feather locking pins will prevent the blades from feathering during a normal shutdown, or often an intentional shutdown in flight. For this reason, the propeller levers must be placed in the feather detent quickly during engine shutdown (while there is still oil in the propeller hub) to overcome the feather locking pins and feather the propeller.

The purpose of the feather locking pins is to prevent the propeller in a twin engine airplane from going into feather when the engine is shut down and oil pressure in the hub is lost. A feathered propeller makes the engine substantially harder to start, as the propeller blades produce much more air resistance, even at low RPM. The feather locking pins are controlled by flyweights, which keep the pins disengaged when RPM is sufficiently high. If RPM is allowed to decline slowly with the propeller in the fully fine position, such as during a normal shutdown, the flyweights will release the locking pins, and the propeller will remain fully fine, even with no oil pressure.

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. This means that airstarts are now physics based, as well as feathering. If a propeller is not successfully feathered on shutdown, physics based windmilling will occur. A windmilling propeller can be locked in place with the compression of the cylinders, but a much lower airspeed is required to stop the propeller than can be achieved without it rotating afterwards.

Unfeathering Accumulators

Once a propeller is feathered and the engine stopped, the engine driven fuel pump is no longer capable of supplying pressurized oil to the propeller hub, making unfeathering the propeller impossible. Many light piston twins, especially trainers, are equipped with unfeathering accumulators for this reason. When the engine is running, oil is pressurized into a hydraulic accumulator. When the engine is no longer running, oil pressure is maintained in this accumulator, and can be injected into the propeller hub to unfeather the propeller at least one time. This can salvage a flight by allowing the engine to be restarted more easily, but it can also significantly hinder emergency operations if the engine cannot be restarted, because the propeller may not feather again, leaving the pilot with a windmilling propeller. For this reason, it is only recommended to unfeather the propeller and attempt a restart if the operator believes the engine will restart normally after shutdown, such as during training, or after inadvertent fuel exhaustion.

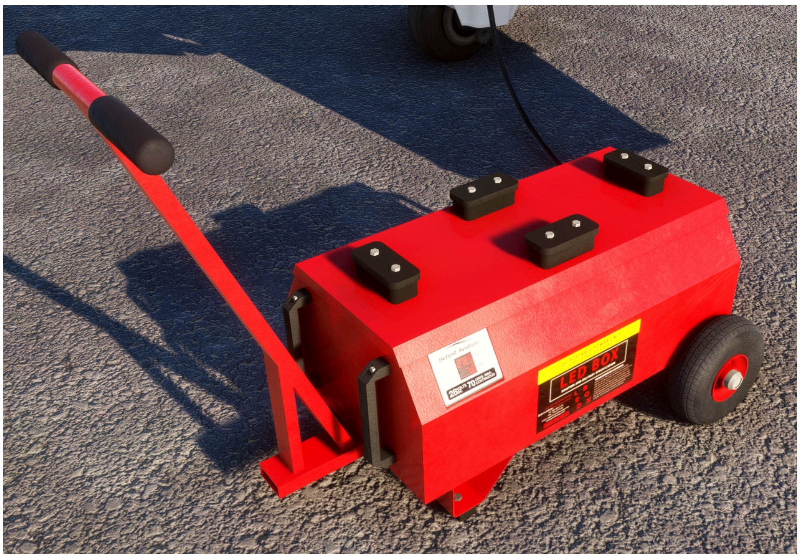
Engine Preheating

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.

External Power

Aircraft batteries are sized much smaller for their application than automotive batteries to save on weight. Running all the aircraft systems on the ground will be enough to drain the battery completely in 20-30 minutes. Starting in cold weather can also prove difficult, as batteries will provide less current with a greater voltage drop in cold conditions. For this reason, this simulation is equipped with an external battery cart. The cart is capable of supplying many times the capacity of the aircraft's onboard batteries, with almost no voltage drop due to high instantaneous loads while starting the aircraft. The external power cart is deployed from the "Exterior Elements" menu on the payload page of the tablet interface.



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 this particular aircraft, the outside air is boosted to a pressure in excess of sea level ambient pressure, of 39.5 inHg. The higher pressure intake air allows for a greater mass of fuel and air to be burned per every stroke of the piston, increasing the power output of the engine for a given RPM.

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 a specified maximum pressure. 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, the maximum rated intake pressure 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 maximum rated 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 turbocharged engine with an automatic wastegate 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, except for increased spool-up times to manifold pressures beyond sea-level. 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 39.5 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. 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-760 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 B58)

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

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

Press. Alt. (ft)	Man. Press. (inHg)	Engine RPM	Fuel Flow (PPH/Eng)	T/O Ground Roll (ft)	50ft Obstacle T/O Dist. (ft)	Rate of Climb (ft/min)
SL	29.6	2,700	141	1,373	2,345	1,720
2,500	27.2	2,700	130	1,692	2,741	1,610
5,000	24.8	2,700	117	2,096	3,392	1,305
7,500	22.6	2,700	106	2,544	4,302	1,120
10,000	20.4	2,700	95	3,141	5,631	915

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

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH / Eng)	KTAS	Range (nm)
SL	25	2,500	98	188	868
6,000	24	2,500	102	202	861
12,000	19	2,500	81	195	1,022
18,000	14	2,500	66	183	1,017
20,000	13	2,500	60	176	1,008

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

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH / Eng)	KTAS	Range (nm)
SL	23	2,300	78	171	1,006
6,000	23	2,300	88	190	935
12,000	19	2,300	76	186	1,038
18,000	14	2,300	61	173	1,047
20,000	13	2,300	55	165	1,096

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

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH / Eng)	KTAS	Range (nm)
SL	21	2,100	48	141	1,296
6,000	21	2,100	54	159	1,276
12,000	19	2,100	53	163	1,262
18,000	14	2,100	42	141	1,250
20,000	13	2,100	37	133	1,168

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)
6,000	24.0	2,500	100	5	4	11
10,000	20.5	2,500	102	10	8	26
14,000	17.2	2,500	96	19	14	48
*18,000	14.5	2,500	84	47	32	140
**20,000	13.6	2,500	81	52	35	148

Recommended Climb Airspeeds: 135 kts to 16,000 ft, 125 kts to 18,000 ft, 110 kts to 25,000 ft.

*Applicable only when gross weight is less than 4,500 lbs.

**Applicable only when gross weight is less than 4,000 lbs.

Engine Power Settings (Turbocharged B58TC & B58P)

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

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

Press. Alt. (ft)	Man. Press. (inHg)	Engine RPM	Fuel Flow (PPH/Eng)	T/O Ground Roll (ft)	50ft Obstacle T/O Dist. (ft)	Rate of Climb (ft/min)
SL	39.5	2,700	210	1,555	2,643	1,980
2,500	37.1	2,700	218	1,740	2,905	1,850
5,000	34.7	2,700	222	2,002	3,301	1,670
7,500	32.5	2,700	225	2,308	3,892	1,510
10,000	30.3	2,700	227	2,611	4,292	1,460

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

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH / Eng)	KTAS	Range (nm)
SL	33	2,400	110	184	870
10,000	33	2,400	118	207	876
15,000	33	2,400	118	218	893
20,000	33	2,400	115	232	963
25,000	32	2,400	111	241	1,002

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

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH / Eng)	KTAS	Range (nm)
SL	30	2,200	81	167	1,112
10,000	30	2,200	86	190	1,140
15,000	30	2,200	87	200	1,157
20,000	30	2,200	87	210	1,186
25,000	25	2,200	86	218	1,202

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

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH / Eng)	KTAS	Range (nm)
SL	24	2,200	62	143	1,266
10,000	24	2,200	65	160	1,273
15,000	24	2,200	67	174	1,438
20,000	24	2,200	68	182	1,340
25,000	24	2,200	69	190	1,328

Cruise Climb - Standard Day (ISA)

Target Alt. (ft)	Man. Press. (inHg)	Engine RPM	Fuel Flow (PPH / Eng)	Time to Climb (min)	Fuel to Climb (gal)	Dist. to Climb (nm)
5,000	35.5	2,750	112	4	4	10
10,000	35.5	2,750	114	8	7	19
15,000	35.5	2,750	118	12	11	32
20,000	35.5	2,750	117	18	15	44
25,000	35.5	2,750	115	23	21	64

Recommended Climb Airspeeds: 130 kts to 16,000 ft, 120 kts to 18,000 ft, 105 kts to 25,000 ft.

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-760 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)	460°F (238°C)
Exhaust Gas Temperature (EGT)	1600°F (870°C)
Engine Oil Temperature	240°F (116°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 Baron 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.

Deicing and Anti-Icing Systems

Ice accumulation and mitigation has been buggy since the release of MSFS. As of Sim Update 11 (SU11), the underlying variables for airframe, engine, pitot-static, and windshield icing have been verified to be working correctly. Unfortunately, the exterior visual airframe icing may continue to accumulate regardless of attempted ice mitigation. Apart from the visual appearance, this should not affect the performance of the aircraft. Windshields are always able to be cleared by deicing equipment, thankfully.

The Baron Professional is equipped with propeller deicing, pitot heat, fuel vent heat, stall warning heat, windshield heat, deicing boots, and windshield defrosters. Electrical anti-icing for the propellers, pitot-static probes, stall warning heat, windshield heat, and fuel vent heat work continuously, and will slowly remove ice from these areas of the aircraft. On the other hand, emergency window defrosting is provided by the cabin heating system, and requires the following conditions to be met: the “DEFROST” knob must be pulled, the “CABIN HEAT” knob must also be pulled, and the combustion heater must be operating. For more information on the defroster and its associated controls, see the Environmental Controls section of this manual.

Lastly, the aircraft is also equipped with deicing boots that use the instrument air supply to inflate, either manually, or automatically, to shed ice from the leading edges of the aircraft. The surface deicing switch may be placed in either the momentary “MAN” position to pressurize all zones of the aircraft’s deicing boots at once, or in the “AUTO” position to automatically cycle deicing pressure around the three dicing boot zones. The deicing pressure gauge should indicate a maximum of around 18 PSI when the system is activated in automatic mode, and 16 PSI when in manual mode. This pressure may be further diminished if the standby door seal valve is open and the standby door seal button is depressed while using the deicing boots.

Mixture & Fuel Flow

Unfortunately, the MSFS internal combustion simulation is lacking as it concerns mixture and fuel flow. Under all but extremely high density altitude conditions, reducing the mixture setting should always result in decreased fuel flow at the same throttle setting. In MSFS, fuel flow will fall off as horsepower decreases with an overly rich mixture setting. This is not detrimental to the operation of this aircraft, but is nevertheless unrealistic. A potential solution is being researched for future Black Square aircraft, and updates for the Baron Professional.

While operating the air conditioner under high load conditions, such as high outside air temperatures and low desired cabin temperature, do not be surprised if differential mixture is required to achieve equal engine performance. Careful leaning of both engines independently with the EDM-760 may be required to achieve optimal performance during low altitude flight with the air conditioner running.

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.

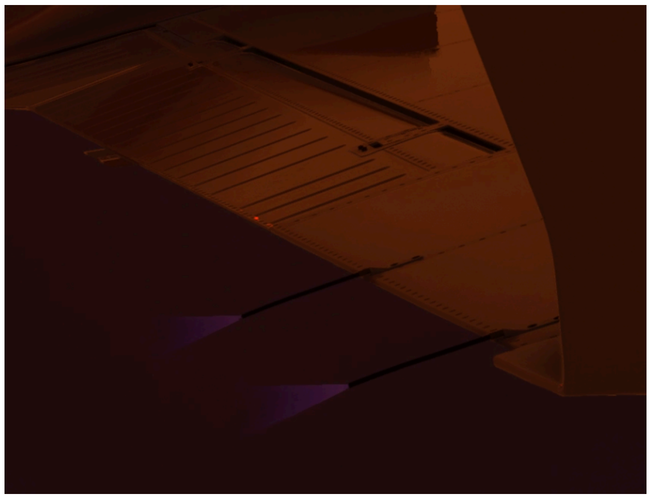
Third Party Navigation and GPS Systems

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.

St. Elmo’s Fire & Electrostatic Discharge

When aircraft operate at high speeds within charged areas of the atmosphere, such as around thunderstorms or in clouds of ash, the metal skin of the aircraft can accumulate charge. Normally, this charge is dissipated to the atmosphere slowly through the static discharge wicks located on the trailing edges of the wings and tail. If the charge buildup is very severe during intense storm conditions, a faint purple glow can emanate from sharp objects on the aircraft, including the static wicks. This corona discharge is colloquially called St. Elmo’s Fire, and it may precede more stunning electrostatic discharges across the aircraft.



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 cover and pitot covers before starting the aircraft, as they will not be removed automatically. Engine covers left deployed will cause rapid destruction of the engines, as the 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.

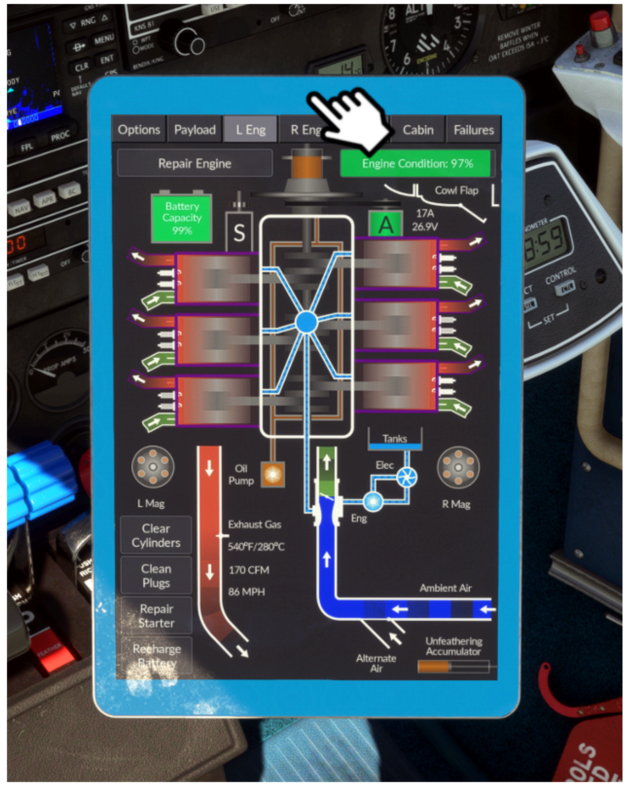
Magnetic Compass Effects

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.

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 pilot's HSI and autopilot. This selection will be saved and recalled at the start of your next flight.

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 pilot's HSI 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 pilot's HSI if the KX155 is selected as the primary radio. This selection will be saved and recalled at the start of your next flight.

3. PMS50 GTN / TDS GTNxi Switch

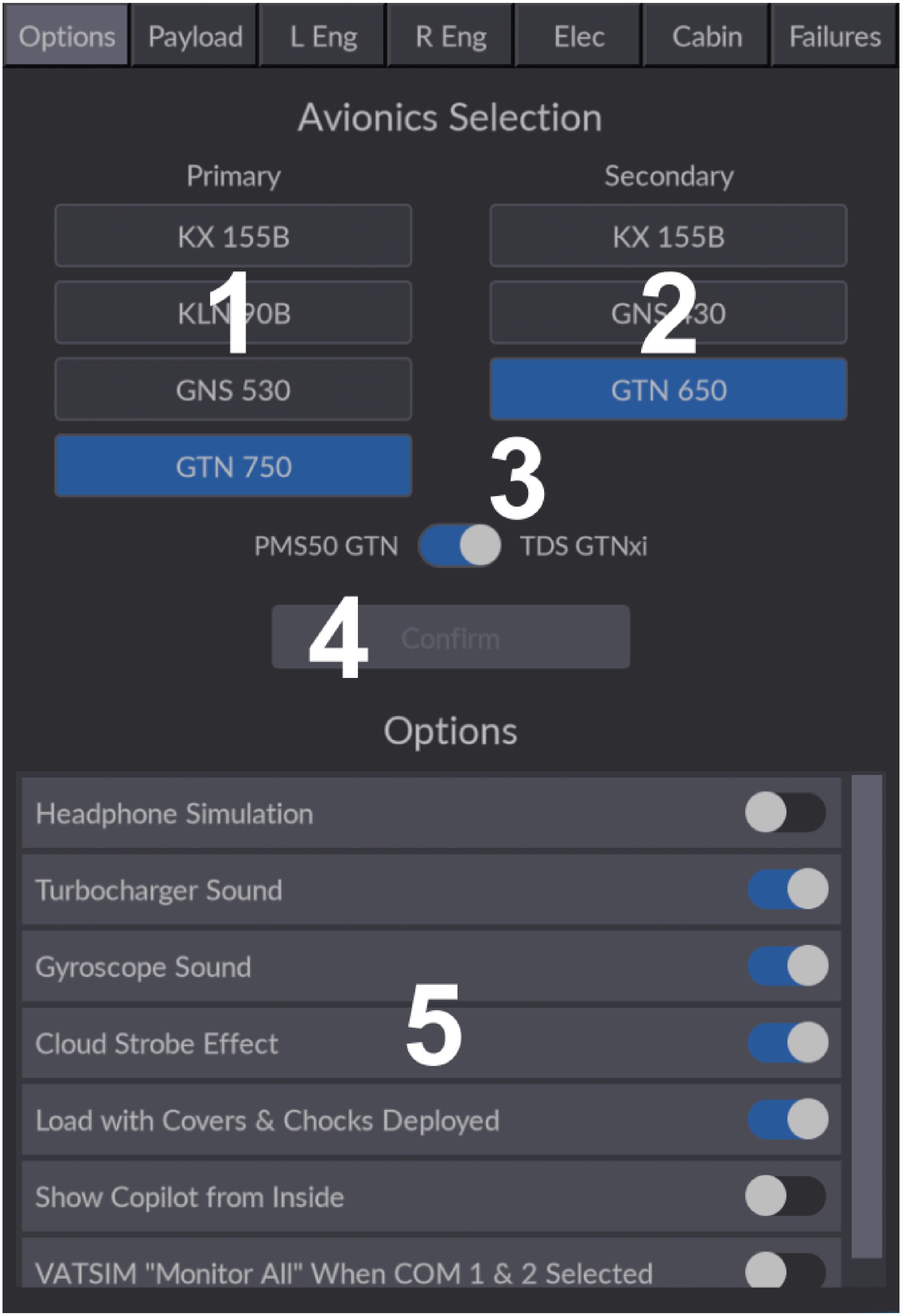
To switch between the PMS50 and TDS offerings of GTN GPS units, toggle this switch. This selection will be saved and recalled at the start of your next flight.

