Black Square

ANALOG CARAVAN

OPERATIONS MANUAL

For Microsoft Flight Simulator

Published By:

Just Flight™

Black Square

"Virtual Aircraft. Real Engineering."

Analog Caravan User Guide

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

Contents

Introduction

The 208B Caravan is one of the most capable, multifunction, utility aircraft in the skies, available in configurations for executive transport, passenger airline service, cargo operations, and even amphibious options. The Caravan's high ground clearance and robust fixed gear makes it ideal for flight into unimproved airports, and a great asset to developing parts of the world. One of the most popular single engine turboprop aircraft on the market, the Caravan has enjoyed many upgrades and expansions over the years. This particular model of Caravan depicts the lengthened Grand Caravan, with a 675 shaft-horsepower PT6A-114A engine, and an improved de-icing system. As the dependable workhorse of the single engine turboprop fleet, most Caravans are still equipped with their original instrumentation, providing a familiar yet challenging increase in complexity and performance for freshly certified commercial pilots.

Black Square's Analog Caravan brings you a completely new interior and panel for the default MSFS Grand Caravan, featuring analog instrumentation (steam gauges), swappable radio configurations, and an overhauled electrical system with every circuit breaker, bus, meter, switch, and knob functioning. Users will find increased detail on the instrument panel and electrical panels when compared to default aircraft, and a similar level of detail in the cabin. The panel of the aircraft contains only fully 3D gauges, modeled and coded to meticulously match their real world counterparts, with reference to real world maintenance and installation manuals. No piece of equipment appears in a Black Square aircraft without a real world unit as reference. Radio and navigation systems are available from several eras of the Caravan's history, so users can fly without GPS via an original Bendix KNS-80 RNAV system, or with the convenience of a Garmin GTN 750 (PMS50 or TDS). Other swappable radio equipment in this aircraft includes KX-155 NAV/COM radios, GNS 530, GNS 430, KR 87 ADF, KDI 572 DME, GTX 327 Transponder, KAP 140 Autopilot, and a Bendix RDR1150XL Color Weather Radar. A 75 page manual provides instruction on all installed equipment, and 30 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 Caravan exterior visual model.** Improvements have been made to almost all aspects of the aircraft, **except** the visual appearance of the exterior. All default Caravan 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

Model

- Accurately modeled 208B Grand Caravan interior ONLY (uses default exterior model), created from hundreds of reference photos, panoramas, 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) textures are used to produce the highest possible texture clarity
- PBR (Physically Based Rendering) materials with real-time environment reflections for superb quality and realism
- 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)
- Extensive use of new MSFS decal system for nearly vector-graphic quality of labels, arrows, and exterior detail features

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 load shedding and standby generators 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 for a more immersive nighttime experience that won't leave you fumbling around in unrealistically dark spots.
- 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
- All placards and warning labels from the real aircraft represented

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…

- Completely intractable electrical system with 12 buses and 90 circuits
- Improved turbine dynamics (ITT, TRQ, Ng, Fuel Flow, Inertial Separator), battery charging circuitry, and load shedding, and ability to cause hot start
- Selective state saving for radio selection, radio frequency memory, cabin aesthetics, etc.
- Engine limit excursions that decrease engine health and will eventually lead to failure
- 90+ 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 the biological demand of each passenger based on weight
- Standby flap motor circuitry, logic, and switches, and working propeller governor test
- Mathematically accurate VOR & ADF signal attenuation and noise, and remote compass

Checklists

Over 350 checklist items are provided for 30+ 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 Caravan features the default MSFS-native (Wwise) 3D Grand Caravan sound package, with new sounds added for warnings, environmental systems, and more. Default sounds are assigned to all interactable elements for an authentic 3D spatial experience.

- Rich audio for every switch, button, lever and electrical system
- Detailed physics-based effects on engine and wind noise
- Accurately positioned 3D sound sources (best enjoyed in VR!)

Flight Dynamics

The Analog Caravan features an improved flight model compared to the default Grand Caravan with tweaks based on operator feedback online.

