Black Square

ANALOG BONANZA

OPERATIONS MANUAL

For Microsoft Flight Simulator

Published By:
Just Flight

Black Square

"Virtual Aircraft. Real Engineering."

Analog Bonanza 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.

Contents

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. This particular model of Bonanza depicts the stretched and improved “A36” model of the mid-2000’s with a 300 hp engine, and the 2001 “A36TC” with an aftermarket turbonormalizing package. Though the A36 model lacks the distinctive V-Tail that made the Bonanza so recognizable to the general public, the redesign improved the instrument panel, control positions, cruise flight characteristics, and helped ensure the airframe’s longevity.

Black Square’s Analog Bonanza brings you a completely new interior, panel, and systems with the default MSFS G36 Bonanza exterior model, including added tip tanks. This product contains both normally aspirated (A36), and turbocharged (A36TC) aircraft with an advanced reciprocating engine simulation, and features analog instrumentation, swappable radio configurations, an overhauled electrical system with every circuit breaker, meter, switch, and knob functioning. Black Square’s failure system allows for persistent wear, MTBF, and scheduled failures for nearly every component in the aircraft, many with multiple different failure modes. The fully 3D gauges are modeled and coded to meticulously match their real world counterparts, with reference to real world manuals. No piece of equipment appears in a Black Square aircraft without a real world unit as reference. Radionavigation systems are available from several eras of the Bonanza’s history, so users can fly without GPS via a Bendix KNS-81 RNAV system, or with the convenience of a Garmin GTN 750 (PMS50 or TDS). Other radio equipment includes KX-155 NAV/COM radios, GNS 530, GNS 430, KR 87 ADF, KDI 572 DME, GTX 327 Transponder, KFC 150 Autopilot, and a Bendix RDR1150XL Color Weather Radar. A nearly 100 page manual provides instruction on all equipment, and 38 in-game checklists with control/instrument highlighting are included for normal and emergency procedures.

Primarily analog instrumentation augmented with modern radionavigation equipment 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. You also may find the analog instrumentation much easier to read with the limited number of pixels available on a computer monitor, and even more so in VR.

NOTE: **This product is an INTERIOR AND SYSTEMS OVERHAUL ONLY that makes use of the default MSFS Bonanza exterior visual model.** Improvements have been made to almost all aspects of the aircraft, **except** the visual appearance of the exterior. All default Bonanza liveries are compatible with this product.

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

Feature Overview

Systems

Black Square's overhauled cockpits with analog instrumentation go far beyond a visual upgrade. Included, you will find a complete redesign of all aircraft systems to more closely match the real aircraft, with a focus on electrical systems. Also included are more accurate weight and balance, lighting systems, flight dynamics, and ground handling. Enjoy features, like…

- Reciprocating engine simulation with fouling, vapor-lock, flooding, and backfires
- The most realistic turbocharger simulation in Microsoft Flight Simulator to date
- Completely intractable electrical system with 4 buses and 70 circuits
- Engine leaning optimization "Lean Find" on EDM-800 engine monitor, and status alarms
- Engine limit excursions that decrease engine health and will eventually lead to failure
- Gyroscope physics simulation for electric and pneumatic gyroscopes with precession, partial failures, based on a coupled quadrature oscillator
- State saving for fuel, radio selection, radio frequency memory, cabin aesthetics, etc.
- 80+ system failures, set via in-cockpit interface. Either random based on settable MTBF, or schedulable, with optional time acceleration.
- Cabin environmental control system for heating, air conditioning, ventilation, ram air cooling. Cool things off by opening a window, or watch the airplane heat up in the sun.
- Crew/Passenger oxygen system that depletes according to pressure altitude, passenger occupancy, and their weight. Working carbon monoxide detector.
- Standby alternator and gyro logic, switches, and working air conditioner condenser door
- Mathematically accurate VOR & ADF signal attenuation and noise, and remote compass

Checklists

Over 350 checklist items are provided for 35+ Normal, Abnormal, and Emergency procedures in textual form in the manual, and in-game, using the MSFS native checklist system with control and instrument highlighting. If it's in the checklist, it's settable in the aircraft!

Sounds

Black Square's Analog Bonanza features the default MSFS-native (Wwise) 3D G36 Bonanza sound package, many new handmade sounds added for warnings, environmental control systems, electronics, and more. The default sounds have been carefully assigned to all interactable cockpit elements for an authentic 3D spatial audio experience, and engine sounds have been integrated with Black Square's piston engine simulation.

Model

- Accurately modeled A36 and A36TC Bonanza interior ONLY (uses default exterior model), created from hundreds of reference photos and technical documentation.

- 100% MSFS native animation code for the smoothest animations and cockpit interactions using either legacy or new cockpit interaction modes

- 4096x4096 (4K) PBR (Physically Based Rendering) materials with real-time environment reflections for superb quality and realism, and vector-graphic-like decal quality.

- Detailed normal mapping for leather, fabric, plastic, stitches, scratches, carpet, and tooling marks, resulting in a texture resolution of 10,000 pixels per square inch (90.0kB)

Cockpit

- Greatly enhanced instrument panel detail compared to default aircraft with every label and marking in its place. If it appears in the real aircraft, you can interact with it!

- Custom coded steam gauges with lowpass filtering, needle bounce, and physics provide ultra-realistic and silky smooth animations like you've never seen before.

- Carefully modeled components match the depth and character of the real instrumentation, based on reference photos, schematics, and real world measurements. Unlike other expensive Flight Sim aircraft, every piece of equipment that appears in a Black Square aircraft is modeled after a real piece of aircraft equipment, and will behave the same way in its primary functionality.

- Every knob, switch, and button is interactable and implemented, along with its respective electrical circuitry. Turn systems on and off or pull circuit breakers to see the impact it has on your generators and battery via the analog meters. Automatic standby generators, and standby gyros are also simulated. Many pieces of equipment respond correctly to electrical configurations with warning messages and diagnostic codes.

- Fully 3D cockpit lighting technology for every gauge and panel, with ambient bounce lighting, and all lights dim with battery voltage and load, an immediately recognizable effect to nighttime pilots. Strobe lights now cause disorienting light bounce in clouds.

- 4096x4096 (4K) PBR textures on cockpit and panel for crisp instrumentation. Even see the fingerprints on instrument glass!

- Hideable yokes, adjustable sun visors, and other cockpit aesthetics

Flight Dynamics

The Analog Bonanza features an improved flight model compared to the default Bonanza with tweaks based on operator feedback and real flight data. The flight model uses the most up to date features available in MSFS, such as CFD propeller and stall physics, and improved ground handling. Drag varies with cowl flap setting and air conditioning condenser scoop position. Engine damage and fouling produces a rough running engine and decreased performance.

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) [with Tip Tanks]

Maximum Cruising Speed	176 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 [1,040 nm]
Maximum Range	920 nm [1,335 nm]
Rate of Climb	1,230 ft/min
Service Ceiling	18,500 ft
Empty Weight	2,145 lbs [2,175 lbs]
Max Ramp Weight	3,650 lbs [3,840 lbs]
Max Takeoff Weight	3,600 lbs [3,790 lbs]
Max Landing Weight	3,600 lbs [3,790 lbs]
Useful Load	1,455 lbs [1,615 lbs]
Usable Fuel Weight	445 lbs [625 lbs]
Full Fuel Payload	1,010 lbs [965 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	692 nm [1,005 nm]
Maximum Range	885 nm [1,280 nm]
Rate of Climb	1,660 ft/min
Service Ceiling	25,000 ft
Empty Weight	2,185 lbs [2,215 lbs]
Max Ramp Weight	4,080 lbs
Max Takeoff Weight	4,030 lbs
Max Landing Weight	4,030 lbs
Useful Load	1,845 lbs [1,815 lbs]
Usable Fuel Weight	625 lbs [805 lbs]
Full Fuel Payload	1,155 lbs [975 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.