4. 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.

5. 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
L Eng
R Eng
Elec
Cabin
Failures
Avionics Selection
Primary
Secondary
KX 155B
KLN 90B
GNS 530
GTN 750
KX 155B
GNS 430
GTN 650
PMS50 GTN
TDS GTNxi
Confirm
Options
Headphone Simulation
Turbocharger Sound
Gyroscope Sound
Cloud Strobe Effect
Load with Covers & Chocks Deployed
Show Copilot from Inside
VATSIM "Monitor All" When COM 1 & 2 Selected
1
2
3
4
5

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

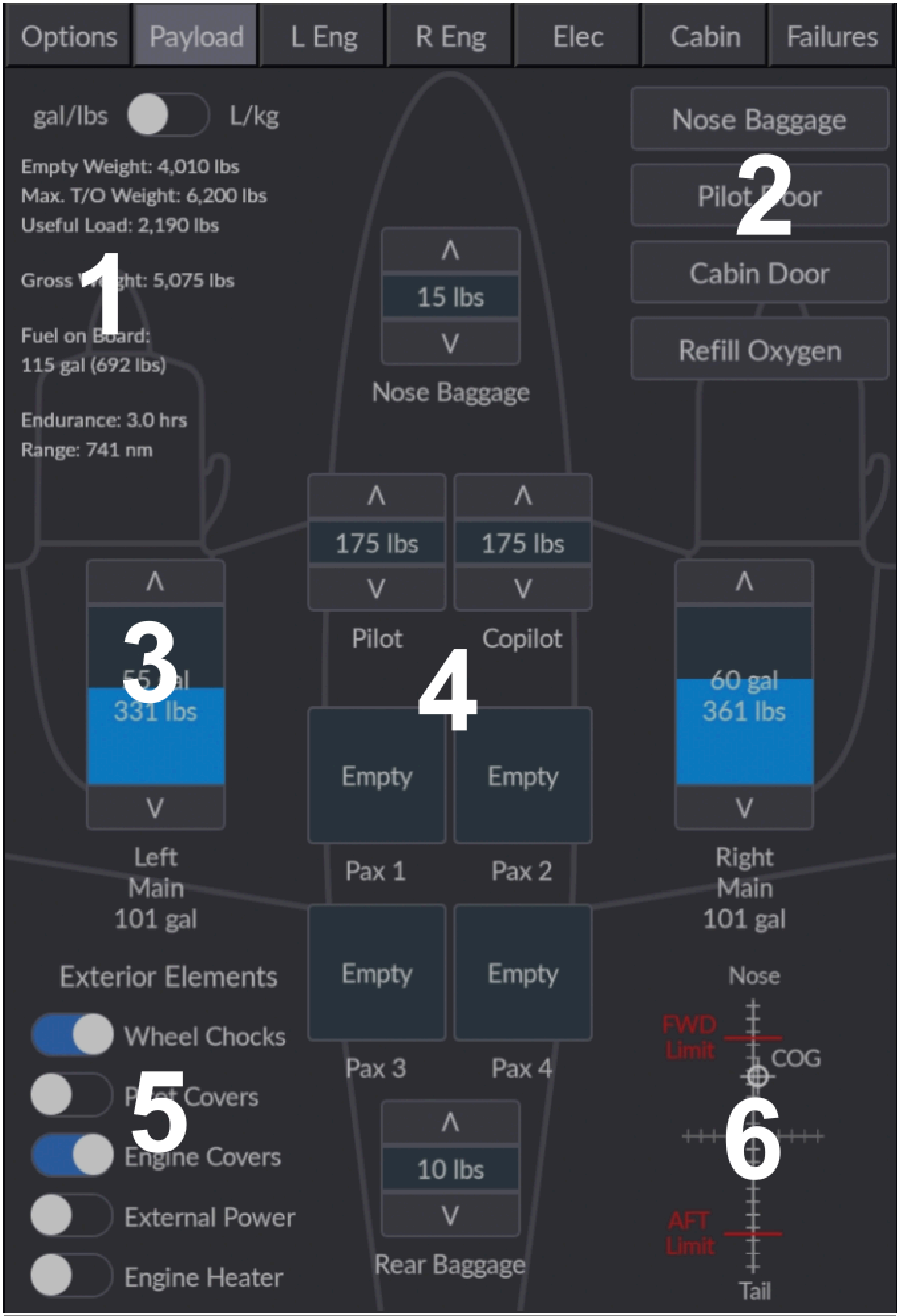
Each payload station in the aircraft is represented by a payload block. When occupied by passengers or cargo, each block shows the current weight of the station in its center. Clicking in the center of the block will toggle the payload between empty, and the default station weight. The weight of the 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
L Eng
R Eng
Elec
Cabin
Failures
gal/lbs
L/kg
Empty Weight: 4,010 lbs
Max. T/O Weight: 6,200 lbs
Useful Load: 2,190 lbs
Gross Weight: 5,075 lbs
Fuel on Board:
115 gal (692 lbs)
Endurance: 3.0 hrs
Range: 741 nm
Nose Baggage
Pilot Door
Cabin Door
Refill Oxygen
15 lbs
Nose Baggage
175 lbs
175 lbs
Pilot
Copilot
331 lbs
60 gal
361 lbs
Empty
Empty
Pax 1
Pax 2
Left
Main
101 gal
Right
Main
101 gal
Exterior Elements
Empty
Empty
Pax 3
Pax 4
Wheel Chocks
Engine Covers
External Power
Engine Heater
10 lbs
Rear Baggage
Nose
FWD Limit
COG
AFT Limit
Tail
1
2
3
4
5
6

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 flap. When the cowl flap is flush with the bottom of the engine nacelle, it is 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-760 engine monitor. For more information on EDM-760, see the "Using the JPI EDM-760 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

Control of the engine's intake air relies on a series of valves and louvers. 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.

While not technically part of the induction air system, the intercooler air is supplied by the same ambient temperature air. This air is used to cool pressurization and heating air that is extracted after the turbocharger in the pressurized version of this aircraft only. When the air conditioning is activated, scoops on both engine nacelles open to supply additional cooling air to the intercoolers so as not to defeat the air conditioning system. See the “Cabin Environmental Controls” section of this manual for more information on the intercooler bypass controls.

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. Lastly, in the pressurized aircraft only, some of the pressurized and heated air is removed from the intake manifold and redirected into the cabin air heat ducting through the intercooler. Should the intake air become contaminated, such as by a carbon monoxide leak, a valve can be opened in the pressurization air duct to dump this pressure overboard into the engine nacelle. See the “Cabin Environmental Controls” section of this manual for more information on the pressurization shutoff controls.

11. Engine Condition Reset Buttons

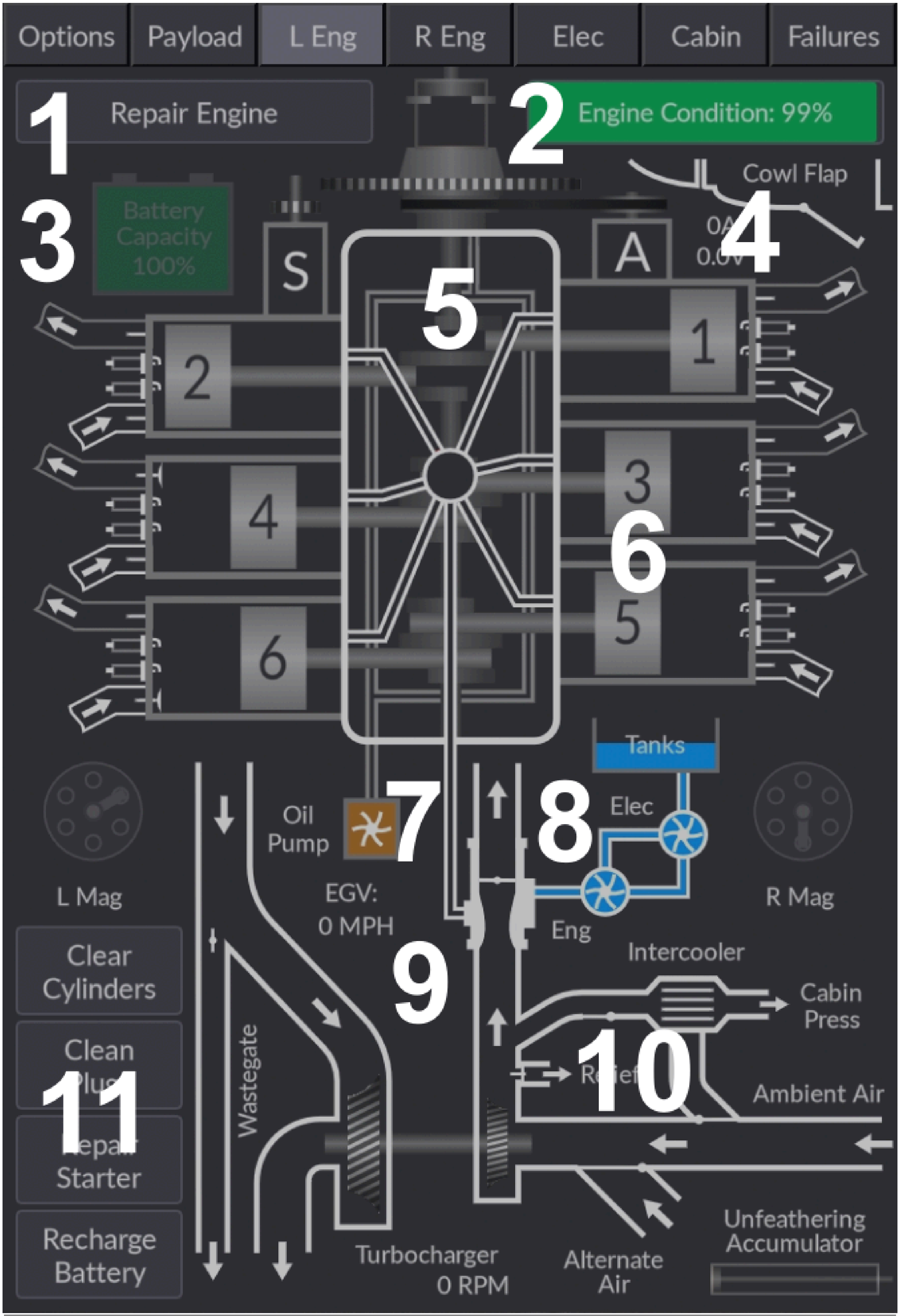
These buttons will not reset the engine’s overall condition, but instead will reset individual elements of the engine’s operating condition that may have become damaged or inoperable due to mismanagement, as opposed to failure.

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

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 & Feather Locks

Atop the flywheel in this visualizer is the propeller hub cylinder and piston. When the piston is at the top 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 the feather locks prevent the propeller from feathering. The feather locks can be seen here to the sides at the top of the cylinder, holding back the piston from descending. For more information on propeller feathering and feather locking pins, see the “Propeller Blade Position & Feathering” section of this manual.

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.

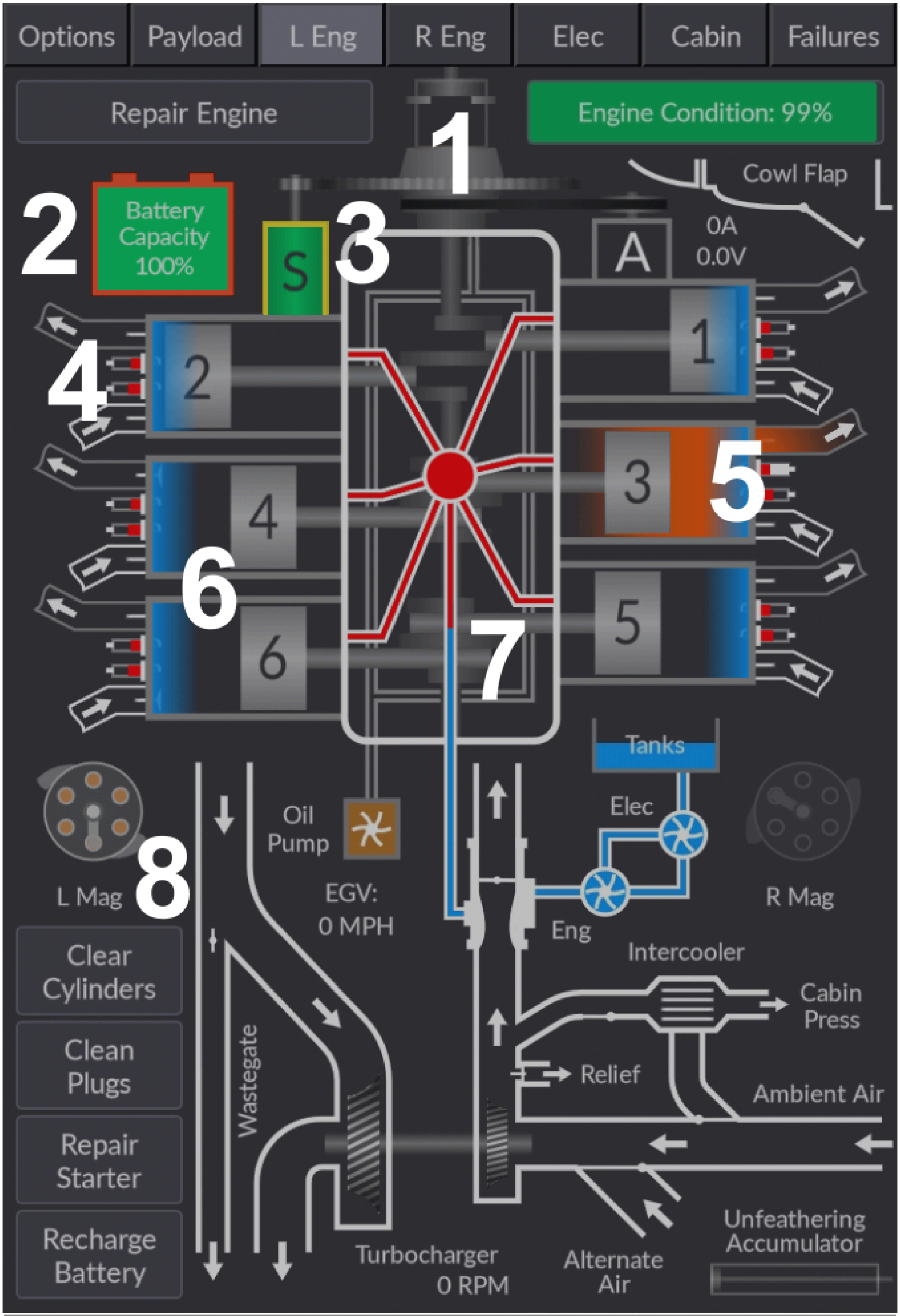
Usually when an engine is shut down, the heat in the cylinders will begin vaporizing fuel in the lines, causing back pressure that can prevent the flow of liquid fuel to the cylinders. This is called vapor lock. It is the bane of many fuel injected aircraft pilots who do not know how to manage it. For 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
L Eng
R Eng
Elec
Cabin
Failures
Repair Engine
Engine Condition: 99%
1
2
Battery Capacity 100%
S
3
Cowl Flap
A
0A
0.0V
4
5
6
7
Tanks
Elec
Oil Pump
L Mag
8
EGV:
0 MPH
Eng
R Mag
Intercooler
Clear Cylinders
Cabin Press
Clean Plugs
Wastegate
Relief
Ambient Air
Repair Starter
Recharge Battery
Turbocharger
0 RPM
Alternate Air
Unfeathering Accumulator

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 & Feather Locks

Unlike the cold engine example above, here the propeller hub is filled with pressurized oil from the engine, and the feather locking pins are retracted. As the engine is supplying oil to the propeller hub, the locking pins are not needed to prevent the propeller from feathering. For more information on propeller feathering and feather locking pins, see the “Propeller Blade Position & Feathering” section of this manual.

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-760 engine monitor. For more information on EDM-760, see the “Using the JPI EDM-760 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.