Aircraft Specifications

Length Overall	41’7”
Height	15'6"
Wheel Base	13’4"
Track Width	11’8"
Wingspan	52'1”
Wing Area	280.9 sqft.
Flight Load Factors	+3.8/-1.52 G’s (+2.4 G’s with Flaps Down)
Design Load Factor	150%
Cabin W/L/H	64” x 21’4" x 54"
Oil Capacity	14 U.S. Quarts
Seating	10-14
Wing Loading	31.5 lbs/sqft
Power Loading	13.0 lbs/shp
Engine	675 SHP (496 kW) Pratt & Whitney PT6A-114A
Propeller	4-Blade McCauley, Constant Speed, Full-Feathering, Reversible, Aluminum, Hydraulically Actuated, 106 inch propeller. Feathered blade angle of 88°, Low pitch blade angle of 15.6°, and maximum reverse blade angle of -14°.
Approved Fuel Grades	JET A (ASTM-D1666) JET A-1 (ASTM-D1666) JET B (ASTM-D1666) JP-1 (MIL-L-5616) JP-4 (MIL-T-5624) JP-5 (MIL-T-5624) JP-8 (MIL-T-83133 A)
Fuel Capacity	Total Capacity: 335.6 U.S. Gallons Total Capacity Each Tank: 167.8 U.S. Gallons Total Usable: 332.0 U.S. Gallons
Electrical System	
Voltage:	28 VDC
Battery:	24V, 42 amp-hour, sealed lead acid battery
Starter-Generator:	28V, 200 amp
Standby Alternator:	28V, 75 amp, automatic operation when engaged

Aircraft Performance

Maximum Cruising Speed	185 ktas
Normal Cruising Speed	182 ktas
Economy Cruising Speed	156 ktas
Takeoff Distance	2,160 ft
Takeoff Ground Roll	1,365 ft
Landing Distance	1,836 ft
Landing Ground Roll	1,004 ft
Normal Range	529 nm
Maximum Range	789 nm
Rate of Climb	975 ft/min
Service Ceiling	25,000 ft
Empty Weight	4,570 lbs
Max Ramp Weight	8,750 lbs
Max Takeoff Weight	8,750 lbs
Max Landing Weight	8,500 lbs
Useful Load	4,180 lbs
Usable Fuel Weight	2,246 lbs
Full Fuel Payload	1,934 lbs
Maximum Operating Temp.	+53°C
Minimum Operating Temp.	-54°C

V-Speeds

Vr	65 kts	(Rotation Speed)
Vs	63 kts	(Clean Stalling Speed)
Vso	50 kts	(Dirty Stalling Speed)
Vx	72 kts	(Best Angle of Climb Speed)
Vy	104 kts	(Best Rate of Climb Speed)
Va	145 kts	(Maneuvering Speed)
Vg	105 kts	(Best Glide Speed)
Vfo	125 kts	(Maximum Flap Operating Speed)
Vne	175 kts	(Do Not Exceed Speed)

Engine Limitations

Maximum ITT:	805°C (T/O) 765°C (Climb) 740°C (Cruise) 1090°C (Starting)
Maximum Torque:	1,970 ft-lbs (T/O) 1,865 ft-lbs (Continuous) 2,400 ft-lbs (Transient)
Maximum Gas Gen RPM:	101.6% (Continuous) 102.6% (Transient)
Maximum Propeller RPM:	1,900 (Continuous) 1,825 (Reverse) 2,090 (Transient)
Oil Pressure:	85-105 PSI (Continuous) 40 PSI min. (Idle)
Oil Temperature:	0-99°C (Continuous) -40-99°C (Idle) 104°C (Transient)

- For every 10°C below -30°C ambient temperature, reduce maximum allowable Ng by 2.2%.
- Reverse thrust operation limited to durations of one minute.
- Normal oil pressure is 85-105 PSI above 72% Ng with oil temperature 60-70°C.
- Oil pressures below 85 PSI are undesirable, and should only be tolerated to complete a flight, preferably at reduced power settings.
- When ITT exceeds 765°C, time at this power setting should be limited to 5 minutes.

Starter Limitations

Using Airplane Battery:

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

Using External Power:

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

Paint Schemes

The Analog Caravan comes with two additional color schemes in the default paint layout to distinguish it from the always available default G1000 Caravan in aircraft selection menus, and screenshots; however, any number of additional liveries may be adapted for the Analog Caravan, and require zero changes to make liveries intended for the default G1000 Caravan compatible with the Analog Caravan. For instructions on how to use your favorite default G1000 Caravan liveries with the Analog Caravan, see the “Liveries” section of this manual. Note: Default paint schemes for the Analog Caravan can implement any tail number, which will be displayed on the interior and exterior of the aircraft.