Paint Schemes

The Analog Bonanza comes with four additional color schemes in the default paint layout to distinguish it from the always available default G36 Bonanza in aircraft selection menus, and screenshots; however, any number of additional liveries may be adapted for the Analog Bonanza, and require zero changes to make liveries intended for the default G36 Bonanza compatible with the Analog Bonanza. For instructions on how to use your favorite default G36 Bonanza liveries with the Analog Bonanza, see the “Liveries” section of this manual. Note: Default paint schemes for the Analog Bonanza can implement any tail number, which will be displayed on the interior and exterior of the aircraft.

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 (Com1) (PMS50 or TDS)
- Garmin GNS 530W (Com1)
- Garmin GNS 430W (Com2)
- Bendix/King KX-155B (Com1/Nav1)
- Bendix/King KX-155B (Com2/Nav2)
- 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
- 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, 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.

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 ‘Analog Bonanza’.
4. The Analog Bonanza is available in three configurations, which appear separately in the aircraft selection menu. They are: Normally Aspirated with no Tip Tanks (same as default G36), Normally Aspirated with Tip Tanks, and Turbonormalized with Tip Tanks.
5. 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 & Exterior Mods

Black Square's Analog Bonanza comes with four complimentary paint colors (Maroon Red, Forest Green, Burnt Orange, and Sandpiper Blue) in the same scheme as the default aircraft, just to help differentiate the two in menus and screenshots. You may adorn these liveries with whatever tail numbers you wish through the default aircraft configuration menu. You may also add more liveries to the Analog Bonanza as mod packages the same way you would add them for any other aircraft.

Compatibility

Since the Black Square Analog Bonanza makes use of the default Bonanza's exterior model, all liveries for the default Bonanza are also compatible with the Analog Bonanza; however, keep in mind that "livery" mods that change the interior features of the default Bonanza, such as seats or panel color, will not have an effect on the Analog Bonanza, since it uses a completely different interior model.

Example Livery Package

An example addon livery mod exists within the file structure of the Analog Bonanza in your Community Folder. If you don't know how to locate your MSFS Community Folder, please refer to the installation section of this manual for step-by-step instructions. Once you have located your Community Folder where the Analog Bonanza is installed, navigate to…

bksq-aircraft-analogbonanza\SimObjects\Airplanes

Within the above folder, you will find **"bksq-aircraft-analogbonanza-livery-example"**. This folder contains everything you need to create a livery mod for the Analog Bonanza. Inside it, you will find an **aircraft.cfg**, which defines how your livery will appear in the aircraft selection menu, and several other features. There is also the **"TEXTURE.LiveryExample"** folder. Within this folder, you will find only a **texture.cfg** file for now. Continue to the next section for how to implement this file structure to create your own livery mod for the Analog Bonanza.

Installation

1. Although liveries for the default Bonanza are fully compatible with the Analog Bonanza, each livery must have its own package inside the Community Folder for each aircraft. Luckily, the Analog Bonanza's livery mod only needs to be a reference to the default livery mod, and none of the textures need to be copied.

2. Begin by creating a new folder in your Community Folder. Name it something like, **"bksq-aircraft-analogbonanza-mylivery"**. Within this folder, make another folder named **"SimObjects"**. Within this folder, make another folder named **"Airplanes"**. Within this folder, make yet another folder with the same name as the first,

“bksq-aircraft-analogbonanza-mylivery”. (We don’t make the rules around here, we just follow them.) Lastly, make yet another folder with the name, **“TEXTURE.mylivery”**, where mylivery matches the unique name you’ve decided to give your livery.

3. Copy the **aircraft.cfg** file from the example livery mod we located above into the SECOND **“bksq-aircraft-analogbonanza-mylivery”** folder (it should be the second to last folder you made). Next, copy the **texture.cfg** file from the example livery mod we located above into the **TEXTURE.mylivery** folder (it should be the last folder you made).

4. Open the **aircraft.cfg** file in a text editor, and rename all occurrences of **“Livery Example“** to a name of your choosing for your livery mod. Leave everything else unchanged, unless you know what you’re doing.

5. Open the **texture.cfg** file in a text editor, and follow the instructions to rename the two occurrences of **“LIVERYNAME“** in the file to match the livery for the default Grand Bonanza that you would like to use with the Analog Bonanza. The provided example is for a popular livery mod for a popular cargo hauler:

   fallback.2=..\..\Asobo_Bonanza_G36-FEDBEXFEEDER\TEXTURE.FEDBEXFEEDER

6. Lastly, you will want to copy the two thumbnail images from the livery you wish you use with the Analog Bonanza into the **TEXTURE.mylivery** folder. They should be named, **“thumbnail.JPG”**, and **“thumbnail_small.JPG”**. This step is not necessary to use the livery, but helps in identifying it within the aircraft selection menu.

7. Finally, download the MSFS Layout Generator by going to the following link, and clicking the **“MSFSLayoutGenerator.exe”** in the latest release at the top of the page. You may have to expand the “Assets” menu in the top section of the page. Do not download anything labeled “Source Code”.

   https://github.com/HughesMDflyer4/MSFSLayoutGenerator/releases

8. Once you have moved the Layout Generator to somewhere on your computer, like your desktop, create two final files in the top most directory of your livery mod, in the FIRST **bksq-aircraft-analogbonanza-mylivery** folder. The files should be plain text files, created in Windows by right clicking within the empty space in a folder, hovering over “New”, and then clicking, “Text Document”. Rename one of these text files to **layout.json**, and the other to **manifest.json**. Copy the following text from this document and paste it into the **manifest.json** file, replacing “mylivery” with your unique livery name.

```
{
 "dependencies": [],
  "content_type": "LIVERY",
  "title": "aircraft-analogbonanza-livery-mylivery",
  "manufacturer": "",
  "creator": "Black Square",
  "package_version": "0.1.0",
```

```
        "minimum_game_version": "1.24.2",
        "release_notes": {
                "neutral": {
                "LastUpdate": "",
                "OlderHistory": ""
                }
        },
        "total_package_size": "00000000000010000000"
}
```

9. The final step is dragging your **layout.json** file on top of the **"MSFSLayoutGenerator.exe"** executable. This will run without any graphical interface, and should populate your **layout.json** with content. Take a look in the file to see if there is text, but do not edit anything.

If you have done everything correctly, your file structure should look like this:

- **bksq-aircraft-analogbonanza-mylivery**
    - layout.json
    - manifest.json
    - **SimObjects**
        - **Airplanes**
            - **bksq-aircraft-analogbonanza-mylivery**
                - aircraft.cfg
                - **TEXTURE.mylivery**
                    - texture.cfg
                    - thumbnail.JPG
                    - thumbnail_small.JPG

This seems like a lot of work to make a simple reference to an already existing livery mod for another aircraft, but once you have done it once and created the file structure, or once you have copied the structure from someone else's mod, it will be extremely easy to make as many new Analog Bonanza liveries as you like.

Alternatively: Once a livery mod has been created for the Analog Bonanza and shared with the community, making your own livery mod should be as easy as pasting in your new textures, changing the aircraft name in aircraft.cfg, and renaming the texture folder in texture.cfg and aircraft.cfg.

Cockpit & System Guide

Main Panel

Annunciator Panel

The Analog Bonanza'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 Analog Bonanza’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.

Vertical Speed Indicator

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

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.

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. To adjust which configuration you're flying with, use the knobs or switches on the right-hand side of the main panel, adjacent to the co-pilot's yoke bearing to select your preferred radio for Com1/Nav1, and Com2/Nav2. It might be easier to hide the co-pilot's yoke while making these selections. The radio selection will be automatically saved and reloaded at the start of a new flight.

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 (Com1)

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 and TDS GTNxi 750 products are supported.** The aircraft will automatically switch between the installed software with no required user action.

It is now possible to manually switch between PMS and TDS products while the aircraft is loaded. Click on the blue memory card on the left of the unit's bezel.