For normally aspirated engines, all exhaust gas is directed overboard. For turbocharged engines (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.

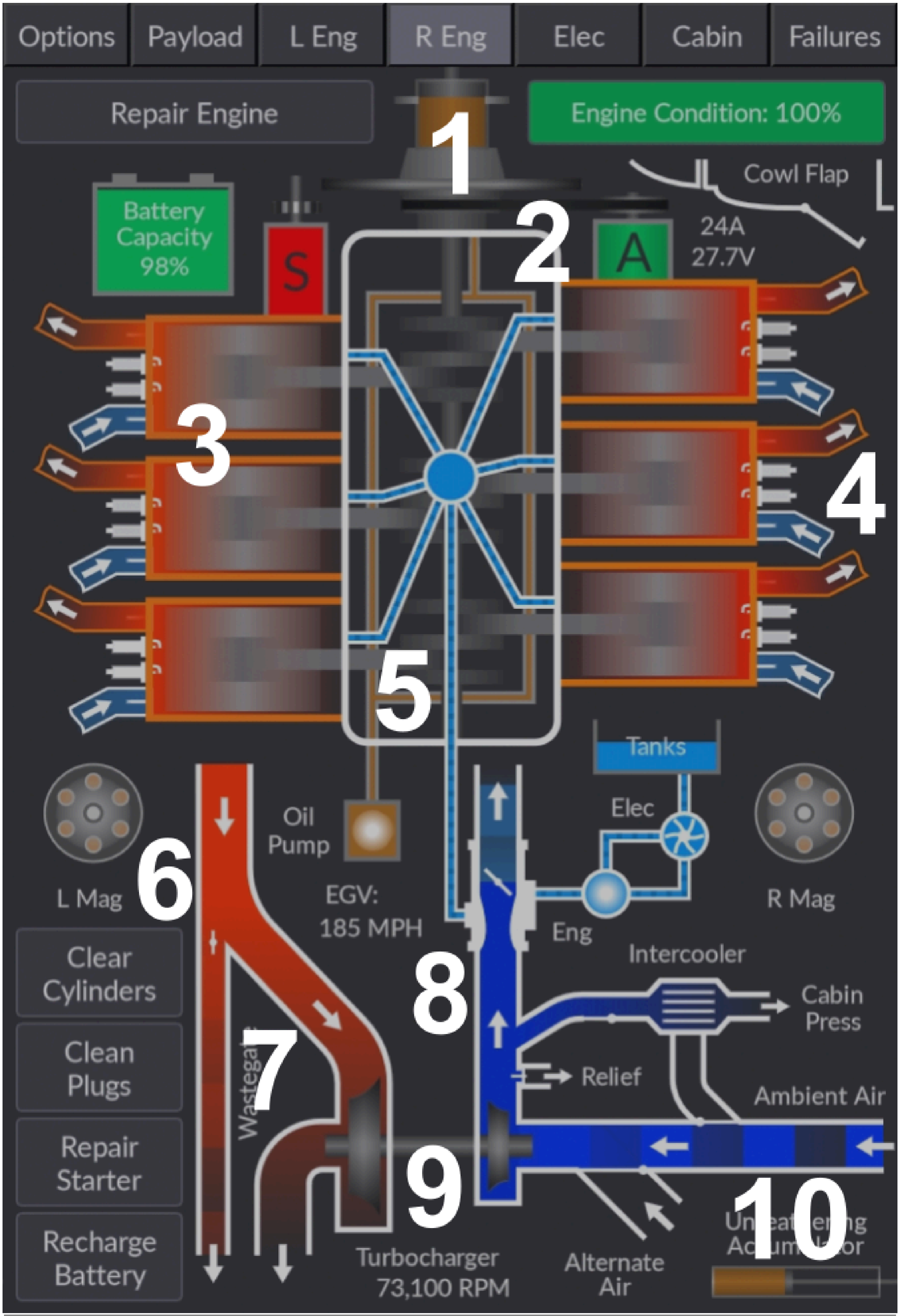
9. Turbocharger (Turbocharged B58TC & Pressurized B58P Only)

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.

10. Unfeathering Accumulator

The unfeathering accumulator allows for the collection of pressurized oil while the engine is running, which can be dumped back into the propeller hub later, to facilitate starting in flight after an engine shutdown. Whenever pressurized oil is present in the engine galleries, oil also flows into the accumulator until the pressure inside and outside the accumulator has equalized.

When the engine is shut down and the propeller feathered, oil vacates the propeller hub. Without the high pressure engine driven oil pump running, developing enough pressure to unfeather the propeller can be almost impossible, and starting a feathered engine is similarly difficult. When the propeller lever is advanced out of the feather detent, high pressure oil will be dumped from the accumulator into the propeller hub, unfeathering the propeller. See the “Unfeathering Accumulators” section of this manual for more information.


Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
Repair Engine
Engine Condition: 100%
Cowl Flap
Battery Capacity 98%
S
A
24A
27.7V
1
2
3
4
5
Tanks
Elec
Oil Pump
EGV: 185 MPH
L Mag
R Mag
6
Eng
Intercooler
Cabin Press
8
Clear Cylinders
Clean Plugs
Repair Starter
Recharge Battery
7
Wastegate
Relief
Ambient Air
9
10
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. 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.

2. 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, generators, or external power 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 to the external power plug 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 avionics controller sends a trigger voltage to the avionics contactors to close, thus supplying power to the avionics buses. A contactor is a large mechanical relay, often used in older aircraft for switching large loads.

3. Active & Inactive Equipment

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

4. 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.

5. Voltmeter

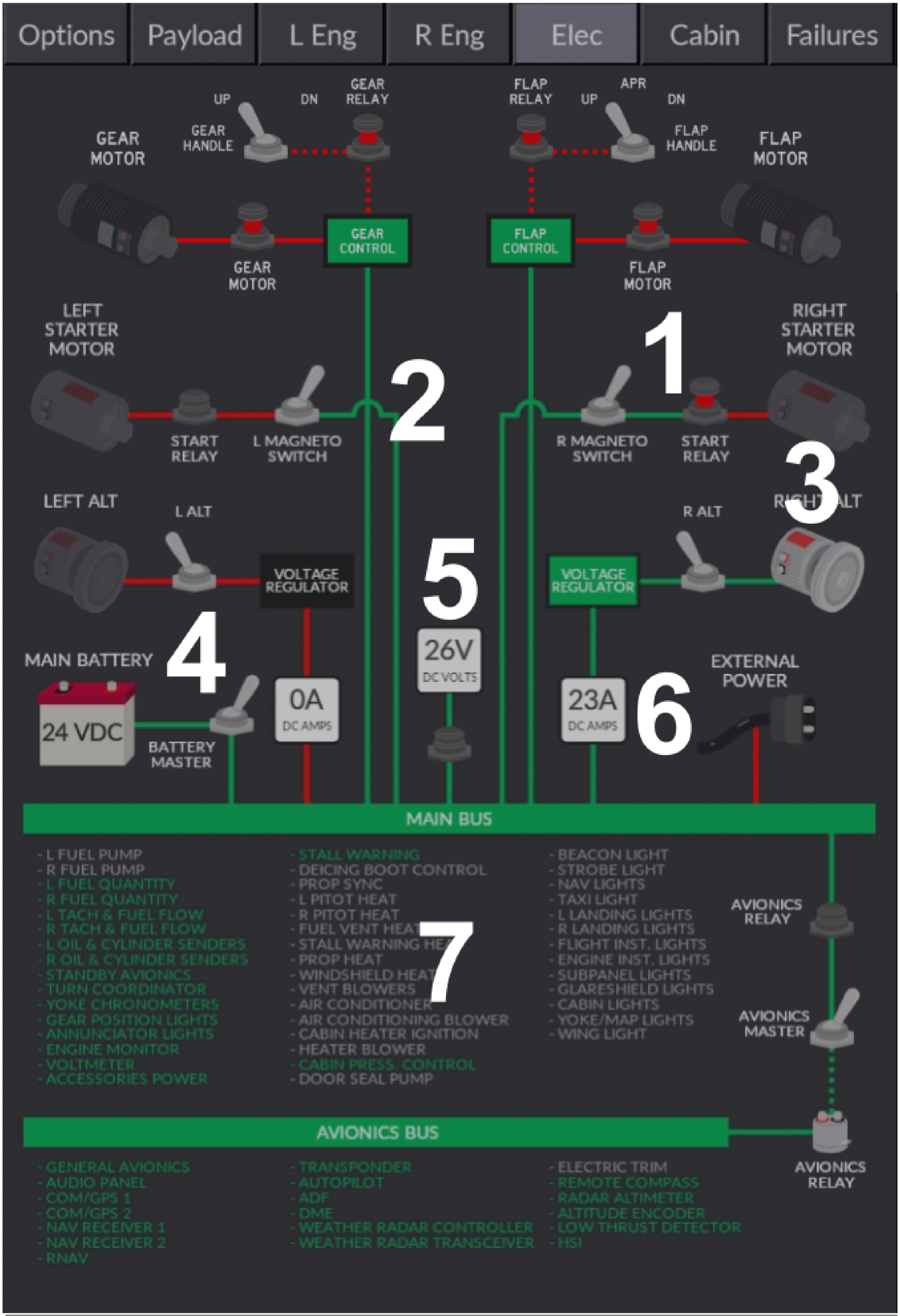
Voltmeters measure the electrical potential between two points in the aircraft's electrical system. Here, the direct current (DC) voltmeter measures the voltage between the main bus, and the chassis (ground) of the aircraft. A second alternating current (AC) voltmeter measures the voltage output by the windshield heat inverter. 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.



Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
GEAR MOTOR
UP
DN
GEAR HANDLE
GEAR RELAY
GEAR CONTROL
GEAR MOTOR
FLAP RELAY
UP
APR
DN
FLAP HANDLE
FLAP MOTOR
FLAP CONTROL
FLAP MOTOR
LEFT STARTER MOTOR
START RELAY
L MAGNETO SWITCH
2
1
R MAGNETO SWITCH
START RELAY
RIGHT STARTER MOTOR
3
LEFT ALT
L ALT
VOLTAGE REGULATOR
5
VOLTAGE REGULATOR
R ALT
RIGHT ALT
MAIN BATTERY
4
24 VDC
BATTERY MASTER
0A DC AMPS
26V DC VOLTS
23A DC AMPS
6
EXTERNAL POWER
MAIN BUS
- L FUEL PUMP
- R FUEL PUMP
- L FUEL QUANTITY
- R FUEL QUANTITY
- L TACH & FUEL FLOW
- R TACH & FUEL FLOW
- L OIL & CYLINDER SENDERS
- R OIL & CYLINDER SENDERS
- STANDBY AVIONICS
- TURN COORDINATOR
- YOKE CHRONOMETERS
- GEAR POSITION LIGHTS
- ANNUNCIATOR LIGHTS
- ENGINE MONITOR
- VOLTMETER
- ACCESSORIES POWER
- STALL WARNING
- DEICING BOOT CONTROL
- PROP SYNC
- L PITOT HEAT
- R PITOT HEAT
- FUEL VENT HEAT
- STALL WARNING HEAT
- PROP HEAT
- WINDSHIELD HEAT
- VENT BLOWERS
- AIR CONDITIONER
- AIR CONDITIONING BLOWER
- CABIN HEATER IGNITION
- HEATER BLOWER
- CABIN PRESS. CONTROL
- DOOR SEAL PUMP
7
- BEACON LIGHT
- STROBE LIGHT
- NAV LIGHTS
- TAXI LIGHT
- L LANDING LIGHTS
- R LANDING LIGHTS
- FLIGHT INST. LIGHTS
- ENGINE INST. LIGHTS
- SUBPANEL LIGHTS
- GLARESHIELD LIGHTS
- CABIN LIGHTS
- YOKE/MAP LIGHTS
- WING LIGHT
AVIONICS RELAY
AVIONICS MASTER
AVIONICS BUS
AVIONICS RELAY
- GENERAL AVIONICS
- AUDIO PANEL
- COM/GPS 1
- COM/GPS 2
- NAV RECEIVER 1
- NAV RECEIVER 2
- RNAV
- TRANSPONDER
- AUTOPILOT
- ADF
- DME
- WEATHER RADAR CONTROLLER
- WEATHER RADAR TRANSCEIVER
- ELECTRIC TRIM
- REMOTE COMPASS
- RADAR ALTIMETER
- ALTITUDE ENCODER
- LOW THRUST DETECTOR
- HSI

Cabin Climate Visualizer Page

With such high performance aircraft, the environmental control systems begin to approach the complexity of light jets and commuter aircraft, and understanding them is paramount to safety.

Heating Cabin

When the desired cabin temperature is warmer than the outside ambient air, heating is provided by two sources: the pressurized air, heated by passing through the turbocharger's compressor turbine, or the combustion heater. For more information on the environmental control systems, see the "Environmental Simulation & Controls" section of this manual.

1. Ram Air Intake

On the left side of the aircraft's nose, a NACA duct sources ram air for the combustion heater's heat exchanger.

2. Combustion Heater

Ambient temperature ram air is heated by a combustion air heater, which is a gasoline powered appliance with its own air intake, ignition, and exhaust. The combustion heater is discussed further in the "Cabin Environmental Controls" section of this manual. Any time the combustion heater is operating, so too should be the combustion heater blower, as it promotes airflow through the combustion chamber, preventing reverse flow and overheating. Should the combustion heater's ignition system malfunction, its spark ignitor will indicate red.

In the pressurized version of the aircraft, the centrifugal vent blower is mounted in the forward part of the cabin, to promote the movement of heated or ambient temperature air through the cabin heat ducting. This blower can be used to increase the rate of passive heating or cooling, or the rate of active heating when the combustion heater is operating.

3. Mixing Valve & Vent Blower

After ambient air has been heated by passing through the combustion air heater's heat exchanger, the air is either admitted into the cabin's heat ducting, or dumped overboard. The direction of flow is controlled by the mixing valve, which is the primary means of regulating the cabin temperature. Pulling the "CABIN HEAT" pull handle away from the instrument panel will send progressively more heating air to the cabin. For more information on controlling the cabin temperature, see the "Cabin Environmental Controls" section of this manual.

4. Pressurization Shutoff & Carbon Monoxide (Pressurized B58P Only)

Carbon monoxide leaks are indicated in this visualizer by the presence of gray gradients emanating from either engine in the pressurized aircraft, or the combustion heater. In the event that carbon monoxide is detected, the suspect engine should be isolated from the cabin air, or the combustion heater disabled. The red pressurization shutoff pull handles on the pilot's subpanel are used to isolate the engines, with the left appearing in the closed position here, and the right open. These shutoff valves can also be used to check the functioning of the pressurized air supply from each engine during runup checks. For more information on the pressurization shutoff valves and carbon monoxide, see the “Cabin Pressurization System”, and “Carbon Monoxide Detector” sections of this manual.

5. Intercooler Scoops (Pressurized B58P Only)

In the pressurized version of this aircraft, both engine nacelles are equipped with electromechanically actuated scoops on the top of the nacelle, which serve to meter the amount of cooling air supplied to the pressurization and heating air intercoolers. The scoops will deploy to further cool the pressurization air whenever the air conditioning switch is in the on position. See the “Cabin Environmental Controls” section of this manual for more information.

6. Air Vents

All heating air that enters the cabin is vented under the instrument panel towards the pilot and copilot, controlled only by the “CABIN HEAT” pull handle. Heating air is only directed through these vents towards the pilot and copilot when the “PILOT AIR” and “COPILOT AIR” pull handles are pulled away from the instrument panel. The defroster valves that direct air towards the aircraft’s windshield are normally closed, and open when the “DEFROST” pull handle is pulled away from the panel.

7. 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 engage the centrifugal clutch on the air conditioning compressor), the target temperature will be shown in red.

8. 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.

