Black Square

BONANZA PROFESSIONAL

OPERATIONS MANUAL

For Microsoft Flight Simulator

Published By:
Just Flight

"Virtual Aircraft. Real Engineering."

Bonanza Professional User Guide

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

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Introduction

The A36 Bonanza redefined an industry in the post-war era, as one of the first “modern” general aviation aircraft. The Bonanza first flew in 1945, employed all metal construction and was equipped with a compact horizontally opposed engine. This design stood the test of time, becoming the single longest production run of an aircraft from a single manufacturer in history. Today, the Bonanza is still a staple of the general aviation industry, continuing to compete with more contemporary designs. Although the A36 lacks the distinctive V-Tail that made the Bonanza so recognizable, its redesigned instrument panel, cockpit layout, and cruise flight characteristics helped ensure the airframe’s longevity.

Black Square’s Bonanza Professional brings you one of the most technically advanced aircraft simulations for Microsoft Flight Simulator, with an advanced reciprocating engine simulation, 110+ possible failures, 12 hot-swappable radio configurations, and the most advanced turbocharger, 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 A36’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 200+ page manual provides instruction on all equipment, and 40 in-game checklists with control highlighting are included for normal and emergency procedures. **This product includes three airframes**: the A36 of the mid-2000’s, the 2001 A36TC with an aftermarket turbonormalizing package, and the A36TP turboprop conversion. Six distinctive interiors and nine paint schemes are included from five decades of flying.

Analog Bonanza Owners: While the panel of the Bonanza 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 Bonanza 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 A36, 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 Bonanza?

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

Feature Overview

- **IMPROVED 200+ page manual** with your complete guide to flying the Black Square Bonanza, including systems guide, tutorials, operating limitations, performance tables, electrical schematics, and a supplement for the A36TP turboprop conversion.
- **NEW Three aircraft in one:** Normally Aspirated A36, Turbonormalized B36TC & Turboprop Conversion A36TP.
- **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 110+ 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 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 oil simulation**, with spring return fine pitch on loss of oil pressure.
- **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 turbine RPM, and engine performance is dependent on boost.
- **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.
- **Physics based instrument needles** respond to aerodynamic forces.
- **Mathematically accurate VOR & ADF signal attenuation and noise degradation.**
- **JPI EDM-800 Engine Monitor** with engine leaning optimization "Lean Find".
- Improper engine management will slowly **damage engines to failure**.
- **Completely simulated electrical system**, with 80 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.

Turboprop A36TP Specific Features

- **Improved turboprop dynamics**, including (ITT, TRQ, Ng, FF, FP), hot starts, residual heat, and exhaust back pressure, P2.5 HP & LP valve simulation, and oil cooler doors.
- **Turbine engine failures**, such as compressor stall and surging, fuel control failure, fuel filter clogs, engine-driven fuel pump failure, and propeller governors failure.
- **FOD damage based on surface type.** Use the inertial separators to avoid engine damage. Tablet interface displays type and intensity of FOD.
- **Turbine engine propeller and feathering physics-driven simulation.**
- **Beta range simulation**: an improvement upon the Black Square TBM beta range.
- **ETM Engine Trend Monitor**.

Checklists

Over 400 checklist items are provided for 40+ 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 Bonanza 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 Bonanza Professional features a flight model with performance to match the real world aircraft based on real Bonanza owner feedback and in-flight data. Engine and aerodynamic performance should be within 2% of POH values, though no two engines are ever the same. The flight model uses the most up to date features available in MSFS 2020 & 2024, such as the new voxel CFD aerodynamics, CFD propeller, adverse yaw & stall parameters, and flexible tire physics. Engine damage and fouling produces a rough running engine and decreased performance.

Paint Schemes

The Black Square Bonanza Professional comes with six paint schemes for the reciprocating engine aircraft, and an additional three for the Turbine Bonanza. The Bonanza 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	27’6”
Height	8'7"
Wheel Base	7’0"
Track Width	9’7"
Wingspan	33'6” (34’0” with Tip Tanks)
Wing Area	181.0 sqft.
Flight Load Factors	+4.4/-1.7 G’s (+3.8/-1.5 G’s with Flaps Down)
Design Load Factor	150%
Cabin W/L/H	42” x 12’7" x 50"
Oil Capacity	8 U.S. Quarts
Seating	6
Wing Loading	20.2 lbs/sqft
Power Loading	12.2 lbs/hp
Engine	300 HP (224 kW) Continental IO-550-B. Normally aspirated (or Turbonormalized), Fuel-injected, direct-drive, air-cooled, horizontally opposed, 6-cylinder, 550-cubic-inch displacement.
Propeller	3-Blade McCauley, Constant Speed, Aluminum, Hydraulically Actuated, 80 inch propeller. Fully fine blade angle of 13.7°, Low pitch blade angle of 28.8°. Propeller (Turbocharged) 3-Blade McCauley, Constant Speed, Aluminum, Hydraulically Actuated, 80 inch propeller. Fully fine blade angle of 15.8°, Low pitch blade angle of 34.9°.
Approved Fuel Grades	Aviation Gasoline Grade 100LL (blue) Aviation Gasoline Grade 100 (green)
Fuel Capacity	Total Capacity: 80 U.S. Gallons Total Capacity Each Tank: 40 U.S. Gallons Total Usable: 74 U.S. Gallons Optional Tip Tanks: +30 U.S. Gallons, 104 U.S. Gallons Usable
Electrical System	
Voltage:	28 VDC
Battery:	24V, 12 amp-hour, sealed lead acid battery
Primary Alternator:	28V, 100 amp @ 2,300 RPM
Standby Alternator:	28V, 20 amp, automatic operation when engaged

Aircraft Performance (Normally Aspirated)

Maximum Cruising Speed	174 ktas
Normal Cruising Speed	169 ktas
Economy Cruising Speed	143 ktas
Takeoff Distance	2,040 ft
Takeoff Ground Roll	962 ft
Landing Distance	1,450 ft
Landing Ground Roll	833 ft
Normal Range	716 nm
Maximum Range	920 nm
Rate of Climb	1,230 ft/min
Service Ceiling	18,500 ft
Empty Weight	2,145 lbs
Max Ramp Weight	3,650 lbs
Max Takeoff Weight	3,600 lbs
Max Landing Weight	3,600 lbs
Useful Load	1,455 lbs
Usable Fuel Weight	445 lbs
Full Fuel Payload	1,010 lbs
Maximum Operating Temp.	+53°C
Minimum Operating Temp.	-54°C

Aircraft Performance (Turbocharged with Tip Tanks)

Maximum Cruising Speed	216 ktas
Normal Cruising Speed	194 ktas
Economy Cruising Speed	151 ktas
Takeoff Distance	2,015 ft
Takeoff Ground Roll	958 ft
Landing Distance	1,450 ft
Landing Ground Roll	833 ft
Normal Range	1,005 nm
Maximum Range	1,280 nm
Rate of Climb	1,660 ft/min
Service Ceiling	25,000 ft
Empty Weight	2,215 lbs
Max Ramp Weight	4,080 lbs
Max Takeoff Weight	4,030 lbs
Max Landing Weight	4,030 lbs
Useful Load	1,815 lbs
Usable Fuel Weight	625 lbs
Full Fuel Payload	1,190 lbs
Maximum Operating Temp.	+53°C
Minimum Operating Temp.	-54°C

V-Speeds

Vr	71 kts	(Rotation Speed)
Vs	64 kts	(Clean Stalling Speed)
Vso	52 kts	(Dirty Stalling Speed)
Vx	77 kts	(Best Angle of Climb Speed)
Vy	96 kts	(Best Rate of Climb Speed)
Va	139 kts	(Maneuvering Speed)
Vg	110 kts	(Best Glide Speed)
Vfe	123 kts	(Maximum Flap Extension Speed)
Vle	152 kts	(Maximum Landing Gear Extension Speed)
Vno	165 kts	(Maximum Structural Cruise Speed - exceed only in clean air)
Vne	205 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

Turbocharger Limitations

Critical Altitude	19,000 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 A36TC is a “turbonormalized” aircraft, meaning that the turbocharger and wastegate work together to provide pressurized air at sea-level pressures to the intake manifold. This is in contrast to other turbocharging configurations, which provide air boosted to pressures exceeding 29.9 inHg to the manifold.

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 13 gallons usable 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-800 Engine Monitor
- ETM Engine Trend Monitor (A36TP only)
- Bendix RDR1150XL Color Weather Radar
- Garmin GTX 327 Transponder

Electrical/Miscellaneous

- 48+ Circuit Breakers
- Voltmeter & Ammeter for Primary and Secondary Alternator
- Bendix/King KA 51B Remote Compass Synchroscope
- Propeller Amps Indicator
- Vacuum Indicator
- Oxygen Pressure Gauge
- Yoke-Mounted Digital Chronometers
- Hobbs Timer & Carbon Monoxide Detector

Installation, Updates & Support

Installation

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

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

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

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

Installing the PMS GTN 750

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

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

   For the Windows Store install:

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

   For the Steam install:

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

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

For the Custom install:

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

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

Installing The Working Title GNS 530/430

No additional downloads are required for the Working Title GNS 530/430 and all previous modifications should be removed from your community folder. Some older aircraft may still require a “link” to the new GPS, which can be downloaded from the in-game marketplace for free. This package is not required for the Black Square Bonanza 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 ‘Bonanza 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 Bonanza Professional's annunciator panel consists of eight 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
- Starter is engaged
- Aft door is unlocked
- Air conditioning condenser door in fully extended (ground) position
- Gyro suction below 3.0 inHg
- Standby electric vacuum pump activated
- Standby alternator is providing power (steady), and load is greater than 20A (blinking)

To test the glareshield annunciator panel, hold the "ANNUN TEST" push button, located to the left of the magneto switch. To the left of the annunciators enumerated above, there is a single red LED marked, "ENGINE MONITOR ALARM", which will blink when there is an active alarm on the EDM-800 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 Bonanza 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. 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 above 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 turbonormalized version of this aircraft is fitted with a different fuel flow gauge scale than the normally aspirated version. At wide-open throttle, fuel flow may approach 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 40 U.S. Gallons, with 37 gal usable. Takeoff is not permitted when either fuel quantity is within the marked yellow arc at the 3/8ths level, or approximately 15 gallons total.

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. 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.

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-800 Engine Monitor

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

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 Bonanza 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 & Ammeter for Primary & Secondary Alternator

Under the fuel quantity gauges on the center subpanel, two meters with horizontal scales indicate the total load on the aircraft's two alternators, and the main bus voltage. The ammeter indicates the current in amps being supplied by either the primary or secondary alternator. The two currents can be selected with the blue "LOADMETER" switch on the pilot's subpanel. The primary alternator is capable of supplying a maximum of 100A, while the secondary alternator is only capable of supplying 20A. 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 Amps Indicator

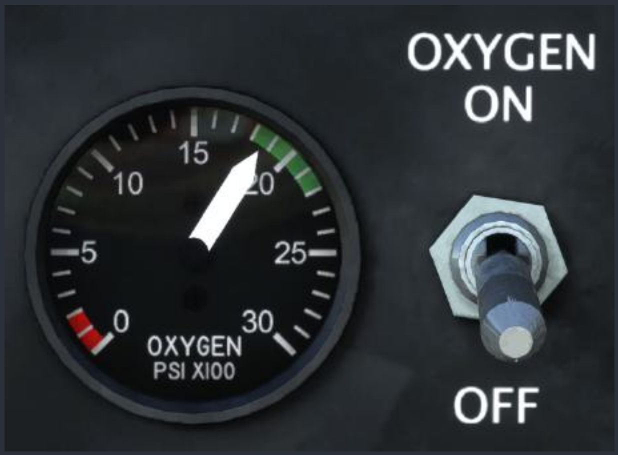
The propeller ammeter gauge indicates the flow of current to the propeller hub during deicing. Nominal current when cycling is 20-25 amps.

Vacuum Indicator

The vacuum indicator shows the vacuum suction generated by either the engine-driven vacuum pump on the engine's accessory gearbox, or the standby electric vacuum pump. The scale on the gauge indicates the acceptable vacuum range through the aircraft's cruising altitudes. At sea level, the vacuum suction should be near the top of the green arc, above 5 inHg.

Oxygen Pressure Gauge

On the copilot's subpanel, 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, place the oxygen supply switch on the copilot's subpanel 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.



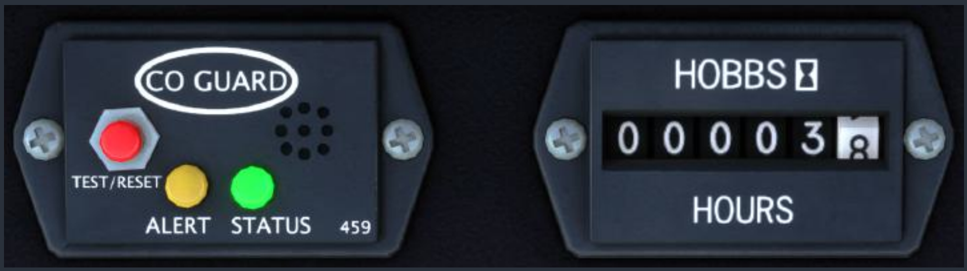
Yoke-Mounted Digital Chronometers

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.



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. The rate at which temperature equalization, active heating, or active cooling can be achieved is influenced by the ram air pressure, and can be supplemented by the air conditioning evaporator fan, or centrifugal vent blower fan. Equalization with the ambient air can also be accomplished by opening the two vents in either footwell of the cockpit, which admit air to the cabin through the wing root inlets.

Cabin Temperature Monitoring

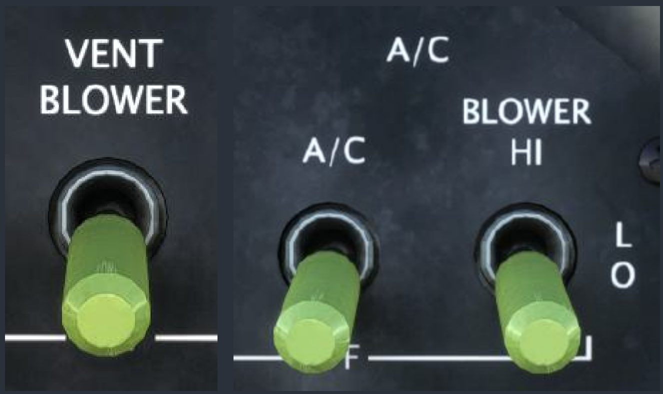
A temperature monitoring system is available in this aircraft to monitor cabin temperature, and alert the pilot to when cabin temperatures have become unacceptably hot or cold. The digital LCD temperature display, located above the copilot's airspeed indicator, will display temperatures from -99° to 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 Bonanza 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 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.

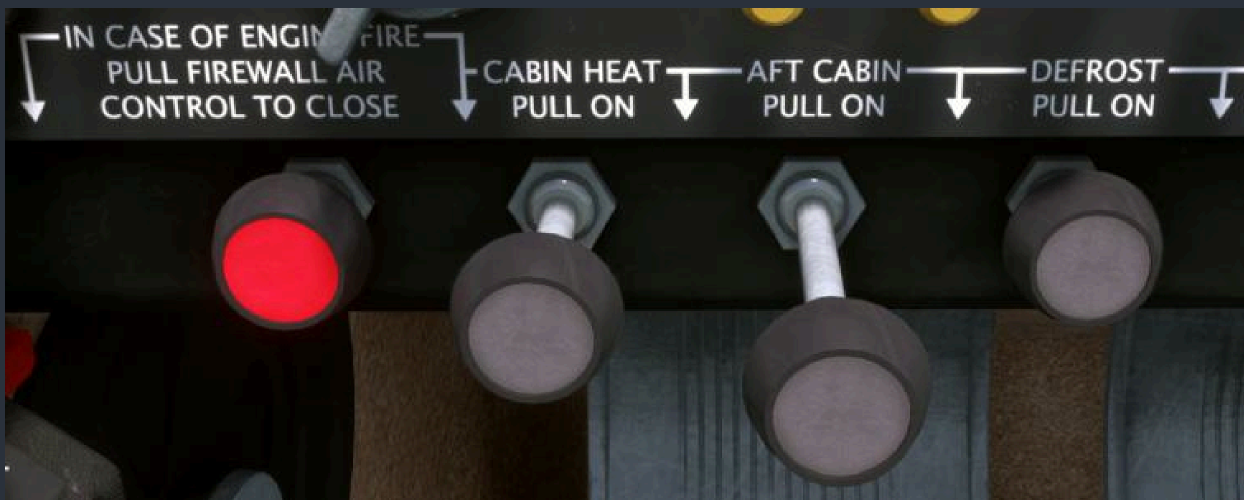


NOTE: The air conditioning fan can be operated independently of the air conditioning; however, the fan will operate at the low speed setting whenever the “A/C” switch is in the on position.

Cabin heating in the Bonanza Professional is supplied by an exhaust heat exchanger, or “exhaust shroud” located around the engine’s exhaust manifold for the pilot’s side cylinders, just forward of the firewall.

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

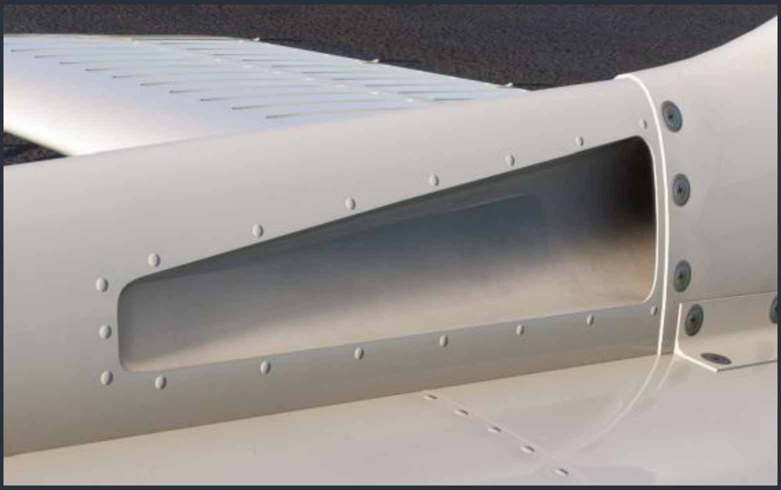
The exchanged air supplied by the exhaust shroud is distributed through the heating air ducts, which can admit heat to the cabin through the windshield defrosters, pilot air vent, copilot air vent, and aft cabin vents. The amount of heated air supplied to this duct from the exhaust shroud is increased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



While the Bonanza Professional is not certified for flight into known icing conditions, and therefore is not equipped with deicing boots or windshield anti-icing, the windshield can be partially deiced using the defroster in the event of an unintentional icing encounter. The “DEFROST” control knob must be pulled away from the instrument panel, the “CABIN HEAT” knob must also be pulled out, the engine must be running, and the “FIREWALL AIR” control handle must be pushed in towards the instrument panel.

Footwell air vents admit ambient air from the two screened vents in the leading edge of each wing root, and serve a similar purpose to the fresh air inlet in the dorsal fairing. These vents are opened by rotating the knob at the center of the circular valve assembly. The air from these vents enters the cockpit without interacting with the heating or cooling systems in any way.

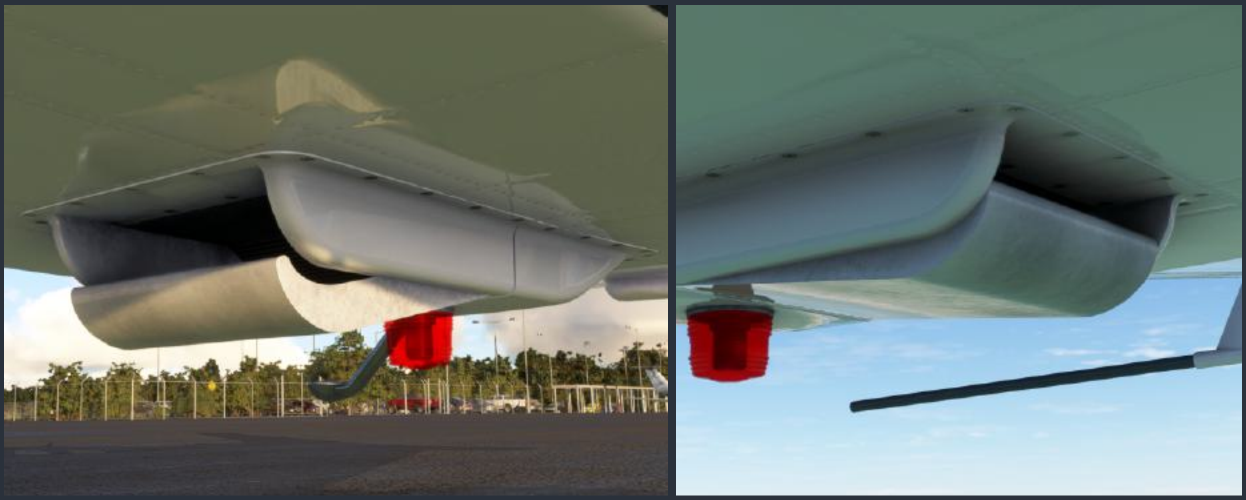
Fresh air for the cabin is sourced from a NACA duct on the pilot's side of the dorsal fairing. When the overhead "FRESH AIR" knob in the cockpit is rotated counterclockwise towards the open position, ram air is admitted into the cabin through this vent. This air can be used to cool the cabin passively,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



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 Scoop

The Bonanza Professional is equipped with an electromechanically actuated air conditioning condenser scoop on the bottom fuselage of the aircraft. When the air conditioner is not in use, the door is fully stowed to minimize drag. When the air conditioner is used in flight, the door is only partially extended. When the air conditioner is activated and the landing gear is extended, the condenser door is 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

An annunciator on the glareshield annunciator panel marked “AC DOOR EXTEND” 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 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 condenser, 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. When the additional load is significant, the 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 single-engine aircraft, the absence of oil pressure will increase the propeller blade pitch to the fine position, so as to fail safely in the event of a propeller governor failure. As a result, single-engine constant speed propellers will not move to coarse pitch after an engine failure, unlike in a multi-engine aircraft; however, a windmilling propeller produces more drag than a stopped propeller.

It has been suggested that the pilot of a single-engine aircraft should reduce their airspeed after an engine failure to stop the propeller from windmilling in order to extend their theoretical glide range. A windmilling propeller can be locked in place 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. This is now possible to experience with Black Square’s engine physics simulation, as the propeller blade angle influences the engine physics simulation by applying torque to the propeller shaft based on the blade angle and apparent wind velocity.

Engine Preheating

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

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

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 the case of a “turbonormalized” engine, the turbocharger and an absolute pressure controller provide consistent sea-level pressure air to the engine until the aircraft reaches critical altitude.

Critical Altitude

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

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

Operation Before & During Takeoff

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

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

Operation During Climb & Cruise

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

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

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

Operation During Landing & Securing

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

Engine Power Settings (Normally Aspirated A36)

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)	T/O Ground Roll (ft)	50ft Obstacle T/O Dist. (ft)	Rate of Climb (ft/min)
SL	29.6	2,700	137	962	2,040	1,230
2,500	27.2	2,700	124	1,202	2,610	1,065
5,000	24.8	2,700	113	1,443	3,490	895
7,500	22.6	2,700	103	1,811	4,040	815
10,000	20.4	2,700	92	2,252	5,170	605

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

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH)	KTAS	Range (nm)
SL	25	2,500	98	165	667
6,000	24	2,500	102	176	663
12,000	19	2,500	81	167	742
18,000	14	2,500	66	151	656

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

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH)	KTAS	Range (nm)
SL	23	2,300	79	150	770
6,000	23	2,300	87	165	733
12,000	19	2,300	75	159	768
18,000	14	2,300	64	140	630

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	52	118	945
6,000	21	2,100	56	134	920
12,000	14	2,100	57	137	882
18,000	NA	2,100	NA	NA	NA

Cruise Climb - Standard Day (ISA)

Target Alt. (ft)	Man. Press. (inHg)	Engine RPM	Fuel Flow (PPH)	Time to Climb (min)	Fuel to Climb (gal)	Dist. to Climb (nm)
6,000	24.0	2,500	100	7	3	13
10,000	20.5	2,500	102	14	5	27
14,000	17.2	2,500	96	25	8	52
*18,000	14.5	2,500	84	55	15	140

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

*Applicable to normally aspirated aircraft only when gross weight is less than 3,400 lbs.

Engine Power Settings (Turbonormalized A36TC)

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)	T/O Ground Roll (ft)	50ft Obstacle T/O Dist. (ft)	Rate of Climb (ft/min)
SL	29.9	2,700	199	958	2,015	1,660
2,500	29.9	2,700	200	964	2,028	1,655
5,000	29.9	2,700	200	972	2,045	1,650
7,500	29.9	2,700	201	983	2,068	1,645
10,000	29.9	2,700	203	998	2,100	1,640

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

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH)	KTAS	Range (nm)
SL	25	2,500	102	170	944
6,000	25	2,500	105	183	947
12,000	25	2,500	108	197	975
18,000	25	2,500	110	210	976
24,000	24	2,500	111	218	908

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

Pressure Alt. (ft)	Manifold Press. (inHg)	Engine RPM	Fuel Flow (PPH)	KTAS	Range (nm)
SL	23	2,300	84	158	1,082
6,000	23	2,300	87	171	1,086
12,000	23	2,300	90	182	1,096
18,000	23	2,300	91	192	1,098
24,000	23	2,300	96	235	1,151

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	68	140	1,206
6,000	21	2,100	70	151	1,210
12,000	21	2,100	72	162	1,240
18,000	21	2,100	73	172	1,098
24,000	21	2,100	77	178	1,060

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	29.9	2,500	103	6	4	12
10,000	29.9	2,500	104	9	5	18
14,000	29.9	2,500	106	12	6	22
18,000	29.9	2,500	108	15	9	33
22,000	26.8	2,500	109	20	12	45
25,000	23.9	2,500	110	30	18	62

Recommended Climb Airspeeds: 110 kts to 16,000 ft, 100 kts to 18,500 ft, 90 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-800 engine monitor is an essential skill of operating a high performance aircraft. The engine monitor is equipped with alarms, which will illuminate an LED on the glareshield panel to alert you to a potentially dangerous engine condition. If engine parameters are not brought back within limits soon, the engine will fail.