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 indicator light must be illuminated on the GMA 340 Audio panel.

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.

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.

The “R” designation of this unit is of fictional nature to indicate that it possesses an additional switch position for viewing RNAV DME information from the KNS-81. When the rotary selector switch is placed in the RNAV position, “RNV” will annunciate to the right of the distance information. In normal operation, the unit will display DME information from the KNS-81, just like any other DME source. When the “RAD” two-position button is depressed on the KNS-81, however, the time (MIN) field will read “F”, for “From”, to indicate that the speed field (KT) is displaying the radial FROM the waypoint or VOR upon which the aircraft currently sits. When is radial mode, the “KT” and “MIN” annunciators will not be illuminated.

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 Analog Bonanza's 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. Pressing the "VS ENG" push button will engage vertical speed hold mode, either maintaining the aircraft's current vertical speed, or attempting to achieve one that has been set in the KAS 297B. Pressing the "ALT ARM" button will engage vertical speed mode and attempt to capture the altitude set in the KAS 297B. 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.

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.

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 Analog Bonanza'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. 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. 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, or whenever required by the software. 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 "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.

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. 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, and fully equalized by ram air cooling, so long as the airspeed of the aircraft is great enough. 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 can be increased by placing the "VENT BLOWER" switch in the on position, by turning the "A/C BLOWER" switch in either the "LO" or "HI" positions when the air conditioning is on, or by opening the cabin vents. The forward cabin vents are opened by rotating the metal "FRESH AIR" knob on the overhead panel in the counterclockwise direction. The rear cabin air vents can be opened by pulling the "AFT CABIN" pull knob under the pilot's subpanel out. 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.

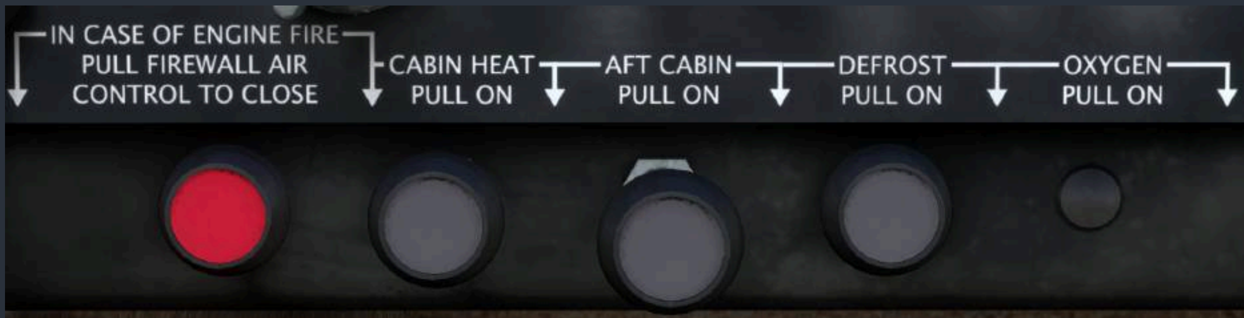
Cabin Temperature Monitoring

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 to the right of the EDM-800 engine monitor, will display temperatures from -99° to 999° Celsius, or Fahrenheit, toggleable with the small blue push button. Backlighting for this instrument is dimmed via the “ENG INST AVIONICS” light dimmer, along with the other avionics backlighting. In addition to this LCD display, two small LED’s are located to the left of 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.

Cabin Environmental Controls

Unlike more complex aircraft with automatic environmental control systems, heating and cooling of the Analog Bonanza 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 “A/C BLOWER” switch must also be placed in the “HI” or “LO” position, the engine must be running, and the air conditioning condenser must be deployed. From here, opening and closing the cabin vents to varying degrees can be used to maintain the desired temperature. The air conditioning blower will automatically turn off when the landing gear is retracted.

The cabin is heated via a heat exchanger on the engine’s exhaust manifold, and funneled to the cabin via the “CABIN HEAT” pull knob under the pilot’s subpanel. The exchanged air can be very hot, so operators should take caution when applying the cabin heat to reduce pilot workload during critical phases of flight, and also to limit the possibility of a cabin fire. The rate of heating is controlled via the cabin vents and blowers, as with equalization and air conditioning. Should an engine fire or other anomaly occur that necessitates the closing of the firewall air control valve, heating air will no longer be available.



NOTE: The Bonanza is equipped with a relatively unique air conditioning condenser system. The air conditioning condenser's air flow scoop, or “A/C Door” can be extended and retracted electromechanically. 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. On the glareshield annunciator panel, there is an annunciator marked “AC DOOR EXTEND” to indicate when the air conditioning condenser door is fully extended into the ground operation. 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's flow 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.

NOTE: While the Analog Bonanza 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. 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.

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 to manage the turbocharged variant, as this is the first fully simulated turbocharger in MSFS.

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 on high 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 cycled 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 on high 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.

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. If the charge rate exceeds 10A, heat will slowly build up in the battery circuitry. If 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 Analog Bonanza is equipped with propeller deicing, pitot heat, and windshield defrosters. As the Analog Bonanza 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.

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, and the Working Title GNS 530/430. 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.

While existing Black Square aircraft have required an update to be fully compatible with some of these new products, the Analog Bonanza should be fully compatible with these products upon release. 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.

NOTE: It is now possible to manually switch between PMS and TDS products while the aircraft is loaded. Click on the blue memory card on the left of the unit’s bezel.

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 Analog Bonanza.

Realistic Strobe Light Bounce

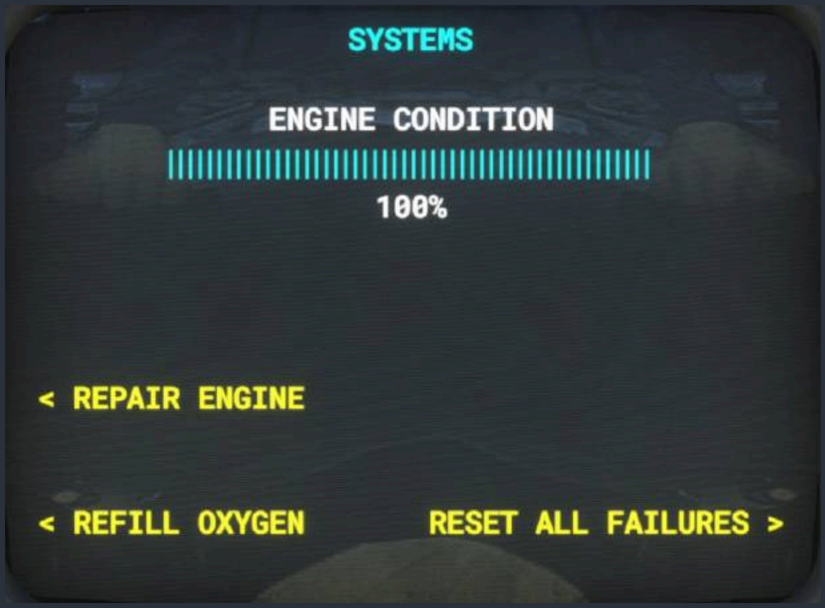
Most light aircraft possess a placard somewhere in the cockpit containing the warning, “turn off strobe lights when operating in clouds or low visibility.” While this message may appear a polite suggestion, real world pilots who have ignored this advice will have experienced the disorienting effects 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.

Failure Configuration & System Status

This aircraft is equipped with an underlying software system that is capable of triggering a failure of almost any simulated aircraft system, either by random, or at a scheduled time. An interface for configuring failure settings, resetting failures, or monitoring active failures is provided in the "NAV" and "LOG" modes of the in-panel weather radar. A list of all possible failures is provided below. Failures are saved between flights, leaving you to discover what has failed during your checklists.