9. Cabin Pressurization Graph (Pressurized B58P Only)

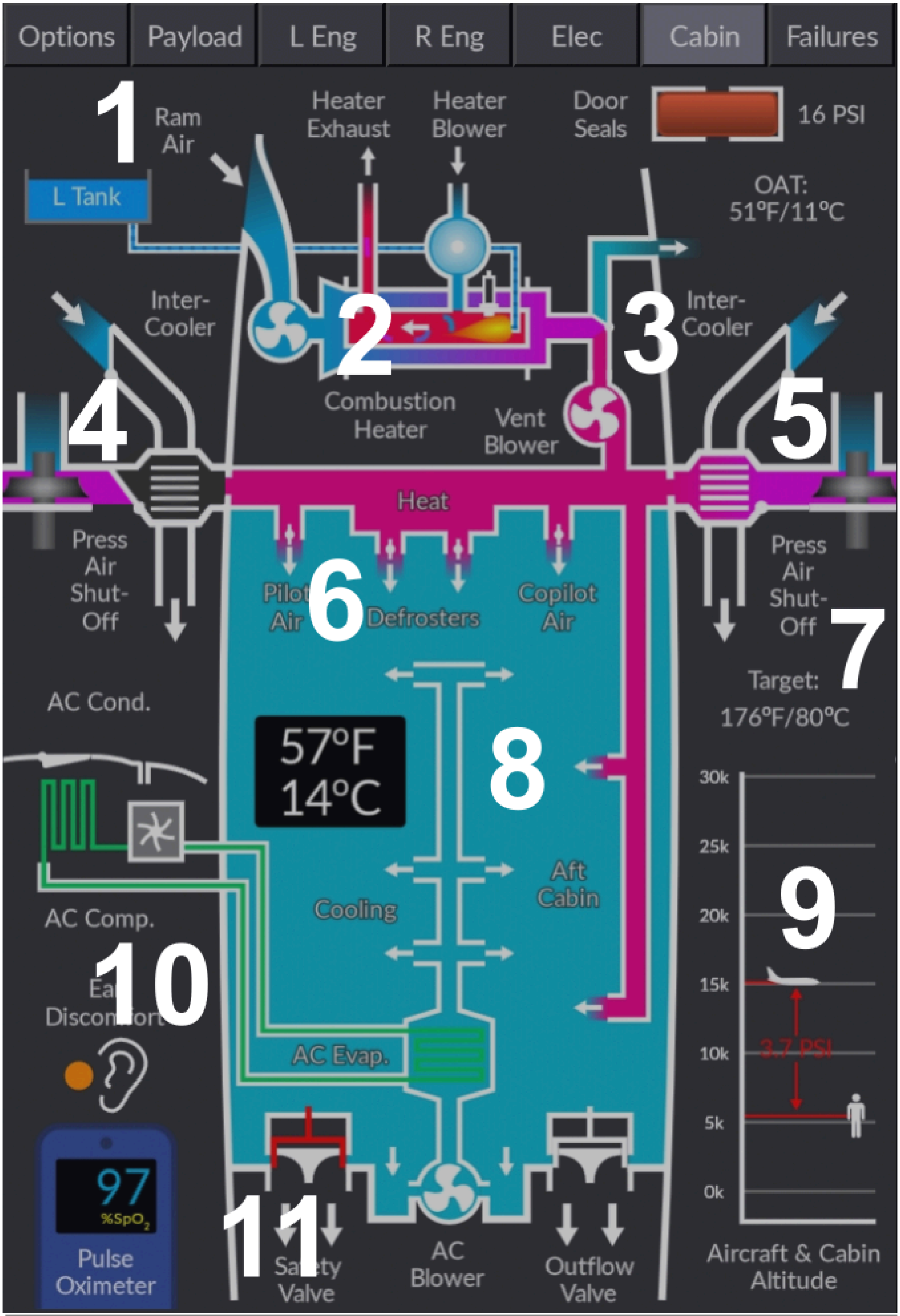
To the right of the main cabin volume is a graph depicting the aircraft altitude (airplane symbol), and the cabin pressurization altitude (human symbol) on the same scale. When the two are sufficiently apart, the cabin differential pressure will be shown between them, always in red.

10. 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 pressure is not consciously equalized through the eustachian tubes. For those used to flying in light aircraft, climb/descent rates of 1,500 ft/min can be a routine affair; however, climb/descent rates of 3,000 ft/min or above will be very uncomfortable for most occupants.

11. Safety & Outflow Valves (Pressurized B58P Only)

Cabin pressurization is controlled primarily by a set of two valves, the safety and outflow valves, on the aft pressure bulkhead of the aircraft. This complex topic is discussed at length in the "Cabin Pressurization System" section of this manual. Here, the outflow valve is open, venting the pressurized cabin air to atmosphere. The safety valve is closed, as it should be during normal operation. Its red coloration indicates that it has suffered a failure, and will not move from the closed position.



Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
1
Ram Air
Heater Exhaust
Heater Blower
Door Seals
16 PSI
L Tank
OAT: 51°F/11°C
Inter-Cooler
2
3
Inter-Cooler
4
Combustion Heater
Vent Blower
5
Heat
Press Air Shut-Off
Pilot Air
6
Defrosters
Copilot Air
Press Air Shut-Off
7
Target: 176°F/80°C
AC Cond.
57°F 14°C
8
30k
25k
Aft Cabin
Cooling
AC Comp.
20k
9
10
15k
Ear Discomfort
AC Evap.
10k
5k
97
%SpO2
0k
11
Pulse Oximeter
Safety Valve
AC Blower
Outflow Valve
Aircraft & Cabin Altitude

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. Cabin Ram Air Intake

As opposed to the cabin heating section above, which depicts an aircraft in flight, this screenshot depicts an aircraft on the ground with the air conditioning running. The outside ambient air temperature is warm, indicated by the orange color of the ram air intake air.

2. 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 right of the cylinder, here seen in the open position, depicts the position of the oxygen valve, controlled via the knob on the pilot’s side panel.

3. Ram Air Valve (Unpressurized B58 & B58TC Only)

Ambient air for passive cabin cooling and active heating by the combustion air heater is controlled by the ram air iris-type valve (shown in this visualizer as a butterfly valve for the sake of clarity). The ram air valve is controlled by the “CABIN AIR VENT” slide handle under the main circuit breaker panel.

4. Mixing Valve

The combustion air heater is more than capable of defeating any cooling provided by the air conditioning system, so the mixing 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.

5. 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 on position, but a condition exists that precludes the cooling of the cabin (such as the engine not running fast enough to engage the centrifugal clutch on the air conditioning compressor), 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.

6. Air Conditioning Compressor, Condenser & Scoop

The air conditioning system (also known as the vapor cycle cooling system), is driven by a clutched compressor from the engine’s crankshaft. This compressor will only engage when the RPM of the engine is high enough, at which point the compressor will indicate with green on this visualizer, and the impeller will begin to rotate.

The uninsulated air conditioning pipes pass through a condenser mounted beneath the cabin of the aircraft on the bottom fuselage skin, which requires cooler ambient air to operate. A scoop will open to varying degrees throughout the flight when the air conditioning is activated. If the condenser scoop motor fails, or its limit switches fail, the door may become stuck. This will be indicated by a red condenser scoop door in this visualizer. For more information on the condenser scoop, see the "Air Conditioning Condenser Scoop" section of this manual.

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. Outflow Port (Unpressurized B58 & B58TC Only)

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.

9. Fresh Air Valve & Vent Blower (Unpressurized B58 & B58TC Only)

Fresh ambient air is admitted to the cabin through a NACA duct in the dorsal fairing. This air is metered by the fresh air valve on the roof of the cabin above the pilot's head. When in flight, the ram air pressure outside the aircraft will force fresh air into the cabin. When on the ground, an electric centrifugal vent blower can be activated to provide airflow and cool the cabin with ambient temperature air. The vent blower will have no effect on cabin temperature unless the fresh air knob is open. For more information on the vent blower and fresh air control, see the "Environmental Simulation & Controls" section of this manual.

10. Pulse Oximeter

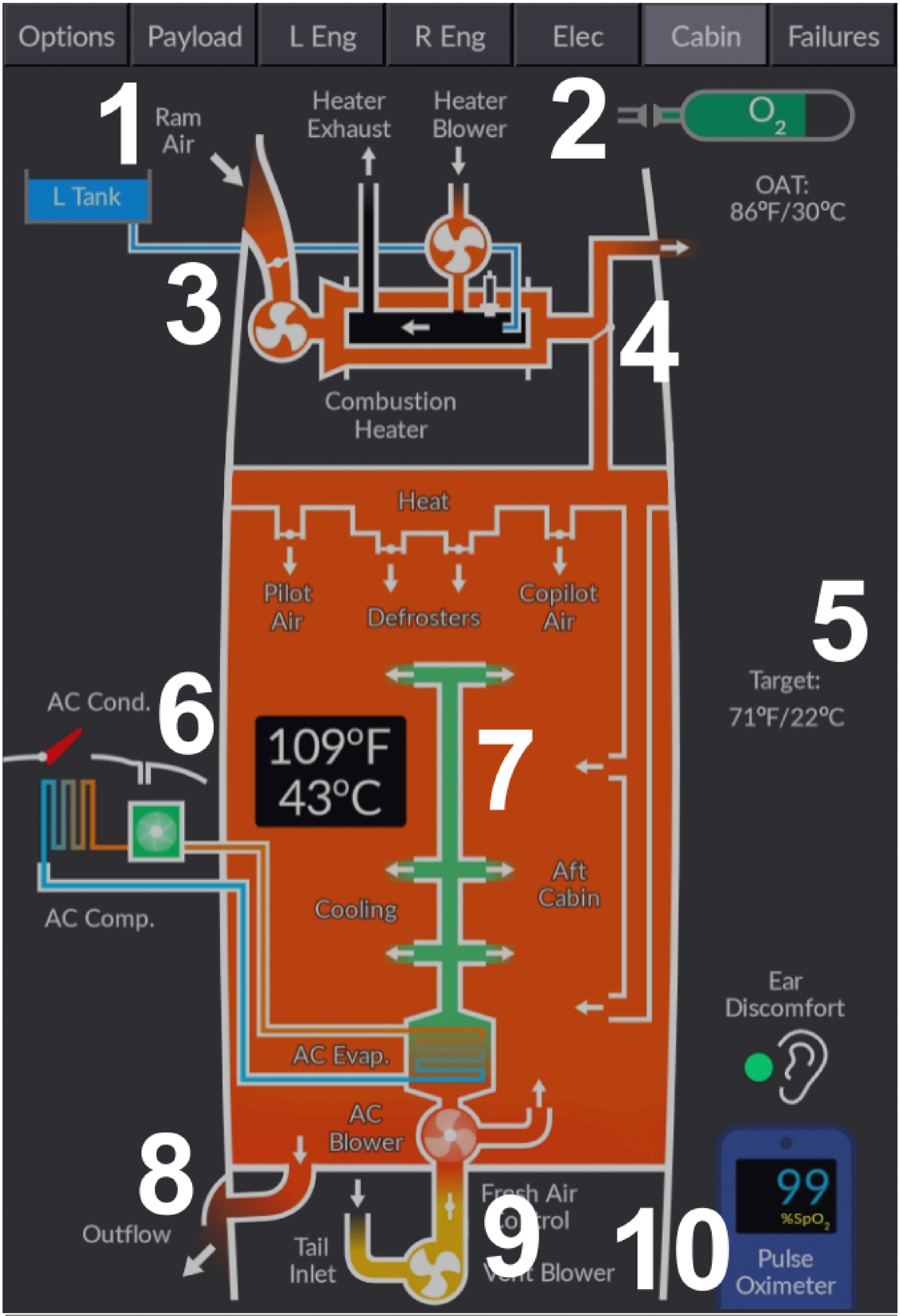
Loss of conscientiousness and impaired cognitive functioning in low oxygen environments does not happen instantaneously. Except in the case of the most severe decompression events, oxygen must leave the blood supply in order for hypoxia to take effect. This process can take over an hour at lower cruising 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
L Eng
R Eng
Elec
Cabin
Failures
1
Ram Air
Heater Exhaust
Heater Blower
2
O2
L Tank
OAT:
86°F/30°C
3
4
Combustion Heater
Heat
Pilot Air
Defrosters
Copilot Air
5
Target:
71°F/22°C
AC Cond.
6
109°F
43°C
7
Aft Cabin
Cooling
AC Comp.
Ear Discomfort
AC Evap.
AC Blower
8
Outflow
Tail Inlet
9
10
99
%SpO2
Pulse Oximeter

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

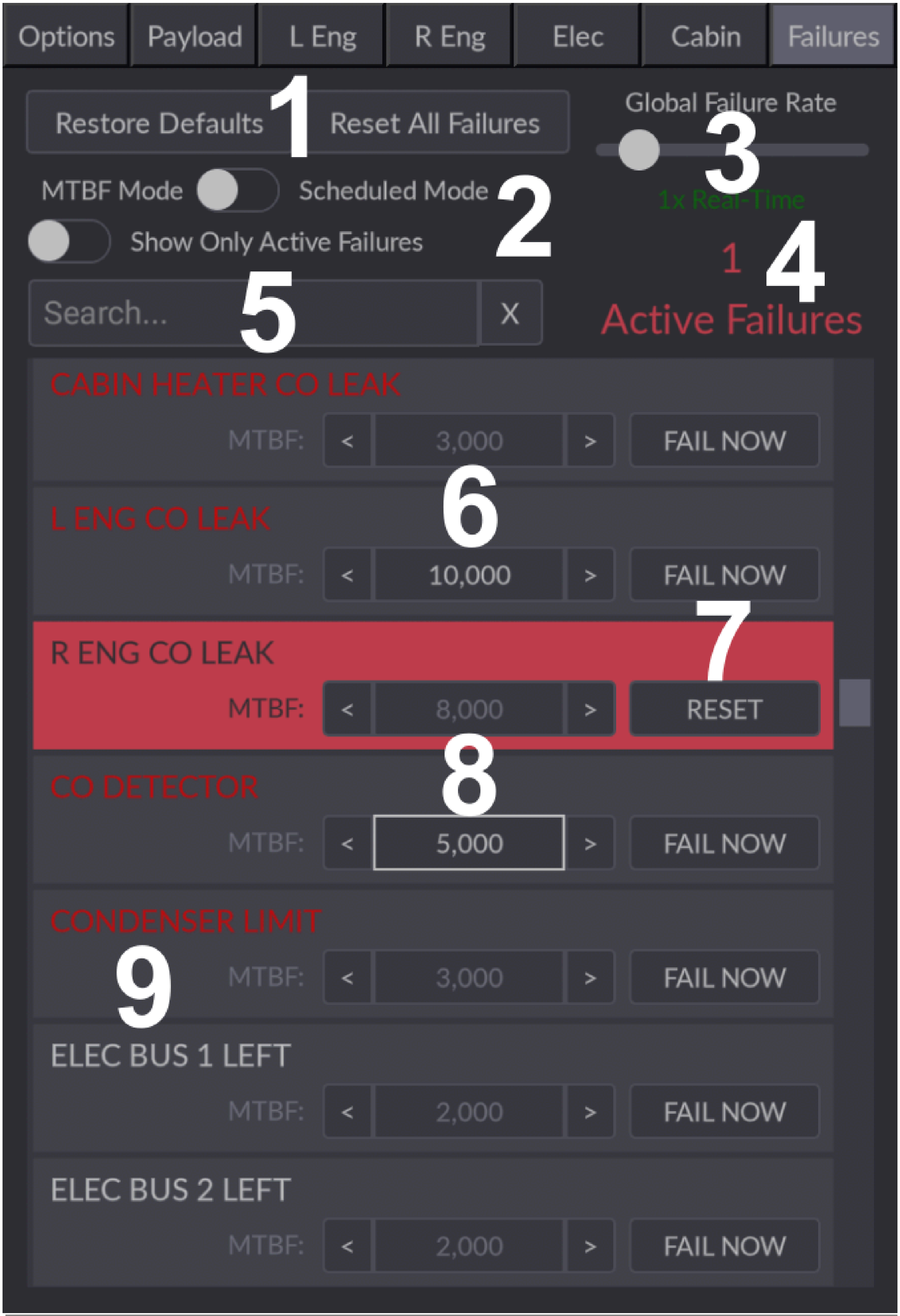
After being triggered by any means, individual failures can be reset by pressing the “RESET” button. Failures can also be triggered manually in this mode by pressing the “FAIL NOW” button.

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

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

L ENGINE FAILURE
R ENGINE FAILURE
L ENGINE FIRE
R ENGINE FIRE
L TURBOCHARGER
R TURBOCHARGER

L ENG L MAGNETO
L ENG R MAGNETO
L ENG L MAGNETO GROUNDING
L ENG R MAGNETO GROUNDING
L IGNITION SWITCH GROUND
L ALTERNATOR
L ENG DRIVEN OIL PUMP
L ENG DRIVEN FUEL PUMP
L UNFEATHERING ACCMLTR
R ENG L MAGNETO
R ENG R MAGNETO
R ENG L MAGNETO GROUNDING
R ENG R MAGNETO GROUNDING
R IGNITION SWITCH GROUND
R ALTERNATOR
R ENG DRIVEN OIL PUMP
R ENG DRIVEN FUEL PUMP
R UNFEATHERING ACCMLTR

INSTRUMENT AIR
INSTRUMENT AIR PARTIAL
PITOT BLOCKAGE
STATIC BLOCKAGE
L BRAKE
R BRAKE
L FUEL LEAK
R FUEL LEAK
CABIN SAFETY VALVE
CABIN OUTFLOW VALVE
INFLOW CONTROL UNIT
DOOR SEAL PRIMARY
DOOR SEAL STANDBY
L ENG CO LEAK
R ENG CO LEAK
CABIN HEATER CO LEAK
CO DETECTOR
COMBUSTION HEATER
CONDENSER LIMIT
NOSE DOOR LATCH
PILOT DOOR LATCH
CABIN DOOR LATCH
DEICE BOOTS INTEG
OXYGEN LEAK

Breaker Protected Failures

L STARTER MOTOR
R STARTER MOTOR
FLAP MOTOR
L FUEL PUMP
R FUEL PUMP
GEAR MOTOR
GEAR WARNING
L FUEL QTY
R FUEL QTY
L TACH AND FF GAUGES
R TACH AND FF GAUGES
L OIL AND CYL GAUGES
R OIL AND CYL GAUGES
STANDBY AVIONICS
TURN COORD
VOLTMETER
YOKE CHRONOS
LANDING GEAR POS LIGHTS
ANNUNCIATOR LIGHTS
ACCESSORIES POWER
VENT BLOWERS
AIR CONDITIONER
AIR CONDITIONING BLOWER
CABIN HEAT IGN
CABIN HEAT BLOWER
ENGINE MONITOR
STALL WARNING
DEICE BOOTS
PROP SYNC
L PITOT HEAT
R PITOT HEAT
PROP HEAT
WINDSHIELD HEAT
FUEL VENT HEAT
STALL WARN HEAT
CABIN PRESS CONTROL
DOOR SEAL PUMP
STROBE LIGHT
BEACON LIGHT
NAV LIGHTS
TAXI LIGHTS
L LANDING LIGHTS
R LANDING LIGHTS
WING LIGHT
PANEL LIGHTS
CABIN LIGHTS
AUDIO PANEL
REMOTE COMPASS
GYRO SLAVING
COM 1
COM 2
NAV 1
NAV 2
RNAV
TRANSPONDER
AUTOPILOT CONTROLLER
AUTOPILOT ACTUATORS
ADF
WX RADAR CONTROLLER
WX RADAR TRANSCEIVER
RADAR ALTIMETER
HSI
DME
ENCODER
LOW THRUST DETECT

Miscellaneous Systems

Audible Warning Tones

This version of the Baron 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:

- Altitude Alerter Tone: A traditional C-Chime will sound when the aircraft is within 1,000 ft of the selected altitude displayed on the KAS 297B Altitude Selector.