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

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

Propeller RPM	2700 RPM
Cylinder Head Temperature (CHT)	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 Bonanza 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 Bonanza Professional is equipped with propeller deicing, pitot heat, and windshield defrosters. As the Bonanza Professional is not certified for flight into known icing conditions, these features are to be used during inadvertent icing encounters only. Electrical anti-icing for the propeller and pitot-static system work continuously, and will slowly remove ice from these areas of the aircraft. On the other hand, 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, the firewall valve must be open, and the engine must be running. For more information on the defroster and its associated controls, see the Environmental Controls section of this manual.

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 Bonanza Professional.

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

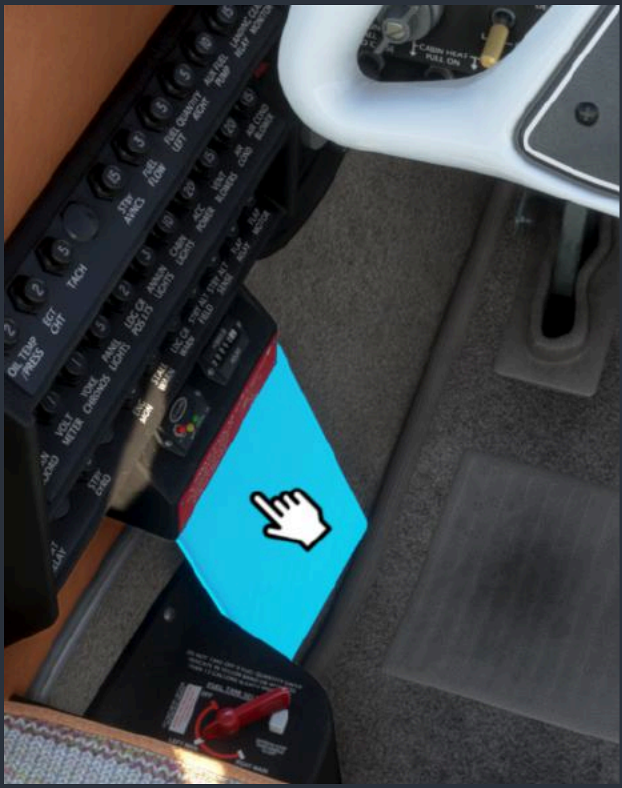
Magnetic Compass Effects

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

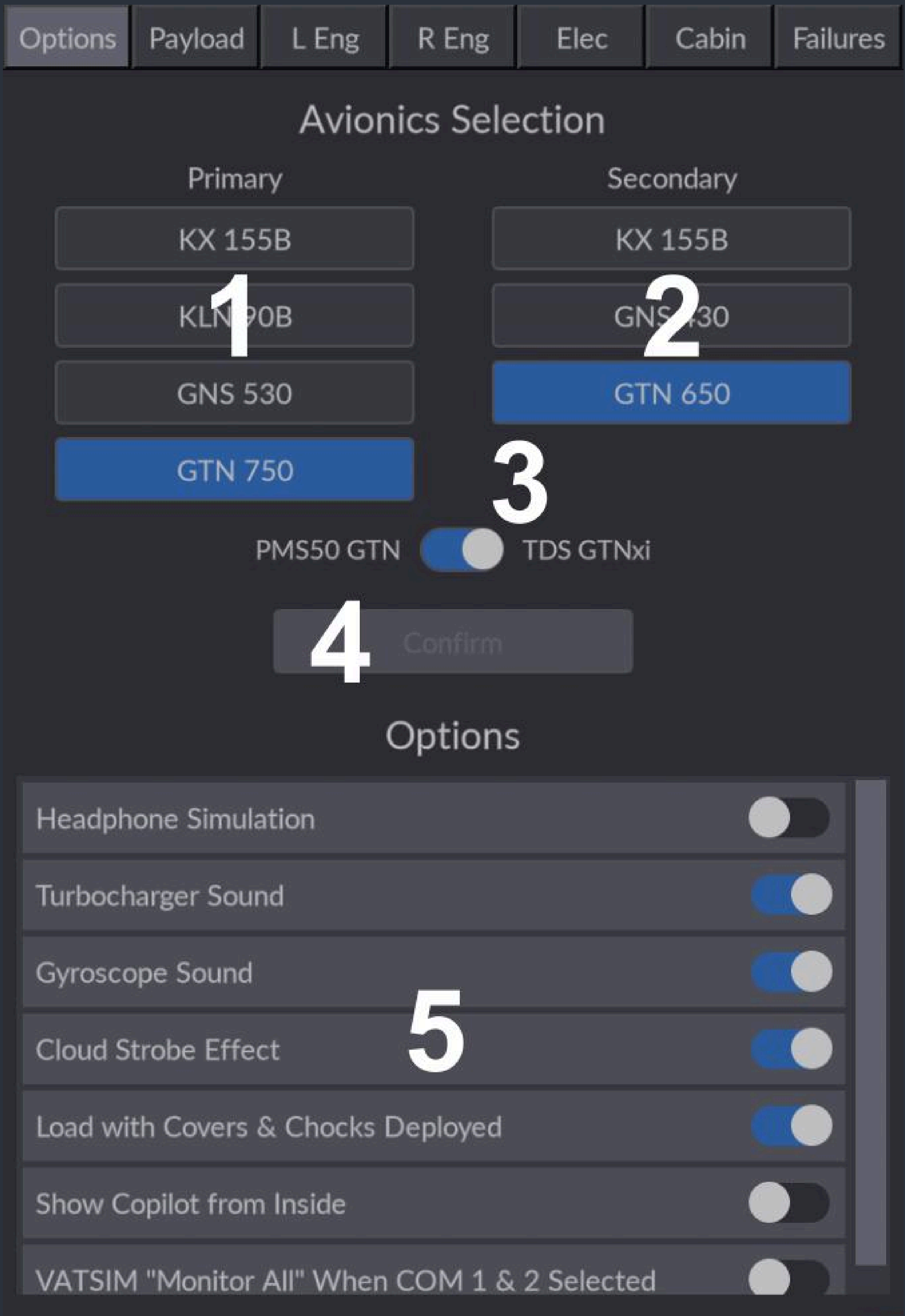
To switch between the PMS50 and TDS offerings of GTN GPS units, toggle this switch. This selection will be saved and recalled at the start of your next flight.

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
KX 155B
1
2
GTN 650
GNS 530
GTN 750
3
PMS50 GTN
TDS GTNxi
4
Confirm
Options
Headphone Simulation
Turbocharger Sound
Gyroscope Sound
5
Cloud Strobe Effect
Load with Covers & Chocks Deployed
Show Copilot from Inside
VATSIM "Monitor All" When COM 1 & 2 Selected

Payload Page

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

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

1. Payload Data

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

2. Exterior Actions

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

3. Fuel Stations

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

4. Payload Stations

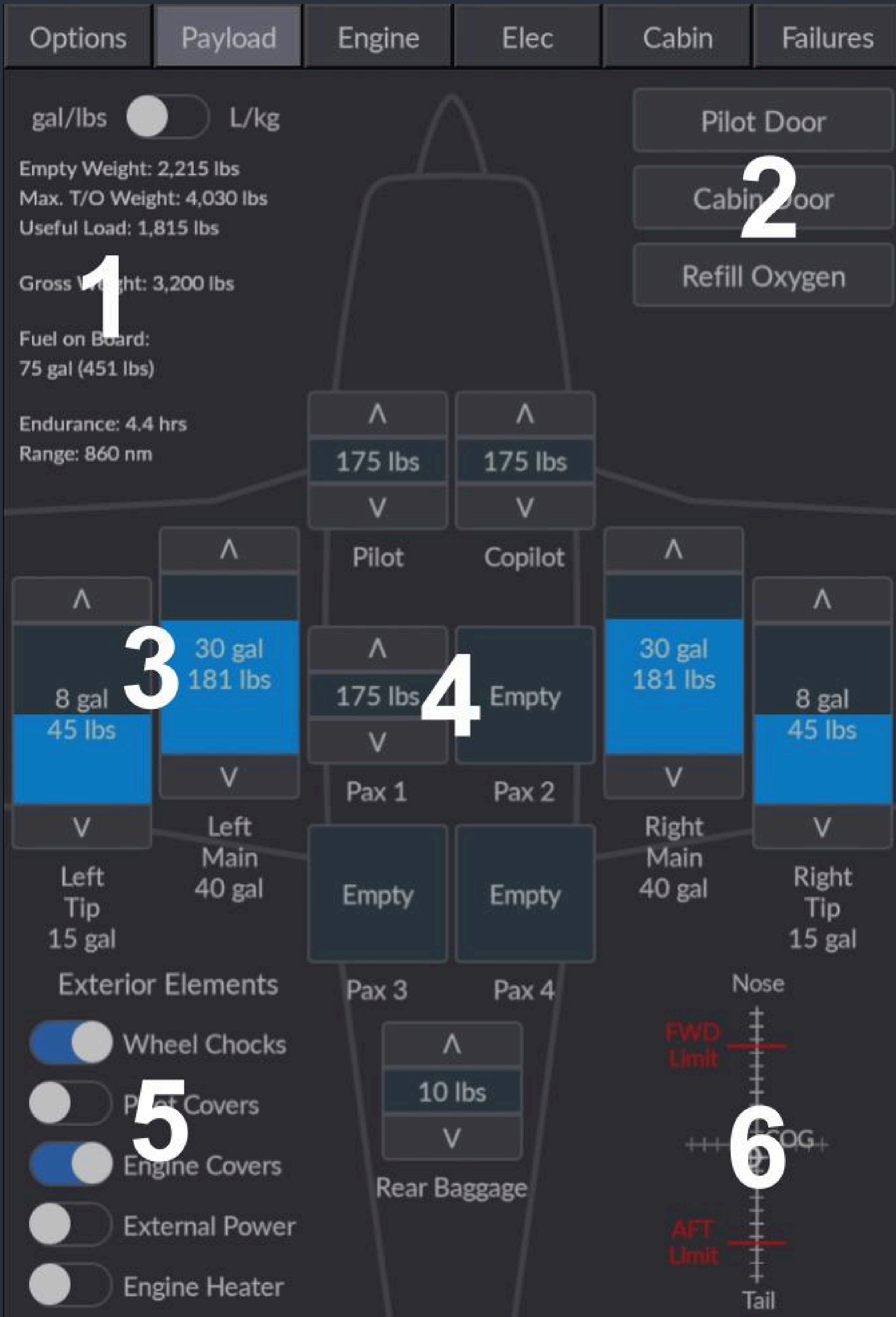
Each payload station in the aircraft is represented by a payload block. When occupied by passengers or cargo, each block shows the current weight of the station in its center. Clicking in the center of the block will toggle the payload between empty, and the default station weight. The weight of the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

5. Exterior Elements

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

6. Center of Gravity

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


Options
Payload
Engine
Elec
Cabin
Failures
gal/lbs
L/kg
Empty Weight: 2,215 lbs
Max. T/O Weight: 4,030 lbs
Useful Load: 1,815 lbs
Gross Weight: 3,200 lbs
Fuel on Board:
75 gal (451 lbs)
Endurance: 4.4 hrs
Range: 860 nm
1
Pilot Door
Cabin Door
Refill Oxygen
2
175 lbs
175 lbs
Pilot
Copilot
8 gal
45 lbs
30 gal
181 lbs
3
175 lbs
4
Empty
30 gal
181 lbs
8 gal
45 lbs
Pax 1
Pax 2
Left
Tip
15 gal
Left
Main
40 gal
Empty
Empty
Right
Main
40 gal
Right
Tip
15 gal
Pax 3
Pax 4
Exterior Elements
Wheel Chocks
Pitot Covers
5
Engine Covers
External Power
Engine Heater
10 lbs
Rear Baggage
Nose
FWD
Limit
COG
6
AFT
Limit
Tail

Engine Visualizer Page

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

Cold Engine

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

1. Repair Engine

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

2. Engine Condition

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

3. Inactive Battery

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

4. Cowl Flap Indicator

The cowl flap indicator shows the current position of the engine's cowl 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-800 engine monitor. For more information on EDM-800, see the "Using the JPI EDM-800 Engine Monitor" section of this manual.

7. Oil Pumps & Lines

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

8. Fuel Pumps & Lines

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

9. Exhaust Gas Parameters

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

10. Induction Air Controls

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

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

11. Engine Condition Reset Buttons

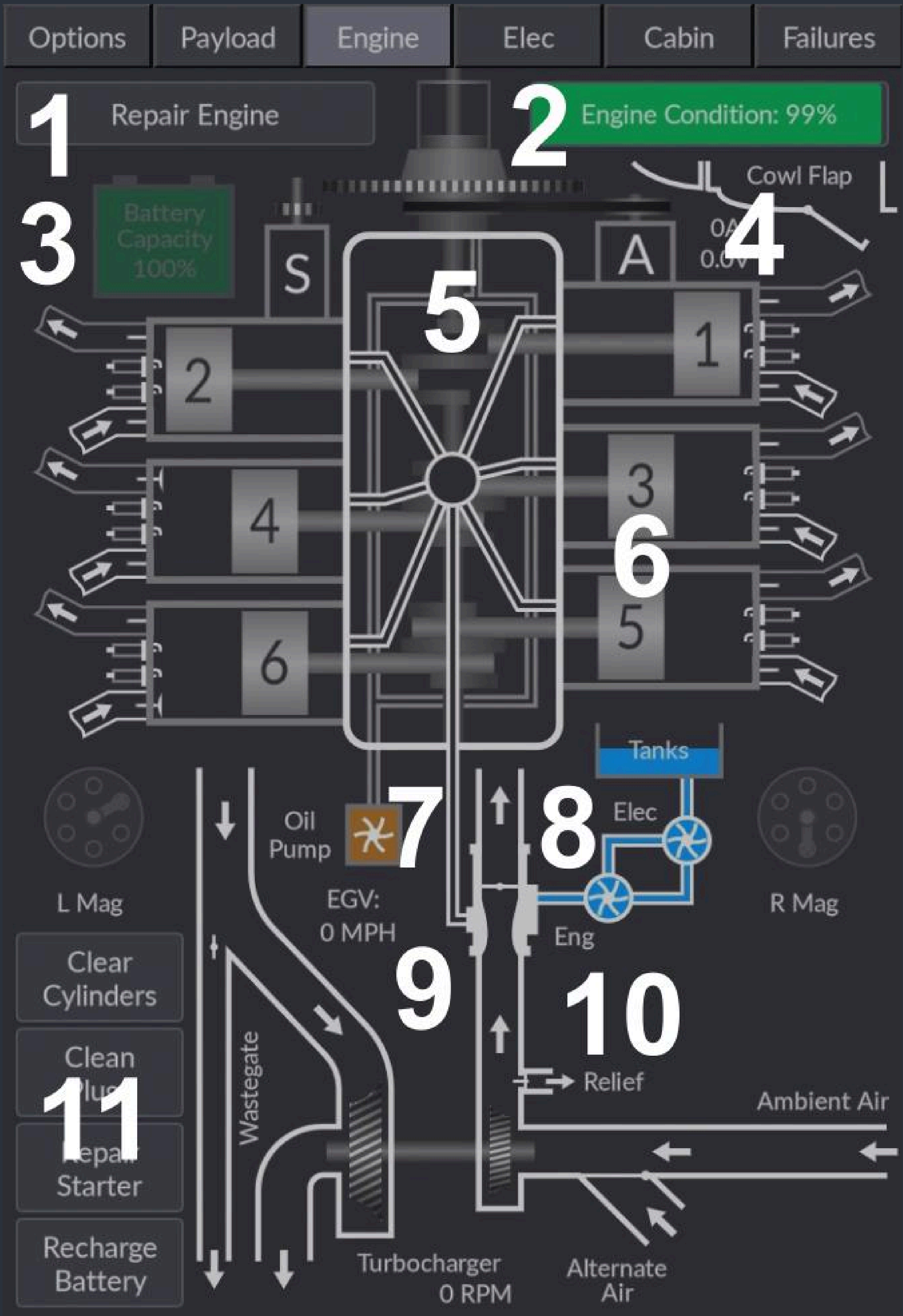
These buttons will not reset the engine’s overall condition, but instead will reset individual elements of the engine’s operating condition that may have become damaged or inoperable due to mismanagement, as opposed to failure.

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

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

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

The Recharge Battery button will fully recharge the battery, set its internal temperature to the ambient, and reconnect it with the hot battery bus. The battery may become disconnected from the hot battery bus if it is charged or discharged too quickly, which results in high temperatures.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Elec
Cabin
Failures
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Cowl Flap
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0.0V
4
5
1
2
3
4
5
6
6
Tanks
Oil Pump
7
8
Elec
L Mag
R Mag
EGV:
0 MPH
Eng
9
10
Clear Cylinders
Clean Plugs
11
Repair Starter
Wastegate
Relief
Ambient Air
Recharge Battery
Turbocharger
0 RPM
Alternate Air

Starting Engine

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

1. Propeller Hub

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

2. Battery Temperature

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

3. Starter Motor in Use

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

4. Spark Plug Fouling

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

5. Early Ignition

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

6. Fuel in Cylinders

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

7. Fuel & Vapor in Lines

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

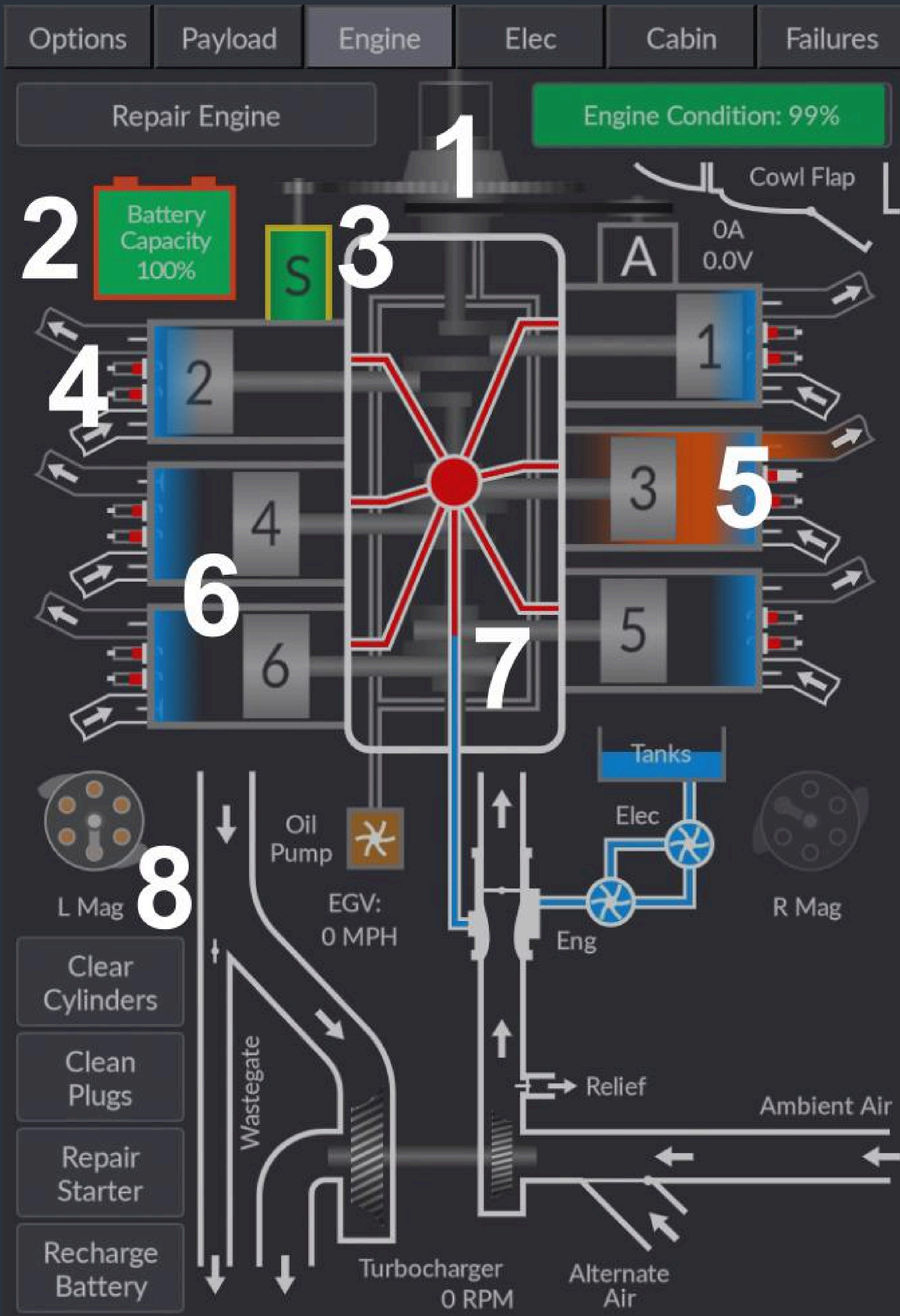
Usually when an engine is shut down, the heat in the cylinders will begin vaporizing fuel in the lines, causing back pressure that can prevent the flow of liquid fuel to the cylinders. This is called vapor lock. It is the bane of many fuel injected aircraft pilots who do not know how to manage it. For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

8. Magneto & Impulse Coupling

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

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

Around the outside of the magneto are the impulse coupling flyweights, which will only be visible when the engine is starting. These weights snap in and out as the engine rotates at low RPM, delaying the ignition of each spark plug, and increasing the angular velocity of the magneto’s rotor to produce larger sparks. These also make a characteristic snapping sound while the starter is cranking, and when the engine is coming to a stop.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Engine
Elec
Cabin
Failures
Repair Engine
Engine Condition: 99%
1
Cowl Flap
2
Battery Capacity 100%
S
3
A
0A
0.0V
1
4
2
3
5
4
6
6
7
5
Tanks
Elec
Oil Pump
L Mag
8
EGV:
0 MPH
Eng
R Mag
Clear Cylinders
Clean Plugs
Repair Starter
Recharge Battery
Wastegate
Relief
Ambient Air
Turbocharger
0 RPM
Alternate Air

Running Engine

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

1. Propeller Hub

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

2. Alternator

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

3. Cylinder Temperatures

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

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

4. Backfire

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

5. Oil Pumps & Lines

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

6. Magnetos

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

7. Exhaust Manifold

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

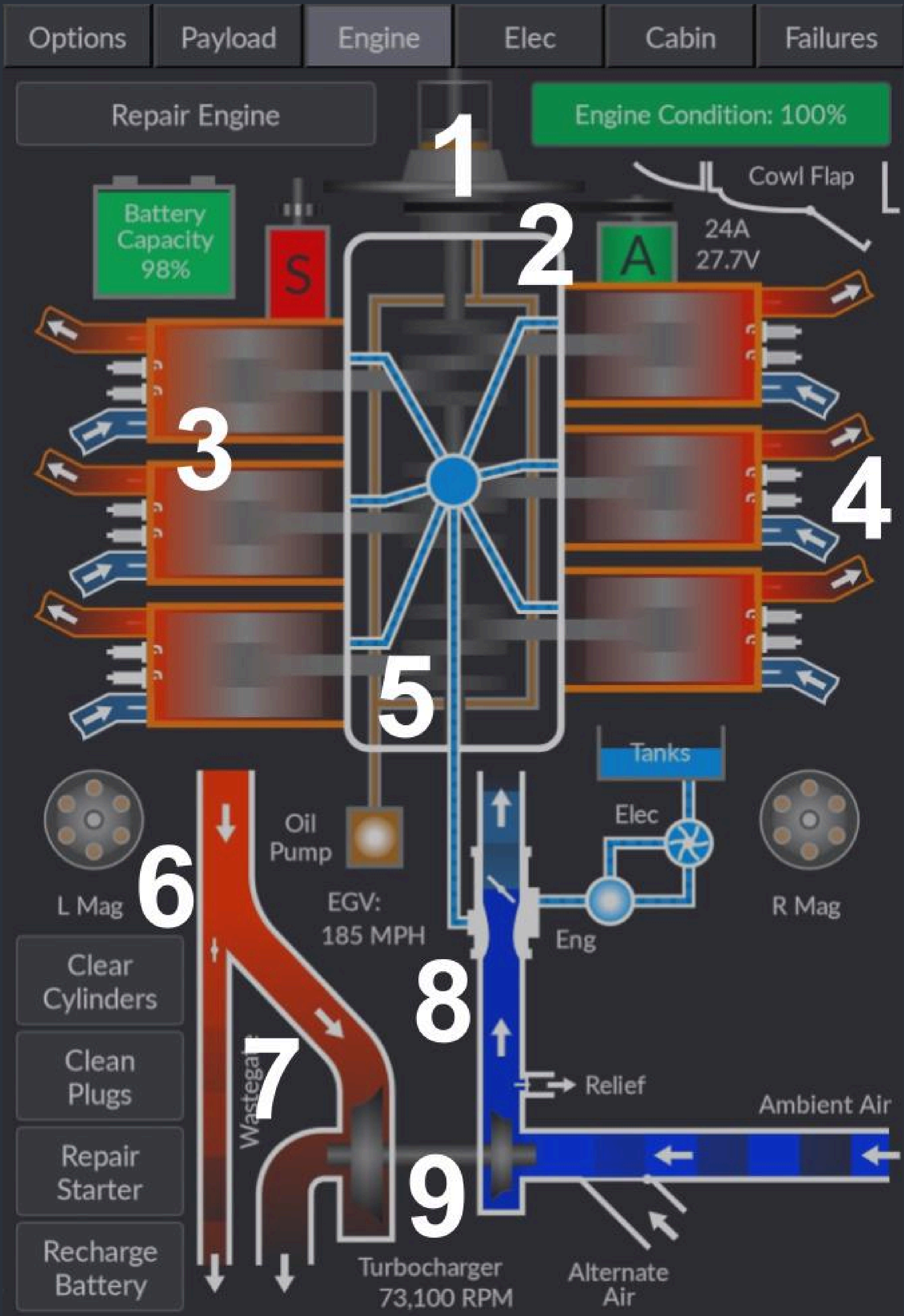
In the case of a normally aspirated aircraft, this exhaust gas will immediately be directed overboard. For turbocharged aircraft (as depicted below) most of this exhaust gas flows into the turbocharger, while some is diverted overboard. The diversion of this gas is controlled by the oil pressure actuated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