Systems Screen

To access the "SYSTEMS" menu, rotate the mode knob on the weather radar to "NAV". On the screen shown, you will be presented with a segmented bar graph indicating the current engine condition, and several options. Using the keys on the weather radar bezel indicated by the YELLOW text and accompanying arrows, you can repair the engine, resetting its condition to 100%, refill the oxygen system, or reset all failures. Resetting all currently active failures will return the aircraft to a state with no failures and all systems functioning normally.



Failures Screen

To access the "FAILURES" menu, rotate the mode knob on the weather radar to "LOG". On the screen shown, you will be presented with a segmented bar graph indicating the current global failure rate as a multiplier of real-time. You may increase or decrease the global failure rate by powers of two with the keys on the weather radar bezel as indicated in YELLOW on the screen. The maximum allowable multiplier is 1024x. Random failures can be completely disabled by pressing the indicated decrease key until the global failure rate indicates "NO FAILURES". The global failure rate multiplies the probability of random failures occurring while in "RANDOM" failure mode based on their selected Mean Time Between Failure (MTBF). For Example, if a specific failure is expected to occur once in every 5,000 hrs of simulated flight time, a global failure rate of 1024x, will result in this failure occurring roughly once in every 5 hrs of simulated flight time instead. Settings between 8x and 32x are recommended to add a little excitement to your virtual flying experience, as many hundreds of hours can be flown a 1x real-time failures without encountering a single failure, while settings above 256x almost guarantee multiple failures per flight.

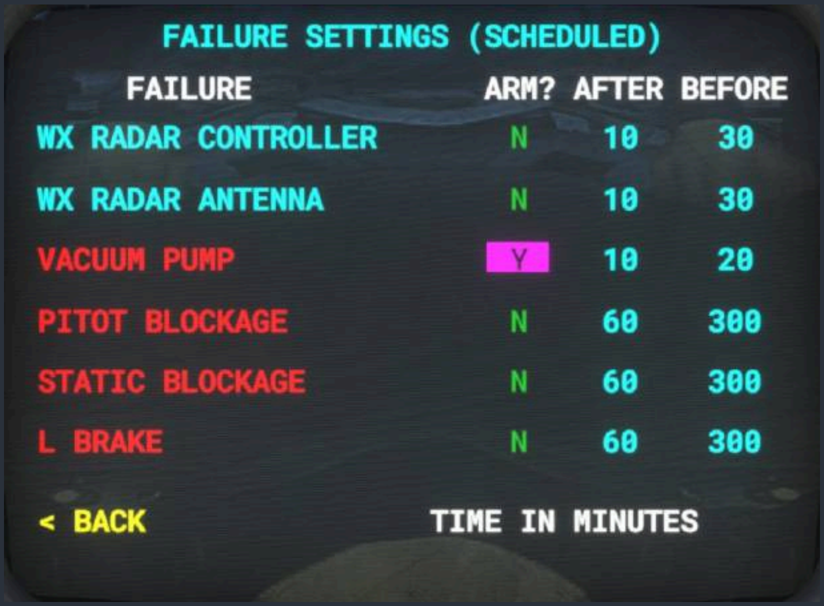
From the failures page, one can also toggle between “RANDOM” and “SCHEDULED” failure modes. (currently active mode is indicated in MAGENTA) All failure settings can be reset to defaults from this page, for which a confirmation warning message will be displayed. Confirming the reset will return all MTBF times to system specific default values, return all scheduled failure times to default, and disable any currently armed scheduled failures. Any currently active failures can be viewed by navigating to the “ACTIVE FAILURES” page, and failures can be configured via the “DETAILED SETTINGS”. The detailed settings page is context sensitive, and will be different depending on whether the failure system is currently in random or scheduled mode.

Random Failures Screen

From the random failures screen, one can set custom failure probabilities in the form of Mean Time Between Failure (MTBF) 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. Upon loading the aircraft for the first time, default values will be displayed for each system, which are representative of their real world counterparts. These values can be modified by navigating to a failure using the “RNG” up and down keys on the weather radar bezel, and the “TRK>” key to move the cursor over to the MTBF column. Further use of the “RNG” keys will adjust the MTBF. Use the “<TRK” key to return the cursor to the list of failures. Failures are color coded into groups. Magenta is used for catastrophic engine failures, red for major systems failures, white for electrical bus distribution failures, and cyan for circuit breaker protected systems failures. The minimum allowable MTBF is 100 hrs, and the maximum is 1,000,000 hrs.

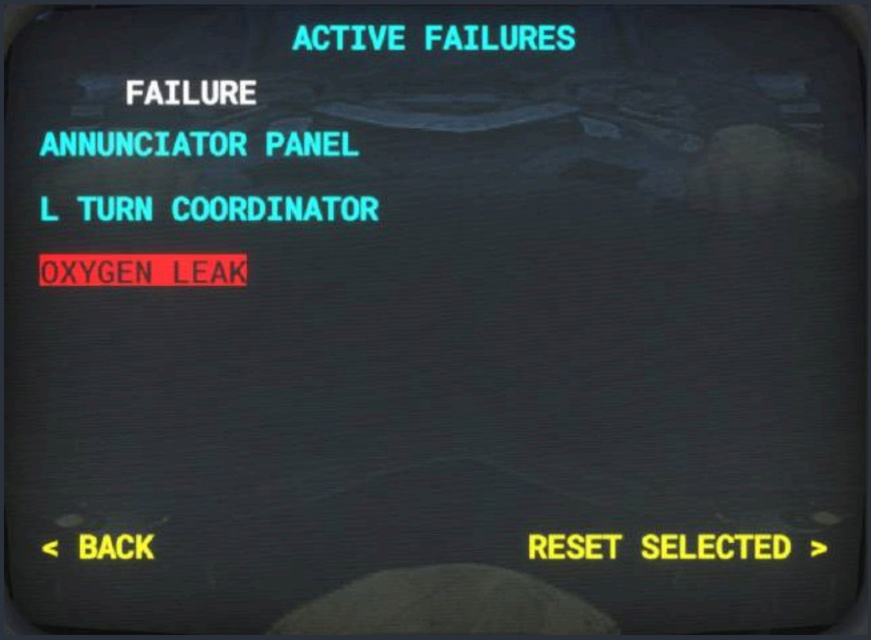
Scheduled Failures Screen

From the scheduled failures screen, individual failures can be scheduled to occur between specific times after the current time. Failures have a constant probability of occurring between the two times listed in minutes, and will only occur after the failure’s “ARM?” value has been set to “Y”. Upon loading the aircraft for the first time, default values will be displayed for each time. These times can be modified by navigating to a failure using the “RNG” up and down keys on the weather radar bezel, and the “TRK>” key to move the cursor over to the other columns. Scheduled failure times can then be adjusted with further use of the “RNG” up and down keys. The “ARM?” flag can be set with either the “RNG” up or down key. Use the “<TRK” key to return the cursor to the list of failures. Failures are color coded into groups. Magenta is used for catastrophic engine failures, red for major systems failures, white for electrical bus distribution failures, and cyan for circuit breaker protected systems failures. The minimum allowable time is 1 minute, and the maximum is 480 minutes, or 8 hours.



Active Failures Screen

From the active failures screen, one can scroll though a list of all active failures affecting the aircraft. Only failure names are displayed, and they can be scrolled through using the "RNG" up and down keys on the weather radar bezel. When the blinking cursor has a failure selected, pressing the "TRK>" key will reset the highlighted failure, returning the system to normal operation. Failures are colored in groups. Magenta is used for catastrophic engine failures, red for major systems failures, white for electrical bus distribution failures, and cyan for circuit breaker protected systems failures.