Instrumentation/Equipment List

Main Panel

- Annunciator Panel
- Quartz Analog Chronometer
- 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
- Duplicate Copilot Instrumentation

Avionics

- Garmin GMA 340 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-80 RNAV Navigation System (incl. Nav3)
- Bendix/King KR 87 (ADF)
- Bendix/King KDI 572 (DME)
- Bendix/King KAP 140 Autopilot
- Bendix RDR1150XL Color Weather Radar
- Garmin GTX 327 Transponder

Electrical/Miscellaneous

- 140+ Circuit Breakers
- Multi-Function Volt/Amp Meter
- Bendix/King KA 51B Remote Compass Synchroscope
- Propeller Amps Indicator
- Vacuum Indicator
- Oxygen Pressure Gauge
- Hobbs Timer

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

The Working Title GNS 530/430 is now in public beta, and downloadable for free from the in-game marketplace. It is recommended that users discontinue use of the PMS50 GNS 530 freeware mod in favor of the WT GNS, which has many more features, and a more realistic graphical display. The WT GNS is expected to become a part of the base simulator soon.

To download and install the Working Title GNS 530/430, click the "MARKETPLACE" tile in the MSFS main menu, and use the search bar to find "GARMIN GNS 430/530" by "Working Title Simulations". After clicking the "GET AND DOWNLOAD" button, the GPS will be ready to use.

The previously recommended PMS50 GNS 530 modification can still be accessed at:

https://github.com/pimarc/pms50-gns530/releases

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 Caravan’.
4. After selecting the aircraft, use the ‘Liveries’ menu to choose your livery.

Uninstalling

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

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

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

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

Updates and Technical Support

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

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

Regular News

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

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

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Liveries & Exterior Mods

Black Square's Analog Caravan comes with two complimentary paint colors (Maroon Red, and Forest Green) 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 Caravan as mod packages the same way you would add them for any other aircraft.

Compatibility

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

Example Livery Package

An example addon livery mod exists within the file structure of the Analog Caravan 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 Caravan is installed, navigate to…

bksq-aircraft-analogcaravan\SimObjects\Airplanes

Within the above folder, you will find **"bksq-aircraft-analogcaravan-livery-example"**. This folder contains everything you need to create a livery mod for the Analog Caravan. 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 Caravan.

Installation

1. Although liveries for the default Caravan are fully compatible with the Analog Caravan, each livery must have its own package inside the Community Folder for each aircraft. Luckily, the Analog Caravan'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-analogcaravan-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-analogcaravan-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-analogcaravan-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 Caravan that you would like to use with the Analog Caravan. The provided example is for a popular livery mod for a popular cargo hauler:

   fallback.2=..\..\Asobo_208B_GRAND_CARAVAN_EX-FEDBEXFEEDER\TEXTURE.FEDBEXFEEDER

6. Lastly, you will want to copy the two thumbnail images from the livery you wish you use with the Analog Caravan 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-analogcaravan-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-analogcaravan-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-analogcaravan-mylivery**
  - layout.json
  - manifest.json
  - **SimObjects**
    - **Airplanes**
      - **bksq-aircraft-analogcaravan-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 Caravan liveries as you like.

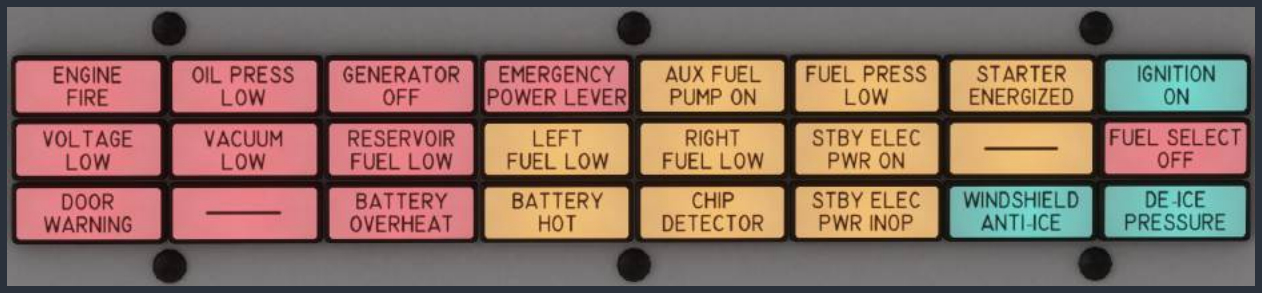
Alternatively: Once a livery mod has been created for the Analog Caravan and shared with the community, making your own livery mod should be as easy as pasting in your new textures, changing the aircraft name in aircraft.cfg, and renaming the texture folder in texture.cfg and aircraft.cfg.