8. Intake Manifold

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

9. Turbocharger (Turbocharged A36TC Only)

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


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

Live Schematic Page

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

1. 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

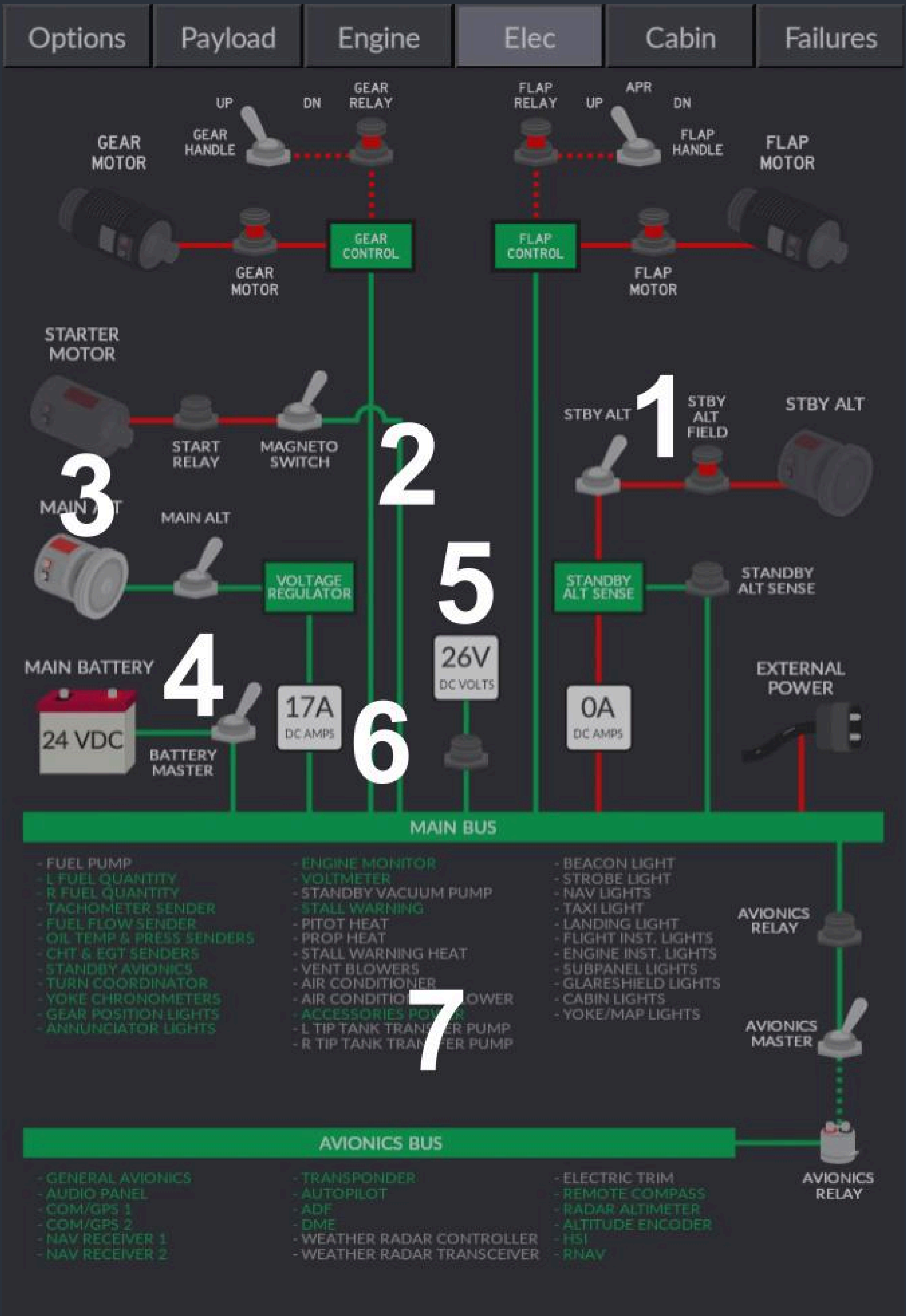
Voltmeters measure the electrical potential between two points in the aircraft's electrical system. Here, the direct current (DC) voltmeter measures the voltage between the main bus, and the chassis (ground) of the aircraft. A second alternating current (AC) voltmeter measures the voltage output by the 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
Engine
Elec
Cabin
Failures
GEAR MOTOR
GEAR HANDLE
UP
DN
GEAR RELAY
FLAP RELAY
UP
APR
DN
FLAP HANDLE
FLAP MOTOR
GEAR CONTROL
FLAP CONTROL
GEAR MOTOR
FLAP MOTOR
STARTER MOTOR
START RELAY
MAGNETO SWITCH
1
2
3
STBY ALT
STBY ALT FIELD
STBY ALT
MAIN ALT
VOLTAGE REGULATOR
5
STANDBY ALT SENSE
STANDBY ALT SENSE
MAIN BATTERY
4
24 VDC
BATTERY MASTER
17A
DC AMPS
6
26V
DC VOLTS
0A
DC AMPS
EXTERNAL POWER
MAIN BUS
- FUEL PUMP
- L FUEL QUANTITY
- R FUEL QUANTITY
- TACHOMETER SENDER
- FUEL FLOW SENDER
- OIL TEMP & PRESS SENDERS
- CHT & EGT SENDERS
- STANDBY AVIONICS
- TURN COORDINATOR
- YOKE CHRONOMETERS
- GEAR POSITION LIGHTS
- ANNUNCIATOR LIGHTS
- ENGINE MONITOR
- VOLTMETER
- STANDBY VACUUM PUMP
- STALL WARNING
- PITOT HEAT
- PROP HEAT
- STALL WARNING HEAT
- VENT BLOWERS
- AIR CONDITIONER
- AIR CONDITIO OWER
- ACCESSORIES PO R
- L TIP TANK TRANS ER PUMP
- R TIP TANK TRAN ER PUMP
7
- BEACON LIGHT
- STROBE LIGHT
- NAV LIGHTS
- TAXI LIGHT
- LANDING LIGHT
- FLIGHT INST. LIGHTS
- ENGINE INST. LIGHTS
- SUBPANEL LIGHTS
- GLARESHIELD LIGHTS
- CABIN LIGHTS
- YOKE/MAP LIGHTS
AVIONICS RELAY
AVIONICS MASTER
AVIONICS BUS
AVIONICS RELAY
- GENERAL AVIONICS
- AUDIO PANEL
- COM/GPS 1
- COM/GPS 2
- NAV RECEIVER 1
- NAV RECEIVER 2
- TRANSPONDER
- AUTOPILOT
- ADF
- DME
- WEATHER RADAR CONTROLLER
- WEATHER RADAR TRANSCEIVER
- ELECTRIC TRIM
- REMOTE COMPASS
- RADAR ALTIMETER
- ALTITUDE ENCODER
- HSI
- RNAV

Cabin Climate Visualizer Page

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

Heating Cabin

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

1. Exhaust Air Heat Exchanger (Exhaust Shroud)

Attached to the left exhaust manifold of this aircraft is an exhaust heat exchanger or “exhaust shroud”. This heat exchanger takes ambient temperature ram air and heats it to potentially very high temperatures for cabin heating. The hotter the exhaust gas temperature, the greater the heating potential.

2. Firewall Shutoff & Mixing Valve

Forward of the cabin firewall, two valves control the heating air that is admitted to the cabin. Air from the exhaust air heat exchanger is limited by a mixing valve, which is used to control the temperature of the cabin. Pulling the “CABIN HEAT” pull handle away from the instrument panel will send progressively more heating air to the cabin and less ram air at ambient temperature. For more information on controlling the cabin temperature, see the “Cabin Environmental Controls” section of this manual.

After the mixing valve, a firewall shutoff valve allows for the complete isolation of air from within the engine cowling in the event of carbon monoxide or other fumes. This valve is closed by pulling the red “FIREWALL AIR” pull handle on the pilot’s subpanel. Should the exhaust air heat exchanger become compromised and begin to allow poisonous carbon monoxide gas into the cabin, a grey gradient will be displayed on the visualizer within this heating manifold.

3. Wing Root Cabin Ram Air Intakes

At the root of each wing, a screen-covered intake sources ram air for the cabin, avionics cooling. Within the cabin, this air flows directly out of the circular vents in the pilot and copilot’s footwells, and does not interact with the heating or cooling systems in any way. These vents are opened and closed by rotating the knobs at the center of the vents near the occupant’s feet.

4. Air Vents & Aft Cabin

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 floor vents in the aft seating area when the “AFT CABIN” pull handle is 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.

5. 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.

6. Target Cabin Temperature

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

7. Ear Discomfort Index

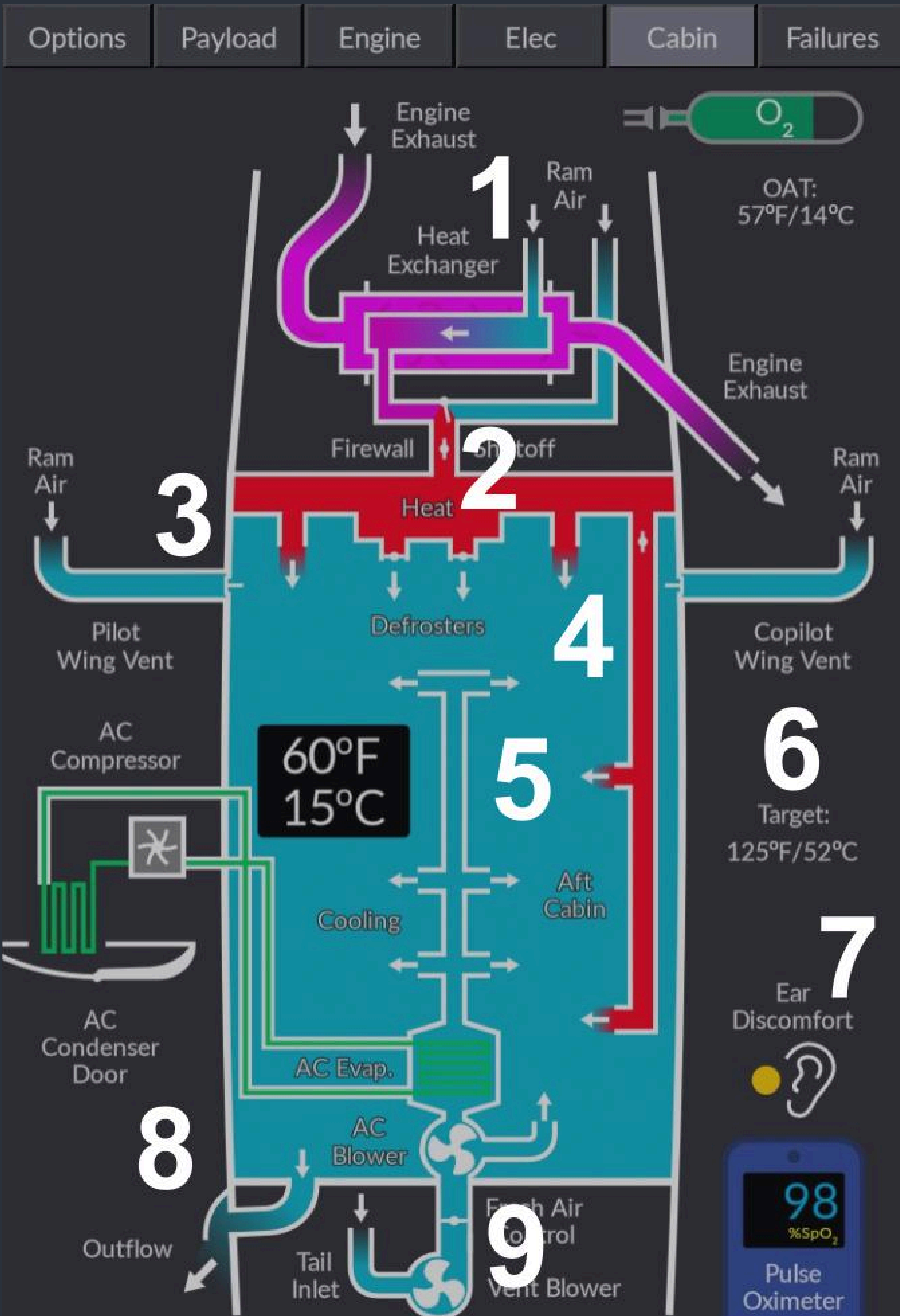
Ear discomfort is a frequent consideration while operating both pressurized and unpressurized aircraft. The colored dot in this visualizer gives some sense of ear discomfort due to pressure equalization between the outer ear and the middle ear. While everyone's physiology is different, rates of climb/descent 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.

8. Outflow Port

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

9. Fresh Air Valve & Vent Blower

Just like the pilot and copilot's footwell vents, fresh ambient air can also enter 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.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Cabin
Failures
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Ram
Air
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Exchanger
Engine
Exhaust
Firewall
Shutoff
2
Ram
Air
3
Heat
Ram
Air
Defrosters
4
Pilot
Wing Vent
Copilot
Wing Vent
AC
Compressor
60ºF
15ºC
5
6
Target:
125ºF/52ºC
Aft
Cabin
Cooling
7
Ear
Discomfort
AC
Condenser
Door
AC Evap.
AC
Blower
8
98
%SpO2
Fresh Air
Control
9
Outflow
Tail
Inlet
Vent Blower
Pulse
Oximeter

Cooling Cabin

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

1. Oxygen Cylinder

The pressure of oxygen in the cylinder (a surrogate for the quantity remaining) is indicated by the green volume in the cylinder. This quantity can be refilled on the payload page of the tablet interface. The valve to the 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.

2. Firewall Shutoff & Mixing Valve

The exhaust air heat exchanger 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.

3. Main Cabin Volume & Vents

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

4. Target Cabin Temperature

When air conditioning is desired, the target cabin temperature text can be useful for determining whether all conditions are met for active cooling. If the air conditioning switch is in the 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.

5. 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.

6. Air Conditioning Blower & Air Conditioning Evaporator

Cooling of the cabin air plenum air is accomplished with an air conditioning evaporator, through which either cabin air or ambient air flows. The insulated lines of the vapor cycle cooling system will change color to indicate that the system is operating. When the air outside the aircraft is cooler than the air inside, the fresh air knob should be used to admit ambient air into the evaporator ducting. The centrifugal vent blower can be used to accelerate cooling while on the ground with the fresh air valve open. When the air within the cabin is cooler than the air outside, the fresh air valve can be closed, and the air conditioning blower fan will recirculate cabin air for cooling while on the ground. Once in the air, the fresh air knob becomes the primary means of controlling the desired amount of cooling from the evaporator.

7. Pulse Oximeter

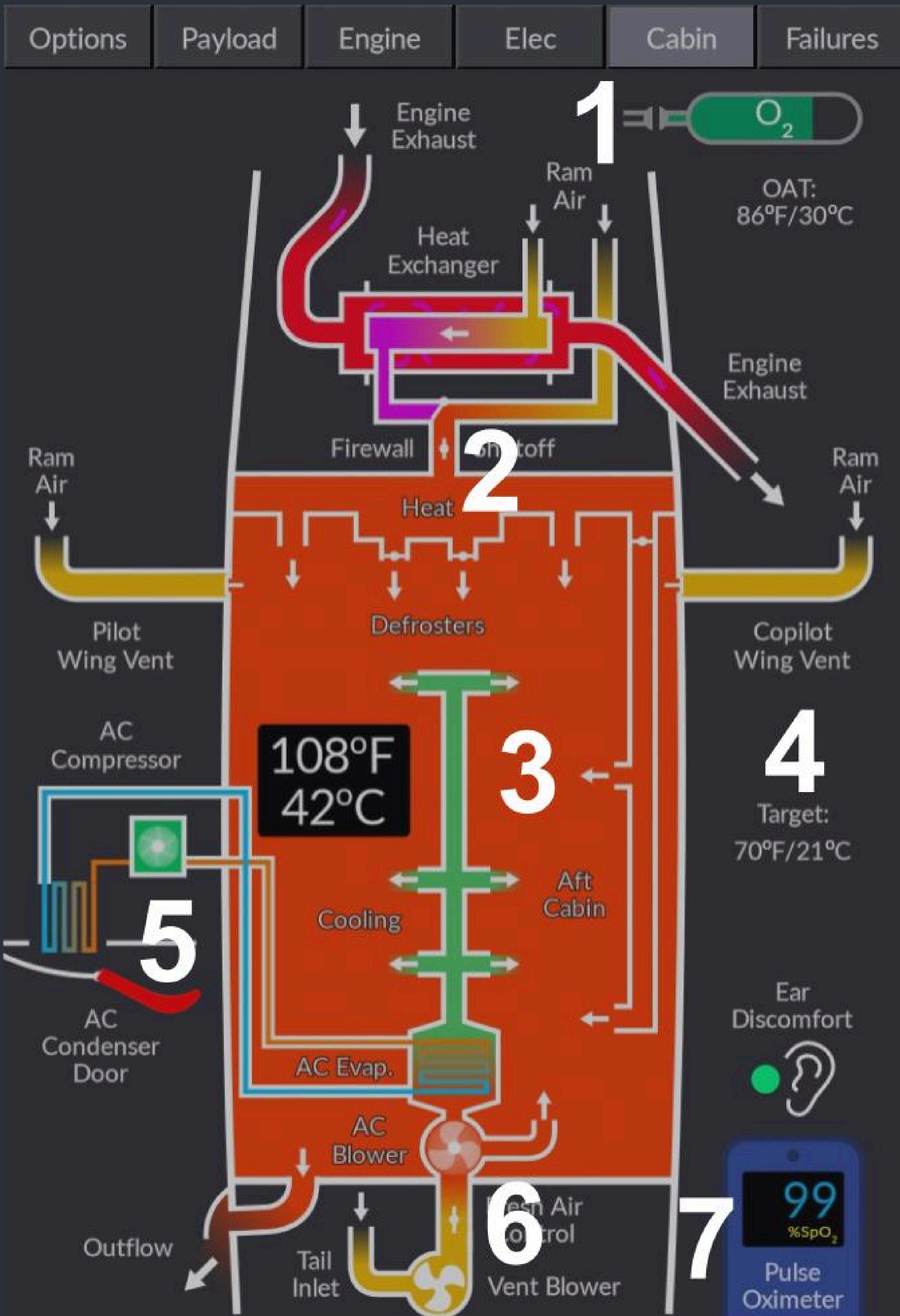
Loss of conscientiousness and impaired cognitive functioning in low oxygen environments does not happen instantaneously. Except in the case of the most severe decompression events, oxygen must leave the blood supply in order for hypoxia to take effect. This process can take over an hour at lower cruising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

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

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

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

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



Options
Payload
Engine
Elec
Cabin
Failures
Engine Exhaust
1
O2
Ram Air
OAT: 86ºF/30ºC
Heat Exchanger
Engine Exhaust
Firewall Shutoff
2
Ram Air
Ram Air
Heat
Defrosters
Pilot Wing Vent
Copilot Wing Vent
AC Compressor
108ºF 42ºC
3
4
Target: 70ºF/21ºC
Aft Cabin
Cooling
5
AC Condenser Door
Ear Discomfort
AC Evap.
AC Blower
Fresh Air Control
6
7
99 %SpO2
Pulse Oximeter
Outflow
Tail Inlet
Vent Blower

Failures Page

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

MTBF Failures

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

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

1. Restore Defaults & Reset All Failures

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

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

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

3. Global Failure Rate Slider

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

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

4. Active Failures

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

5. Search Failures

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

6. Adjust MTBF

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

7. Instantaneously Fail or Reset Failure

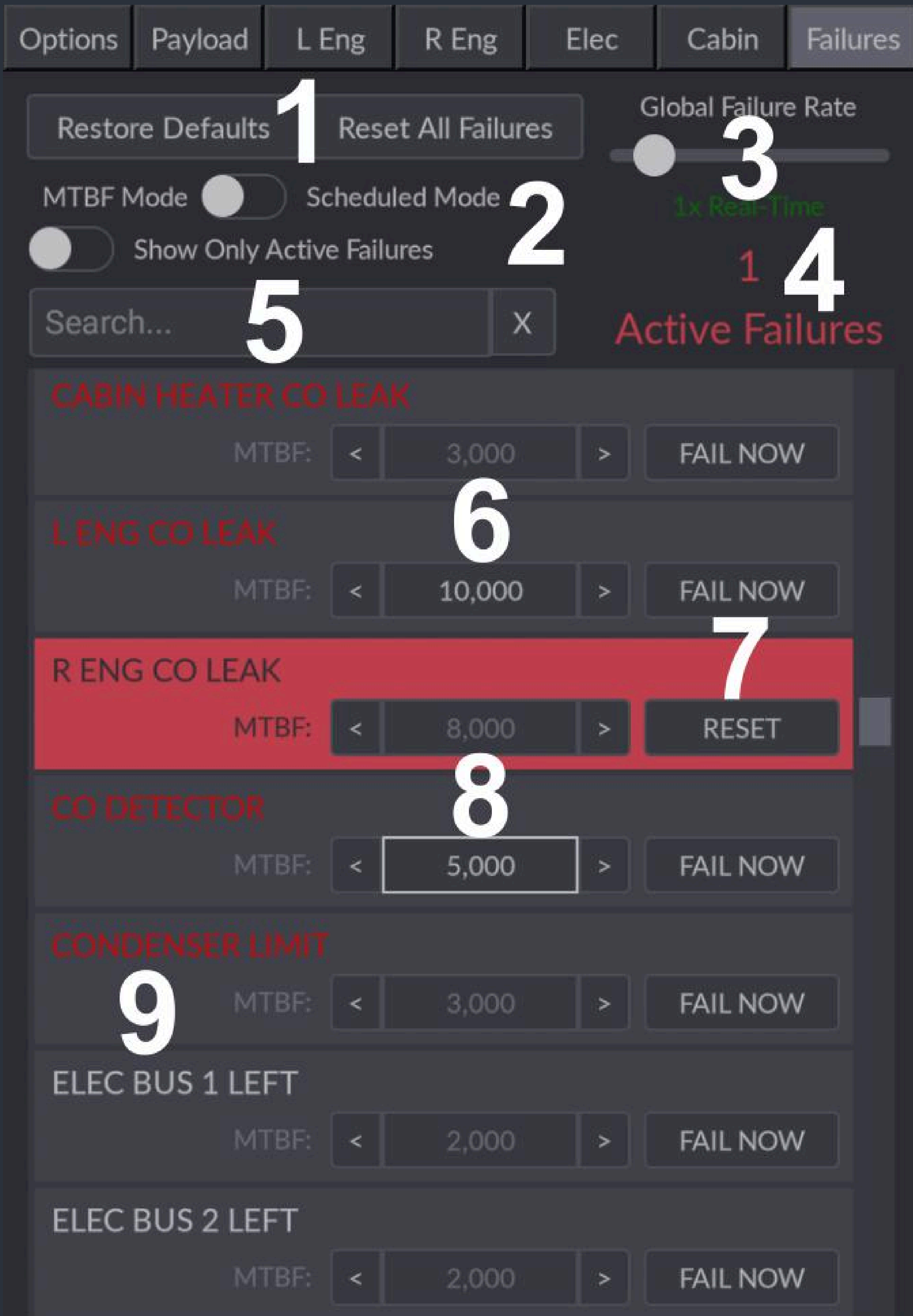
After being triggered by any means, individual failures can be reset by pressing the “RESET” button. Failures can also be triggered manually in this mode by pressing the “FAIL NOW” button.