- 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 buzzer will sound.

- Stall Warning Horn: When the aircraft is within approximately 5-10 knots of stalling speed, a constant tone warning horn will sound.

- Overspeed Horn: When the aircraft exceeds the VNE (red line) airspeed on the airspeed indicator, a repeating beeping tone warning will sound until the speed of the aircraft is reduced to below VNE.

- Gear Configuration Warning Horn: When both throttle levers are reduced below approximately 20% of their travel, or the flaps are placed in their landing configuration, and the landing gear has not been deployed, a repeating tone will sound.

- Carbon Monoxide Detector: When an engine or the combustion heater 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 (pull) the cabin pressurization air shutoff valves immediately if operating the pressurized version of this aircraft.

- 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.

Range Extending Devices (Winglets)

Should a user have a strong desire for a normally aspirated Baron Professional with winglets, or a turbocharged model without winglets, any one of these options is possible with a simple community mod. These options have simply been omitted here to reduce clutter in the aircraft selection menu, and also to differentiate the Baron Professional from the default G58 Baron. To do so, simply create a new aircraft mod with the adjusted weight and balance information, engine parameters, or other modifications, and new flight files (*.flt), containing the desired permutation of the following lines. While this process looks very similar to creating a livery-only community mod, it is necessary to also include all the config files, not just aircraft.cfg. Give your aircraft configuration a new name (ui_type) in aircraft.cfg, so that a whole new aircraft type is added to the aircraft selection UI, not just a new livery.

[LocalVars.0]
BKSQ_Turbocharged=1
BKSQ_Pressurized=1
BKSQ_Winglets=1

Windshield Hot-Plate

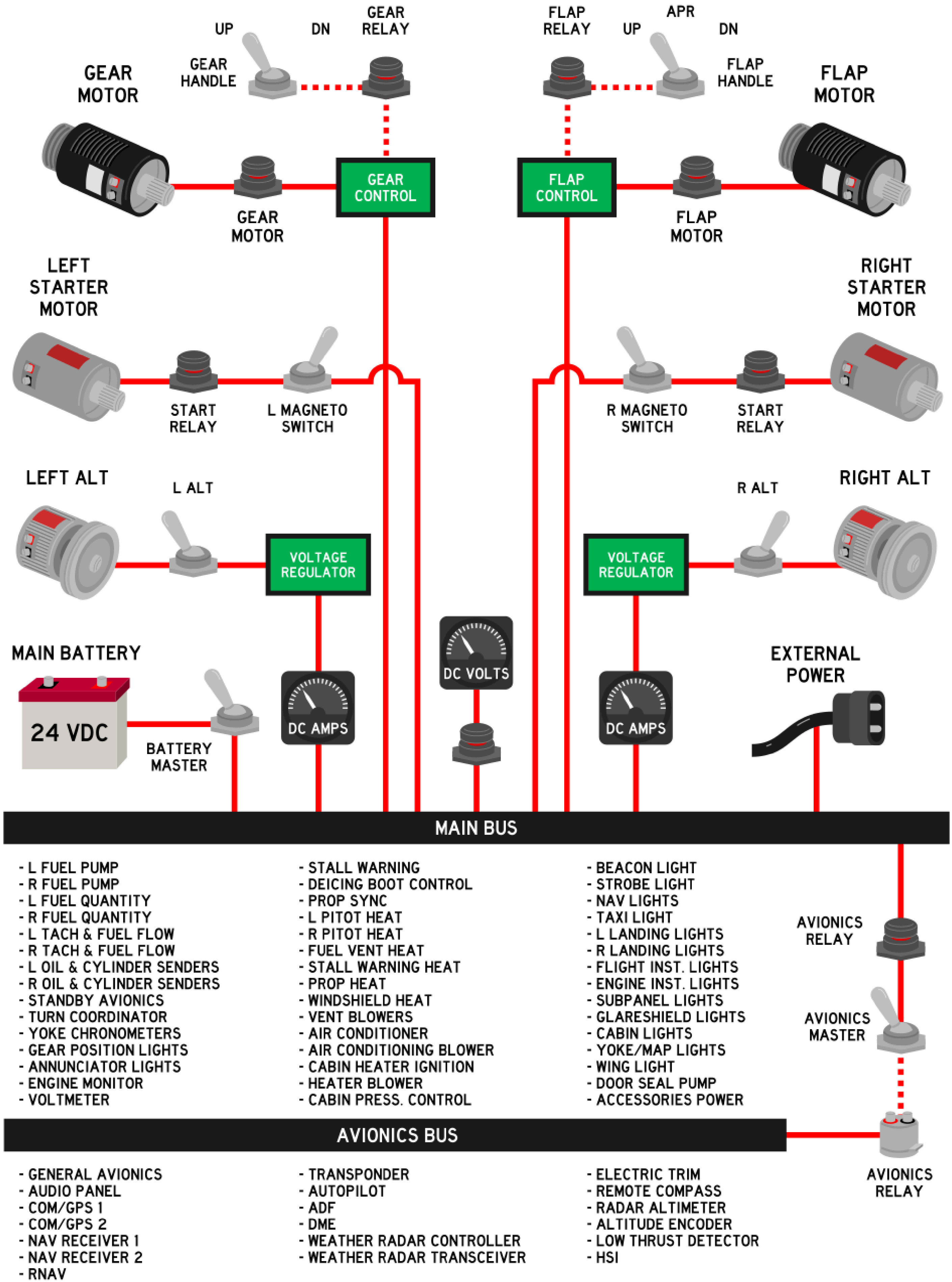
Unlike larger and more capable aircraft that possess windshields with integrated heating elements, the Baron Professional is equipped with a “hot-plate”, fixed to the middle of the windshield. While far from ideal, this heated element should allow the operator to descend below the icing conditions and conduct a normal landing; however, the hot-plate does obscure the forward view of the pilot. For this reason, there is an option present on the tablet’s options page to hide the hot-plate.

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.

Overview Electrical Schematic



GEAR RELAY
UP
DN
GEAR HANDLE
GEAR MOTOR
GEAR CONTROL
GEAR MOTOR
FLAP RELAY
APR
UP
DN
FLAP HANDLE
FLAP MOTOR
FLAP CONTROL
FLAP MOTOR
LEFT STARTER MOTOR
START RELAY
L MAGNETO SWITCH
RIGHT STARTER MOTOR
R MAGNETO SWITCH
START RELAY
LEFT ALT
L ALT
VOLTAGE REGULATOR
RIGHT ALT
R ALT
VOLTAGE REGULATOR
MAIN BATTERY
24 VDC
BATTERY MASTER
DC AMPS
DC VOLTS
DC AMPS
EXTERNAL POWER
MAIN BUS
- L FUEL PUMP
- R FUEL PUMP
- L FUEL QUANTITY
- R FUEL QUANTITY
- L TACH & FUEL FLOW
- R TACH & FUEL FLOW
- L OIL & CYLINDER SENDERS
- R OIL & CYLINDER SENDERS
- STANDBY AVIONICS
- TURN COORDINATOR
- YOKE CHRONOMETERS
- GEAR POSITION LIGHTS
- ANNUNCIATOR LIGHTS
- ENGINE MONITOR
- VOLTMETER
- STALL WARNING
- DEICING BOOT CONTROL
- PROP SYNC
- L PITOT HEAT
- R PITOT HEAT
- FUEL VENT HEAT
- STALL WARNING HEAT
- PROP HEAT
- WINDSHIELD HEAT
- VENT BLOWERS
- AIR CONDITIONER
- AIR CONDITIONING BLOWER
- CABIN HEATER IGNITION
- HEATER BLOWER
- CABIN PRESS. CONTROL
- BEACON LIGHT
- STROBE LIGHT
- NAV LIGHTS
- TAXI LIGHT
- L LANDING LIGHTS
- R LANDING LIGHTS
- FLIGHT INST. LIGHTS
- ENGINE INST. LIGHTS
- SUBPANEL LIGHTS
- GLARESHIELD LIGHTS
- CABIN LIGHTS
- YOKE/MAP LIGHTS
- WING LIGHT
- DOOR SEAL PUMP
- ACCESSORIES POWER
AVIONICS RELAY
AVIONICS MASTER
AVIONICS BUS
- GENERAL AVIONICS
- AUDIO PANEL
- COM/GPS 1
- COM/GPS 2
- NAV RECEIVER 1
- NAV RECEIVER 2
- RNAV
- TRANSPONDER
- AUTOPILOT
- ADF
- DME
- WEATHER RADAR CONTROLLER
- WEATHER RADAR TRANSCEIVER
- ELECTRIC TRIM
- REMOTE COMPASS
- RADAR ALTIMETER
- ALTITUDE ENCODER
- LOW THRUST DETECTOR
- HSI
AVIONICS RELAY

Using the KNS-81 RNAV 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 KNS-81 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 HSI in the same manner as any other VOR, assuming the HSI source selector switch is set to “RNAV”, and not “NAV1”. This means that you can rotate the course select adjustment 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 KNS-81. On the right side of the unit, you will find the “DATA” push button, and the adjacent data entry knob. Along the bottom of the display, “FREQ”, “RAD”, and “DST”, annunciators remind you of the order in which data should be entered, frequency first, then radial, and finally distance. At any given time, one of these annunciators is bracketed to indicate which type of data is being entered. Press the “DATA” push button to cycle through the data entry process, and use the data entry knob to tune a frequency, enter a radial, and finally a distance.

Data Storage Bins

On the left of the display, a 7-segment display marked “WPT” indicates the current RNAV waypoint for which data is being shown and edited on the right of the display. The KNS-81 can hold up to ten different combinations of frequency, radial, and distance data at one time. This can be greatly useful while planning a flight on the ground. To cycle through waypoints, rotate the inner knob of the dual concentric rotary encoder on the left of the unit’s face. The active waypoint currently being used by the computer and subsequently displayed on the HSI and DME instruments can be selected by pressing the “USE” button while the desired waypoint is being displayed. Whenever the currently displayed waypoint is different from the currently active waypoint, the number of the currently displayed waypoint will flash continuously.

Distance Measuring Equipment

Most notably different than this unit’s predecessor unit, the KNS-80, is the lack of integrated DME information. The KNS-81 was designed to be used as a secondary, or tertiary navigation radio with an external DME display installed elsewhere on the panel. In this case, a KDI-572R fulfills this role. The KDI-572R is a traditional Distance Measuring Equipment (DME) display, with an extra rotary selector position to display RNAV information. See this manual’s section on the KDI-572 for complete information on operation. It should be noted that, like all other DME displays, this one is similarly dependent on being within the VOR service volume, and having good line-of-sight reception of the station. It should also be noted that these distances, speeds, and times, are based on slant-range to the station, not distance along the ground, as one would draw on a map. For most procedures, it was determined that this fact did not make such a large difference as to be detrimental to the procedure, but pilots should still be aware of the distinction. The KNS-81 also possesses a “RAD” toggling push button, which will force the DME display to indicate the current radial upon which the aircraft sits, relative to the waypoint.

Modes of Operation

Lastly, on the left side of the display, the KNS-81's many modes are annunciated. The KNS-81's modes fall into two categories; VOR and RNAV, and are activated by rotating the outer dual concentric knob on the left of the unit's face. The VOR modes allow for the driving of an HSI with traditional VOR and ILS (including glideslope) data from the unit's third VHF navigation receiver. The VOR mode allows for behavior identical to a standard VOR receiver, with 10° of full-scale deflection to either side of the HSI's course deviation indicator (CDI). The PAR mode, which puts the CDI in a "PARallel" mode of operation, and linearizes the course deviation to +/- 5 nm full-scale deflection. This can be useful for tracking airways more accurately. In the two RNAV modes, CDI deflection is based on the displaced virtual VOR of the currently active waypoint. There are two RNAV modes, "RNV/ENR" (Enroute), which drives the CDI with linear deflections of +/- 5 nm full-scale, and "RNV/APR" (Approach), which drives the CDI with linear deflections of +/- 1.25 nm full-scale. Lastly, the KNS-81 has a momentary display mode, which can be activated by holding the "CHK" push button. This mode will display the aircraft's current position relative to the tuned physical VOR station. Pressing the "RTN" button will return the data displays to the active waypoint being used for navigation.

Modes in Summary:

VOR:	Angular course deviation, 10° full-scale deflection, just like a third NAV radio.
VOR/PAR:	Linear course deviation, 5 nm full-scale deflection, useful for existing airways.
RNV:	Linear course deviation, 5 nm full-scale deflection, displaced VOR waypoints.
RNV/APR:	Linear course deviation, 1.25 nm full-scale deflection, displaced VOR waypoints.

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 KNS-81 as a navigation source when no-GPS is selected as COM1. Press the "GPS/NAV" source button to select RNAV deviation as the active autopilot lateral navigation source. Then, select the desired course with the HSI's course 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.

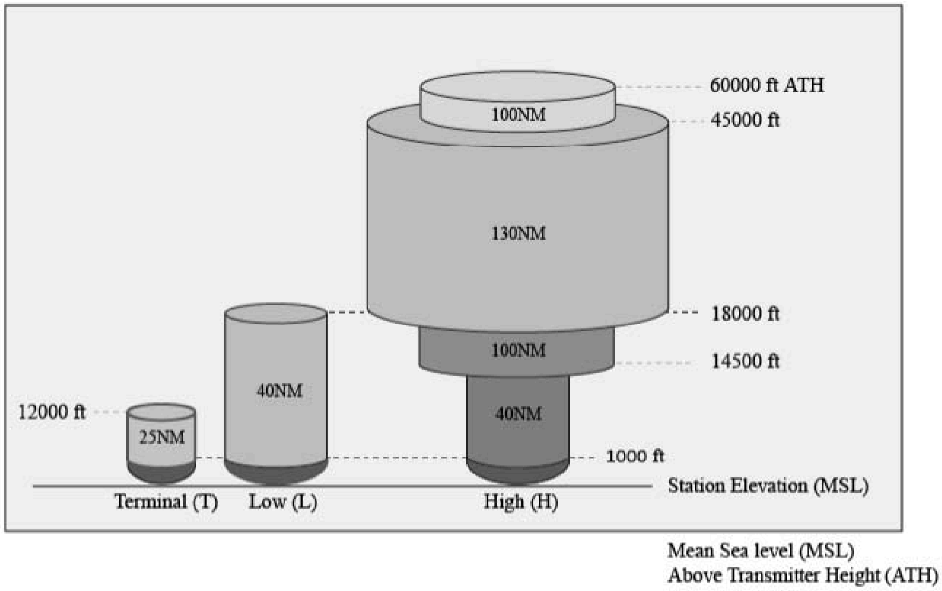
1. Locate the nearest VOR station to your desired destination, and its frequency, radial, and distance from the destination airport. While other station frequencies, radials, and distances can be found on approach, arrival, and departure charts, the easiest place to start is often with a mobile app or 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 Massachustts.

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. Enter the three pieces of data we located above into the KNS-81 RNAV computer. Once the KNS-81 is powered on, all your data entered during previous flights will be loaded from memory, and the active "display", and "use" data channels will be set to 1, and 1. First, we will use the dual concentric rotary knobs on the right of the unit to enter the frequency 112.5 Mhz into data channel 1, just as we would with any other navigation radio.

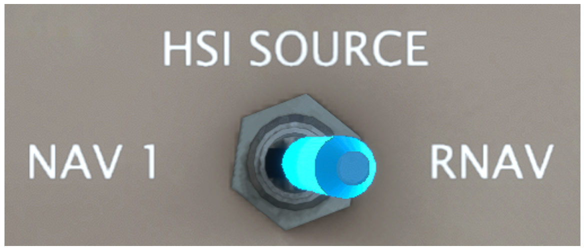
3. Once our desired frequency has been set we will use the “DATA” push button to page through the three required pieces of data in this data channel in the order “FREQ”, “RAD”, and “DST”. Press the “DATA” button once, and then enter the radial 154.0, again with the dual concentric rotary knobs. Should your desired radial include a decimal component, the inner rotary knob can be pulled and rotated for decimal entry.