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
TURBOCHARGER (only present in turbocharged aircraft)

ALTERNATOR
VACUUM PUMP
VACUUM PUMP PARTIAL
PITOT BLOCKAGE
STATIC BLOCKAGE
L BRAKE
R BRAKE
OXYGEN LEAK
L FUEL LEAK
R FUEL LEAK
L TIP TANK LEAK
R TIP TANK LEAK
CO LEAK
CO DETECTOR
CONDENSER LIMIT SWITCH

Circuit 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
GEAR MONITOR
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
HSIDME
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

One of three Analog Bonanza configurations may be selected for flight from the main menu. They are: Normally Aspirated with no Tip Tanks (same as default G36), Normally Aspirated with Tip Tanks, and Turbonormalized with Tip Tanks. The tip fuel tanks add 30 U.S. Gallons of usable fuel to the Analog Bonanza 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 maximum ranges of over 1,200 nm for all versions.

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 Analog Bonanza without tip tanks, it is possible to create a mod, which will add this aircraft to your simulator. It has simply been omitted here to reduce clutter in the aircraft selection menu, and help differentiate the Analog Bonanza 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.

NOTE: 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

Radar Pod

Since the Steam Gauge Overhaul aircraft are all equipped with a weather radar which doubles as 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 Analog Baron, but single engine aircraft often have a radar pod mounted on the wing, such as on the Analog Caravan, and the Analog TBM. While not unheard of, radar pods on Bonanzas are unusual. For this reason, the radar pod is only visible on the turbocharged model of the Analog Bonanza. Any variant of the Analog Bonanza may be equipped with a radar pod using the LocalVar method described in the Tip Tanks section, above, using the variable: **BKSQ_RadarPod=1**.

Turbocharger Sound

For users who find the high-pitched whine of turbocharger annoying, the sound can be disabled while retaining the function of the turbocharger by setting **BKSQ_TurbochargerSound=0**, using the LocalVar method described above.

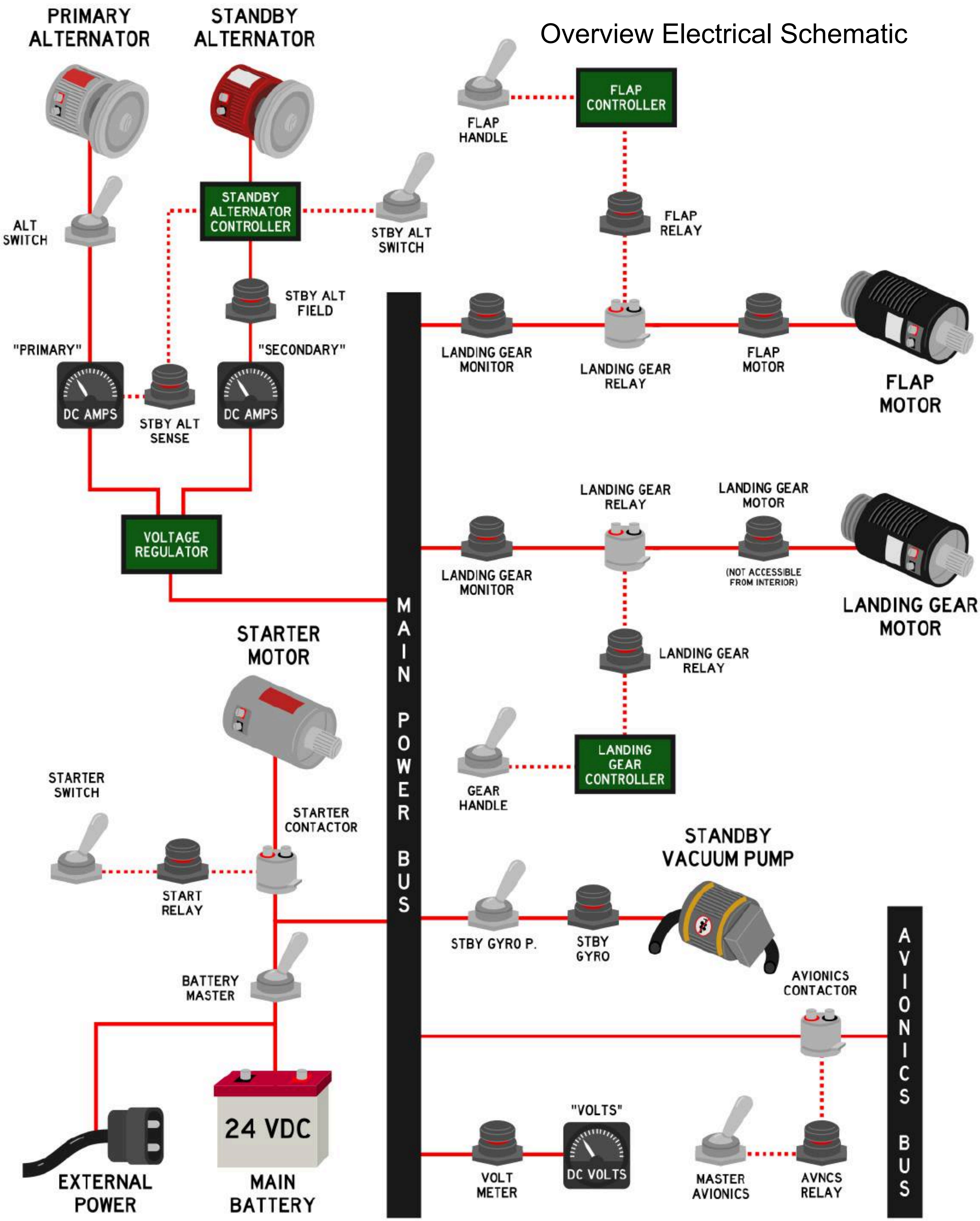
When the throttle is advanced too rapidly, or with cool oil, the wastegate may not react quickly enough to prevent an overboost condition. Should this occur, a pressure relief poppet valve will open, emitting an audible hissing sound.

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 future 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



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.

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.

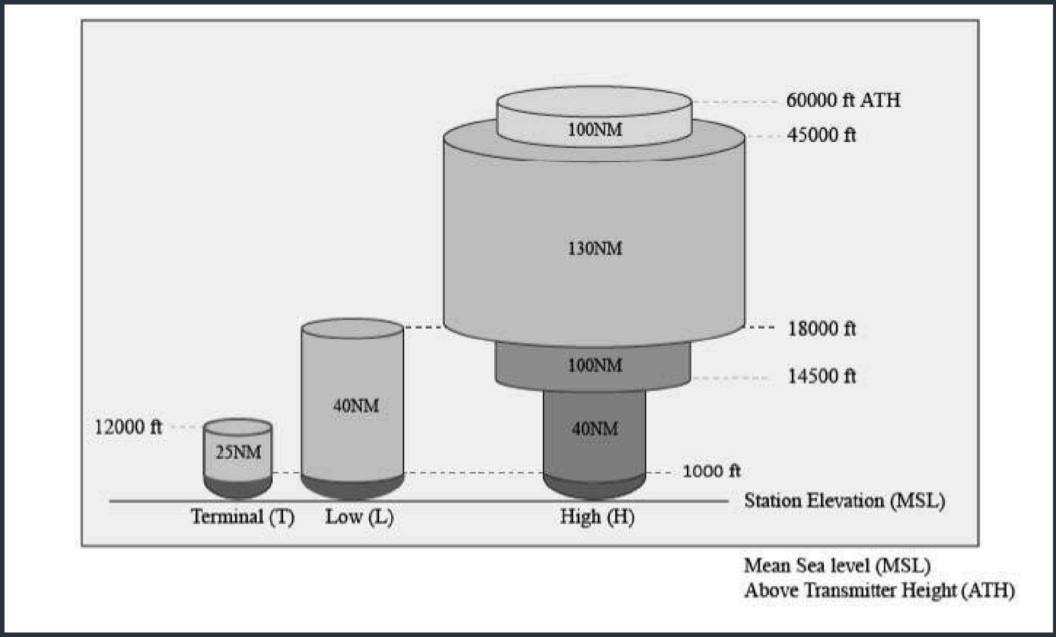
1. Locate the nearest VOR station to your desired destination, and its frequency, radial, and distance from the destination airport. While other station frequencies, radials, and distances can be found on approach, arrival, and departure charts, the easiest place to start is often with a mobile app or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