8. Restore Default MTBF

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

9. Failure Names & Color Codes

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


Options
Payload
L Eng
R Eng
Elec
Cabin
Failures
Restore Defaults
Reset All Failures
Global Failure Rate
1x Real-Time
MTBF Mode
Scheduled Mode
Show Only Active Failures
Search...
X
1
Active Failures
1
2
3
4
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

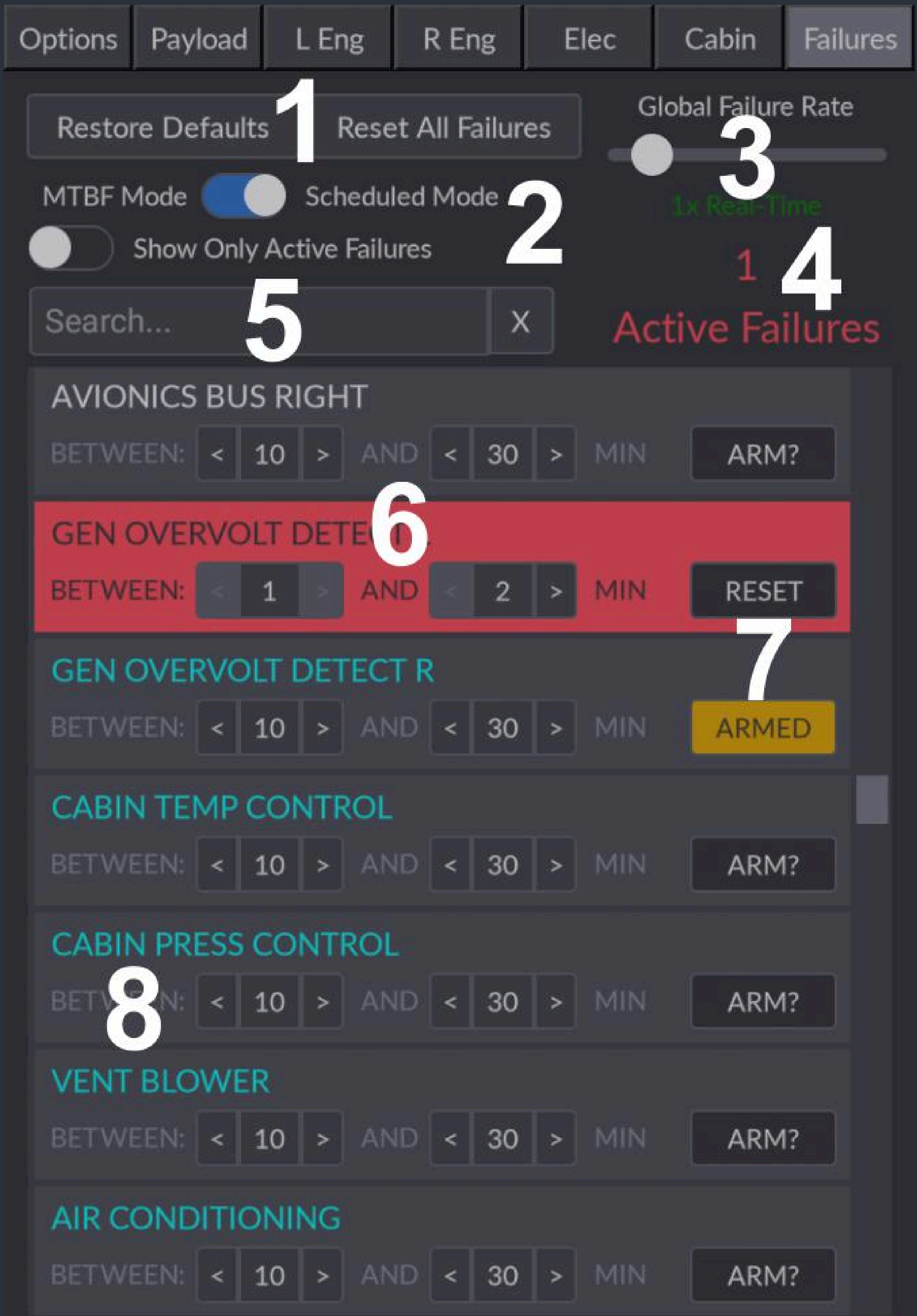
The time window in which a specific failure will occur can be adjusted with the arrow buttons beside the “after” and “before” times. These times are expressed in minutes. The minimum time after which a failure will occur is one minute, and the maximum time before which a failure will occur is ninety 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
Reset All Failures
Global Failure Rate
1x Real-Time
MTBF Mode
Scheduled Mode
Show Only Active Failures
Search...
X
1
Active Failures
AVIONICS BUS RIGHT
BETWEEN: < 10 > AND < 30 > MIN
ARM?
GEN OVERVOLT DETECT L
BETWEEN: < 1 > AND < 2 > MIN
RESET
GEN OVERVOLT DETECT R
BETWEEN: < 10 > AND < 30 > MIN
ARMED
CABIN TEMP CONTROL
BETWEEN: < 10 > AND < 30 > MIN
ARM?
CABIN PRESS CONTROL
BETWEEN: < 10 > AND < 30 > MIN
ARM?
VENT BLOWER
BETWEEN: < 10 > AND < 30 > MIN
ARM?
AIR CONDITIONING
BETWEEN: < 10 > AND < 30 > MIN
ARM?
1
2
3
4
5
6
7
8

Failure System HTML Interface

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

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

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

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

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

>H:BKSQ_FAILURE_L_FUEL_QTY

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

List of Possible Failures

Major System Failures

ENGINE FAILURE
ENGINE FIRE

L MAGNETO
R MAGNETO
L MAGNETO GROUNDING
R MAGNETO GROUNDING
IGNITION SWITCH GROUND
ALTERNATOR
ENG DRIVEN OIL PUMP
ENG DRIVEN FUEL PUMP
VACUUM PUMP
VACUUM PUMP PARTIAL
PITOT BLOCKAGE
STATIC BLOCKAGE

L BRAKE
R BRAKE
L FUEL LEAK
R FUEL LEAK
L TIP TANK LEAK
R TIP TANK LEAK
CO LEAK
CO DETECTOR
CONDENSER LIMIT
PILOT DOOR LATCH
CABIN DOOR LATCH
OXYGEN LEAK

Breaker Protected Failures

STARTER MOTOR
FLAP MOTOR
FUEL PUMP
L TIP TANK X-FER PUMP
R TIP TANK X-FER PUMP
STANDBY VACUUM
GEAR MOTOR
GEAR WARNING
L FUEL QTY
R FUEL QTY
FUEL FLOW GAUGE
STANDBY AVIONICS
TACHOMETER
EGT/CHT
OIL TEMP/PRESS
TURN COORD
VOLTMETER
YOKE CHRONOS
LANDING GEAR POS LIGHTS
ANNUNCIATOR LIGHTS
ACCESSORIES POWER
VENT BLOWERS
AIR CONDITIONER
AIR CONDITIONING BLOWER
ENGINE MONITOR
STALL WARNING
STANDBY ALT FIELD
STANDBY ALT SENSE
PITOT HEAT
PROP HEAT
STROBE LIGHT
BEACON LIGHT
NAV LIGHTS
TAXI LIGHTS
LANDING LIGHTS
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

Miscellaneous Systems

Audible Warning Tones

This version of the Bonanza 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 the throttle lever is reduced below approximately 20% of its travel, or the flaps are placed in their landing configuration, and the landing gear has not been deployed, a repeating tone will sound.
- Carbon Monoxide Detector: When an engine or its exhaust systems becomes compromised, it is possible for poisonous gas to leak into the cabin of the aircraft. When this colorless, odorless, gas is present, a beeping alarm will sound. The alarm will continue to sound as long as the gas is present. Follow the checklists for Carbon Monoxide leaks, and close (pull) the firewall shutoff valve immediately.
- Engine Cooling Ticking: The ticking sound an engine makes after shutdown while it cools and contracts is modeled in this simulation. This sound can be used to roughly estimate when temperatures are high enough in the engine cowling to vaporize fuel and contribute to vapor lock.

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

Tip Tanks

By default, the turbonormalized Bonanza Professional is equipped with tip tanks. The tip fuel tanks add 30 U.S. Gallons of usable fuel to the aircraft at the cost of approximately 30 lbs of empty weight. This extra fuel will extend the range of the aircraft by approximately 45%, resulting in normal operating ranges in excess of 1,000 nm, and ferry ranges of over 1,200 nm.

Fuel quantities in the tip tanks are monitored via separate indicators at the far right-hand side of the main instrument panel. The quantity shown on this instrument must be added to the quantity shown on the main fuel quantity gauges to obtain the current total fuel quantity. The EDM-800 engine monitor will automatically detect the presence of tip tanks and adjust accordingly for accurate fuel totalizer behavior.

Fuel must be manually transferred from the tip tanks to the main tanks to be used. This is accomplished with two electrically powered “Facet-style” solenoid fuel pumps. These pumps are activated by two toggle switches mounted on the main instrument panel labeled “TIP TANK TRANSFER PUMPS”. When the pump is running, an integrated green indicator light will illuminate within the toggle switch, and the pump’s distinctive pulsating sound should be audible. When there is no fuel remaining in the tip tank, the pump will cease operation automatically. Each pump is capable of transferring approximately 36 gallons of fuel per hour.

Should a user have a strong desire for a turbonormalized Bonanza Professional without tip tanks, or a normally aspirated aircraft with tip tanks, 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 help differentiate the Bonanza Professional from the default G36 Bonanza. To do so, simply create a new aircraft mod with the adjusted weight and balance information contained within this manual, and new flight files (*.flt), containing the following lines. The existing aircraft models can also be edited in the same way. 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_TipTanks=0
BKSQ_Winglets=0

Radar Pod

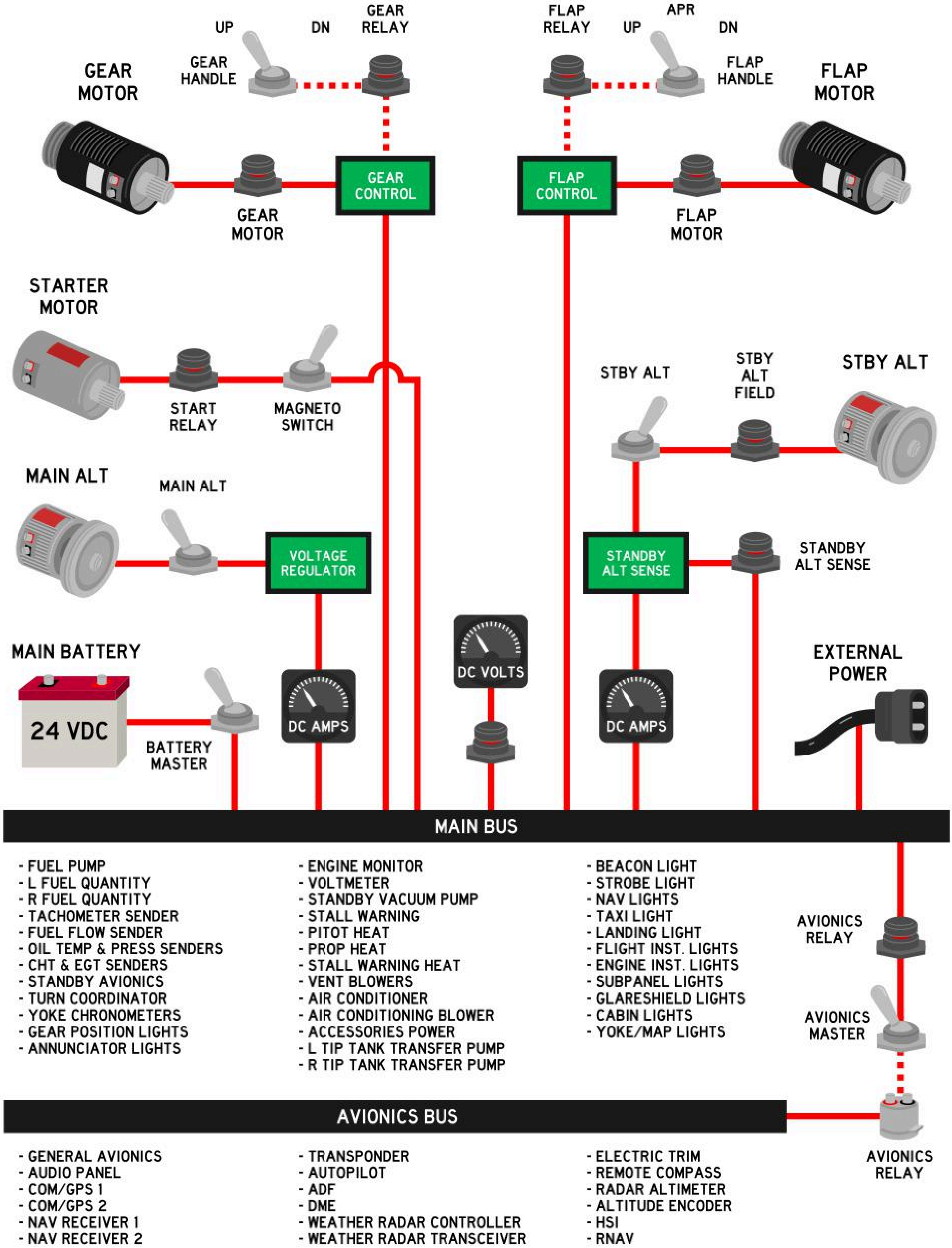
Since all versions of the aircraft are equipped with a weather radar which doubles as quick access to the failure system interface, the aircraft should also be equipped with a radar transducer. This transducer is often located in the nose of twin engine aircraft, like the Baron Professional, but radar-equipped single engine aircraft often have a radar pod mounted on the wing, such as on the Caravan Professional, and Black Square's TBM 850. While not unheard of, radar pods on single-engine piston aircraft are unusual. For this reason, there is a persistent option on the tablet's interface's options page to hide the radar pod.

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 MOTOR
GEAR HANDLE
UP
DN
GEAR RELAY
GEAR CONTROL
GEAR MOTOR
FLAP RELAY
UP
APR
DN
FLAP HANDLE
FLAP MOTOR
FLAP CONTROL
FLAP MOTOR
STARTER MOTOR
START RELAY
MAGNETO SWITCH
STBY ALT
STBY ALT FIELD
STBY ALT
MAIN ALT
MAIN ALT
VOLTAGE REGULATOR
STANDBY ALT SENSE
STANDBY ALT SENSE
MAIN BATTERY
24 VDC
BATTERY MASTER
DC AMPS
DC VOLTS
DC AMPS
EXTERNAL POWER
MAIN BUS
- FUEL PUMP
- L FUEL QUANTITY
- R FUEL QUANTITY
- TACHOMETER SENDER
- FUEL FLOW SENDER
- OIL TEMP & PRESS SENDERS
- CHT & EGT SENDERS
- STANDBY AVIONICS
- TURN COORDINATOR
- YOKE CHRONOMETERS
- GEAR POSITION LIGHTS
- ANNUNCIATOR LIGHTS
- ENGINE MONITOR
- VOLTMETER
- STANDBY VACUUM PUMP
- STALL WARNING
- PITOT HEAT
- PROP HEAT
- STALL WARNING HEAT
- VENT BLOWERS
- AIR CONDITIONER
- AIR CONDITIONING BLOWER
- ACCESSORIES POWER
- L TIP TANK TRANSFER PUMP
- R TIP TANK TRANSFER PUMP
- BEACON LIGHT
- STROBE LIGHT
- NAV LIGHTS
- TAXI LIGHT
- LANDING LIGHT
- FLIGHT INST. LIGHTS
- ENGINE INST. LIGHTS
- SUBPANEL LIGHTS
- GLARESHIELD LIGHTS
- CABIN LIGHTS
- YOKE/MAP LIGHTS
AVIONICS RELAY
AVIONICS MASTER
AVIONICS BUS
- GENERAL AVIONICS
- AUDIO PANEL
- COM/GPS 1
- COM/GPS 2
- NAV RECEIVER 1
- NAV RECEIVER 2
- TRANSPONDER
- AUTOPILOT
- ADF
- DME
- WEATHER RADAR CONTROLLER
- WEATHER RADAR TRANSCEIVER
- ELECTRIC TRIM
- REMOTE COMPASS
- RADAR ALTIMETER
- ALTITUDE ENCODER
- HSI
- RNAV
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.

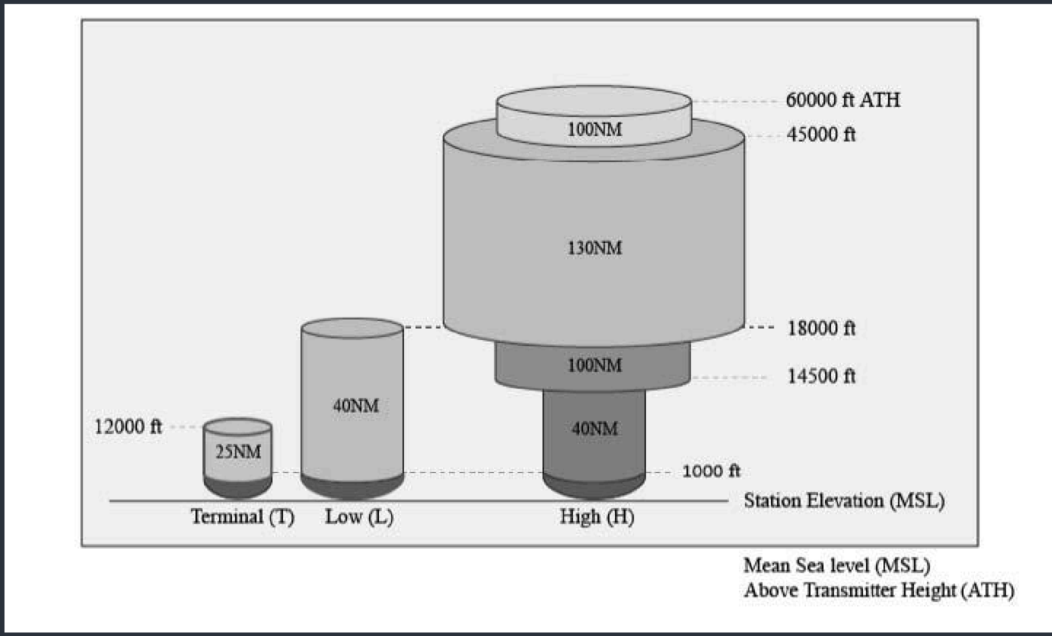
   Nearby Navigation Aids

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.

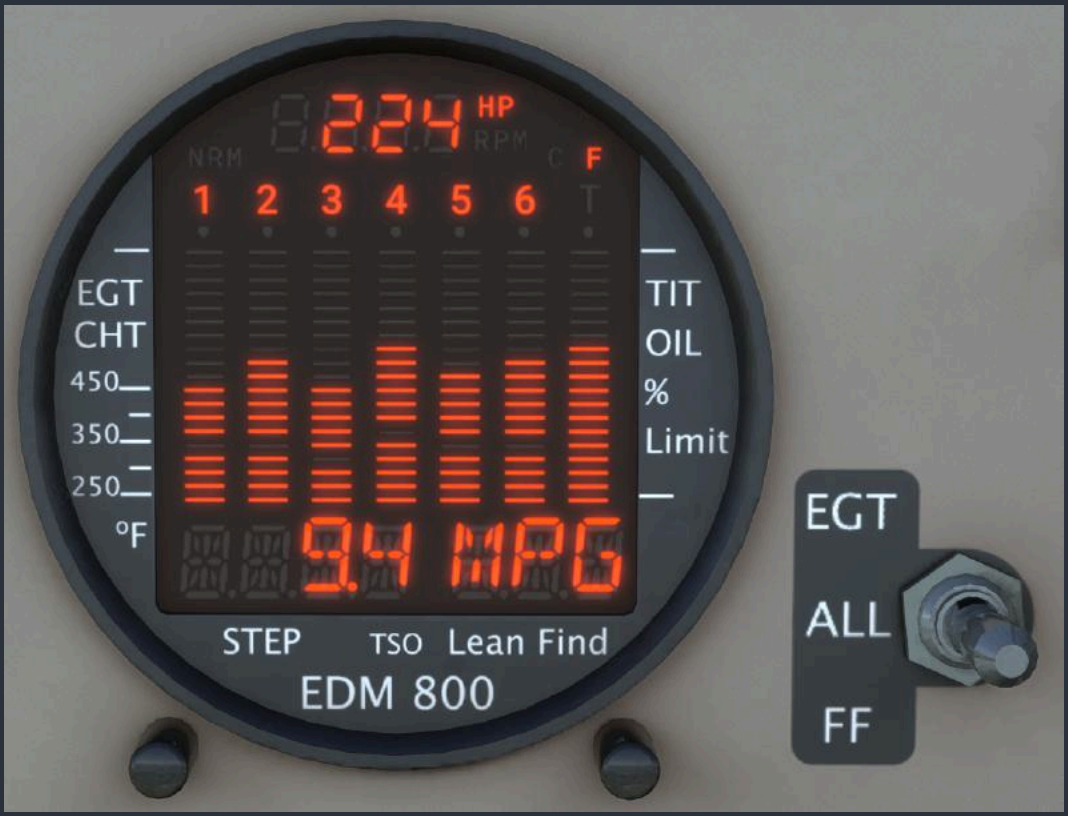
7. To fly directly to the displaced VOR waypoint at our destination airport, simply rotate the omni-bearing selector (OBS) or course (CRS) knob on your HSI, as you would to fly to a VOR, and follow the CDI needle with a TO indication. Countdown the distance and time remaining until arriving at your destination 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-800 Engine Monitor



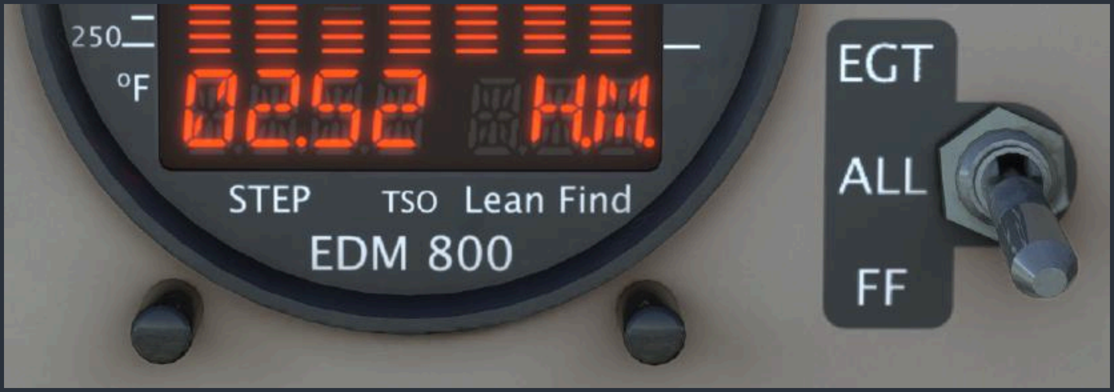
The Bonanza Professional is equipped with the most complete implementation of the EDM-800 engine monitor to appear in a flight simulator. The EDM-800 is one of the more common pieces of engine monitoring equipment found in general aviation aircraft, and is often underestimated in its power and utility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

Static Displays

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

Data Display

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



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

Temperature Columns

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

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

Lean Find Mode

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

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

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

Leaning Rich of Peak

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

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

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

Leaning Lean of Peak

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

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

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

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

Alarms

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

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

Normal Checklists

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
Oxygen Pressure	1550-1850 psi
Avionics	Off
Throttle	Closed
Propeller	High RPM
Mixture	Full Rich
Cowl Flaps	Open
Aileron Trim	Centered
Alternate Air	Off
Firewall Valve	Open (Push)
Landing Gear	Down
All Subpanel Switches	Off
Loadmeter	Primary
Main Breakers	All In
Alternate Static Air	Normal
CO Detector	Test
Fuel Selector	Fullest Tank
Beacon Light	On
Battery Master	On
Bus Volts	23V Minimum
Annunciators	Test & Consider
Primary Alternator	On
Standby Alternator	On
Fuel Quantities	Check
Aux Fuel Pump	Lo
Aux Fuel Pump	Audible
Aux Fuel Pump	Off
Standby Gyro Pump	On
STBY GYRO P Annun	Illuminated
Instrument Air	Green
Standby Gyro Pump	Off

Engine Start (Cold)

Mixture	Full Rich
Propeller	High RPM
Throttle	Full Open
Aux Fuel Pump	Hi for 2-3s
Fuel Flow	Greater than 3 GPH
Aux Fuel Pump	Off
Throttle	Open 1/2in
Starter	Engage
Throttle	1000-1200 RPM

Engine Start (Hot)

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

Engine Start (Flooded)

Mixture	Lean
Propeller	High RPM
Throttle	Open 1/2in
Throttle	Advance Until Start
Starter	Engage
Throttle	Idle
Mixture	Full Rich

After Starting

Throttle	1000-1200 RPM
Oil Pressure	Green
Start Annun	Extinguished
Low Volts Annun	Extinguished
Alternator Load	Below 25A in 2min
Bus Volts	28V
Engine Instruments	Check
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 Propeller	To 300 RPM Drop
Check Magnetos	150 RPM Drop Max
Instrument Air	Green
Primary Alternator	Off
Loadmeter	Secondary

Alternator Load	Increase
STBY ALT Annun	Illuminated
Standby Alternator	Off
Alternator Load	Zero
Loadmeter	Primary
Primary Alternator	On
Standby Alternator	On
Alternator Load	Above 25A
Propeller Heat	On
Propeller Amps	20-25A
Propeller Heat	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

Mixture	Max Power
Oil Temperature	24c Minimum
Aux Fuel Pump	Off
Air Conditioning	Off
Landing Light	On
Transponder	Alt Mode
Weather Radar	On

Takeoff

Throttle	Full Open
Brakes	Release
Engine Instruments	Check
Landing Gear Up	No Rwy Remain
Flaps	Retract at 80kts
Autopilot	Engage

Max Continuous Power

Mixture	Max Power
Propeller	2700 RPM
Throttle	Full Open
Cowl Flaps	As Required
Air Conditioning	As Desired

Enroute Climb

Mixture	Max Power
Propeller	2500 RPM
Throttle	Full Open
Cowl Flaps	As Required
Air Conditioning	As Desired
Oxygen	As Required
Engine Performance	Monitor

Cruise

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

Descent

Cowl Flaps	Closed
Throttle	Reduce
Mixture	Enrichen
Engine Performance	Monitor
Cylinder Head Temp	116c Min.