4. When our desired radial is set, press the “DATA” push button once again to enter our desired distance offset of 12.3 nm. Again, should your desired distance include a decimal component, the inner rotary knob can be pulled and rotated for decimal entry.

5. Data entry is now complete; however, before we can begin following the CDI to the airport, we need to choose an RNAV mode of operation, probably RNV/ENR for enroute operation, unless we need increased precision for some reason. Rotate the outer dual concentric rotary encoder on the left of the unit’s face until only “RNV” is annunciated above the knob. In RNAV modes of operation, our CDI will guide us to the displaced VOR waypoint at Beverly Airport that we just created, and all displayed DME information will be relative to that new waypoint

NOTE: VOR modes of operation WILL NOT provide CDI or DME information relative to the active waypoint. They are for operation as a conventional navigation radio with reference to existing VOR stations, in either angular or linear course deviation mode.

6. Lastly, make sure the HSI SOURCE switch in your aircraft is set to RNAV; otherwise, we will not see the RNAV information displayed on the HSI.



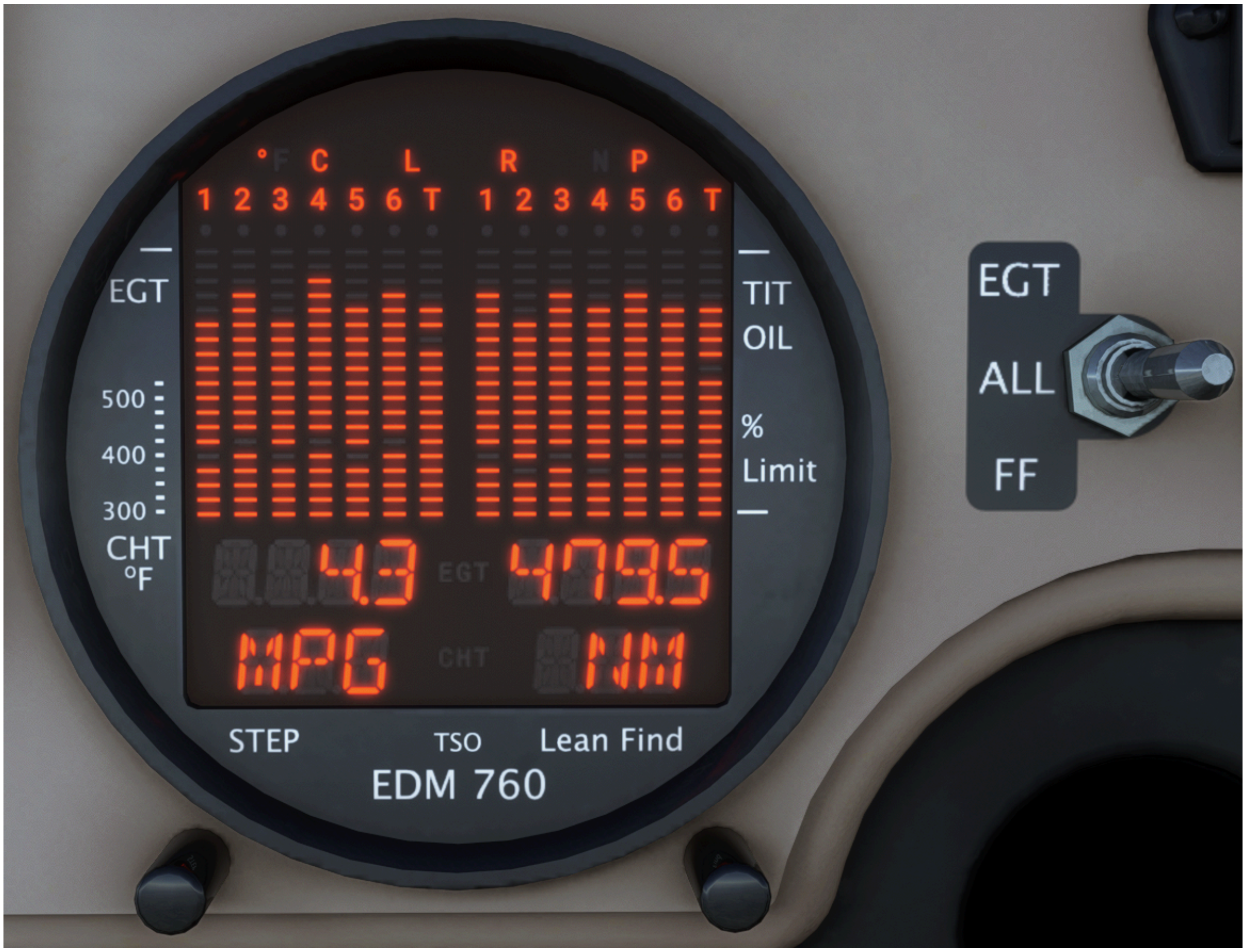
7. To fly directly to the displaced VOR waypoint at our destination airport, simply rotate the omni-bearing selector (OBS) or course (CRS) knob on your HSI, as you would to fly to a VOR, and follow the CDI needle with a TO indication. Countdown the distance and time remaining until arriving at your destination on the external DME instrument. 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, press and hold the “CHK” button. The RAD and DST displays will now indicator your actual distance from the VOR station, and the radial upon which the aircraft sits. Release the “CHK” button to return to viewing RNAV information appropriate to the currently selected mode of operation.

Flying an RNAV Course with the Autopilot

The autopilot will only use the KNS-81 as a navigation source when no-GPS is selected as COM1. Press the “GPS/NAV” source button to select RNAV deviation as the active autopilot lateral navigation source. Then, select the desired course with the HSI’s course select knob.

Using the JPI EDM-760 Engine Monitor



The Baron Professional is equipped with the most complete implementation of the EDM-760 engine monitor to appear in a flight simulator. The EDM-760 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-760 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 twin engine EDM-760 is very similar in appearance and operation to the single engine EDM-800, which is featured in the Bonanza Professional.

Static Displays

Upon startup, the EDM-760 will perform a self-test and illuminate every segment of the display. At the top of the unit will be "L" and "R" characters, statically displayed, above the left and right engine temperature columns. To the left 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 are two more static displays with numerals 1-6, for each cylinder of each engine, 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, four 14-segment displays at the bottom of the unit will display many different types of information, units, alarm ID's, and more.

Data Display

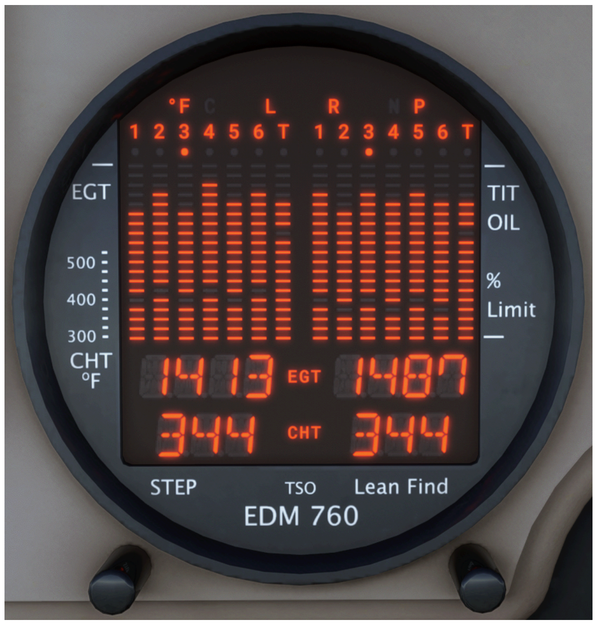
When the unit is powered on, the data display will be in manual mode for 10 minutes, at which time, it will enter automatic mode. In manual mode, the user can cycle through all available data by tapping the "STEP" button. To cycle through data in the opposite order to save oneself the trouble of cycling 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 & Outside Air Temp.	25.7 BAT	75 OAT	None
EGT, ALL	Difference between hottest and coldest CHT.	52 DIF	61 DIF	None
ALL, FF	Fuel Remaining & Time to Empty (endurance in hours.minutes)	78.4 REM	01.28 H.M.	None
ALL, FF	Fuel Required to next GPS waypoint & Fuel Remaining at next GPS waypoint	17.4 REQ	61.0 REM	Compatible GPS
ALL, FF	Nautical Miles per Gallon & Estimated Range	5.2 MPG	407.5 NM	Compatible GPS
ALL, FF	Fuel Flow Rate	24.2 GPH	24.5 GPH	None
ALL, FF	Fuel Used since unit startup each engine	21.8 USD	21.4 USD	None
ALL, FF	Total Fuel Used since unit startup	43.2 GAL	TOTL USD	None
ALL, FF	Approximate Horsepower	285 HP	287 HP	None
EGT, ALL	EGT & CHT (cycles through all cylinders)	1412 392	1437 398	None
EGT, ALL	Turbine Inlet Temp. & Fuel Flow	1465 24.2	1468 24.5	Turbocharger
EGT, ALL	Oil Temp.	161 OIL	168 OIL	None
EGT, ALL	Fastest Cooling Cylinder Head (°/min)	-25 CLD	-28 CLD	None

Temperature Columns

When the unit is in manual or automatic mode, the majority of the display will be occupied by the fourteen temperature columns. The six cylinder columns for each engine 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 “N” at the top right of the display, rather than a “P” for percent view.. 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 for each engine. Each of the twelve cylinder columns can also display cylinder head temperature (CHT), on a fixed

Fahrenheit scale, inscribed on the bezel of the unit, from 300°F to 525°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.



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 ROP" 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 LOP" is shown. This is the only time the leaning method can be toggled.

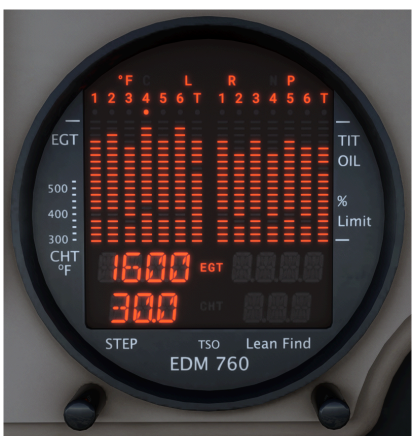
Both methods of leaning begin by “pre-leaning” the engine to approximately 50°F (28°C) EGT rich of peak on any cylinder. After waiting for temperatures to stabilize, begin leaning the engine. When a dot begins flashing above one of the cylinder columns to indicate the hottest cylinder, Lean Find mode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

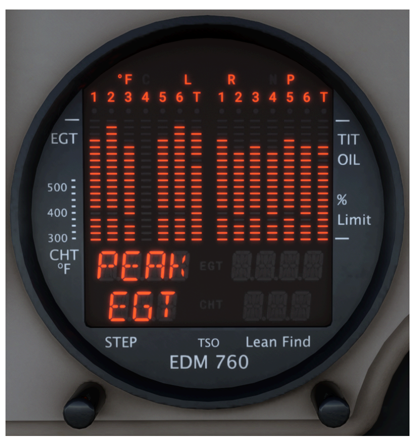
NOTE: For your convenience while leaning, the friction lock knob located on the right of the throttle quadrant can be used to increase the fidelity of mixture control adjustments via the mouse wheel. Roll the friction lock clockwise (drag up) to make very fine adjustments to the mixture control. Use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

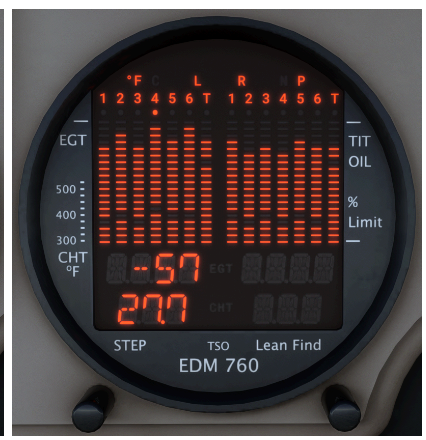
Leaning Rich of Peak

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 “PEAK EGT” is shown on the data display. This means that the peak EGT for the first cylinder to peak has been detected. Afterwards, 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 “LAST PK” 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-760 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
Low Fuel Quantity Remaining	FUEL 17.4 LOW GAL	20 gal	
Low Endurance Remaining	TIME 00.22 LOW H.M.	45 min	

Normal Checklists

*Pressurized Model Only

Before Starting Engine

Preflight Inspection	Complete
Control Locks	Stowed
Seats & Seatbelts	Secure
Cabin Doors	Latched
Parking Brake	Set
Emergency Gear Handle	Stowed
Avionics Breakers	All In
Flaps	Up
Avionics	Off
Throttles	Closed
Propeller	High RPM
Mixture	Full Rich
Cowl Flaps	Open
Aileron Trim	Centered
Rudder Trim	Centered
Landing Gear	Down
All Subpanel Switches	Off
Main Breakers	All In
Alternate Static Air	Normal
CO Detector	Test
Fuel Selectors	On
*Cabin Press Shutoff	Pushed
*Door Seal Standby Air	Off
*Cabin Press Mode	Dump
*Door Seal Mode	Off
Beacon Light	On
Battery Master	On
Bus Volts	23V Minimum
Annunciators	Test & Consider
Left Alternator	On
Right Alternator	On
Main Fuel Quantities	Check
Tip Tank Quantities	Check
Cabin Heater	As Desired
Left Boost Pump	Lo
Left Boost Pump	Audible
Left Boost Pump	Off
Right Boost Pump	Lo
Right Boost Pump	Audible
Right Boost Pump	Off

Engine Start (Cold)

Right Mixture	Full Rich
Right Propeller	High RPM
Right Throttle	Full Open
Right Boost Pump	Hi for 2-3s
Fuel Flow	Greater than 3 GPH
Right Boost Pump	Off
Right Throttle	Open 1/2in
Right Starter	Engage
Right Throttle	1000-1200 RPM
Oil Pressure	Green
Start Annun	Extinguished
Low Volts Annun	Extinguished
R ALT Annun	Extinguished
Right Alternator Load	Below 25A in 2min
Bus Volts	28V
Engine Instruments	Check

Left Mixture	Full Rich
Left Propeller	High RPM
Left Throttle	Full Open
Left Boost Pump	Hi for 2-3s
Fuel Flow	Greater than 3 GPH
Left Boost Pump	Off
Left Throttle	Open 1/2in
Left Starter	Engage
Left Throttle	1000-1200 RPM
Oil Pressure	Green
Start Annun	Extinguished
Low Volts Annun	Extinguished
L ALT Annun	Extinguished
Left Alternator Load	Below 25A in 2min
Bus Volts	28V
Engine Instruments	Check

Engine Start (Hot)

Right Mixture	Cut-Off
Right Propeller	High RPM
Right Boost Pump	Hi for 10-20s
Right Boost Pump	Off
Right Mixture	Full Rich
Right Throttle	Full Open
Right Boost Pump	Hi for 2-3s
Fuel Flow	Greater than 3 GPH
Right Boost Pump	Off
Right Throttle	Open 1/2in
Right Starter	Engage
If No Start...	Repeat

Right Throttle	1000-1200 RPM
Oil Pressure	Green
Start Annun	Extinguished
Low Volts Annun	Extinguished
R ALT Annun	Extinguished
Right Alternator Load	Below 25A in 2min
Bus Volts	28V
Engine Instruments	Check

Left Mixture	Cut-Off
Left Propeller	High RPM
Left Boost Pump	Hi for 10-20s
Left Boost Pump	Off
Left Mixture	Full Rich
Left Throttle	Full Open
Left Boost Pump	Hi for 2-3s
Fuel Flow	Greater than 3 GPH
Left Boost Pump	Off
Left Throttle	Open 1/2in
Left Starter	Engage
If No Start...	Repeat
Left Throttle	1000-1200 RPM

Oil Pressure	Green
Start Annun	Extinguished
Low Volts Annun	Extinguished
L ALT Annun	Extinguished
Left Alternator Load	Below 25A in 2min
Bus Volts	28V
Engine Instruments	Check

Engine Start (Flooded)

Right Mixture	Lean
Right Propeller	High RPM
Right Throttle	Open 1/2in
Right Starter	Engage
Right Throttle	Advance Until Start
Right Throttle	Idle
Right Mixture	Full Rich
Oil Pressure	Green
Start Annun	Extinguished
Low Volts Annun	Extinguished
R ALT Annun	Extinguished
Right Alternator Load	Below 25A in 2min
Bus Volts	28V
Engine Instruments	Check

Left Mixture	Lean
Left Propeller	High RPM
Left Throttle	Open 1/2in
Left Starter	Engage
Left Throttle	Advance Until Start
Left Throttle	Idle
Left Mixture	Full Rich
Oil Pressure	Green
Start Annun	Extinguished
Low Volts Annun	Extinguished
L ALT Annun	Extinguished
Left Alternator Load	Below 25A in 2min
Bus Volts	28V
Engine Instruments	Check

After Starting

Lights	As Required
Weather Radar	Off/Standby
Avionics	On
Cabin Air & Heat	As Desired
Air Conditioning	As Desired
Mixture	Lean for Taxi
Parking Brake	Release
Brakes	Check