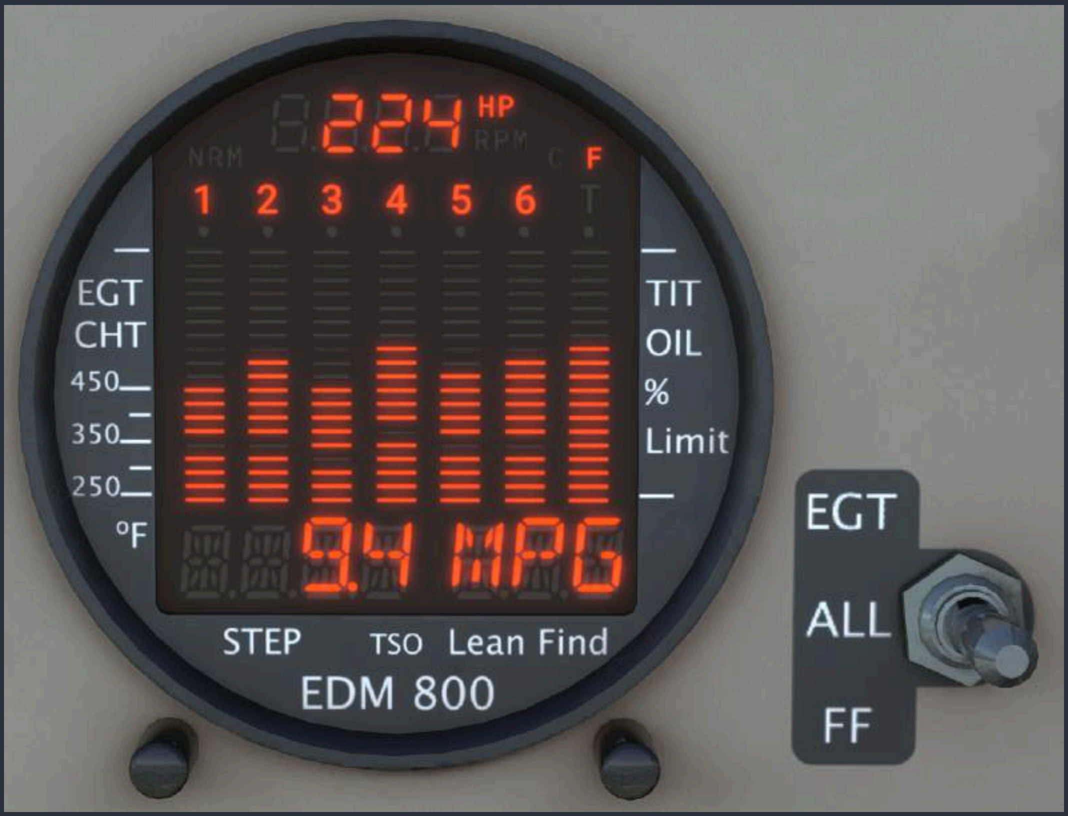
7. To fly directly to the displaced VOR waypoint at our destination airport, simply rotate the omni-bearing selector (OBS) or course (CRS) knob on your HSI, as you would to fly to a VOR, and follow the CDI needle with a TO indication. Countdown the distance and time remaining until arriving at your destination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



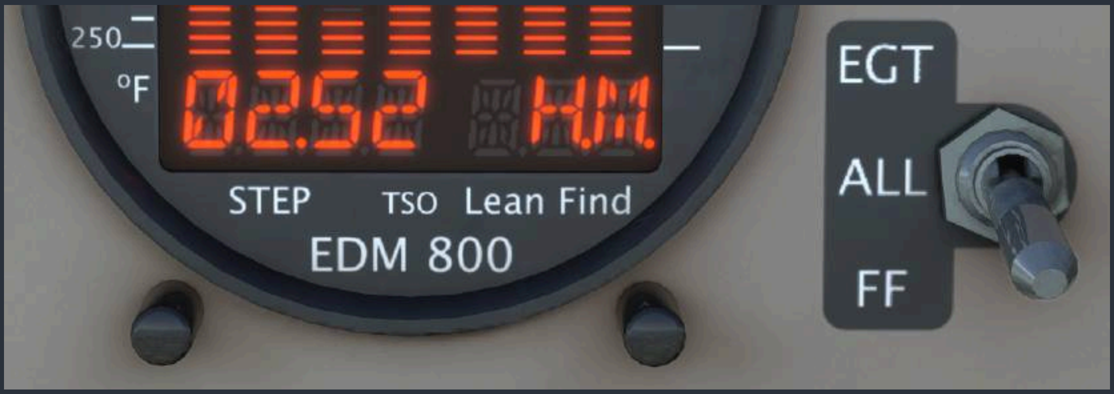
The Analog Bonanza is equipped with the most complete implementation of the EDM-800 engine monitor to appear in a flight simulator. The EDM-800 is one of the more common pieces of engine monitoring equipment found in general aviation aircraft, and is often underestimated in its power and utility due 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.

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
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

Starter Does Not Disengage

Alternators	Off
Battery Master	Off
Mixture	Cut-Off
Magnetos	Off

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

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:
4.5-6.0 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

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 EXTEND Illuminated in Flight

Air Conditioning	Discontinue Use
Increased Drag	Anticipate

Landing Gear Manual Extension

Airspeed	154 kts or Less
Landing Gear Relay	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 Relay	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].

Frequently Asked Questions

Will I still be able to fly the default G1000 G36 Bonanza?

Absolutely! The default G36 Bonanza will be unaffected by this product, and will always be available in the aircraft selection menu. The two installations may sit side-by-side without interference; however, we think that once you've flown the analog systems, you won't want to go back to the generic LCD displays of the default aircraft!

Are liveries for the default MSFS G36 Bonanza Compatible?

Yes! They are all compatible, as they only affect the exterior model, and they can be easily integrated into this product. For more information, see the "Liveries" section of this manual.

Why is the GTN 750 GPS screen black?

Make sure you have the PMS GTN 750 or TDS GTNxi 750 installed properly in your community folder. The mod can be obtained for free from the following link. Installation instructions are included in the "Installation, Updates & Support" section of this manual.

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

Why do my GNS 430/530 displays not look like the screenshots?

Make sure you have the Working Title GNS 530/430 mod installed properly. The mod can be obtained for free from the in-game marketplace while it is still in beta. Installation instructions are included in the "Installation, Updates & Support" section of this manual.

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.

Do I need to have the original default aircraft installed?

Yes, but also no. This product uses models, textures, and sound from the original default; therefore, you must have it installed for this product to be able to find those files. If you do not, the exterior model might not appear, or there might be pink checkerboard textures in the cockpit, or there might be no sound. However, if you really want to uninstall the default aircraft for some reason, it is possible for advanced users to copy over the necessary files and link them in this aircraft's aircraft.cfg, and model.cfg.

Why can't I see the exterior of the aircraft, or why are there pink checkerboard textures on the inside of the cockpit?

Some files are shared between this product and the default aircraft in MSFS. The files are located within your existing installation by reference, so if you do not have the necessary default aircraft installed, you will not have an exterior model, some textures, or sound. See the above question for more information.

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 on the "SYSTEMS" page of the weather radar by rotating its mode knob to "NAV".

Why don't the doors open?

Since this product uses the default exterior model for the Bonanza, it is beholden to the limitations of that model. Nothing can be done to add this functionality to a model that doesn't have it. Mods that create opening doors for default aircraft, like the C152 and TBM-930, either already have opening doors in the exterior model, or alter the exterior model, which cannot be distributed as part of a paid product.

I have the TDS or PMS GTN 750 installed. Why do they not automatically show up on the panel?