Approach

Seats & Seatbelts	Secure
Fuel Selector	Fullest Tank
Fuel Imbalance	15 gal Max.
Tip Tank Transfer	As Required
Oxygen	Off
Landing Light	On
Pitot Heat	On if OAT less than 4c
Propeller Heat	Off
Air Conditioning	Off
Cowl Flaps	As Required
Mixture	Max Power
Flaps	Approach

Landing

Propeller	High RPM
Mixture	Max Power
Flaps	As Required
Landing Gear	Down & Locked
Autopilot Disconnect	Press Once

After Landing

Cowl Flaps	Open
Flaps	Up
Lights	As Required
Pitot Heat	Off
Air Conditioning	As Desired
Cabin Air & Heat	As Desired

Shutdown & Securing

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

Instrument Markings & Colors

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

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

Fuel Flow:
0-27.5 gal/hr (GREEN)
27.5 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)
240 lbs / 40 gal (MAXIMUM)
0-78 lbs / 0-13 gal (YELLOW)

Tip Tank Fuel Quantity:
0 lbs / 0 gal (MINIMUM)
90 lbs / 15 gal (MAXIMUM)

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

Vacuum Suction:
4.25-6.0 inHg (GREEN)

Propeller Ammeter:
0-30 amps

Airspeed Indicator:
SEE V-SPEEDS

Abnormal & Emergency Checklists

Engine Fire (Ground)

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

Engine Failure (Takeoff)

Throttle	Closed
Braking	Maximum
Fuel Selector	Off
Alternators	Off
Battery Master	Off

Engine Failure (In Flight)

Airspeed	110 kts
Fuel Selector	Opposite Tank
Magnetos	Check Both
Aux Fuel Pump	Hi
Mixture	Rich then Lean
Starter	Engage
Engine	If No Restart...
Aux Fuel Pump	Off
Mixture	Full Rich
Magnetos	Check Both
Alternate Air	On
Starter	Engage
Engine	If No Restart...
Favorable Landing Site	Select

Rough Running Engine

Aux Fuel Pump	Lo
Mixture	Rich then Lean
Magnetos	Check Both
Alternate Air	On

Engine Fire (Flight)

Firewall Valve	Close (Pull)
Fuel Selector	Off
Mixture	Cut-Off
Alternators	Off
Battery Master	Off
Magnetos	Off
Engine	Do Not Restart

Starter Does Not Disengage

Alternators	Off
Battery Master	Off
Mixture	Cut-Off
Magnetos	Off

Emergency Descent

Throttle	Close
Propeller	High RPM
Landing Gear	Down
Flaps	Approach
Airspeed	154 kts

Maximum Glide

Landing Gear	Up
Flaps	Up
Cowl Flaps	Close
Propeller	Low RPM
Airspeed	110 kts
Air Conditioning	Off
Nonessential Equipment	Off

Electrical Smoke or Fire

Firewall Valve	Close (Pull)
Alternators	Off
Battery Master	Off
Windows	Open
Avionics	Off
Air Conditioning	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

Carbon Monoxide Detected

Firewall Valve	Close (Pull)
Cabin Air & Heat	Close (Push)
CO Detector	Reset
CO Alarm	If Persists...
Throttle	Closed
Mixture	Cut-Off
Propeller	Low RPM
Magnetos	Off
Windows	Open
Cabin Air	Full Open
Nonessential Equipment	Off

Alternator Failure

Loadmeter	Primary
Alternator Load	Verify No Load
Primary Alternator	Reset
Alternator Load	If No Load...
Loadmeter	Secondary
Standby Alternator	On
STBY ALT Annun	Illuminate
Alternator Load	If No Load...
Stby Alt Breakers	Check
Standby Alternator	Reset
Alternator Load	If No Load...
Bus Volts	If Under 23V...
Low Volts Annun	If Illuminated...
Nonessential Equipment	Off
Land	As Soon as Practical

Turbocharger Failure

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

Instrument Air Failure

GYRO WARN	If Illuminated...
Standby Gyro Pump	On
STBY GYRO P Annun	If Extinguished...
Standby Gyro Breaker	Push On
STBY GYRO P Annun	Illuminated
Instrument Air	Green

Severe Icing Encounter

Ice Protection	All On
Ice Build-Up	Monitor
Propeller	High RPM
Cowl Flaps	Closed
Cabin Air & Heat	On Maximum
Defroster	On Maximum
Alternate Static Air	On

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

CABIN DOOR Annun Illuminated

Door Handle	Check
Airspeed	Reduce
Increased Drag	Anticipate
Land	

Landing Gear Manual Extension

Airspeed	154 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
Propeller	2700 RPM
Throttle	Full Open
Cowl Flaps	Open
Engine Instruments	Check
Landing Gear Up	No Rwy Remain
Flaps	Retract at 80kts

No Power Landing

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

More Information on Operation

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

In the case of this particular product, 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 **"EDM 700 and 800 Video Toutorial"** [sic]. A complete **"Pilot's Operation Manual" to the ETM Engine Trend Monitor** can be found on the Shadin Avionics website. Additionally, the **"KLN-90B Pilot's Guide"** is also available on Bendix/King's website.

Hardware Inputs & Outputs

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

Inputs

Exterior & Cabin Element Variables

Description	Variable	Range
Yoke Control Locks	L:bksq_controlLocks	Boolean
Pitot Covers	L:bksq_PitotCovers	Boolean
Engine Covers	L:bksq_EngineCovers	Boolean
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
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
Mixture Lever	K:MIXTURE1_SET - OR - L:BKSQ_MixtureLeverPosition_1	0 - 100 -OR- (0 - 1)
Friction Lock (mixture adjust speed)	L:var_FrictionLock	0 - 100
Hide Pilot's Yoke	L:XMLVAR_YokeHidden1	Boolean
Hide Copilot's Yoke	L:XMLVAR_YokeHidden2	Boolean
Control Wheel Steering Yoke Button	L:var_PilotCws	Boolean
Prop Heat	L:var_PropHeatSwitch	Boolean
Fuel Pump	L:var_FUEL_Switch_Pump_1	0 - 2
Annunciator Light Test	L:var_AnnunciatorTestButton	Boolean
Ignition Switch	K:MAGNETO1_INCR/DECR - OR - L:BKSQ_IgnitionPosition_1	0 - 5
Cowl Flaps	RECIP ENG COWL FLAP POSITION:1	0 - 100
Carbon Monoxide Detector Test	L:var_CoTest	Boolean
Alternate Induction Air Handle	L:var_AlternateAirHandle	0 - 100
Standby Vacuum Pump Switch	L:var_StandbyVacuumPumpSwitch	Boolean
Loadmeter Select Switch	L:BKSQ_loadMeterMode	Boolean
Left Tip Tank Transfer Pump Switch	L:TipTankTransferSwitch_L	Boolean
Right Tip Tank Transfer Pump Switch	L:TipTankTransferSwitch_R	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)	
Taxi Light	B:LIGHTING_TAXI_1_Toggle (K:TOGGLE_TAXI_LIGHTS)	
Landing Light	B:LIGHTING_LANDING_1_Toggle (1 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_oxygenOn	0 - 100
Firewall Air Valve	L:var_FirewallAirHandle	0 - 100
Cabin Heat Valve	L:var_CabinHeatHandle	0 - 100
Defroster Valve	L:var_DefrosterHandle	0 - 100
Fresh Air Valve	L:var_FreshAirKnob	0 - 100
Pilot Footwell Air Valve	L:var_FootwellVentKnob_L	0 - 100
Copilot Footwell Air Valve	L:var_FootwellVentKnob_R	0 - 100
Air Conditioning Switch	L:var_AirConditionerSwitch	Boolean

Air Conditioning Blower Switch	L:var_AirConditioningBlowerSwitch	0 - 2
Vent Blower Switch	L:var_VentBlowersSwitch	Boolean

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
Main Alternator	K:TOGGLE_ALTERNATOR1
Standby 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 800 Engine Monitor

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

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
Manifold Pressure	L:BKSQ_MANIFOLD_PRESSURE_1	inHg
Propeller RPM	L:BKSQ_PROP_RPM_1	RPM
Fuel Flow	L:BKSQ_FuelFlow_1	GPH
Oil Pressure	L:BKSQ_OIL_PRESS_1	PSI
Oil Temperature	L:BKSQ_OIL_TEMP_1	CELSIUS
Exhaust Gas Temperature	L:BKSQ_EGT_1	CELSIUS
Cylinder Head Temperature	L:BKSQ_CHT_1	CELSIUS
Left Fuel Quantity	A:FUEL TANK LEFT MAIN QUANTITY	GALLONS
Right Fuel Quantity	A:FUEL TANK RIGHT MAIN QUANTITY	GALLONS
Vertical Speed Needle	L:BKSQ_VerticalSpeed_1	FPM
Turn Coordinator Ball	L:BKSQ_TurnCoordinatorBall	0 - 100
Suction Pressure	L:BKSQ_SUCTION_PRESSURE	PSI
Oxygen Pressure	L:var_oxygenPressure	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 BonanzaProfessional_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).

This concludes the Bonanza Professional Operations Manual for the reciprocating engine version of this aircraft.

Continue to the end of this document for Frequently Asked Questions (FAQ), changelog, and development credits.

A36TP Turbine Conversion Supplement

Aircraft Specifications

Length Overall	27’6”
Height	8'7"
Wheel Base	7’0"
Track Width	9’7"
Wingspan	37'10” (39’6” with Winglets)
Wing Area	199.0 sqft.
Flight Load Factors	+4.4/-1.7 G’s (+3.8/-1.5 G’s with Flaps Down)
Design Load Factor	150%
Cabin W/L/H	42” x 12’7" x 50"
Oil Capacity	2.3 U.S. Gallons
Seating	6
Wing Loading	20.4 lbs/sqft
Power Loading	8.1 lbs/hp
Engines	500 SHP (373 kW) Pratt & Whitney PT6A-21 Free-Turbine
Propellers	4-Blade Hartzell, Constant Speed, Fully Reversible, Aluminum, Hydraulically Actuated, 84 inch propeller. Fully fine blade angle of 15.0°, Low pitch blade angle of 59.5°, feathering angle of 85.0°.
Approved Fuel Grades	JET A (ASTM-D1666) JET A-1 (ASTM-D1666) JET B (ASTM-D1666) JP-4 (MIL-DTL-5624) JP-5 (MIL-DTL-5624)
Fuel Capacity	Total Capacity: 124 U.S. Gallons Total Capacity Each Tank: 62 U.S. Gallons Total Usable: 118 U.S. Gallons
Electrical System	
Voltage:	28 VDC
Battery:	24V, 12 amp-hour, sealed lead acid battery
Primary Generator:	28V, 200 amp @ 2,000 RPM
Standby Alternator:	28V, 100 amp, automatic operation when engaged

Aircraft Performance (A36TP Turboprop)

Maximum Cruising Speed	250 ktas
Normal Cruising Speed	230 ktas
Economy Cruising Speed	210 ktas
Takeoff Distance	840 ft
Takeoff Ground Roll	700 ft
Landing Distance	1,105 ft
Landing Ground Roll	720 ft
Normal Range	595 nm
Maximum Range	764 nm
Rate of Climb	2,520 ft/min
Service Ceiling	25,000 ft
Empty Weight	2,355 lbs
Max Ramp Weight	4,100 lbs
Max Takeoff Weight	4,050 lbs
Max Landing Weight	4,050 lbs
Useful Load	1,695 lbs
Usable Fuel Weight	791 lbs
Full Fuel Payload	904 lbs
Maximum Operating Temp.	+38°C
Minimum Operating Temp.	-54°C

V-Speeds

Vr	71 kts	(Rotation Speed)
Vs	64 kts	(Clean Stalling Speed)
Vso	52 kts	(Dirty Stalling Speed)
Vx	77 kts	(Best Angle of Climb Speed)
Vy	96 kts	(Best Rate of Climb Speed)
Va	139 kts	(Maneuvering Speed)
Vg	110 kts	(Best Glide Speed)
Vfe	123 kts	(Maximum Flap Extension Speed)
Vle	152 kts	(Maximum Landing Gear Extension Speed)
Vno	165 kts	(Maximum Structural Cruise Speed - exceed only in clean air)
Vne	**171 kts**	**(Do Not Exceed Speed)**

Engine Limitations

Engine Speed	2,200 RPM (2,225 RPM Momentary)
Torque	1,200 FT-LBS
ITT	700°C (T/O) 700°C (Climb) 700°C (Cruise) 1090°C (Starting)
Gas Generator	101.5% (Continuous) 102.6% (Momentary) 101.5% (Reverse)
Oil Temperature	40°F (4°C) (min.) 210°F (99°C) (max.)
Oil Pressure	40 PSI (min.) 105 PSI (max.)
Fuel Pressure	15-30 PSI (normal)

Other Operating Limitations

- When ITT exceeds 690°C, time at this power setting should be limited to 10 minutes.
- Reverse thrust operation limited to durations of one minute.
- Aircraft shall not be operated when outside takeoff temperature exceeds 100°F (38°C).
- BOTH the Pump 1 and Pump 2 must be functional for takeoff.
- Do not take-off when fuel quantity gauges indicate in the yellow arc, or with less than 20 gallons in each 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.

Starter Limitations

Using Airplane Battery:

30 seconds ON - 60 seconds OFF
30 seconds ON - 60 seconds OFF
30 seconds ON - 30 **minutes** OFF

Using External Power:

20 seconds ON - 120 seconds OFF
20 seconds ON - 120 seconds OFF
20 seconds ON - 60 **minutes** OFF

Annunciator Panel

The Bonanza Professional Turboprop’s annunciator panel consists of 17 annunciator lamps located on the pilot’s side glareshield. From left to right, the lamps indicate the following conditions:

- The fire detector loop has detected a fire, or is being tested
- The chip detector has detected metal particles in the engine oil sump
- Fuel remaining in the left wing is less than ~12 U.S. gallons
- Fuel remaining in the right wing is less than ~12 U.S. gallons
- Landing gear is up when flaps are fully extended or throttle is retarded
- The battery is hot, and charging/discharging should be limited
- Bus voltage is below 24 VDC
- The main generator is offline
- Starter is engaged
- Standby alternator is providing power (steady), and load is greater than 100A (blinking)
- Aft door is unlocked
- Gyro suction below 3.0 inHg
- The standby electric instrument air pump is activated
- Air conditioning is operating
- Pitot heating elements are energized
- The ice deflector vane is in the bypass position
- The oil cooler door is fully closed

To test the glareshield annunciator panel, hold the “ANNUN TEST” push button, located to the left of the ice deflector switch.

Fire Detector

This aircraft is equipped with a fire detector loop in the engine nacelle. When temperatures in the nacelle are sufficiently high, the presence of an engine fire is likely, and the red ENG FIRE annunciator light illuminates. To test the fire detector loop, press and hold the "FIRE DET TEST" push button on the pilot's left subpanel.

Airspeed Limitation Marking & Overspeed Warning

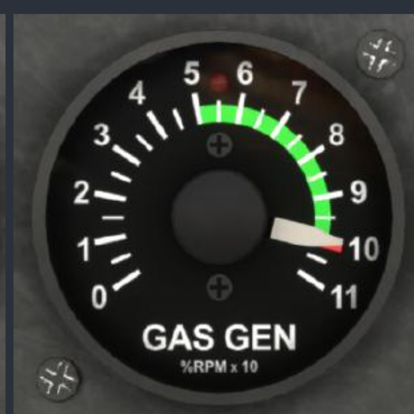
The true airspeed indicator's gauge face has been replaced with one that reflects the limited VNE speed of the turbine aircraft (171 KIAS). A red cross-hatched region from 171-180 KIAS further emphasizes this limitation. At the bottom left of the instrument is an LED indicator lamp that illuminates when the VNE limitation has been exceeded. An audible warning tone will also sound to signal the overspeed condition.

Voltmeter & Ammeters

On the center subpanel, three digital 7-segment displays indicate various electrical parameters of the aircraft. The top meter is a loadmeter, indicating generator load in amps. The number within this display will flash when the standby alternator is online and supplying power to the main bus. The middle meter indicates the voltage sensed at the main distribution bus. The bottom meter indicates the current supplied to the propeller hub and induction air inlet for deicing in amps.

Engine Instruments

A column of five electronically controlled engine instruments replace the instruments in the reciprocating engine version of the aircraft. From top to bottom, the instruments are: Torque (FT-LBS), Interstage Turbine Temperature (ITT) (°C), Gas Generator RPM (Ng%) (% rated RPM), Propeller RPM, and engine oil parameters, including oil temperature (°C), and oil pressure (PSI). Above the throttle quadrant, an additional gauge is added to indicate fuel flow (PPH), and fuel pressure (PSI). Each instrument possesses a red indicating lamp that illuminates when the displayed quantity exceeds a safe limit.



Indicating Lamps

Several small indicating LED lamps have been added to the instrument panel in addition to the overspeed warning light discussed above. Adjacent to the altimeter and vertical speed indicator, a green LED illuminates to indicate that the turbine engine's ignition system is activated. Below the vertical speed indicator, an optional blue beta indicator illuminates any time the power lever is within the beta range. Across the subpanel behind the throttle quadrant, four indicator lamps have been added. From left to right, they indicate the selected fuel tank (left or right) in green, a bleed air overheat condition in red, and when the fuel filter low pressure bypass valve is open in red. When the fuel filter becomes contaminated (indicated in red on the engine visualizer page of the tablet interface), a valve opens, allowing unfiltered fuel to flow into the fuel control unit, but also reducing fuel pressure and maximum power output.

Fuel Sender Limitations

The analog fuel instrumentation in the reciprocating engine version of this aircraft was designed for displaying fuel quantities up to 40 gallons in each main wing tank, but the turboprop conversion includes additional fuel cells in the extended wings. Each wing contains an additional 22 gallons of usable fuel that is not reflected on these fuel gauges. The fuel totalizer function of the ETM Engine Trend Monitor can help estimate the quantity of fuel remaining before the quantity remaining comes within the range depicted on the analog fuel instrumentation.

Environmental Simulation & Controls

Cabin Environmental Controls

The unpressurized cabin's environmental control system remains very similar to that of the reciprocating engine aircraft. Instead of an engine exhaust heat exchanger supplying heated air for the cabin, pressurized and heated bleed air from the compressor section of the engine is used. Normally, the cabin is heated with bleed air from the high pressure P2.5 bleed valve. This is sufficient for operation at mid-level cruising altitudes, or during mild conditions on the ground. Should the P2.5 bleed air be insufficient to heat the aircraft, the pilot should pull the "P3 HEAT" pull handle away from the instrument panel. This opens a valve, admitting hotter air from the P3 section of the engine's compressor into the cabin. Cabin temperature is then regulated, as in the reciprocating engine version of the aircraft, with the "CABIN HEAT" pull handle. The bleed air system can also be isolated from the cabin with the red "FIREWALL AIR" pull handle.

NOTE: Keep in mind that any increase in bleed air diverted from the compressor section of the engine to the cabin will result in an increase in ITT.

Door Seal System

In place of the electric fuel boost pump switch in the reciprocating engine version of the aircraft, a green toggle switch has been installed to control the aircraft's inflatable door seals. While door seals are common in pressurized aircraft to better seal the cabin pressure vessel, high performance homebuilt and experimental aircraft often use them to decrease noise in the cabin.

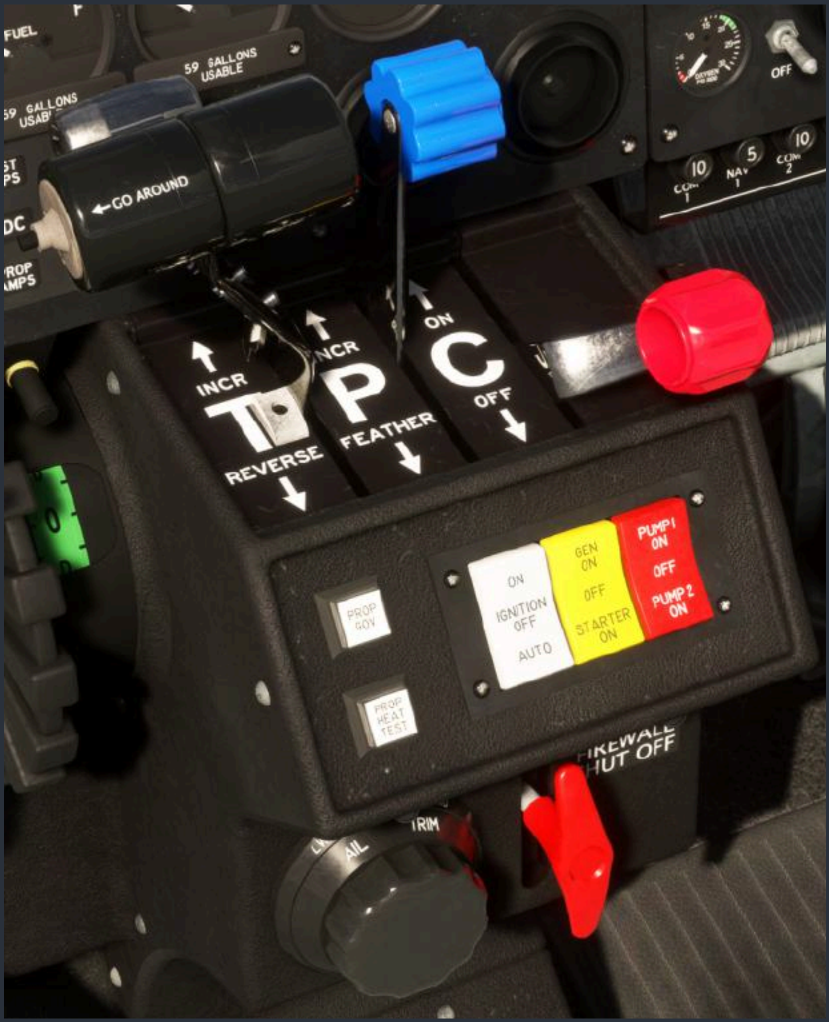
Unlike the factory installed door seals in the Baron Professional, which are primarily inflated with instrument air, the after-market door seals in this aircraft are inflated by an electric motor with no redundancy, as they are only a comfort feature. Placing the switch in the "INFLATE" position will fully inflate the door seals to around 16 PSI within a few seconds. Returning the switch to the "DEFLATE" position, or opening either of the cabin doors, will deflate them within a few seconds. Should the door seal pump fail, however, it may take several minutes for the door seals to slowly deflate.

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.

Air Conditioning Temperature Effects

When the air conditioner is operating, the load is increased on the engine's accessory gearbox. This increased load may cause engine temperatures to rise, similarly to the reciprocating engine version of the aircraft. During low airspeed climbs or while operating at low altitudes, the additional cooling required in the engine may send interstage turbine temperatures and oil temperatures into a dangerous regime if not properly managed. This may require the oil cooler door to be left open longer than normal to keep temperatures within limits. Increased ITT in the engine may require a reduction of power during climbs to observe ITT limits.

Turboprop Engine Operation



The turbine engine simulation in this aircraft is significantly more complex than most employed in flight simulators, especially as it pertains to engine starting. Improper starting technique can destroy an engine within seconds. The engine installed in the Bonanza Professional Turboprop can also suffer from overheating oil, if not managed properly.

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

Condition Levers

Unlike most PT6 turboprop engine installations, the Bonanza Professional does not have low-idle and high-idle positions for its condition lever. The Bonanza Professional's fuel condition lever positions are labeled simply "ON" and "OFF". To avoid hot starts, the condition lever should not be moved to the "ON" position before the gas generator reaches its maximum RPM via the electric starter motor. For more information on starting see the Starting Temperature, Residual Heat & Dry Motoring section, below.

Turbine Engine Ignition

Turboprop engines are equipped with a continuous ignition system that can be toggled on and off manually, or automatically with the white rocker switch on the throttle quadrant. In the "ON" position, the igniters arc continuously. This position should be used during starting, and during extreme weather conditions to prevent engine flameout. In the "AUTO" position the igniters will only be energized when the torque of the associated engine falls below approximately 250 FT-LBS. The automatic position should be used whenever the inertial separators are required, during moderate and severe turbulence, and when operating at high altitudes at night.

Fuel Pumps

The Bonanza Professional Turboprop has two electric fuel pumps, controlled via the red rocker switch on the throttle quadrant. Pump 1 is a submerged wet pump, operating within a small header fuel tank. Pump 2 is an in-line pump operating within the engine nacelle. The fuel system is designed to only have one fuel pump operating at a time. Both fuel pumps must be functional for takeoff, in addition to the mechanically driven engine fuel pump.

Inertial Separators (Ice Deflectors / Ice Door)

Most turboprop engines possess a method of separating particulate from engine induction air by repositioning louvers within the engine air intake. These louvers can be inspected from the exterior of the aircraft. When operating normally, incoming air takes a direct path to the PT6's internal radial intake. When the inertial separator (sometimes called an ice deflector, or simply "bypass") is activated, the airflow must take a sharp turn, which ejects particulate through a large vent at the bottom of the engine. The inertial separators have the disadvantage of reducing free airflow to the engine, thus reducing maximum torque, or torque available at a given ITT for a given set of conditions. This aircraft simulates damage from foreign objects caused by operation on unimproved surfaces. For more information, see the "Foreign Object Debris Damage" section of this manual.

The inertial separator is controlled via a switch located on the pilot's left subpanel, labeled "ICE DOOR". The inertial separator should be used whenever operating on unimproved or marginal surfaces, and whenever entering visible moisture. It takes 15-20 seconds for the inertial separator louvers to reposition, so anticipation of sky conditions as far as five miles ahead of the aircraft may be required to ensure proper use.