Cockpit & System Guide

Main Panel

Annunciator Panel

The Caravan's annunciator panel can be tested by two buttons adjacent and to the left of the panel, lebled "Fire Detect Test", and "Lamp Test". Press and hold the buttons to confirm all 24 colored annunciators illuminate in the panel. Also adjacent to the annunciator panel is a night dimming switch, which dims the annunciator panel, as well as several other annunciators in the main panel. Below the engine instrumentation and to the right of the altimeter is also an autopilot specific annunciator panel, which indicates active autopilot modes in a different format than on the KAP 140 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.



Quartz Analog Chronometer

A precision (second counting) quartz chronometer for timing IFR approach legs or departure clearance void times.

True Airspeed Indicator

The Caravan's airspeed indicator displays both knots (outer scale), and miles per hour (inner scale), as well as reference speeds with colored arcs. The red marking corresponds to the never-exceed 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 calculating ring, which can be positioned for pressure altitude and air temperature, much like an E6B flight computer, and produce a rough true airspeed indicator at the airspeed needle.

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. Note that while the KI256 is capable of displaying flight director command bars, the KAP140 autopilot is not capable of driving them.

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. Currently set barometric pressure is displayed in the Kholsman window on the right of the unit in inHg, and in the Kholsman window on the left of the unit in Millibars.

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 the localizer.

NOTE: Unfortunately, it is not possible to drive the stock MSFS autopilot system with a custom navigation source without implementing a whole new autopilot (to the best of my knowledge). It is recommended that you simply steer the autopilot via the heading bug with reference to the RNAV course deviation shown on the CDI.

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

A row of eight round-dial engine instruments at the top of the main panel is used to monitor the health of the powerplant. From left to right, the gauges are Propeller Torque (TRQ), Propeller RPM (RPM), Interstage Turbine Temperature (ITT), Gas Generator RPM (Ng), Oil Pressure (PSI), Oil Temperature (°C), Fuel Flow (FF), Left Fuel Tank Quantity (L QTY), and Right Fuel Tank Quantity (R QTY). 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.

NOTE: This aircraft makes use of custom turbine engine dynamics code. Users should research and anticipate the following potentially novel turbine engine phenomenon:

Torque Bloom: While accelerating on the runway, increased ram air pressure increases combustion efficiency and fuel flow. Caution must be used while setting takeoff power, as torque may rapidly increase beyond the redline while accelerating.

Increased ITT with Inertial Separator and Bleed Air: Aircraft configuration can have a substantial impact on ITT, which may cause limit exceedances if not managed properly.

Apparent Fuel Imbalance: The fuel sender units in the Caravan are notoriously sensitive to lateral G-force, and how level the aircraft is sitting on the ground. 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

A duplicate six-pack of primary flight instrumentation is included on the co-pilot's side of the aircraft. Notably, the directional gyroscopic instrument is a traditional DG, and is not driven by the remote compass, and must be adjusted manually at startup, and continually for drift.

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.

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.

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-80 RNAV Navigation System

See the standalone section of this manual for instructions on using the KNS-80, 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. On the left of the unit, the “ADF” push button toggles the ADF receiver’s antenna mode between normal operation, and listening to the sense-only antenna (disabling the loop antenna), which makes receiving audio-only transmissions easier in low signal strength conditions. Lastly, the “BFO” push button toggles the unit’s beat frequency oscillator, which is used to listen to the tuned station’s morse code identifier in low signal strength conditions.

Bendix/King KDI 572 DME

This implementation of a KDI 572 behaves similarly to any other Distance Measuring Equipment (DME) receiver, displaying a nautical mile distance to the selected and tuned station, the current speed of the aircraft relative to the selected and tuned station, and a time-to-go until over the station. It should be noted that, like all other DME displays, this one is similarly dependent on being within the VOR service volume, and having good line-of-sight reception of the station. It should also be noted that these distances, speeds, and times, are based on slant-range to the station, not distance along the ground, as one would draw on a map. In order to receive DME information on the KDI 572, the station must be tuned in one of the two navigation radios, the station must be equipped with DME transmitting equipment, the station must have adequate signal strength, and the KDI 572 must have the appropriate navigation source selected via the selector knob mounted on its face. Selecting “HLD” mode will hold the current DME frequency and information on the unit, while allowing the user to change the tuned NAV frequencies on the NAV1 or NAV2 radios. This can be useful for some specific instrument approaches. This unit’s state will be automatically saved and reloaded at the start of the next flight.