The "automatic detection" of the TDS or PMS software refers to automatic switching between the freeware PMS, and the TDS or PMS payware products. There are six different choices for avionics available for this aircraft that must be manually selected with the two selector switches located to the left of the copilot's yoke. Your avionics selection is automatically saved and restored between sessions. For more information on selecting different avionics, see the "Avionics" section of this manual. **It is now possible to manually switch between PMS and TDS products while the aircraft is loaded. Click on the blue memory card on the left of the unit's bezel.**

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 engine?

The Analog Bonanza 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.

Why is the autopilot behaving strangely, not changing modes, or not capturing altitudes?

This, and many other aircraft, recently required updates to make them compatible with the new Working Title GNS 530, which is available in the in-game marketplace. This GPS caused significant unintended consequences with hot-swappable avionics, such as are in this aircraft. Please make sure that you have updated all the avionics packages that you are using, including the TDS GTNxi 750, the PMS50 GTN 750, and the WT GNS 530. Please see the changelog and "Third Party Navigation & GPS Systems" section of this manual for more information.

Is this compatible with the G36 Bonanza Improvement Mod?

Yes, both the Analog Bonanza and the Bonanza Improvement Project will appear as separate aircraft in the aircraft selection menu. You will still be able to fly the original G36 Bonanza, the Bonanza Improvement Project's G36 Bonanza, and the Analog A36 Bonanza. This question specifically pertains to the "Bonanza Improvement Project". There is no guarantee that other mods will not modify the core G36 Bonanza files that the Analog Bonanza depends on. Should this occur, it will most likely affect only the sounds of the Analog Bonanza, and a compatibility mod is always possible.

Why is the STBY ALT annunciator always illuminated with a very brief blinking effect?

This is a hardware binding issue most often encountered with the Honeycomb system. The Analog Bonanza is a complex aircraft that is not responsive to all the hardware binding inputs that are used for very simplistic aircraft. Version 1.1 of the Analog Bonanza added the following common hardware bindings for the alternators: TOGGLE_MASTER_ALTERNATOR, TOGGLE_MASTER_BATTERY_ALTERNATOR, TOGGLE_ALTERNATOR1, ALTERNATOR_OFF, ALTERNATOR_ON, TOGGLE_ALTERNATOR2. If your hardware is constantly trying to set either alternator to on or off, especially using the SimVar “A:GENERAL ENG MASTER ALTERNATOR”, the electrical system will not behave correctly.

Why do screens flicker at night when adjusting lighting intensity?

This is a long standing bug in MSFS with some graphics settings caused by the NanoVG renderer for legacy XML gauges. Disabling NanoVG from the “Experimental” menu in General Settings will stop the flickering. Black Square products do not use rendered XML gauges, so there will be no impact on performance.

Change Log

v1.0 - Initial Release

New Features:

- Radar pod added to turbonormalized model, but also available on all variants. See the "Radar Pod" section of this manual for more information and how to equip the Analog Bonanza model of your choice with a radar pod or tip-tanks.
- Voltage drop from battery load was accidentally not implemented. Fixed.
- Note added to manual on "Mixture & Fuel Flow" limitations of MSFS.

Bug Fixes:

- Autopilot engagement is now MUCH smoother, with the aircraft maintaining its present attitude unless commanded to do otherwise. The PID reset mode is set to "current aircraft state" now, which resets the integrator upon engagement.
- Magneto switch order corrected. L & R switch position grounding was reversed.
- Signal degradation effect reduced by approximately 15% according to user taste.
- Full flap drag reduced by 10%.
- Removed KX-155 kHz rollover.
- Oil temperature time constant reduced to slow oil heating and cooling.
- Cabin climate control pull knob tool tips fixed.

v1.1 - Switch Bindings & Requested Features

New Features:

- Event ID bindings have been added for the ignition switch, alternator, and standby alternator. This should allow users to use their hardware without having to change event bindings. The following are examples of acceptable key events: MAGNETO_OFF, MAGNETO_LEFT, MAGNETO_RIGHT, MAGNETO_BOTH, MAGNETO_START, MAGNETO1_OFF, MAGNETO1_LEFT, MAGNETO1_RIGHT, MAGNETO1_BOTH, MAGNETO1_START, SET_STARTER1_HELD, SET_STARTER_ALL_HELD, TOGGLE_ALL_STARTERS, TOGGLE_STARTER1, MAGNETO_INCR, MAGNETO_DECR, MAGNETO1_INCR, MAGNETO1_DECR, TOGGLE_MASTER_ALTERNATOR, TOGGLE_MASTER_BATTERY_ALTERNATOR, TOGGLE_ALTERNATOR1, ALTERNATOR_OFF, ALTERNATOR_ON, TOGGLE_ALTERNATOR2.
- Spark plug fouling will now affect temperatures in a much smoother fashion, which is more realistic, and also makes the condition harder to spot on the EDM-800.

- Turbocharger overboost pressure relief valve sound. When you advance the throttle too rapidly with cool oil, the wastegate may not react quickly enough to prevent an overboost. If this occurs, a pressure relief poppet valve will open, emitting an audible hissing sound.
- EGT now increases with poor combustion, such as from single magneto operation, or fouling spark plugs.

Bug Fixes:

- Panel.noreg did not remove external registration after the preview build. Fixed.
- European 8.33kHz mode on the KX-155 units will now display the "tune to" frequency, rather than the actual frequency. Tuning frequency spacing is 5kHz, which matches the underlying behavior of the WT GNS, otherwise the WT GNS will refuse to tune.
- Spelling fix on strobe light warning in cabin.

v1.2 - Engine Damage Model, Usability & More Update

New Features:

- **New gyroscope physics simulation** for electric and pneumatic gyroscopes with precession, and partial failures, based on a coupled quadrature oscillator. 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.
- **Improved engine damage modeling** to prevent unexpected damage. Cylinder cooling damage reworked. Should prevent decreasing engine health after shutdown unless the engine is very hot. Cylinder temperature aircraft pitch effect smoothed. This will reduce the apparent rate of cylinder cooling due to aircraft pitch changes, which could sometimes manifest in engine damage during abrupt pitch inputs.
- **New voltage-based light dimming and incandescent effects** have been added to all interior and exterior lights. 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, an alternator failure in flight will result in the dimming of lights. The incandescent lights also simulate the dynamics of filaments, creating a noticeably smoother effect to changes in their intensity.

  Panel and glareshield lights are now toggled with the following L:Vars:

  L:bksq_MasterPanelLights, L:bksq_MasterGlareshieldLights

  And brightness knobs are adjusted with the following L:Vars (0-100):

  L:var_FlightInstrumentsLightingKnob, L:var_GlareshieldLightingKnob,
  L:var_EngineInstrumentsLightingKnob, L:var_SubpanelLightingKnob

- **New custom strobe light system**. Just as in the real world, strobe light volumetric effects are now visible at night on dark nights. The strobe lights will now become disorientingly bright flashes surrounding the aircraft while operating in clouds, especially at night. Finally, you have a reason to heed the warning in , "Turn off strobe lights when operating in clouds or low visibility." See the "Realistic Strobe Bounce" section of this manual for more information.

- The **KNS81 RNAV unit is now capable of controlling the autopilot** when no GPS is selected as the primary radio. See the "Using the KNS-81 RNAV Navigation System" for more information.

- **WTT Mode autopilot is now integrated natively.** No additional packages are required to access all features of the PMS50 GTN 750 any longer.

- **Fuel level saving** has been implemented, and payload saving code has been added preemptively for when MSFS allows access write to the variables required to do so.

- **Functional go-around button** on the throttle has been added, and will now issue the native TOGA command to the autopilot. The behavior of this command may differ depending on which autopilot (GPS software) is in use, but will default to 8 degrees pitch up on the attitude indicator's flight director.

- **Solar calculations for display backlighting** have been added for a much smoother dimming effect during sunrise and sunset. Unlike other 3rd party implementations, this takes all factors into account, including leap years, and the earth's tilt.