Oil Cooler Door

A door within the engine nacelle is used to vary the amount of airflow over the oil cooler radiator. This actuator is controlled via the “OIL DOOR” pull handle on the pilot’s subpanel. The oil cooler door is positioned for maximum oil cooling when the handle is pushed in fully. A blue “OIL DR CLOSED” annunciator lamp will illuminate when the handle is pulled outwards. The doors should be opened for takeoff and landing, and closed for cruise flight. When operating at lower airspeeds with the air conditioner operating, it may be necessary to leave the oil door open for longer than normal, especially on particularly hot days, to keep the oil temperature within limits.

Turbine Engine Fuel Control Failures

This aircraft implements two types of partial engine failures that are unique to turbine engines. The first is a fuel control failure, resulting in the engine’s power lever having minimal or zero control over the engine’s fuel flow. This failure can occur during any phase of flight. Unlike some other turboprop aircraft like the Turbine Duke, a fuel control failure in the Bonanza Professional Turboprop might not necessitate an engine shutdown, as an auxiliary fuel control system is provided. The guarded “MANUAL OVERRIDE” switch on the copilot’s left subpanel can be actuated in an attempt to restore control over the fuel control unit. When the manual override system is activated, an amber LED will illuminate adjacent to the switch.

The manual override feature can only be used to increase engine power, but not to reduce it. To use the manual override feature, actuate the momentary toggle switch to the up position, and observe the engine instruments for an increase in power. Continue to hold or bump the momentary switch until the desired power is achieved. To deactivate manual override, actuate the switch to the down position to reduce power. When the amber LED extinguishes, manual override is disabled.

The second type of failure is engine compressor surging. Turboprop engine surging is the result of disrupted airflow to the engine, and manifests as unstable gas generator RPM, or sudden changes in engine performance. This may occur as the result of severe turbulence, ingestion of large debris (such as birds), or catastrophic failure of internal engine components. At the first indication of compressor stall or surging, engine power should be reduced, and continuous ignition activated to prevent flameout. The surging will be less severe when power is reduced, but the flight should only be continued to the nearest practical field for landing.

Propeller Governor

The propeller governor is an essential component of a high performance aircraft that controls the pitch of the propeller blades, usually by metering oil pressure to the propeller hub. While single engine piston aircraft (including the reciprocating engine version of this aircraft) are typically configured such that the propeller blade pitch returns to the fine position when oil pressure is lost, this is not true for most single engine turboprop aircraft. This aircraft is also equipped with an overspeed governor test button. Holding the button will offset the overspeed propeller governor to a lower RPM, limiting the propeller to around 1,990 RPM. Should the governor fail to maintain the expected RPM in flight, or on the ground, the flight should be discontinued as soon as practical.

Starting Temperature, Residual Heat & Dry Motoring

The rate at which heat is dissipated or accumulates in the combustion chamber of a turboprop engine is largely determined by the rate of airflow through the engine. When the engine is not self-sustaining combustion, this airflow is created by the gas generator, or the wind flowing around the aircraft.

During starting, it is essential to allow the gas generator to reach its maximum attainable RPM while operating on the starter motor before introducing fuel to the engine. This will keep engine starting temperatures to a minimum. The rate of airflow during starting is also influenced by the apparent wind around the engine nacelles. Facing the aircraft into the wind before starting will help keep temperatures low, but starting with a significant tailwind opposing the exhaust flow can lead to excessively hot starts.

After shutdown, ITT may remain sufficiently hot as to preclude a safe engine start without exceeding upper temperature limits. This limitation may present itself during quick turnarounds in high ambient temperatures with little wind to provide passive cooling. In this situation, the engine can be dry motored to reduce temperatures to safe levels before attempting a start. Should the ITT remain above around 150°C, cranking the engine with the electric starter motor will promote airflow through the compressor section, more quickly cooling the engine. Repositioning the aircraft into the wind will also help cool the engine before attempting a restart.

P2.5 Bleed Air Valves

The P2.5 Bleed Air valves are a feature of the PT6A engine, which stabilize the engine at lower power settings by allowing excess air to escape from the gas generator section of the engine, thus reducing the amount that makes its way into the combustion chamber. Both valves are operated by the pressure differential between the higher pressure P3, and lower pressure P2.5 compressor air. When the engine is not running, the valves rest in the open position. The low pressure P2.5 bleed valve closes around 68% Ng, while the high pressure P2.5 bleed valve closes around 92% Ng. Both valves can fail, becoming stuck in their open positions. This will prevent the combustion chamber from receiving the air it needs to produce full power. Should aircraft not develop the full power expected on takeoff, but all other indications are normal, a stuck P2.5 bleed air valve should be suspected.

Engine Power Settings (Turboprop A36TP)

Shaded areas denote operation at max. torque or max. ITT. **All figures at max. gross weight.**

Take-Off Power 100% Torque - Standard Day (ISA) No Wind

Press. Alt. (ft)	Torque (FT-LBS)	Prop RPM	Fuel Flow (GPH)	T/O Ground Roll (ft)	50ft Obstacle T/O Dist. (ft)	Rate of Climb (ft/min)
SL	1,200	2,200	44	700	840	2,520
2,500	1,200	2,200	42	840	1,010	2,350
5,000	1,200	2,200	41	960	1,150	2,180
7,500	1,200	2,200	40	1,070	1,290	2,030
10,000	1,200	2,200	40	1,100	1,320	1,890

Maximum Continuous Power (or limit) - Standard Day (ISA)

Pressure Alt. (ft)	Torque (FT-LBS)	Prop RPM	Fuel Flow (GPH)	True Airspeed	Range (nm)
SL	1,000	2,200	37	174	457
10,000	1,040	2,200	36	200	515
15,000	1,060	2,200	35	214	557
20,000	1,130	2,200	37	235	560
25,000	1,080	2,200	33	247	660

Normal Cruise Power (or limit) - Standard Day (ISA)

Pressure Alt. (ft)	Torque (FT-LBS)	Prop RPM	Fuel Flow (GPH)	True Airspeed	Range (nm)
SL	900	2,000	33	162	486
10,000	1,000	2,000	33	189	560
15,000	1,040	2,000	33	207	578
20,000	1,100	2,000	34	229	604
25,000	1,060	2,000	32	242	670

Economy Cruise Power (or limit) - Standard Day (ISA)

Pressure Alt. (ft)	Torque (FT-LBS)	Prop RPM	Fuel Flow (GPH)	True Airspeed	Range (nm)
SL	700	1,800	28	144	523
10,000	720	1,800	25	162	656
15,000	780	1,800	26	185	681
20,000	900	1,800	27	202	697
25,000	880	1,800	26	215	758

Cruise Climb 95% Torque (or limit) - Standard Day (ISA)

Target Alt. (ft)	Torque (FT-LBS)	Prop RPM	Fuel Flow (GPH)	Time to Climb (min)	Fuel to Climb (gal)	Dist. to Climb (nm)
5,000	1,200	2,200	42	2	2	5
10,000	1,200	2,200	41	5	5	10
15,000	1,200	2,200	39	8	7	15
20,000	1,150	2,200	38	12	9	24
25,000	1,100	2,200	36	16	11	31

Recommended Climb Airspeeds: 110 kts to 15,000 ft, 105 kts to 20,000 ft, 100 kts to 25,000 ft.

Tips on Operation within MSFS

Turboprop Engine Simulation

The aircraft makes use of Black Square's new gas generator and engine temperature simulation, which offers a vast improvement over the default behavior. Along with the new beta range implementation, these systems produce one of the most realistic turboprop simulations in MSFS. Expect realistic hot starts based on numerous environmental factors, accurate ITT and oil temperature behavior that becomes limiting at high altitude, and precise beta operations while taxiing. The gas generator RPM is also influenced by many factors, and follows a more realistic speed curve at different throttle settings.

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 Page" section of this manual.

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 starting ITT limits will destroy an engine in seconds, while a slight exceedance of the maximum governed propeller RPM would not cause an engine failure for quite some time. When engine health is reduced to 25% of its initialized value, the CHIP DETECT annunciator light will illuminate. 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.

Exceeding the engine starter limitations stated in this manual significantly will permanently disconnect the starter from electrical power. Be aware that the Bonanza Professional does not possess an annunciator pertaining to starter motor overheat, so failure may arise unannounced.

Deicing and Anti-Icing Systems

The Bonanza Professional Turboprop lacks the ice protection equipment of most other turboprop aircraft, making it particularly susceptible to icing conditions at high altitude. In addition to what is installed in the reciprocating aircraft, the turboprop conversion also includes inertial separator vanes in the engine intake to separate ice and foreign objects from the induction airflow. The lip of the induction air intake is also heated by the same electrical circuit as the propeller heat to prevent large amounts of ice from developing on the lip and entering the engine.

NOTE: The electric propeller heat is disabled when the aircraft is on the ground. To test the propeller heat during ground operations, the "PROP HEAT TEST" push button on the throttle quadrant.

Foreign Object Debris Damage

This aircraft simulates damage caused to turbine engines by the ingestion of particulate matter, better known as foreign object debris, or "FOD". FOD can include dust, sand, gravel, ice, etc., and is typically associated with operating on unimproved runways. The amount of damage caused by the FOD is calculated based on which of the 25 recognizable surface types the aircraft is currently operating on, the thrust of the propeller, and the position of the inertial separator vanes. In order to prevent damage, be sure to use the inertial separators whenever operating on unimproved surfaces, including all ground operations, and whenever ice is present.

NOTE: The quantity and type of FOD encountered, as well as the position and functioning of the inertial separators, can be monitored via the engine pages of the tablet interface. For more information on the tablet's engine pages, see the "Engine Visualizer Page" section of this manual.

Beta Range

Due to the large static thrust produced by turboprop engines, they are often equipped with a "beta range". When the power levers are moved over a gate into this range below the normal flight idle position, the propeller pitch is further flattened to reduce thrust. This aids in controlling the aircraft on the ground without causing excessive brake wear.

This aircraft makes use of Black Square's new beta range implementation, which is designed to provide accurate ground handling for advanced users, while not interfering with the basic functionality for novices. Beta range is incorporated into the bottom 15% of forward throttle input. Users can assign this 0-15% range to their hardware using 3rd party applications, or with physical detents. The remaining throttle input, including reverse, is assigned normally. By default, the beta range will be inaccessible during flight. An optional power lever beta range annunciator has been added to the annunciator panel for those who do not have hardware or software detents for their throttle input. The annunciator is enabled by default, but can be disabled from the options page of the tablet interface.

NOTE: Inadvertent activation of propeller beta range will be prevented anytime the aircraft is airborne, unless the "Unrestricted Beta Range" option is enabled on the options page of the tablet interface. Use of beta range in flight is not permitted by this aircraft's operating limitations.

Audible Warning Tones

Due to the reduced maximum allowable airspeed that comes with turboprop certification, the Bonanza Professional Turboprop is equipped with an additional warning horn. All warning tones can be disabled by pulling the circuit breaker for the respective tone's underlying warning system. These tones are as follows:

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

Tablet Interface (A36TP Turboprop)

The following sections regarding the tablet interface in the Bonanza Professional Turboprop only include significant changes or additions to the reciprocating version of the aircraft, such as the bleed air heating system, and the turbine engines. For complete details on the Black Square tablet interface, see the main "Tablet Interface" section of this manual, above.

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 ensuring cool engine starts, 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 engine, or recharging the batteries. The engine condition can also be reset via the legacy weather radar systems display.

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.

2. 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 Clear Engine button will reset the engine temperatures to ambient, remove all fuel from the lines and combustion chamber, and prepare the engine for a normal cold start.

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 Clean Filters button will remove any contaminants from the oil and fuel filters. These filters are depicted by cross-hatched rectangles in this visualizer. Clogged filters may result in higher than normal oil temperatures, or lower than normal fuel pressures, accompanied by a warning light.

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.

3. Fuel & Oil Lines

This aircraft has two electric fuel pumps, one engine driven pump, an inline primary fuel filter which can become clogged, and an oil-to-fuel heat exchanger.

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. The oil has a large normal operating temperature span, throughout which its color will be the brown seen below.

4. Output Shaft

On the front of the engine is the output shaft, which is directly connected to the propeller. This shaft drives the propeller governor, and incorporates the torqometer, and beta feedback ring.

5. Planetary Reduction Gearbox

The planetary reduction gearbox is responsible for reducing the 30,000+ shaft RPM of the power turbine to a higher torque and more useful speed to drive the propeller. Since this is such a high wear area of the engine, it receives a constant flow of oil, and has its own oil sump.

6. Power Turbine

The power turbine blades are positioned just downstream of the combustion chamber, and capture the energy of the rapidly expanding exhaust gasses. One of the three turbines in this section returns power back to the gas generator to sustain combustion. Important to the understanding of free turbines, the power turbine and the gas generator are not connected by a common shaft or gears. There is no mechanical connection between the two sections. Instead, only the airflow that passes between the two connects them.

7. Gas Generator

The gas generator comprises a set of turbines and stators that progressively compress ram air to about ten times its ambient density. This air is then distributed through small holes into the combustion chamber. The gas generator is driven by expanding exhaust gasses when the engine is running, and the starter motor while starting.

8. Accessory Gearbox

The accessory gearbox resides on the back of the engine, and is used to transfer power from the gas generator to accessory equipment, such as fuel and oil pumps, the fuel control unit, and the starter-generator. The gearbox contains reduction gears to reduce the high RPM, low torque output of the gas generator to lower RPM, higher torque output for the accessories. It is important to remember that in a free turbine engine, accessories are driven by the gas generator, not the propeller output shaft. The main oil reservoir and sump separate the accessory gearbox from the rest of the engine.

9. Induction & Bleed Air Controls

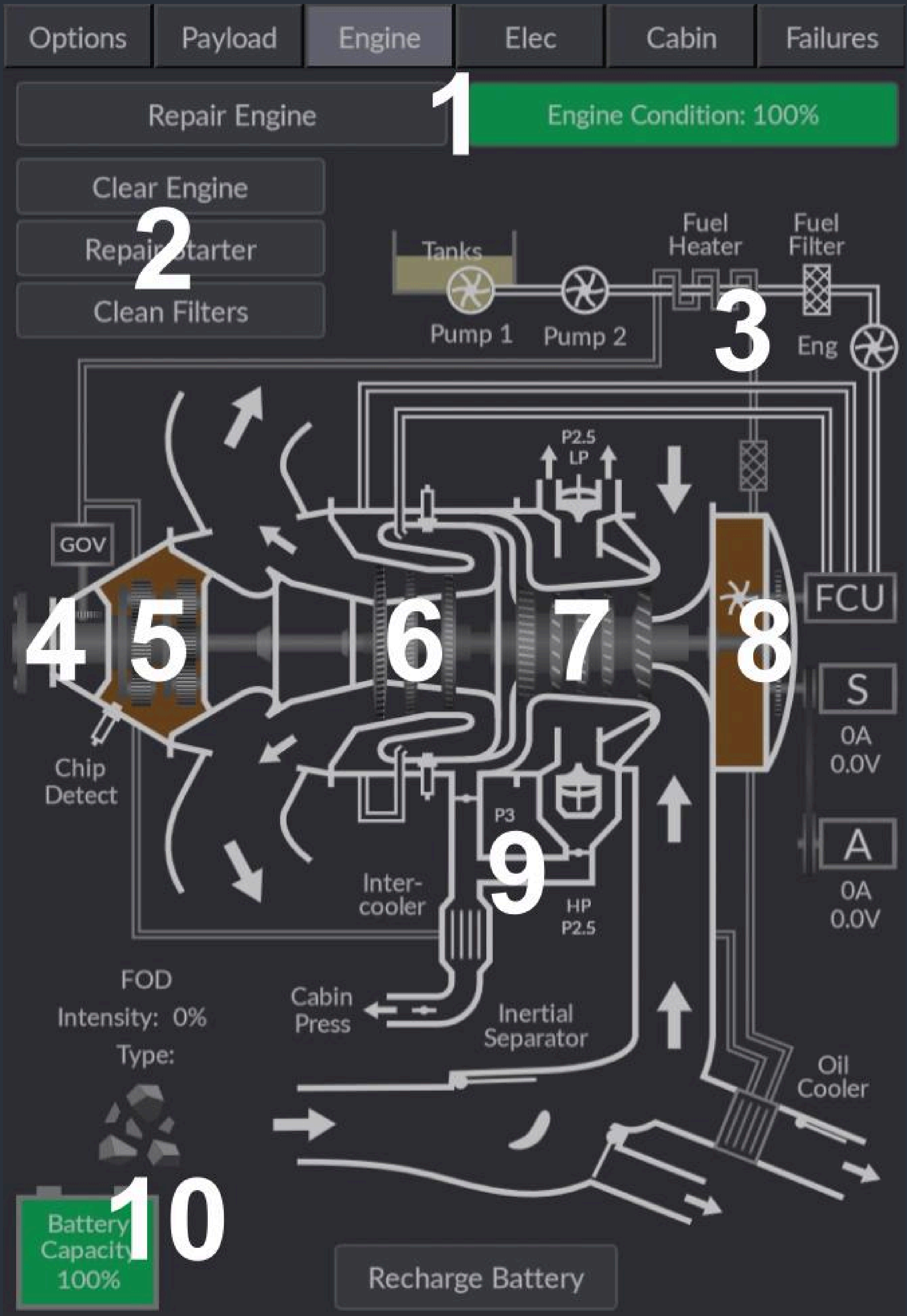
Control of the engine's intake and bleed air relies on a series of valves and louvers. Ambient air enters the induction system through the air inlet under the engine, at the bottom of the visualizer. This air is always at the same temperature and pressure as the air surrounding the aircraft.

The air used to heat the cabin is extracted from the high pressure P2.5 and P3 bleed air valves. See the "Cabin Environmental Controls" section of this manual for more information on bleed air sources and climate control.

When ambient pressure and temperature ram air reaches the gas generator, it is pressurized before entering the combustion chamber. This air is metered by the bleed air controller, before being passed through an intercooler, and then sent into the cabin air heating ducts. Should the bleed air become contaminated, such as by a carbon monoxide leak, the bleed air can be isolated by pulling the same red "FIREWALL AIR" pull handle on the pilot's subpanel, as with the reciprocating engine version of the aircraft. See the "Cabin Environmental Controls" section of this manual for more information on the bleed air controls.

10. Active & Inactive Batteries

The capacity of each battery 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 a battery is not connected to the main bus of the aircraft, it will appear grayed out.


Options
Payload
Engine
Elec
Cabin
Failures
Repair Engine
1
Engine Condition: 100%
Clear Engine
2
Repair Starter
Clean Filters
Tanks
Pump 1
Pump 2
Fuel Heater
Fuel Filter
3
Eng
P2.5 LP
GOV
4
5
6
7
8
FCU
S
0A
0.0V
A
0A
0.0V
Chip Detect
P3
9
HP P2.5
Inter-cooler
FOD
Intensity: 0%
Type:
Cabin Press
Inertial Separator
Oil Cooler
Battery Capacity 100%
10
Recharge Battery

Starting Engine

This visualizer can be very helpful for understanding the starting sequence of a free turbine engine, and learning how to keep the engine as cool as possible during starting.

1. Fuel Pumps

This aircraft has two electric fuel pumps and one engine driven pump, which serve different purposes. For more information on the different fuel pumps, see the “Fuel Pumps” section of this manual.

When an electric or engine-driven fuel pump runs, fuel will flow from the tanks into the fuel control unit (FCU). As the fuel lines are pressurized, a slug of fuel will travel from the tanks to the FCU. Dashed lines indicate the rate of fuel flow. Not until this slug reaches the FCU will the engine be capable of sustaining combustion.

2. Ignitors

In order to ignite the relatively non-volatile jet fuel, several ignitors are mounted radially around the combustion chamber. Not unlike spark plugs in a reciprocating engine aircraft, an exciter coil sends a high voltage pulse of electricity to these electrodes to produce a spark. The ignitors can be run automatically, whenever the engine is at low power output, or manually, usually when the aircraft encounters severe turbulence or precipitation. See the “Turbine Engine Ignition” section of this manual for more information

3. Fuel Control Unit & Starter Motor

The fuel control unit (FCU) is a purely mechanical control system in a turbine engine that meters the amount of fuel injected into the combustion chamber to achieve the desired power output level set by the power lever. A combination of pressurized fuel and pressurized bleed air are provided as inputs to the FCU. When the FCU is receiving pressurized fuel and functioning normally, its internal volume will be shown in green. When an FCU failure has occurred, it will be shown in red. For more information on the FCU and its possible failures, see the “Turbine Engine Fuel Control Failures” section of this manual.

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. Since the starter motor is also the generator, the interior body will also be green when the generator is in use, except the letter “G” will be shown, instead of “S” for starter.

The exterior casing of the starter-generator will change color to indicate its temperature. When the starter-generator is cold, the casing color will be gray. As it warms the color will change from blues and greens, to ambers and reds.

4. Intake Air

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 intake air is at the same pressure as the ambient air, but the air in the combustion chamber has been compressed by the gas generator. Before the engine is sustaining combustion the P2.5 bleed air valves will be open, as there is no P3 bleed air pressure to close them. For more information on P2.5 bleed valve operation and failures, see the “P2.5 Bleed Air Valves” section of this manual.

5. Battery Temperature

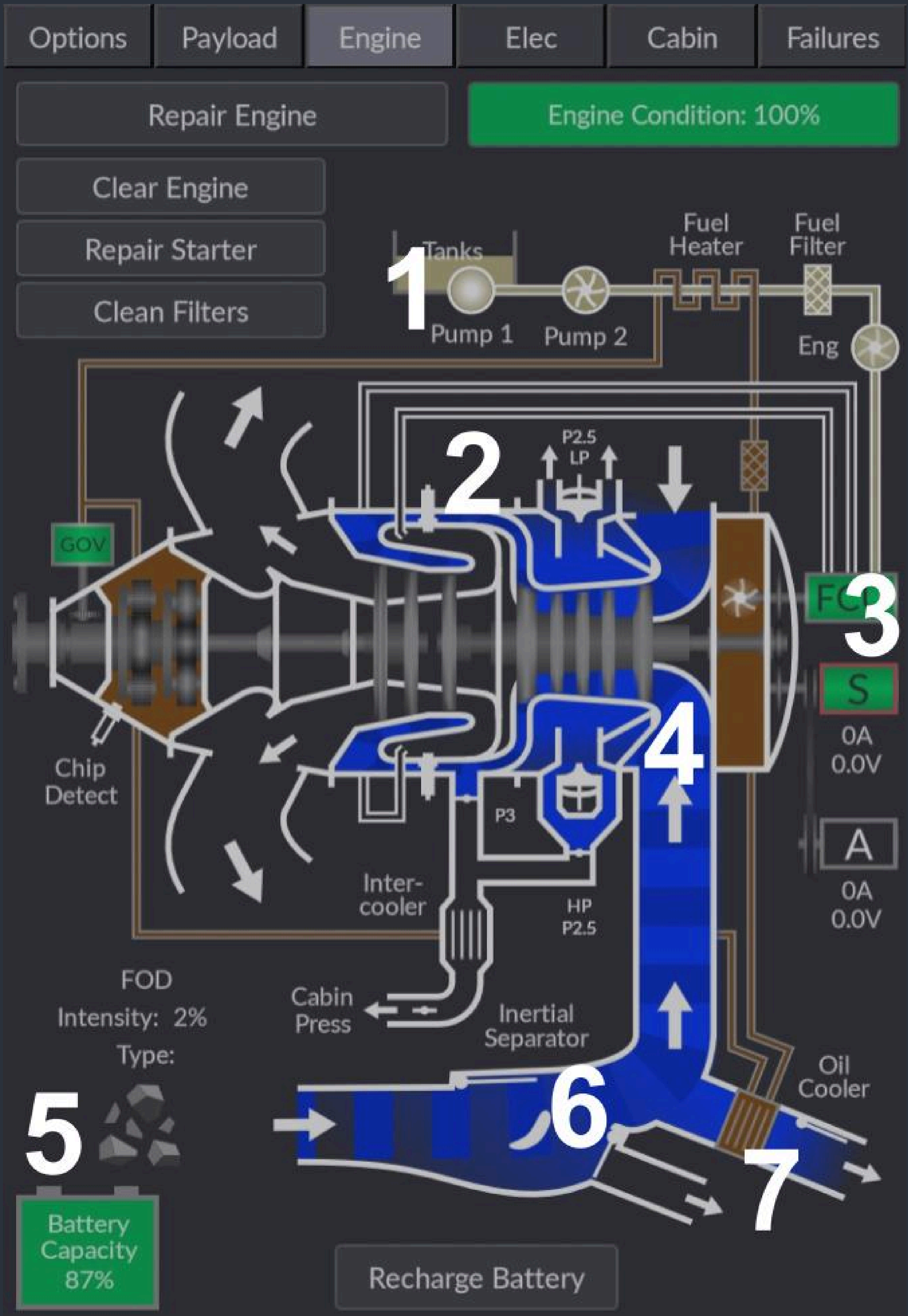
Here, the left battery can be seen connected to the main electrical bus, and the right is disconnected. The exterior casing of the battery will change color to indicate the temperature of the battery’s terminals and electrodes. When the battery is cold, the casing color will be gray. As the battery warms 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.

6. Inertial Separator Stowed

With the inertial separator in the stowed (normal) position, ram air will flow unimpeded through the intake manifold and into the engine’s radial inlet. While this configuration is best for engine performance and cooling, it allows foreign object debris (FOD) to enter the engine. For best practices regarding the inertial separator, see the “Inertial Separators (Ice Deflectors / Ice Door)“ section of this manual.