Runup

Parking Brake	Set
Annunciators	Test & Consider
Remote Compass	Slaved & Aligned
Mixture	Full Rich
Throttle	1700 RPM
Exercise Left Propeller	To 300 RPM Drop
Exercise Right Propeller	To 300 RPM Drop
Check Left Magnetos	150 RPM Drop Max
Check Right Magnetos	150 RPM Drop Max
Instrument Air	Green & No Lights
Left Alternator	Off
L ALT Annun	Illuminated
Left Alternator Load	Zero
Right Alternator	Off
R ALT Annun	Illuminated
Right Alternator Load	Zero
Left Alternator	On
L ALT Annun	Extinguished
Left Alternator Load	Above 10A
Right Alternator	On
R ALT Annun	Extinguished
Right Alternator Load	Above 10A
Propeller Heat	On
Propeller Amps	20-25A & Cycles
Propeller Heat	Off
Windshield Heat	On
WSHLD HEAT Annun	Illuminated
Ammeters	Increase
Windshield Heat	Off
Left Pitot Heat	On
PITOT HEAT Annun	Illuminated
Ammeters	Increase
Right Pitot Heat	On
Ammeters	Increase
Fuel Vent Heat	On
Ammeters	Increase
Stall Warning Heat	On
Ammeters	Increase
Heating Switches	Off
Surface Deice	Manual
Boot Pressure	15-20 psi
BOOT PRESS Annun	Illuminated
Surface Deice	Auto
Boot Pressure	15-20 psi
Boot Press Annun	Cycles
Surface Deice	Off

*Cockpit Window	Closed
*Throttle	2000 RPM
*Cabin Altitude	Field Elevation
*Cabin Differential	Zero
*Cabin Climb Rate	10 O'Clock
*Cabin Altitude Goal	1000ft below field elev.
*Cabin Press Mode	Press.
*Door Seal Mode	Press.
*Cabin Press Test	Hold
*Cabin Alt, Diff & Climb	Observe Descent
*Cabin Altitude Goal	Set First Assigned Alt
*Cabin Press Mode	Dump
*Door Seal Mode	Off

Throttle	1000-1200 RPM
Electric Trim	Exercise
Autopilot	Test
Heading Bug	30 Degrees Left
Autopilot Master	Engage
Heading Mode	Engage
Yoke Movement	Observe
Flight Director	Bank Left
Heading Bug	30 Degrees Right
Yoke Movement	Observe
Flight Director	Bank Right

Autopilot Disconnect	Press AP Off
Autopilot Disconnect	Press FD Off
Elevator Trim	Set Takeoff
Flaps	Check Operation
Flaps	Set Takeoff
Windows	Closed
AFT DOOR Annun	Extinguished
Flight Controls	Free & Correct
Altimeter	Set
Departure Altitude	Set
Takeoff Heading	Set
Panel Lights	Dim for Takeoff
Parking Brake	Release

Before Takeoff

*Cabin Press Mode	Press.
*Door Seal Mode	Press.
Mixture	Max Power
Oil Temperatures	24c Minimum
Boost Pumps	Off
Air Conditioning	Off
Landing Lights	On
Transponder	Alt Mode
Weather Radar	On

Takeoff

Throttles	Full Open
Brakes	Release
Engine Instruments	Check
Landing Gear Up	Positive Rate
Flaps	Retract at 100kts
Autopilot	Engage
*Cabin Alt, Diff & Climb	Observe Climb

Max Continuous Power

Mixture	Max Power
Propeller	2700 RPM
Throttle	Full Open
Cowl Flaps	As Required
Air Conditioning	As Desired
Cabin Heater	As Desired
Prop Sync	On

Enroute Climb

Mixture	Max Power
Propeller	2500 RPM
Throttle	Full Open *36.0 MP
Cowl Flaps	As Required
*Cabin Pressure	Monitor
Air Conditioning	As Desired
Cabin Heater	As Desired
Engine Performance	Monitor

Cruise

Cowl Flaps	Close
Landing Lights	Off
Pitot Heat	On if OAT less than 4c
Windshield Heat	As Required
Propeller Heat	As Required
Surface Deice	As Required
Fuel Imbalance	15 gal Max.
Tip Tank Transfer	As Required
Lean Mixture	LOP or ROP
Propeller	2500 RPM
Throttle	Full Open *33.0 MP
Cabin Air & Heat	As Desired
Air Conditioning	As Desired
Cabin Heater	As Desired
*Cabin Pressure	Monitor
Engine Performance	Monitor

Descent

*Cabin Altitude Goal	Set Destination Alt
Cowl Flaps	Closed
Throttle	Reduce
Mixture	Enrichen
Engine Performance	Monitor
Cylinder Head Temp	116c Min.
Tip Tank Transfer	As Required

Approach

Seats & Seatbelts	Secure
*Cabin Alt, Diff & Climb	Check Progress
Fuel Selectors	On
Fuel Imbalance	15 gal Max.
Tip Tank Transfer	As Required
Landing Lights	On
Pitot Heat	On if OAT less than 4c
Windshield Heat	Off
Propeller Heat	Off
Air Conditioning	Off
Cowl Flaps	As Required
Mixture	Max Power
Flaps	Approach

Landing

*Cabin Differential	Zero
Propellers	High RPM
Mixture	Max Power
Flaps	As Required
Landing Gear	Down & Locked
Autopilot Disconnect	Press Once

After Landing

Cowl Flaps	Open
Flaps	Up
*Cabin Alt, Diff & Climb	Verify Zero
*Cabin Press Mode	Dump
*Door Seal Mode	Off
Weather Radar	Off/Standby
Lights	As Required
Ice Protection	All Off
Air Conditioning	As Desired
Cabin Air & Heat	As Desired

Shutdown & Securing

Parking Brake	Set
Avionics	Off
All Subpanel Switches	Off
Throttles	Closed
Propellers	High RPM
Mixture	Cut-Off
Magnetos	Off
Alternators	Off
Battery Master	Off
Parking Brake	Release
Control Locks	Installed

Instrument Markings & Colors

Manifold Pressure (Normally Aspirated):
15.0-29.6 inHg (GREEN)
29.6 inHg (RED)

Manifold Pressure (Turbocharged):
15.0-39.5 inHg (GREEN)
39.5 inHg (RED)

Propeller RPM:
1800-2700 RPM (GREEN)
2700 RPM (RED)

Fuel Flow (Normally Aspirated):
0-27.5 gal/hr (GREEN)
27.5 gal/hr (RED)

Fuel Flow (Turbocharged):
0-40.0 gal/hr (GREEN)
40.0 gal/hr (RED)

Cylinder Head Temperature:
120-238 °C (GREEN)
238 °C (RED)

Exhaust Gas Temperature:
20 °C per division

Oil Temperature:
22 °C (YELLOW)
22-116 °C (GREEN)
116 °C (RED)

Oil Pressure:
30 psi (RED)
30-38 psi (YELLOW)
38-100 psi (GREEN)
100 psi (RED)

Main Fuel Quantity:
0 lbs / 0 gal (MINIMUM)
516 lbs / 86 gal (MAXIMUM)
0-120 lbs / 0-20 gal (YELLOW)

Oxygen Pressure:
0-200 psi (RED)
1850-2200 psi (GREEN)

Instrument Air Pressure:
2.5-3.5 inHg (YELLOW)
4.25-6.0 inHg (GREEN)
5.5-6.5 inHg (YELLOW)

Propeller Ammeter:
0-30 amps

Airspeed Indicator:
SEE V-SPEEDS

Abnormal & Emergency Checklists

Engine Fire (Ground)

Fuel Selectors	Off
Mixture	Cut-Off
Alternators	Off
Battery Master	Off
Magnetos	Off

Engine Failure (Ground Roll)

Throttles	Closed
Braking	Maximum
Fuel Selectors	Off
Alternators	Off
Battery Master	Off

Engine Failure (Takeoff)

Landing Gear Up	Up
Flaps	Retract above 85kts
Inoperative Engine	Identify
Inop. Eng. Throttle	Closed
Inop. Eng. Propeller	Feather
Airspeed	Maintain 100 kts
Inop. Eng. Mixture	Cut-Off
Inop. Eng. Fuel Selector	Off
Inop. Boost Pump	Off
Inop. Eng. Magnetos	Off
Inop. Eng. Alternator	Off
Cowl Flaps	Closed
Alternator Load	80A Max.

Engine Failure (In Flight)

Airspeed	115 kts
Inoperative Engine	Identify
Inop. Eng. Throttle	Closed
Inop. Eng. Propeller	Feather
Fuel Selector	Inop. Eng. Crossfeed
Inop. Eng. Magnetos	Check Both
Inop. Eng. Boost Pump	Hi
Inop. Eng. Mixture	Rich then Lean
Inop. Eng. Starter	Engage
Inop. Eng. Engine	If No Restart...
Inop. Eng. Boost Pump	Off
Inop. Eng. Mixture	Full Rich
Inop. Eng. Magnetos	Check Both
Inop. Eng. Starter	Engage
Inop. Eng. Engine	If No Restart...
Nearest Airport	Select
Inop. Eng. Fuel Selector	Off
Inop. Eng. Boost Pump	Off
Inop. Magnetos	Off
Inop. Alternator	Off
Cowl Flaps	Closed
Alternator Load	80A Max.

Rough Running Engine

Boost Pump	Lo
Mixture	Rich then Lean
Magnetos	Check Both

Engine Fire (Flight)

Inop. Eng. Fuel Selector	Off
Inop. Eng. Mixture	Cut-Off
Inop. Eng. Alternator	Off
Inop. Eng. Magneto	Off
Inop. Eng. Engine	Do Not Restart

Starter Does Not Disengage

Alternators	Off
Battery Master	Off
Mixture	Cut-Off
Magnetos	Off

Emergency Descent

Throttles	Close
Propellers	High RPM
Landing Gear	Down
Flaps	Approach
Airspeed	152 kts

Maximum Glide

Landing Gear	Up
Flaps	Up
Cowl Flaps	Close
Propellers	Feathered
Airspeed	115 kts
Air Conditioning	Off
Cabin Heater	Off
Nonessential Equipment	Off

Electrical Smoke or Fire

Alternators	Off
Battery Master	Off
Windows	Open
Avionics	Off
Air Conditioning	Off
Cabin Heater	Off
Electrical Equipment	Off
Cabin Air & Heat	Off
Avionics Relay	Off

Observe	If No Fire...
Battery Master	On
Restore Essential Power	Circuit by Circuit
Avionics	On
Avionics Relay	On
Restore Avionics Power	Circuit by Circuit

High Pressure Differential

Cabin Altitude Goal	Set Higher Altitude
Cabin Climb	If No Descent...
Cabin Press Shutoff	Pull
Cabin Press Mode	Dump
Differential Press	Green
Diff Press Annun	If Extinguished...
Cabin Press Mode	Press.
Cabin Press Shutoff	Push

Cabin Depressurization

Cabin Alt Annun	If Illuminated...
Emergency Descent	Begin
Cabin Press Test	Hold
Cabin Climb	If no Climb Observed...
Pressurization Circuit Breakers	Check/Reset
Cabin Press Test	Hold
Cabin Climb	If no Climb Observed...
Door Seal Annun	If Illuminated...
Door Seal Standby Air	On
Door Seal Standby	Hold
Door Seal Annun	If Illuminated...
Cabin Press Shutoff	Pull

Turbocharger Failure

Observe	If No Fire...
Throttles	Advance
Manifold Pressure	If Still Low...
Restart Engine	If Necessary...
Mixture	Lean Max Power
Cabin Press Shutoff	Pull
Land	At Nearest Airport

Carbon Monoxide Detected

Cabin Heater	Off
Cabin Air & Heat	Close (Push)
CO Detector	Reset
CO Alarm	If Persists...
Cabin Press Shutoff	Pull
CO Alarm	If Persists...
Throttle	Closed
Mixture	Cut-Off
Propellers	Feathered
Magnetos	Off
Windows	Open
Cabin Air	Full Open
Nonessential Equipment	Off

Alternator Failure

Alternator Load	Verify No Load
Inop. Eng. Alternator	Reset
Inop. Eng. Alternator Load	If No Load...
Inop. Eng. Alternator	Off
Alternator Load	80A Max.
Alternator Load	If Dual Failure...
Nonessential Equipment	Off
Land	As Soon as Practical

Dual Instrument Air Failure

Land	As Soon as Practical

Severe Icing Encounter

Ice Protection	All On
Wing Light	On
Ice Build-Up	Monitor
Propellers	High RPM
Cowl Flaps	Closed
Cabin Heater	On
Cabin Air & Heat	On Maximum
Defroster	On Maximum

Remote Compass Misalignment

Gyro Slave Circuit Breaker	Pull & Reset
Remote Compass Alignment	If Misaligned...
Remote Compass	Free Mode
Compass Position	Slew to Mag. Heading

Autopilot Failure or Trim Runaway

Autopilot	Disconnect
Autopilot Circuit Breakers	Pull Off

AC DOOR Illuminated in Flight

Air Conditioning	Discontinue Use
Increased Drag	Anticipate

Nose Baggage Door Unlatched

Airspeed	Reduce
Cabin Heater	Off
Increased Drag	Anticipate
Land	As Soon as Practical

CABIN DOOR Annun Illuminated

Door Handle	Check
Airspeed	Reduce
Increased Drag	Anticipate
Land	As Soon as Practical

Landing Gear Manual Extension

Airspeed	152 kts or Less
Landing Gear Motor	Pull Off
Landing Gear	Handle Down
Emergency Gear Handle	Engage
Crank Handle	50 Turns
Gear Warning	Push On
Gear Indicators	Three Green
Emergency Gear Handle	Stow

Landing Gear Up after Man Ext

Emergency Gear Handle	Stowed
Landing Gear Motor	Push On
Landing Gear	Handle Up

Flap Failure

Flap Breakers	Check On
Bus Volts	23V Minimum
Flaps	As Required
Flap Indicators	Check
Flaps	Visually Check

Balked Landing

Mixture	Max Power
Propellers	2700 RPM
Throttles	Full Open
Cowl Flaps	Open
Engine Instruments	Check
Landing Gear Up	Positive Rate
Flaps	Retract at 100kts

No Power Landing

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

Cabin Door Will Not Open

Cabin Door Handle	Pull Firmly
Cabin Alt, Diff & Climb	Verify Zero
Cabin Press Mode	Dump
Cabin Door Handle	If still stuck…
Door Pressure Bypass	Pull
Cabin Door Handle	Pull Firmly

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, featuring the KNS-81 Navigation System, and the RDR 1150XL, additional resources are available online for the real world counterparts of these units. In particular the **"KNS-81 Pilot's Guide"**, available on Bendix/King's website, and the **"Weather Radar Pilot Training DVD"** on Bendix/King's YouTube channel. There are also comprehensive video tutorials for the EDM-700/800 on Youtube. You will find one complete overview of the instrument under the title of **"JPI EDM 760 Overview, display features, and leanfind mode"**. 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
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
Main Cabin Door	L:bksq_CabinDoor	Boolean
Pilot Door	L:bksq_PilotDoor	Boolean
Baggage Compartment Door	L:bksq_NoseDoor	Boolean
Pilot’s Window	L:bksq_stormWindow	Boolean
Cabin Door Pressure Bypass	L:var_CabinDoorPressureBypass	Boolean
Pilot Door Pressure Bypass	L:var_PilotDoorPressureBypass	Boolean
Cabin Table	L:bksq_CabinTable	Boolean
Pilot’s Sun Visor Position	L:var_Visor_L	0 - 100
Copilot’s Sun Visor Position	L:var_Visor_R	0 - 100

Primary Control Variables

Description	Variable	Range
Left Mixture Lever	K:MIXTURE1_SET - OR - L:BKSQ_MixtureLeverPosition_1	0 - 100 -OR- (0 - 1)
Right Mixture Lever	K:MIXTURE2_SET - OR - L:BKSQ_MixtureLeverPosition_2	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
Control Wheel Steering Yoke Button	L:var_PilotCws	Boolean
Prop Heat	L:var_PropHeatSwitch	Boolean
Fuel Vent Heat	L:var_FuelVentHeatSwitch	Boolean
Stall Warning Heat	L:var_StallWarningHeatSwitch	Boolean
Windshield Heat	L:var_windshieldHeatSwitch	Boolean
Left Fuel Pump	L:var_FUEL_Switch_Pump_1	0 - 2
Right Fuel Pump	L:var_FUEL_Switch_Pump_2	0 - 2
Door Seal Inflate Switch	L:var_doorSealPrimaryInflate	Boolean
Door Seal Standby Valve	L:var_doorSealStandbyAirValve	Boolean
Door Seal Standby Inflate Button	L:var_doorSealStandbyInflate	Boolean
Pressurization Mode Switch	L:var_pressurizationPress	Boolean
Pressurization Test Switch	L:var_pressurizationTest	Boolean
Surface Deice	L:var_surfaceDeiceSwitch	0 = AUTO, 2 = MAN
Annunciator Light Test	L:var_AnnunciatorTestButton	Boolean
Left Ignition Switch	K:MAGNETO1_INCR/DECR - OR - L:BKSQ_IgnitionPosition_1	0 - 5
Right Ignition Switch	K:MAGNETO2_INCR/DECR - OR - L:BKSQ_IgnitionPosition_2	0 - 5
Left Cowl Flap	RECIP ENG COWL FLAP POSITION:1	0 - 100
Right Cowl Flap	RECIP ENG COWL FLAP POSITION:2	0 - 100
Prop Sync	L:var_PropSyncSwitch	Boolean