- The **turbonormalized version of this aircraft now has considerably increased fuel flow at high power settings** due to exhaust back pressure from the turbocharger. Takeoff fuel flow is around 35 GPH. An extended fuel flow indicator scale was added to accommodate this higher fuel flow. This change has the unfortunate side effect of making mixture control more sensitive in some circumstances. This new fuel flow behavior can be disabled with the "BKSQ_TurbochargerExcessFuelBurn" flag in the *.flt files.

- It is now possible to manually switch between PMS and TDS products while the aircraft is loaded. Click on the blue memory card on the left of the unit's bezel.

- Added true Pitch Sync functionality to yoke CWS buttons. Pressing and holding "L:var_PilotCws" or binding "K:SYNC_FLIGHT_DIRECTOR_PITCH" to hardware controls will now allow the aircraft to be maneuvered in pitch while temporarily disabling the autopilot pitch servo.

- Added support for 0.5 kHz ADF frequency tuning on the KR 87. A secondary click on the power knob will increment the standby frequency by 0.5 kHz, which will indicate on the display with a small dot to the left of the frequency.

- In the turbonormalized model, the turbocharger's overly-rich mixture falloff curve was reduced, thanks to new performance options available in the configuration files. As a result, you can expect that engine performance will now degrade slowly as you climb beyond the critical altitude with an overly rich mixture. Combustion should not cease, so long as you maintain full throttle while climbing up to the service ceiling; however, a significant reduction of throttle at those altitudes may still result in a total loss of power.

- Added propeller slipstream effects to vertical speed needle.
- Added L:Var variables to access more information from the KNS81, including L:var_RNAV_WAYPOINT_NUMBER, L:var_RNAV_RADIAL_NUMBER, and L:var_RNAV_DISTANCE_NUMBER.
- Added L:Var output for every annunciator light for use with home cockpits.
- Now supports TDS GTNxi Advanced Glide Advisor features.
- When the rocker switch on the KFC 150 (or external hardware) causes a change in the target vertical speed, the KAS 297B will now momentarily display the vertical speed information for a few seconds, if the inner knob is not currently pulled out.
- Added partial vacuum failure mode.
- True Airspeed indicator can now be rotated with the L:Var "var_TrueAirspeedKnob_L", and has twice the precision as before.
- Replaced annoying, jumpy default turn coordinator bubble animation. Now silky smooth.
- Reverse compatibility for VATSIM clients that use "COM RECIEVE ALL" for monitoring COM2 audio while transmitting on COM1.
- Improved annunciator light materials for more realistic appearance.
- Radar altimeter decision height tooltip will now show altitude in feet instead of meters.
- Decision height annunciator light logic revised for persistent illumination below the decision height until below 20ft radar altitude.
- Touchscreen click sound added for PMS50 GTN 750.
- Added support for WeatherSquare 4000.

Bug Fixes:

- Massive improvement to dynamic shadow quality in cockpit.
- Cabin light bleed significantly reduced, especially near rudder pedals.
- Finally! There is a solution for the simulator's internal rounding error when setting COM frequencies above ~134 MHz. These frequencies will now work properly with 3rd party air traffic control clients in all Black Square Aircraft.
- Landing and taxi lighting intensity doubled.
- EDM-800 absolute Celcuis readings corrected for relative EGT and max diff temp.
- EDM-800 engine alarm LED functionality restored.
- Possible fix for intermittent configuration saving between flights. This bug could have affected anyone using hardware peripherals to control the avionics master switch state.

- Fixed possibility of EDM-800 showing GPS derived data when no GPS was available.
- The latest version of the TDS GTNxi now correctly responds to the COM1 circuit power, instead of the “general avionics” circuit power.
- Fix for volume knob momentary push action on the TDS GTNxi 750 producing “Knob Stuck” warning.
- KRA-10 Radar Altimeter off-scale high needle parking position corrected to below mask, not in the hashed “OFF” range at the bottom of the scale.
- Fuel flow could read positive with the fuel pump running when fuel selector valves were off in some circumstances.
- Turbocharger sounds have been modified to behave more like those in the Piston Duke, meaning that they are less audible at high turbocharger RPM.
- Engine oil temperature time constant decreased for slower heating and cooling.
- Loadmeter zero position tweaked.
- Engine cylinder head and oil temperature damage progression reduced.
- Aileron trim knob animation was reversed.
- Cockpit Left Quick-View camera fixed.
- Propeller lever will start at full forward when loading the aircraft in cold/dark state.
- VR default cockpit camera entry added.
- Nose heaviness reduced slightly.
- QuickView system overhaul.
- Generally reduced elevator control input sensitivity.
- Transponder state will now be set to “on” when loading in cold-and-dark state.
- Performance fix for when both PMS50 GTN 750 and TDS GTNxi 750 are installed.
- Fixed bug where PMS50 GTN 750 might not turn on when using hardware peripherals.
- Reduced brightness of GNS knob ring LEDs.
- Fixed COM 1 KX155 volume knob animation that had a lower maximum position than the COM 2 KXX155.
- KI-229 RMI visuals improved to match real world unit.
- HSI lighting improved for better glideslope indicator visibility.
- Storm window reflections were ugly. Big improvement.

Credits

Analog Bonanza	Nicholas Cyganski
Publishing	Just Flight
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.

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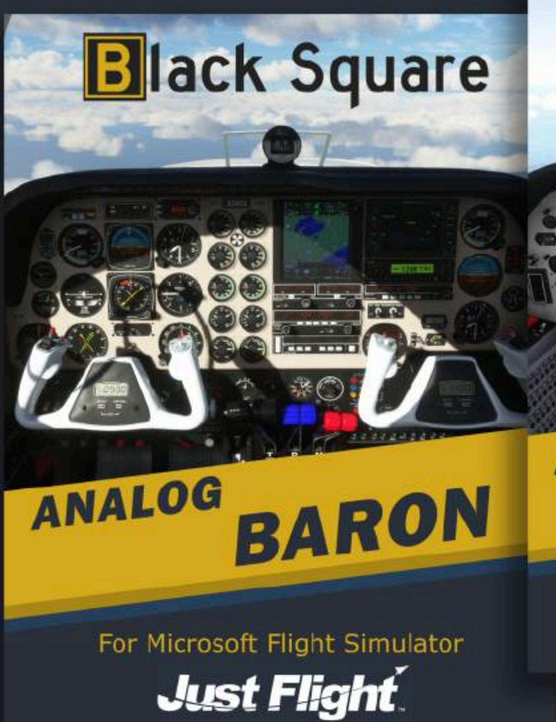

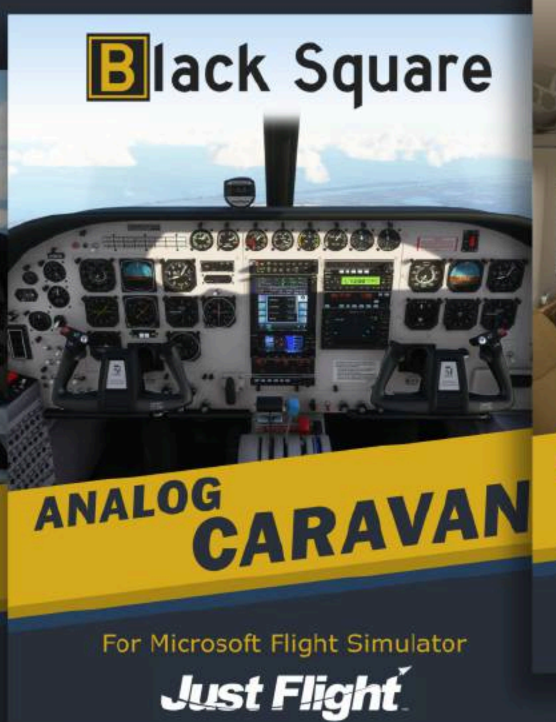

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