7. Oil Cooler Door

The oil cooler doors provide a way to meter the amount of intake air that passes over the oil cooler heat exchanger. The doors are actually positioned behind the oil coolers, but their opening and closing controls the restriction of air exiting the air intake, much as cowl flaps control reciprocating engine cooling air, despite being at the bottom of the engine cowling. The management of oil cooling is particularly important to the operation of this aircraft. See the “Oil Cooler Door” section of this manual for information on when the doors should be opened or closed.


Options
Payload
Engine
Elec
Cabin
Failures
Repair Engine
Engine Condition: 100%
Clear Engine
Repair Starter
Clean Filters
Tanks
1
Pump 1
Pump 2
Fuel Heater
Fuel Filter
Eng
2
P2.5 LP
GOV
3
S
0A
0.0V
4
A
0A
0.0V
Chip Detect
P3
Inter-cooler
HP P2.5
FOD
Intensity: 2%
Type:
Cabin Press
Inertial Separator
Oil Cooler
5
6
7
Battery Capacity 87%
Recharge Battery

Running Engine

While the engine is running, the engine visualizer is best used for detecting component failure, monitoring air intake valve positions, and bleed air valve activation.

1. Propeller Governor

The propeller governor controls the pitch of the propeller to indirectly control engine torque and output shaft RPM. The governor's flyweights are driven by a mechanical connection to the output shaft, and meter the high pressure oil supply to the propeller hub. When the propeller governor is receiving oil and functioning properly, it will be depicted with a green body. The body will become red if the governor fails. For information on the testing and failure modes of the governor, see the "Propeller Governor" section of this manual.

2. Exhaust Gasses

When the engine has achieved self-sustaining combustion, the resultant exhaust gasses are expelled through the power turbine, and out the exhaust stubs on either side of the engine. While the intake gasses are color-coded for pressure, the exhaust gasses are color-coded for temperature. The color spectrum is the same as for the other elements discussed above. As the gasses warm, their color will change from yellows and oranges, to reds and magentas. Magenta should be considered dangerously hot for any equipment depicted in this visualizer.

3. Combustion Chamber

When the ignitors successfully light off self-sustaining combustion, flame will emanate from the fuel injector nozzles. This engine has two injector circuits, primary and secondary. The primary injectors work alone when the engine is spooling up from a cold start, while the secondary injectors begin to function at around 40% Ng. Should an injector fail, fuel will not be shown in the pipeline, and the flame will be absent.

4. Bleed Air Valves

This engine has three bleed air valves. P3 bleed air is drawn from just prior to the combustion chamber, and is used to supply the heating and pressurization system. The low pressure and high pressure P2.5 bleed valves help maintain the correct engine operating RPM, and are sometimes used for heating, as in this aircraft. The position of these valves is indicated on the visualizer. Should a valve fail and become stuck open, the valve body will be shown in red. For more information on P2.5 bleed valve operation and failures, see the "P2.5 Bleed Air Valves" section of this manual.

5. Oil Pumps, sumps & Lines

While dark brown oil in the lines indicated very cold and viscous oil, red indicates oil that is too hot. Here, the engine driven oil pump can also be seen running inside the main engine oil sump. The oil cooler door is also now shown in the open position.

6. Chip Detector

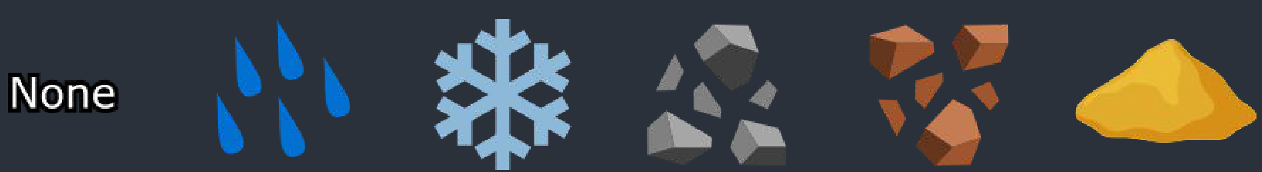
The chip detector is a magnetic pair of electrodes at the bottom of the planetary reduction gearbox oil sump. This is the most likely location in the engine for metallic particles to collect due to wear. The magnet attracts the particulate, and the electrodes allow for a complete circuit to be created when the metallic particles collect on them. When the presence of metal particles in the oil is detected, the body of the chip detector will show red, and a warning light will illuminate on the instrument panel. A chip detect warning is usually indicative of an incipient engine failure, and power should be reduced immediately.

7. Standby Alternator

This aircraft incorporates a belt-driven standby alternator, the depiction of which here is similar to that of the main generator, described in the “Fuel Control Unit & Starter Motor” section, above. Since operation of the standby alternator is electronically controlled, the two power sources should never be online at the same time, even when both the generator and standby alternator switches are in the on position with both operating normally.

8. Foreign Object Debris (FOD)

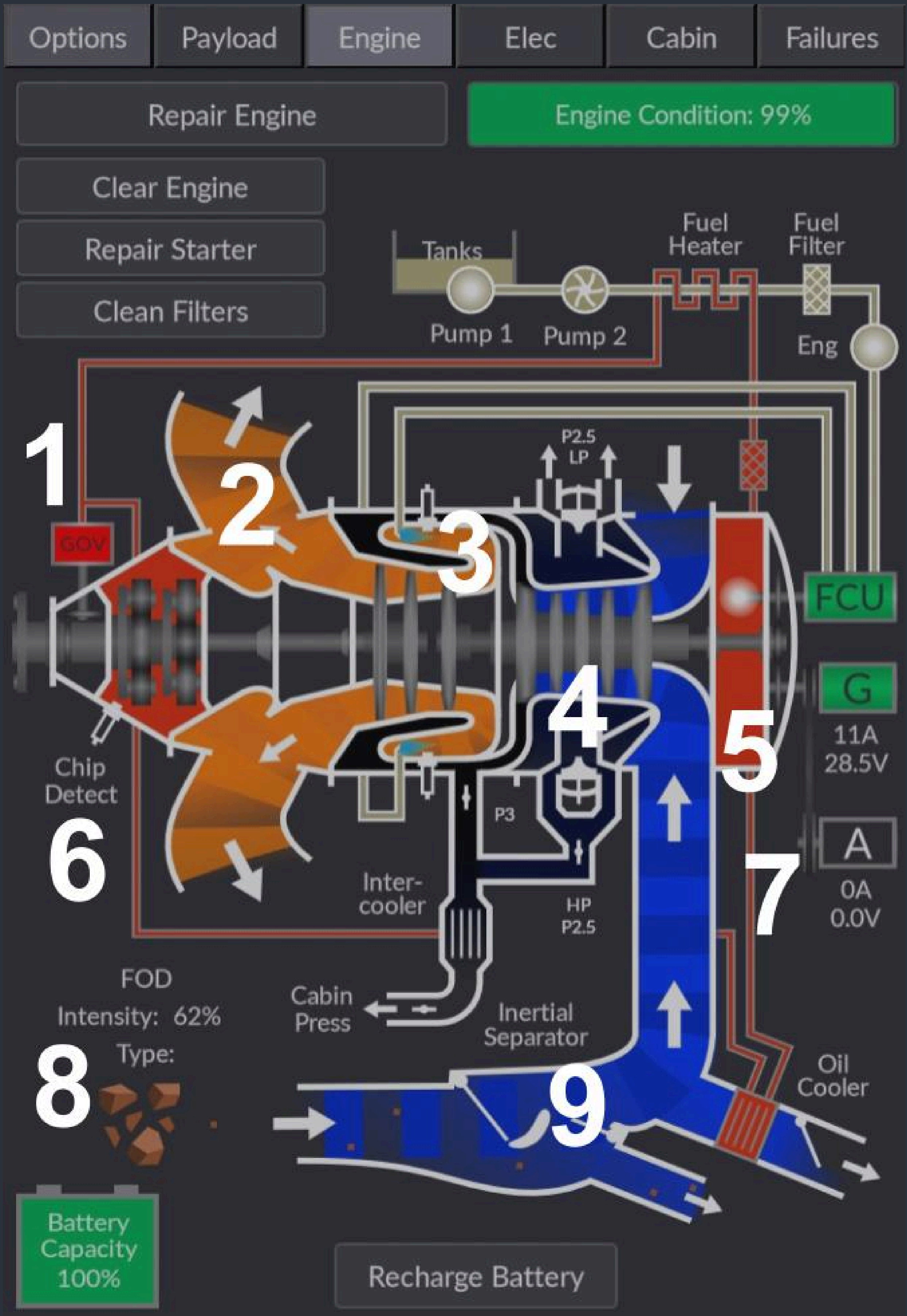
It is possible to encounter Foreign Object Debris (FOD) whenever operating on the ground, particularly on unimproved or worn surfaces. FOD can also enter the engine in flight in the form of ice, heavy precipitation, or birds. An icon representing the current type of FOD being encountered will appear on this visualizer. The intensity of the FOD is expressed as a number from 0 to 100%. Particles of FOD can be seen entering the air inlet, and flowing either into the engine or out the ejection ports, depending on how the inertial separator is positioned. For more information on the avoidance of FOD, and the consequences of encountering FOD, see the “Foreign Object Debris Damage” section of this manual.



No FOD | Rain | Ice/Snow | Asphalt/Stone | Dirt | Sand

9. Inertial Separator Deployed

When the inertial separator is in the fully deployed (bypass) position, any Foreign Object Debris (FOD) that enters the engine air intake below the propeller will flow harmlessly out the ejection ports at the rear of the nacelle. If the inertial separator’s louvers fail to fully deploy, the amount of FOD admitted to the engine is proportional to their position. For best practices regarding the inertial separator, see the “Inertial Separators (Ice Deflectors)“ section of this manual.



Options
Payload
Engine
Elec
Cabin
Failures
Repair Engine
Engine Condition: 99%
Clear Engine
Repair Starter
Clean Filters
Tanks
Fuel Heater
Fuel Filter
Pump 1
Pump 2
Eng
1
2
3
P2.5 LP
GOV
FCU
G
11A
28.5V
4
5
Chip Detect
6
P3
A
0A
0.0V
7
Inter-cooler
HP P2.5
FOD
Intensity: 62%
Type:
Cabin Press
Inertial Separator
8
9
Oil Cooler
Battery Capacity 100%
Recharge Battery

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 the P2.5 or P3 bleed air. The bleed air is heated by compression, and by proximity to the engine's combustion chamber. The majority of the environmental control system remains intact from the reciprocating engine version of the aircraft. The air conditioning system remains unchanged, but the exhaust air heat exchanger has been replaced by compressor bleed air from the turbine engine. For more information on the environmental control systems, see the “Environmental Simulation & Controls” section of this manual.

1. Engine Bleed Air Supply

The heating system in this aircraft derives hot air primarily from the P2.5 bleed valve in the engine’s compressor section. Additional, hotter air can be sourced from the P3 bleed valve later in the compressor section. This bleed air is then mixed, and cooled via an intercooler.

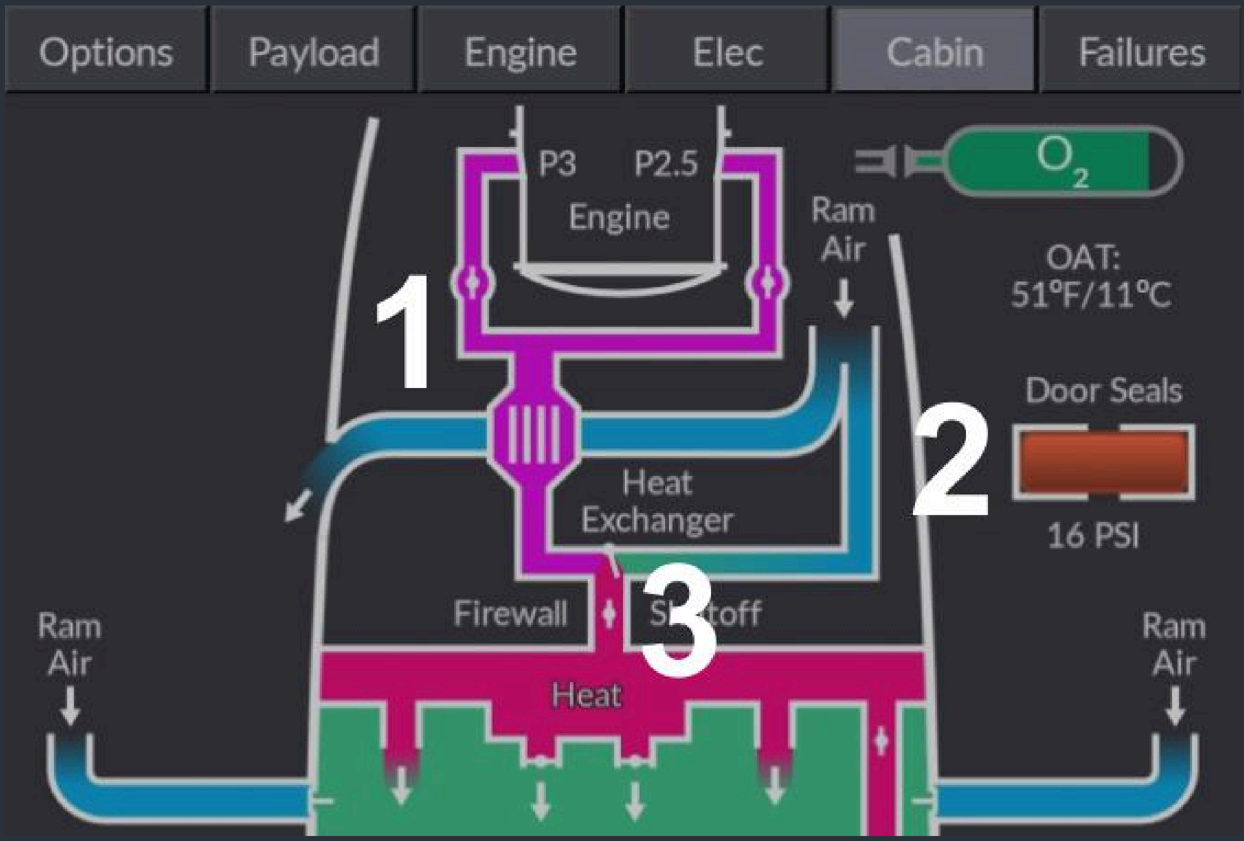
2. Door Seals

This aircraft is equipped with inflatable door seals to reduce wind and engine noise in flight. The door seals are pressurized to approximately 16 PSI. Their inflation status is depicted on this visualizer with the orange gradient bar, seen below.

3. Firewall Shutoff & Mixing Valve

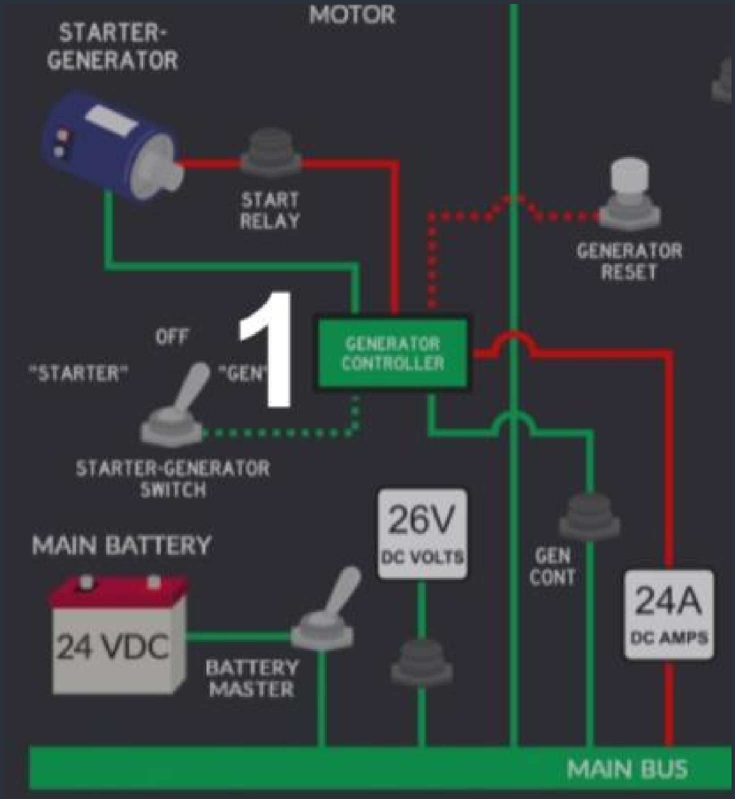
Forward of the cabin firewall, two valves control the heating air that is admitted to the cabin. Air from the engine’s bleed air valves is limited by a mixing valve, which is used to control the temperature of the cabin. Pulling the “CABIN HEAT” pull handle away from the instrument panel will send progressively more heating air to the cabin and less ram air at ambient temperature. For more information on controlling the cabin temperature, see the “Cabin Environmental Controls” section of this manual.

After the mixing valve, a firewall shutoff valve allows for the complete isolation of air from within the engine cowling in the event of carbon monoxide or other fumes. This valve is closed by pulling the red “FIREWALL AIR” pull handle on the pilot’s subpanel. Should the bleed air system overheat, as indicated by the red LED indicator lamp, or become compromised and begin to allow poisonous carbon monoxide gas into the cabin, a grey gradient will be displayed on the visualizer within this heating manifold.



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.



1. Generator Controller

The layout of the aircraft’s electrical system remains largely unchanged from the reciprocating engine version. A generator controller replaces the simple alternator, which energizes the starter-generator. The generator reset button can be used to trip the generator offline, and to attempt to reenergize it after it has been tripped due to an overload or other failure.

List of Possible Failures (Turboprop A36TP)

Major System Failures

ENGINE FAILURE
ENGINE FIRE

PROPELLER GOVERNOR
FUEL CONTROLLER
ENGINE SURGE
PRIMARY INJECTORS
SECONDARY INJECTORS
LP BLEED
HP BLEED
FUEL FILTER
ENG DRIVEN FUEL PUMP

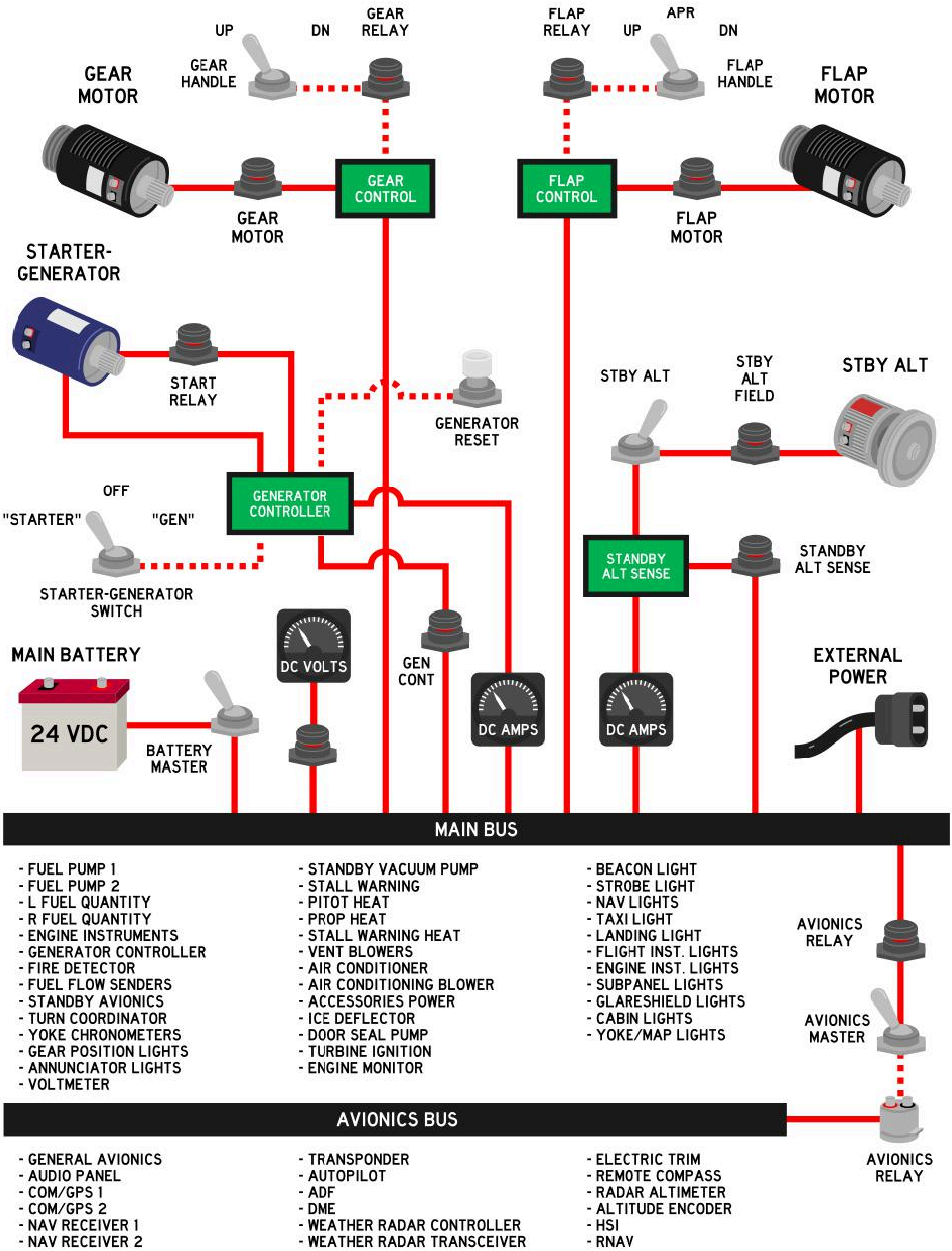
VACUUM PUMP
VACUUM PUMP PARTIAL
PITOT BLOCKAGE
STATIC BLOCKAGE
L BRAKE
R BRAKE
L FUEL LEAK
R FUEL LEAK
DOOR SEAL INTEG
CO LEAK
CO DETECTOR
CONDENSER LIMIT
PILOT DOOR LATCH
CABIN DOOR LATCH
OXYGEN LEAK

Breaker Protected Failures

STARTER MOTOR
FLAP MOTOR
FUEL PUMP 1
FUEL PUMP 2
STANDBY VACUUM
GEAR MOTOR
GEAR WARNING
L FUEL QTY
R FUEL QTY
FUEL FLOW GAUGE
STANDBY AVIONICS
ENGINE INSTRUMENTS
GENERATOR CONTROLLER
FIRE DETECTOR
TURN COORD
VOLTMETER
YOKE CHRONOS
LANDING GEAR POS LIGHTS
ANNUNCIATOR LIGHTS
ACCESSORIES POWER
VENT BLOWERS
AIR CONDITIONER
AIR CONDITIONING BLOWER
ENGINE MONITOR
STALL WARNING
STANDBY ALT FIELD
STANDBY ALT SENSE
ICE DEFLECTOR
TURBINE IGNITION
DOOR SEAL PUMP
PITOT HEAT
PROP HEAT
STROBE LIGHT
BEACON LIGHT
NAV LIGHTS
TAXI LIGHTS
LANDING LIGHTS
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

Overview Electrical Schematic

The turboprop conversion process leaves the reciprocating engine aircraft's electrical system larger unchanged, with the exception of the main alternator's replacement with a starter-generator and associated electronic control system. Additional circuits for turbine engine control have been added to the main distribution bus. Although the door seal electric motor circuit breaker appears with the avionics circuit breakers on the copilot's subpanel, the circuit is connected to the main bus, not the avionics bus.


GEAR MOTOR
GEAR HANDLE
UP
DN
GEAR RELAY
GEAR CONTROL
GEAR MOTOR
FLAP RELAY
UP
APR
DN
FLAP HANDLE
FLAP MOTOR
FLAP CONTROL
FLAP MOTOR
STARTER-GENERATOR
START RELAY
GENERATOR RESET
GENERATOR CONTROLLER
OFF
"STARTER"
"GEN"
STARTER-GENERATOR SWITCH
STBY ALT
STBY ALT FIELD
STBY ALT
STANDBY ALT SENSE
STANDBY ALT SENSE
MAIN BATTERY
24 VDC
BATTERY MASTER
DC VOLTS
GEN CONT
DC AMPS
DC AMPS
EXTERNAL POWER
MAIN BUS
- FUEL PUMP 1
- FUEL PUMP 2
- L FUEL QUANTITY
- R FUEL QUANTITY
- ENGINE INSTRUMENTS
- GENERATOR CONTROLLER
- FIRE DETECTOR
- FUEL FLOW SENDERS
- STANDBY AVIONICS
- TURN COORDINATOR
- YOKE CHRONOMETERS
- GEAR POSITION LIGHTS
- ANNUNCIATOR LIGHTS
- VOLTMETER
- STANDBY VACUUM PUMP
- STALL WARNING
- PITOT HEAT
- PROP HEAT
- STALL WARNING HEAT
- VENT BLOWERS
- AIR CONDITIONER
- AIR CONDITIONING BLOWER
- ACCESSORIES POWER
- ICE DEFLECTOR
- DOOR SEAL PUMP
- TURBINE IGNITION
- ENGINE MONITOR
- BEACON LIGHT
- STROBE LIGHT
- NAV LIGHTS
- TAXI LIGHT
- LANDING LIGHT
- FLIGHT INST. LIGHTS
- ENGINE INST. LIGHTS
- SUBPANEL LIGHTS
- GLARESHIELD LIGHTS
- CABIN LIGHTS
- YOKE/MAP LIGHTS
AVIONICS RELAY
AVIONICS MASTER
AVIONICS BUS
AVIONICS RELAY
- GENERAL AVIONICS
- AUDIO PANEL
- COM/GPS 1
- COM/GPS 2
- NAV RECEIVER 1
- NAV RECEIVER 2
- TRANSPONDER
- AUTOPILOT
- ADF
- DME
- WEATHER RADAR CONTROLLER
- WEATHER RADAR TRANSCEIVER
- ELECTRIC TRIM
- REMOTE COMPASS
- RADAR ALTIMETER
- ALTITUDE ENCODER
- HSI
- RNAV

Using the ETM Engine Trend Monitor

The Bonanza Professional Turboprop is equipped with the most complete implementation of the ETM engine trend monitor to appear in a flight simulator. The ETM is a common piece of engine monitoring equipment found in general aviation turbine engine 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. Due to the cost and relative fragility of turboprop engines, operators keep a close watch on recorded engine parameters. Exceedance alarms alert pilots to dangerous conditions, and realtime information on engine performance provides a means to increase fuel efficiency and reduce wear. For a complete understanding of the unit's functionality, please see the "More Information on Operation" section of this manual for real world operating resources.