Carbon Monoxide Detector Test	L:var_CoTest	Boolean

Lighting Control Events & Variables

Description	Variable	Range
Pilot’s Yoke Map Light Button	L:OatMapCompassLightButton_1	Boolean
Copilot’s Yoke Map Light Button	L:OatMapCompassLightButton_2	Boolean
Navigation Lights	B:LIGHTING_NAVIGATION_1_Toggle (K:TOGGLE_NAV_LIGHTS)	
Strobe Lights	B:LIGHTING_STROBE_1_Toggle (K:STROBES_TOGGLE)	
Beacon Lights	B:LIGHTING_BEACON_1_Toggle (K:TOGGLE_BEACON_LIGHTS)	
Wing/Ice Light	B:LIGHTING_WING_1_Toggle (K:TOGGLE_WING_LIGHTS)	
Taxi Light	B:LIGHTING_TAXI_1_Toggle (K:TOGGLE_TAXI_LIGHTS)	
Left Landing Light	B:LIGHTING_LANDING_1_Toggle (1 K:LANDING_LIGHTS_SET)	
Right Landing Light	B:LIGHTING_LANDING_2_Toggle (2 K:LANDING_LIGHTS_SET)	
Master Panel Lighting Switch	L:bksq_MasterPanelLights	Boolean
Glareshield Flood Lights Switch	L:bksq_MasterGlareshieldLights	Boolean
Instrument Lights Dimmer	L:var_FlightInstrumentsLightingKnob	0 - 100
Glareshield Flood Lights Dimmer	L:var_GlareshieldLightingKnob	0 - 100
Engine Instruments & Avionics Lighting Dimmer	L:var_EngineInstrumentsLightingKnob	0 - 100
Subpanel Integrity Lighting Dimmer	L:var_SubpanelLightingKnob	0 - 100
Pilot Cabin Reading Light	L:var_LIGHTING_Push_Cockpit_1	Boolean
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
Passenger Cabin Reading Light	L:var_LIGHTING_Push_Cockpit_5	Boolean

Passenger Cabin Reading Light	L:var_LIGHTING_Push_Cockpit_6	Boolean

Environmental Control Variables

Description	Variable	Range
Oxygen Flow Valve	L:var_OxygenHandle	0 - 100
Pilot Air Valve	L:var_PilotAirHandle	0 - 100
Copilot Air Valve	L:var_CopilotAirHandle	0 - 100
Ram Air Valve	L:var_RarmAirHandle	0 - 100
Cabin Heat Valve	L:var_CabinHeatHandle	0 - 100
Defroster Valve	L:var_DefrosterHandle	0 - 100
Left Pressurization Air Shutoff	L:var_PressurizationAirShutoffHandle_L	0 - 100
Right Pressurization Air Shutoff	L:var_PressurizationAirShutoffHandle_R	0 - 100
Fresh Air Valve	L:var_FreshAirKnob	0 - 100
Combustion Heater Ignition Switch	L:var_CabinHeaterIgnitionSwitch	Boolean
Heater Blower Switch	L:var_CabinHeaterBlowerSwitch	0 - 2
Air Conditioning Switch	L:var_AirConditionerSwitch	Boolean
Air Conditioning Blower Switch	L:var_AirConditioningBlowerSwitch	0 - 2
Vent Blower Switch	L:var_VentBlowersSwitch	Boolean
Pressurization Goal Knob	L:var_pressurizationGoal	-1000 - 15000
Pressurization Rate Knob	L:var_pressurizationClimbRate	150 - 2000
Pressurization Mode Switch	L:bksq_PressurizationMode	0 = TEST, 2 = DUMP

Instrument Variables

Description	Variable	Range
RNAV Drives HSI	L:var_rnavDrivesHsi	Boolean
Gyro Slaving Mode	L:var_GyroSlaveModeSwitch	Boolean
Dme Mode	L:var_dmeMode	0 - 4
Left True Airspeed Calculator	L:var_TrueAirspeedKnob_L	4.30 - 69.85
Right True Airspeed Calculator	L:var_TrueAirspeedKnob_R	4.30 - 69.85
Copilot Gyro Compass Heading	L:var_copilotHeading	0 - 360
Pilot Transmitting Radio Selector	L:var_PilotTransmitSelector	0 - 1
Cabin Temperature Display Unit	L:var_CabinTempUnitMode	Boolean
Autopilot Test Button	20 >L:var_AutopilotStartupCounter	Number

Primary Control Events Events

Description	Event
Battery Master	K:BATTERY1_SET
Left Alternator	K:TOGGLE_ALTERNATOR1
Right Alternator	K:TOGGLE_ALTERNATOR2
Avionics Master	K:AVIONICS_MASTER_1_SET
Left Pitot Heat	1 >K:PITOT_HEAT_TOGGLE
Right Pitot Heat	2 >K:PITOT_HEAT_TOGGLE
Alternate Static Air	K:TOGGLE_ALTERNATE_STATIC

Instrument Events

Description	**Variable**
Autopilot Master	K:AP_MASTER
Transponder Ident	K:XPNDR_IDENT_ON
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
Toggle Marker High Sensitivity	K:MARKER_BEACON_SENSITIVITY_HIGH
Toggle RNAV Receive	K:RADIO_VOR3_IDENT_TOGGLE
Altimeter Baro Increase	K:KOHLSMAN_INC
Altimeter Baro Decrease	K:KOHLSMAN_DEC
Decision Height Increase	K:INCREASE_DECISION_HEIGHT
Decision Height Decrease	K:DECREASE_DECISION_HEIGHT
Emergency Gear Extension	K:GEAR_PUMP

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

KNS81

Description	Variable or Event
Data Knob Outer Increase	H:KNS81_bigInc
Data Knob Outer Decrease	H:KNS81_bigDec
Data Knob Inner Increase	H:KNS81_smallInc
Data Knob Inner Decrease	H:KNS81_smallDec
Mode Knob Increase	H:KNS81_modeInc
Mode Knob Decrease	H:KNS81_modeDec
Waypoint Knob Increase	H:KNS81_wptInc
Waypoint Knob Decrease	H:KNS81_wptDec
Use Button	H:KNS81_useButton
Check Button	L:var_RNAV_CHECKMODE
Return Button	H:KNS81_returnButton
Data Button	H:KNS81_dataButton
Data Entry Knob Push/Pull	L:var_rnavKnobPulled
Volume Knob	L:var_RNAV_VOLUME
Radial Button	L:var_RNAV_DMERADIALMODE

KX155B

Description	Variable or Event
COM Knob Outer Increase	H:RADIO1_COM_Knob_Large_INC
COM Knob Outer Decrease	H:RADIO1_COM_Knob_Large_DEC
COM Knob Inner Increase	H:RADIO1_COM_Knob_Small_INC
COM Knob Inner Decrease	H:RADIO1_COM_Knob_Small_DEC
COM Knob Push/Pull	H:RADIO1_COM_Knob_Small_PUSH
NAV Knob Outer Increase	H:RADIO1_NAV_Knob_Large_INC
NAV Knob Outer Decrease	H:RADIO1_NAV_Knob_Large_DEC
NAV Knob Inner Increase	H:RADIO1_NAV_Knob_Small_INC
NAV Knob Inner Decrease	H:RADIO1_NAV_Knob_Small_DEC
NAV Knob Push/Pull	H:RADIO1_NAV_Knob_Small_PUSH
COM Volume Increase	K:COM1_VOLUME_INC
COM Volume Decrease	K:COM1_VOLUME_DEC
COM Frequency Spacing Toggle	H:RADIO1_COM_Freq_Spacing_PUSH
NAV Volume Increase	K:NAV1_VOLUME_INC
NAV Volume Decrease	K:NAV1_VOLUME_DEC
NAV Ident Toggle	K:RADIO_VOR1_IDENT_TOGGLE
COM Swap Button	K:COM1_RADIO_SWAP
NAV Swap Button	K:NAV1_RADIO_SWAP

KR87 ADF

Description	Variable or Event
Tuning Knob Push/Pull	L:var_adfKnobPulled
Tuning Increase by 100	K:ADF_100_INC
Tuning Decrease by 100	K:ADF_100_DEC
Tuning Increase by 10	K:ADF_10_INC
Tuning Decrease by 10	K:ADF_10_DEC

Tuning Increase by 1	K:ADF_1_INC
Tuning Decrease by 1	K:ADF_1_DEC
Antenna Button	H:adf_AntAdf
BFO Button	H:adf_bfo
Frequency Swap Button	H:adf_frqTransfert
Timer Mode Button	H:adf_FltEt
Timer Reset Button	H:adf_SetRst

GTX 327 Transponder

Description	Variable or Event
Off Button	H:TRANSPONDER_Push_OFF
Standby Button	H:TRANSPONDER_Push_STBY
Test Button	H:TRANSPONDER_Push_TST
On Button	H:TRANSPONDER_Push_ON
Altitude Reporting Mode Button	H:TRANSPONDER_Push_ALT
0 Button	H:TRANSPONDER_Push_0
1 Button	H:TRANSPONDER_Push_1
2 Button	H:TRANSPONDER_Push_2
3 Button	H:TRANSPONDER_Push_3
4 Button	H:TRANSPONDER_Push_4
5 Button	H:TRANSPONDER_Push_5
6 Button	H:TRANSPONDER_Push_6
7 Button	H:TRANSPONDER_Push_7
8 Button	H:TRANSPONDER_Push_CLR
9 Button	H:TRANSPONDER_Push_VFR
Function Button	H:TRANSPONDER_Push_FUNC
Cursor Button	H:TRANSPONDER_Push_CRSR

Weather Radar

Description	Variable or Event	Range
Mode Knob	L:var_radarMode	0 - 5
Brightness Knob	L:var_RadarBrightness	0 - 100
Gain Knob	L:var_RadarGain	0 - 100
Tilt Knob	L:var_RadarTilt	0 - 100
Alert Button	H:bksq_wradar1_radarAlertToggle	
Vertical Profile Button	H:bksq_wradar1_radarProfile	
Map Button	H:bksq_wradar1_radarMap	
Hold Button	H:bksq_wradar1_radarHold	
Range Increase Button	H:bksq_wradar1_radarRangeInc	
Range Decrease Button	H:bksq_wradar1_radarRangeDec	
Track Left Button	H:bksq_wradar1_radarTrackLeft	
Track Right Button	H:bksq_wradar1_radarTrackRight	

EDM 760 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	

KAS 297B Altitude Selector

Description	Variable or Event	Range
Altitude Select Knob Push/Pull	L:var_VsAdjustMode	Boolean
Outer Knob Increase	H:kas297b_1000_INC	
Outer Knob Decrease	H:kas297b_1000_DEC	
Inner Knob Increase	H:kas297b_100_INC	
Inner Knob Decrease	H:kas297b_100_DEC	
Vertical Speed Engage Button	H:kas297b_VsButton	
Altitude Capture Arm Button	H:kas297b_ArmButton	

Outputs

Since the Black Square Duke 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
Left Manifold Pressure	L:BKSQ_MANIFOLD_PRESSURE_1	inHg
Right Manifold Pressure	L:BKSQ_MANIFOLD_PRESSURE_2	inHg
Left Propeller RPM	L:BKSQ_PROP_RPM_1	RPM
Right Propeller RPM	L:BKSQ_PROP_RPM_2	RPM
Left Fuel Flow	L:BKSQ_FuelFlow_1	GPH
Right Fuel Flow	L:BKSQ_FuelFlow_2	GPH
Left Oil Pressure	L:BKSQ_OIL_PRESS_1	PSI
Right Oil Pressure	L:BKSQ_OIL_PRESS_2	PSI
Left Oil Temperature	L:BKSQ_OIL_TEMP_1	CELSIUS
Right Oil Temperature	L:BKSQ_OIL_TEMP_2	CELSIUS
Left Exhaust Gas Temperature	L:BKSQ_EGT_1	CELSIUS
Right Exhaust Gas Temperature	L:BKSQ_EGT_2	CELSIUS
Left Cylinder Head Temperature	L:BKSQ_CHT_1	CELSIUS
Right Cylinder Head Temperature	L:BKSQ_CHT_2	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
Instrument Air Pressure	L:BKSQ_SUCTION_PRESSURE	PSI
Oxygen Pressure	L:var_oxygenPressure	PSI
Propeller Synchroscope	L:var_propSyncIndicatorPosition	0 - 100
Cabin Climb Rate	L:var_cabinClimbRate	FPM

Cabin Pressurization Altitude	L:var_cabinPressurizationAltitude	FEET
Cabin Differential Pressure	L:var_cabinPressureDifferential	PSI

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
HSI CDI Needle	L:BKSQ_HSI_LOC	-127 - 127
HSI CDI Flag	L:BKSQ_HSI_LOC_FLAG	Boolean
HSI TO Flag	L:BKSQ_CDI_1_TO_FLAG	0 - 100
HSI FROM Flag	L:BKSQ_CDI_1_FROM_FLAG	0 - 100
HSI Glideslope Needle	L:BKSQ_HSI_GLIDE	0 - 100
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
RMI ADF Needle	L:BKSQ_RmiAdfNeedle	0 - 360
RMI VOR Needle	L:BKSQ_RmiVorNeedle	0 - 360
ADF Needle	L:BKSQ_ADF_BRG_1_Degraded	0 - 360
RNAV CDI Linear Deviation Mode	L:var_rnavCourseLinearFlag	Boolean
RNAV CDI Approach Deviation Mode	L:var_rnavApproachMode	Boolean
RNAV Data Entry Mode	L:var_rnavDataEntryMode	Number
RNAV Waypoint Number	L:var_RNAV_WAYPOINT_NUMBER	1 - 10
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 Frequency Data Display	A:NAV STANDBY FREQUENCY:3	Hz
RNAV Radial Data Display	L:var_RNAV_RADIAL_NUMBER	0 - 360
RNAV Distance Data Display	L:var_RNAV_DISTANCE_NUMBER	0.0 - 999.9

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 BaronProfessional_Base_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. After v1.1 of the Piston Duke, the tablet can also be moved by dragging the bezel using legacy interaction mode. 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 door?

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 Baron Professional 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-760 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 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 KNS-81 RNAV waypoints?

Yes! This is a new feature in this aircraft. By the nature of how the KNS-81 autopilot has been implemented, it cannot conflict with other GPS sources of navigation; therefore, the KNS-81 can only drive the autopilot’s NAV mode in the no-GPS avionics configuration. For more information, see the “Using the KNS-81 RNAV Navigation System” or the “Bendix/King KNS-81 RNAV 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 does the aircraft tip over or veer sideways during takeoff?

The ground handling physics added in SU15 make proper crosswind control deflection on takeoff essential. **With the ailerons deflected towards the wind, and nose-down pressure reduced during takeoff, the aircraft will not exhibit any of these behaviors**. While this might be more realistic than before SU15, the effect of nose wheel friction seems to be overdone, and will perhaps see improvements in future sim updates.

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.

Does this aircraft use Sim Update 13 engine improvements?

Sim Update 13 in October of 2023 introduced improved native simulation for turbochargers and superchargers. Luckily, these changes were non-breaking, because Black Square's turbocharger simulation is much more advanced than the native simulation, and enables advanced failures into the turbocharger simulation. In short, the turbocharged Black Square aircraft do not use the new SU13 turbocharger simulation, because **Black Square's turbocharger simulation is equally accurate, and has many more features**.

Why does the flight director not disengage when I press the autopilot disconnect button on my hardware yoke or joystick?

While the autopilot disconnect buttons in the virtual aircraft will always work as described in this manual, you must use a specific hardware binding for the autopilot disconnect button on your hardware to behave in the same way. **Use the event "AUTOPILOT_DISENGAGE_TOGGLE", rather than "AUTOPILOT_OFF".** This may cause the autopilots in other addon aircraft that have not implemented this feature correctly to not reengage. If this happens, just press your autopilot disconnect hardware button a second time to release the autopilot. For this reason, you can always use the "AUTOPILOT_OFF" event with Black Square aircraft, though you will have to disengage the flight director from the virtual cockpit.

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:

-

Bug Fixes:

-

Credits

Baron Professional	Nicholas Cyganski
Publishing	Just Flight
Audio	Boris Audio Works
Liveries	Ryan “ryanbatc” Butterworth
	Tim "TimHH" Scharnhop
Manual	Nicholas Cyganski
Testing	Just Flight Testing Team

Dedication

My first aircraft for MSFS, the Velocity XL, was dedicated to my father, as I owe him for making me the technical thinker and engineer that I am today; however, I would be remiss not to credit my mother, Janet Cyganski, for giving me my start in aviation. Though she has always been somewhat of a nervous flyer, and never pursued a career in engineering, my mother gifted me my first flying lesson at the age of 16. We rarely have the pleasure of knowing when a single decision has affected the outcome of our lives, so we are forced to ascribe meaning to certain milestones instead. As any pilot knows, your first flight lesson tends to be one of those landmark moments. I also have my mother to thank for teaching me all the life skills that are often overlooked by technical thinkers, yet play just as significant of a role in determining success. Most impressively, my mother has also been able to put up with two engineers as her only close relatives for many years now, and that kind of fortitude deserves recognition.

This dedication also appeared at the end of the Analog Baron manual.

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