The ETM's interface is divided into four "Files" with an arbitrary number of "Pages" in each file. The files are selected with the rotary knob, and pages with the "PAGE UP/DOWN" toggle switch. Some pages have additional subpages, which are selected from with the "INCR/DECR" toggle switch. When power is applied to the unit, a self-test is initiated while the current software version, data version, aircraft model number, and company information is shown.

ETM File - Engine Trend Monitor

Page Name	Example	Description
NG & ITT	NG% 98.4 ITT 746	Gas Generator RPM % Interstage Turbine Temperature °C
TQ & ITT	TQ 1124 ITT 728	Propeller Torque in FT-LBS Interstage Turbine Temperature °C
Prop & NG	NG% 98.4 NP 746	Gas Generator RPM % Propeller RPM
SHP	SHAFT HP: 955	Derived Shaft Horsepower HP = Tq * RPM / 5252
Specific Fuel	SFC: 0.452	Pounds of fuel consumed to produce one shaft horsepower - engine efficiency
Key Status	Key 21.4%used Status: Init	Amount of data used on USB data stick
Log of Totals, Title Page Total Cycles, Total Flight Time Engine Total Starts, Engine Total Time	LOG OF TOTALS AF TC/TT 825/1285:15 Eng TS/TT 858/1498:58	Use INCR/DECR toggle switch to select sub-page. Total takeoff/landing cycles of the airframe/ Total hours and minutes of flight time Total engine start/shutdown cycles/ Total hours and minutes of engine run time
Lowest Voltage Highest ITT	LoV|Hi ITT 18.8 821	Lowest voltage and highest ITT during start Symbols: - = stopped, / = starting, | = running
Next Inspection	Inspection Due 72:34:12	Time until regular inspection Interval set by maintenance technician

NAV File - Navigation Data

Page Name	Example	Description
Current GPS Position	Pos N 45°23.2 W081°10.8	*Current GPS longitude and latitude
ETE Next Waypoint	To BOSOX ETE 24.7nm 00:08	*Identifier, distance, and time-to-go (HH:MM) for the next waypoint in the flightplan
ETA Next Waypoint	ETA > BOSOX 17:35 LCL	*Estimated time of arrival in local time at the next waypoint in the flightplan
ETE Last Waypoint	To Dest. ETE 410.7nm 02:35	*Distance and time-to-go (HH:MM) for the last waypoint in the flightplan
ETA Last Waypoint	ETA > Dest. 01:20 LCL	*Estimated time of arrival in local time at the last waypoint in the flightplan
Track & Groundspeed	MTrk098 Var GS292kt W13.8	*Magnetic track and groundspeed of the aircraft, and magnetic variation in the area
Wind Speed & Direction	Wind/Drift 072/18kt 07R	*Current wind direction from and speed based on the GPS drift angle of the aircraft
Heading & Drift Angle	Headng/Drift 321/ 9L"	*Current heading and drift angle of the aircraft based on GPS track
Heading & Turn Rate	Heading/ ROT 135/ -05.8	Current heading and rate of turn of the aircraft

*A hot-swapping radio configuration with a GPS must be active for these pages to display data.

FUEL File - Fuel Flight Planning Data

Page Name	Example	Description
Full Fuel	Full Fuel 290.6GL	Full fuel payload of the aircraft in gallons
Fuel Required to Last Waypoint	Fuel to KTPA 84.9 GAL	*Fuel required to reach the last waypoint in the flightplan at current consumption rate
Fuel at Last Waypoint	Fuel at KTPA 42.7 GAL	*Fuel remaining at the last waypoint in the flightplan at current consumption rate
Specific Range	Specfic Range 2.12NM/GAL	*GPS groundspeed divided by fuel consumption in GPH - flight efficiency
Fuel Flow	F/Flow GPH 45.6	Fuel flow in gallons per hour
Fuel Used & Fuel Remaining	F/Use 24.8GL F/Rem 107.4GL	Fuel used since power was applied to the ETM unit, and fuel remaining in gallons
Endurance	T/Rem 01:40HR F/Use 24.8GL	Time remaining until empty at current rate of consumption, and fuel used in gallons

*A hot-swapping radio configuration with a GPS must be active for these pages to display data.

AIRDATA File - Aircraft Sensor & Flight Data

Page Name	Example	Description
Local Date & Time	THU 6 JUL23 08:17:43 EST	Current local date and time
Universal Time	TIME 12:17:43 GMT	Current Greenwich Mean Time
Flight Timer	FLIGHT TIMER 02:10:35	Time elapsed since airspeed exceeded the takeoff threshold set by maintenance
OAT & Density Altitude	OAT D.ALT -08C 10800	Outside air temperature in °C, and calculated density altitude in feet
Pressure Altitude & Density Altitude	P.ALTft D.ALT 16000 18400	Pressure altitude, and calculated density altitude in feet
IAS, TAS, MACH	IAS TAS MACH 184kt220 0.291	Indicated airspeed, calculated true airspeed, and calculated mach number
Gross Weight	Gross Weight 6145LB	Current calculated gross weight of the aircraft, accounting for fuel burned

Alarms

The ETM 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 while the exceedance is occurring. To cancel the active alarm press the ENTER button, or use the PAGE UP/DOWN switch. 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	High Limit
High Interstage Turbine Temp	`Exceedance` `ITT 921`	805 °C (Normal) 1,090 °C (Starting)
High Propeller Torque	`Exceedance` `TQ 1971`	1,260 FT-LBS
High Gas Generator RPM	`Exceedance` `NG 107.2`	102.0%
High Propeller RPM	`Exceedance` `NP 2552`	2,400 RPM

Stopwatch

The ETM possesses a stopwatch, which can be accessed from any mode via the “CLOCK” controls on the right of the unit. In this mode, the words “STOP WATCH” will appear at the top of the display, with hours, minutes, and seconds elapsed below. The START/STOP switch is used to start and stop counting. The RESET button will stop and reset the time to all zeros.

Normal Checklists (A36TP Turboprop)

Before Starting Engine

Preflight Inspection	Complete
Control Locks	Remove
Seats & Seatbelts	Secure
Cabin Doors	Latched
Parking Brake	Set
Emergency Gear Handle	Stowed
Avionics Breakers	All In
Flaps	Up
Oxygen Pressure	1550-1850 psi
Avionics	Off
Power Lever	Flight Idle
Propeller	High RPM
Condition Lever	Cut-Off
Aileron Trim	Centered
Firewall Fuel Shutoff	Open (Push)
Ice Deflector	Off
Firewall Valve	Open (Push)
Oil Door	Open (Push)
P3 Bleed Air	Off (Push)
Landing Gear	Down
All Subpanel Switches	Off
All Turbine Engine Switches	Off
Main Breakers	All In
Alternate Static Air	Normal
CO Detector	Test
Fuel Selector	Fullest Tank
Beacon Light	On
Battery Master	On
Bus Volts	23V Minimum
Annunciators	Test & Consider
Standby Alternator	On
Fuel Quantities	Check
Fuel Pump 1	On and Audible
Fuel Pump 2	On and Audible
Fuel Pumps	Off
Ignition	Check Auto then On
Standby Gyro Pump	On
STBY GYRO Annun	Illuminated
Instrument Air	Green
Standby Gyro Pump	Off

Engine Start

Oil Door Closed If...	Exceptionally Cold
Starter	On
Bus Volts	15V Minimum
Gas Generator	15% Minimum
Condition Lever	On
ITT	Less than 1090C
Starter	Off at 52% Ng
Ignition	Off
Engine Instruments	Check
Generator	On
Generator Load	Below 60A in 2min
Bus Volts	28V

After Starting

All Annunciators	Extinguished
Generator Load	Below 25A in 2min
Lights	As Required
Weather Radar	Off/Standby
Avionics	On
Cabin Air & Heat	As Desired
Air Conditioning	As Desired
Parking Brake	Release
Brakes	Check

Runup

Parking Brake	Set
Annunciators	Test & Consider
Remote Compass	Slaved & Aligned
Fuel Pump 1	On
Power Lever	2000 RPM
Prop Gov Test	1990 RPM
Exercise Propeller	To 1500 RPM
Fire Detector	Test
Generator Reset	Hold
Generator Load	Zero
STBY ALT Annun	Illuminated
Generator Load	Flashing Positive
Generator Reset	Release
STBY ALT Annun	Extinguished
Generator Load	Below 75A
Power Lever	Idle
Ice Deflector	On
Oil Door	On
OIL DR CLOSED Annun	Illuminated
Oil Door Open Unless...	Exceptionally Cold
Instrument Air	Green
Propeller Heat	On
Prop Heat Test	Press & Hold
Propeller Amps	20-25A
Propeller Heat	Off
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
ICE DEFLEC Annun	Illuminated
Ice Deflector	As Required

Flaps	Check Operation
Flaps	Set Takeoff
Cockpit Window	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

Oil Temperature	115F Minimum
BATT TEMP Annun	Extinguished
Air Conditioning	Off
Landing Light	On
Transponder	Alt Mode
Weather Radar	On

Takeoff

Power Lever	1200 FT-LBS
Brakes	Release
Engine Instruments	Check
Landing Gear Up	No Rwy Remain
Flaps	Retract at 80kts
Autopilot	Engage

Max Continuous Power

Ignition	Auto or Off
Oil Door Open Unless...	Exceptionally Cold
Propeller	2200 RPM
Power Lever	1200 FT-LBS
Ice Deflector	As Required
Fuel Imbalance	15 gal Max.
Air Conditioning	As Desired

Enroute Climb

Propeller	2200 RPM
Power Lever	1100 FT-LBS
Ignition	Auto or Off
Oil Door	Closed (Pull)
Ice Deflector	As Required
Fuel Imbalance	15 gal Max.
Oxygen	As Required
Air Conditioning	As Desired
Cabin Air & Heat	As Desired
Engine Performance	Monitor

Cruise

Ignition	Auto or Off
Oil Door	Closed (Pull)
Ice Deflector	As Required
Pitot Heat	On if OAT less than 4c
Propeller Heat	As Required
Fuel Imbalance	15 gal Max.
Propeller	2000 RPM
Power Lever	1050 FT-LBS
Oxygen	As Required
Air Conditioning	As Desired
Cabin Air & Heat	As Desired
Engine Performance	Monitor

Descent

Ignition	Auto or Off
Oil Door	Closed (Pull)
Ice Deflector	As Required
Power Lever	Reduce
Engine Performance	Monitor
Ice Protection	As Required
Fuel Imbalance	15 gal Max.

Approach

Seats & Seatbelts	Secure
Fuel Selector	Fullest Tank
Oxygen	Off
Landing Light	On
Pitot Heat	On if OAT less than 4c
Propeller Heat	Off
Air Conditioning	Off
Ignition	Auto
Ice Deflector	As Required
Flaps	Approach

Landing

Fuel Pump 1	On
Propeller	High RPM
Oil Door Open Unless...	Exceptionally Cold
Flaps	As Required
Landing Gear	Down & Locked
Autopilot Disconnect	Press Once

After Landing

Ignition	Off
Flaps	Up
Ice Deflector	As Required
Weather Radar	Off/Standby
Lights	As Required
Pitot Heat	Off
Air Conditioning	As Desired
Cabin Air & Heat	As Desired

Shutdown & Securing

Parking Brake	Set
Avionics	Off
All Subpanel Switches	Off
Throttle	Idle
Propeller	High RPM
Condition Lever	Cut-Off
Generator	Off
Standby Alternator	Off
Fuel Pumps	Off when Ng below 10%
Battery Master	Off
Parking Brake	Release
Control Locks	Install

Instrument Markings & Colors

Engine Torque:
0-1,200 FT-LBS (GREEN)
1,200 FT-LBS (RED)

Interstage Turbine Temperature:
400-700 °C (GREEN)
700 °C (RED)
1,090 °C (RED TRIANGLE)

Gan Generator RPM:
50-101.5 % (GREEN)
101.5 % (RED)

Propeller RPM:
400-1,200 RPM (YELLOW)
1,200-1,400 RPM (GREEN)
1,400-1,600 RPM (YELLOW)
1,600-2,200 RPM (GREEN)
2,215 RPM (RED LINE)

Fuel Flow:
0-400 PPH

Fuel Pressure:
15-30 PSI (GREEN)

Oil Temperature:
35-115 °F (YELLOW)
115-200 °F (GREEN)
200-210 °F (YELLOW)
210 °F (RED)

Oil Pressure:
40 psi (RED)
40-80 psi (YELLOW)
80-105 psi (GREEN)
105 psi (RED)

Vacuum Suction:
4.25-6.0 inHg (GREEN)

Main Fuel Quantity:
132.5/130.0 gal (795/780 lbs) (MAXIMUM)
0-25 gal (0-150 lbs) (YELLOW)

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

Vacuum Suction:
4.5-6.0 inHg (GREEN)

Propeller Ammeter:
0-30 amps

Airspeed Indicator:
SEE V-SPEEDS

Abnormal & Emergency Checklists (A36TP Turboprop)

Engine Fire (Ground)

Condition Lever	Cut-Off
Ignition	Off
Fuel Selector	Off
Starter	On for 30s
Observe	If fire continues...
Battery Master	Off

Engine Failure (Takeoff)

Power Lever	Full Reverse
Braking	Maximum
Fuel Selector	Off
Generator	Off
Standby Alternator	Off
Battery Master	Off

Engine Failure (In Flight)

Airspeed	115 kts
Fuel Selector	Opposite Tank
Firewall Fuel Shutoff	Open (Push)
Fuel Pump 2	On
Fuel Pressure	5 PSI Minimum
If No Pressure...	Fuel Pump 1 On
Airspeed	100-190 kts
Altitude	Below 20,000 FT
Ignition	On
Starter	On
Gas Generator	12% Minimum
Condition Lever	On
ITT	Less than 1090C
Starter	Off at 52% Ng
Ignition	Auto
Engine Instruments	Check
Generator	On
Generator Load	Below 60A in 2min
Bus Volts	28V
Engine Power	If Not Restored...
Power Lever	Idle
Propeller	Feather
Fuel Selector	Off
Firewall Fuel Shutoff	Closed (Pull)
Fuel Pumps	Off
Generator	Off
Standby Alternator	Off
Ignition	Off
Favorable Landing Site	Select

Starter Does Not Disengage

Generator	Off
Battery Master	Off
Condition Lever	Cut-Off

Engine Clearing

Propeller	Feather
Condition Lever	Cut-Off
Power Lever	Idle
Ignition	Off
Starter	On for 30s

Engine Fire (Flight)

Firewall Valve	Close (Pull)
Firewall Fuel Shutoff	Closed (Pull)
Power Lever	Idle
Propeller	Feather
Fuel Selector	Off
Firewall Fuel Shutoff	Closed (Pull)
Fuel Pumps	Off
Generator	Off
Standby Alternator	Off
Ignition	Off
Favorable Landing Site	Select
Battery Master	Off

Emergency Descent

Power Lever	Idle
Propeller	High RPM
Landing Gear	Down
Flaps	Approach
Airspeed	154 kts

Maximum Glide

Landing Gear	Up
Flaps	Up
Propeller	Feather
Airspeed	115 kts
Air Conditioning	Off
Nonessential Equipment	Off

Electrical Smoke or Fire

Firewall Valve	Close (Pull)
Generator	Off
Standby Alternator	Off
Battery Master	Off
Windows	Open
Avionics	Off
Air Conditioning	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

Carbon Monoxide Detected

Firewall Valve	Close (Pull)
Cabin Air & Heat	Close (Push)
CO Detector	Reset
CO Alarm	If Persists…
Power Lever	Idle
Propeller	Feather
Condition Lever	Cut-Off
Windows	Open
Cabin Air	Full Open
Firewall Fuel Shutoff	Closed (Pull)
Nonessential Equipment	Off

LOW VOLTS Annun

System Amps	Verify No Load
Gen Control Breaker	Check
Generator Reset	Press & Release
System Amps	If No Load...
Stby Alt Breakers	Check
Standby Alternator	Reset
System Amps	If No Load...
Bus Volts	If Under 23V...
Low Volts Annun	If Illuminated...
Nonessential Equipment	Off
Land	As Soon as Practical

Gen Failure (STBY ALT Annun)

System Amps	Verify Flashing
Generator Reset	Press & Release
System Amps	If Flashing...
Gen Control Breaker	Check
Generator Reset	Press & Release
STBY ALT Annun	If Illuminated...
Bus Volts	If Under 23V...
Low Volts Annun	If Illuminated...
Nonessential Equipment	Off
Land	As Soon as Practical

Fuel Control Failure

Observe	If Producing Power...
Manual Override	Engage
Power Lever	Exercise
If Control	Is Not Restored...
Land	As Soon as Practical
When Landing	Assured...
Power Lever	Idle
Propeller	Feather
Fuel Selector	Off
Firewall Fuel Shutoff	Closed (Pull)
Fuel Pumps	Off
Generator	Off
Standby Alternator	Off
Ignition	Off

Engine Surges

Power Lever	Reduce
Observe	If Surging is Severe...
Power Lever	Idle
Land	As Soon as Practical.

CHIP DETECTOR Annun Illuminated

Possible Engine Failure	Anticipate
Power Lever	Reduce
Land	As Soon as Practical

Low Fuel Pressure

Fuel Pump 2	On
Fuel Selector	Check Position
Fuel Quantities	Check
Fuel Pressure	If Still Low...
Possible Engine Failure	Anticipate
Power Lever	Reduce
Land	As Soon as Practical

Prop Governor Failure

Power Lever	Reduce
Oil Pressure	Check
Exercise Propeller	If No Control...
Airspeed	Reduce
Power Lever	To Maintain RPM
Land	As Soon as Practical

Instrument Air Failure

GYRO WARN	If Illuminated...
Standby Gyro Pump	On
STBY GYRO P Annun	If Extinguished...
Standby Gyro Breaker	Push On
STBY GYRO P Annun	Illuminated
Instrument Air	Green

Severe Icing Encounter

Ice Deflector	On
Ignition	On
Ice Protection	All On
Ice Build-Up	Monitor
Propeller	High RPM
Cabin Air & Heat	On Maximum
Defroster	On Maximum
Oil Door	Closed (Pull)

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

CABIN DOOR Annun Illuminated

Door Handle	Check
Airspeed	Reduce
Increased Drag	Anticipate
Land	

Landing Gear Manual Extension

Airspeed	154 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

Power Lever	1200 FT-LBS
Propeller	HIGH RPM
Engine Instruments	Check
Landing Gear Up	No Rwy Remain
Flaps	Retract at 80kts

No Power Landing

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

Hardware Inputs & Outputs (A36TP Turboprop)

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.

NOTE: The following tables only contain the additional variables and events required to control the equipment installed in the Bonanza Professional Turboprop. All other variables and events can be found in the main “Hardware Inputs & Outputs” section of this manual, above.

Primary Control Variables

Description	Variable	Range
Condition Lever	B:FUEL_1_Condition_Lever_High_Idle B:FUEL_1_Condition_Lever_Cut_Off L:BKSQ_ConditionLever_1	Boolean
Ignition Switch	L:var_IgnitionSwitch	0 = ON, 2 = AUTO
Starter-Generator Switch	L:var_StarterGenSwitch	0 = GEN, 2 = START
Fuel Pump Switch	L:var_FuelPumpSwitch	0 = Pmp.1, 2= Pmp.2
Prop Heat Ground Test Button	L:var_PropHeatTest	Boolean
Propeller Governor Test Button	L:var_propGovTestButton	Boolean
Generator Reset Button	L:var_GeneratorResetButton	Boolean
Oil Cooler Door Pull Handle	L:var_OilDoorHandle	0 - 100
Ice Deflector Switch	L:var_IceDeflectorSwitch	Boolean
Fire Detector Test	L:var_FireDetectorTestButton	Boolean
Manual Override Switch Cover	L:var_FuelControlManualOverride_Co ver	Boolean
Manual Override Switch	L:var_FuelControlManualOverride	0 = Inc., 2= Dec.
Firewall Fuel Cutoff Handle	L:var_FirewallFuelShutoffHandle	0 - 100

Environmental Control Variables

Description	Variable	Range
Door Seal Switch	L:var_DoorSealSwitch	Boolean
P3 Bleed Air Pull Handle	L:var_P3BleedHandle	0 - 100

ETM Engine Trend Monitor

Description	Variable or Event	Range
Mode Knob	L:var_EtmMode	0 - 3
Enter Button	H:Etm_EnterTest	
Record Button	H:Etm_Record	
Clock Reset Button	H:Etm_ClockReset	
Increase Switch	H:Etm_Inc	
Decrease Switch	H:Etm_Dec	
Page Up Switch	H:Etm_PageUp	
Page Down Switch	H:Etm_PageDown	
Clock Start Switch	H:Etm_ClockStart	
Clock Stop Switch	H:Etm_ClockStop	

Outputs

NOTE: The following tables only contain the additional variables and events required to control the equipment installed in the Bonanza Professional Turboprop. All other variables and events can be found in the “Hardware Inputs & Outputs” section of this manual, above.

Aircraft & Engine Variables

Description	**Variable**	**Units**
Propeller Torque	L:BKSQ_TQ	Number (FT-LBS)
Interstage Turbine Temperature	L:BKSQ_ITT	Number (°C)
Gas Generator RPM	L:BKSQ_NG	Number (%)
Propeller RPM	L:BKSQ_PROP_RPM_1	RPM
Oil Temperature	L:BKSQ_OIL_TEMP_1	FAHRENHEIT
Oil Pressure	A:ENG OIL PRESSURE:1	PSI
Fuel Flow	L:BKSQ_FuelFlow	Number (GPH)
Fuel Pressure	L:BKSQ_FuelPressure	PSI

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 BonanzaProfessional_Turbine_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 “GSATurbine_LowBusVolts”, therefore…

The low voltage annunciator L:Var is (L:var_**GSATurbine_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 Bonanza 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.

How do I set the vertical speed of the aircraft?

This aircraft is equipped with a Century IV autopilot, which **controls the pitch of the aircraft directly, rather than the vertical speed** of the aircraft. The desired pitch of the aircraft is set with the motorized pitch knob on the autopilot control panel, or with the clickspot on the right of the altitude selector. For more information, see the Century IV Autopilot section of this manual.

Why can't I enable the autopilot?

This aircraft has a toggle switch that controls power to the autopilot servo motors. Make sure the toggle switch to the right of the cockpit lighting dimmers, labeled **"PITCH TRIM" is in the on position**. Additionally, check the "PITCH TRIM" circuit breaker on the copilot's upper side panel to make sure power is available to the autopilot servo motors.

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

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

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

Make sure you have the Falcon71 KLN-90B installed properly in your community folder. **The free addon can be obtained for free from the following link**.

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

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

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

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

Can the autopilot track 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 do screens flicker at night when adjusting lighting intensity?

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

Why does 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.

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.

Is beta range simulated? (A36TP Turboprop Specific)

Yes! An accurate beta range is now fully simulated across the Black Square turbine aircraft family and **incorporated into the bottom 15% of forward throttle input travel**. Users who do not create virtual detents or have physical detents on their hardware peripherals will be using beta range anytime their throttle is below 15% See the "Beta Range" section of this manual for more information on beta range and the new turboprop engine simulation.

Why does it take so much power to get the aircraft moving? (A36TP Turboprop Specific)

The aircraft will begin moving on level ground as soon as the power lever is out of the beta range (15% throttle input). As this implementation of beta range may differ from other turboprop aircraft that you are used to flying, it may appear as if significantly more power is required to get the aircraft moving, when **in reality, you're just advancing the power lever through the beta** range, where almost no thrust is produced. For more information on the realistic beta range implementation in this aircraft, see the "Beta Range" section of this manual.

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

Bonanza 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

It takes a village to raise a child, and probably a small city to raise an engineer in our time of ever increasing specialization. I would like to dedicate this product to two mentors who played a significant role in making me who I am today: Jim Kamosky, and Fred Looft. Jim has worn many hats in life, touching lives with his endless selflessness wherever he goes. He was the best science teacher a young man could hope to have. His status as a renaissance man of science provided countless hours of practical stories for his students, and he was never short on time to celebrate my successes and encourage me on my personal projects. Fred played a similar role for me at university, as I pursued a very ambitious project in unmanned aviation. Fred gave me an incredible amount of freedom to essentially run a startup company from his laboratory with a team of 16 like-minded students. Being a fellow aviator, Fred shared my passion for flying machines, though he was always trying to convert me into a sailplane pilot. I hope this small message of gratitude towards these two role models can provide the illusive satisfaction of knowing what a memorable impact they had on so many of their students’ lives.

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

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