Bendix/King KAP 140 Autopilot

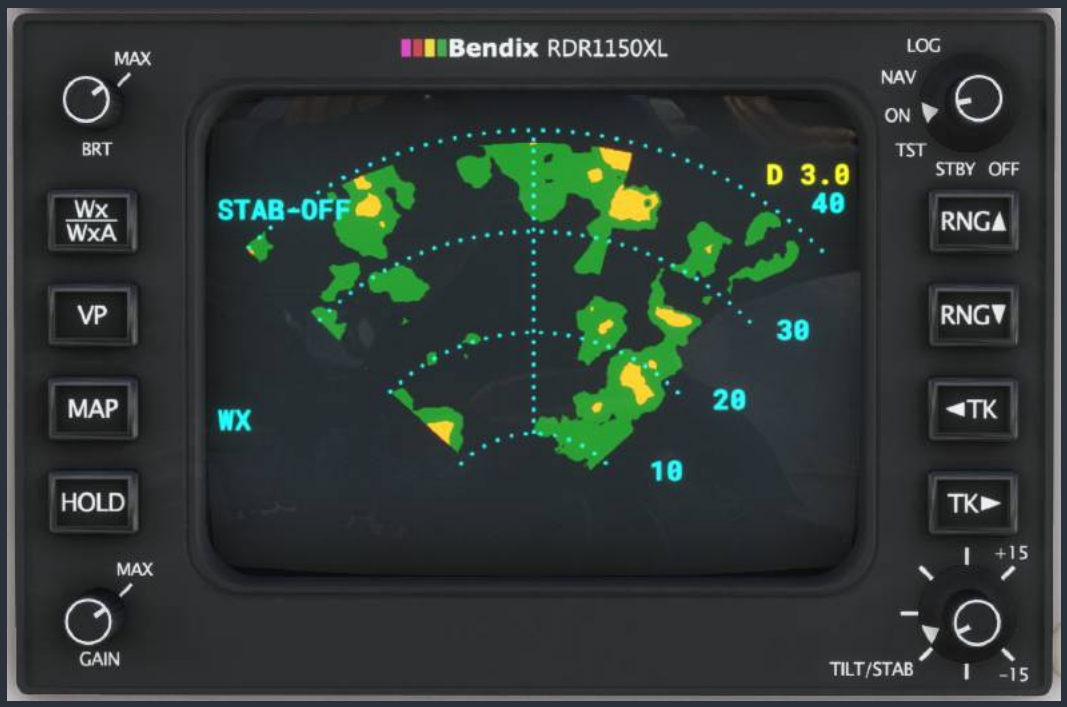
The KAP 140 is a relatively simple autopilot, with standard modes of control. The unit has an autopilot master push button, and can be disabled via the yoke-mounted autopilot disconnect push buttons. The autopilot's mode selections include (left to right along the row of push buttons), heading hold mode, lateral navigation mode, approach coupling mode, back course mode, and altitude hold mode. When the autopilot is disabled by any means except loss of power, the "AP" annunciator will flash for five seconds, and an audible tone will be heard.

The unit's display consists of a right section with annunciators, and an altitude pre-selector, which can also be used to display the current barometric setting, and a left section with four annunciator locations for active and armed modes. On the left, active modes will appear in the top row, with lateral modes on the left, and vertical modes on the right. The bottom row will display armed modes for lateral and vertical control underneath their respective active modes. For instance, "ALT" will display in the upper row when an altitude has been captured, and the autopilot is holding that altitude. When a new altitude has been selected, and vertical speed mode has been activated to capture that altitude, "VS" will appear in the top row, and "ALT" in the bottom row to indicate that altitude holding is armed. On the right of the unit, the numerical display will show the currently selected altitude, adjusted with the dual concentric rotary encoder. When in altitude holding mode, this value can also be nudged by 100ft with the "UP" and "DN" buttons. Selecting a new altitude will not cause the aircraft to immediately attempt to capture that altitude. Pressing the "ALT" push button again, however, will activate vertical speed mode, which will automatically arm the altitude capture. The "ARM" push button has become unnecessary with updates to the KAP140 software over the years that incorporate automatically altitude arming. The vertical speed can then be adjusted with the "UP" and "DN" buttons.

NOTE: The KAP140 has its own dedicated electronic altimeter. This means that the aircraft will not climb or descend to match the altitude shown on the primary altimeter. The unit's dedicated altimeter must be adjusted by pressing the "BARO" push button and selecting the desired barometric setting. Barometric pressure units can be toggled by holding the "BARO" push button for three seconds.

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 Caravan's circuit breaker panel is located on the electrical pedestal to the left of the pilot's seat. 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 multi-function volt/amp meter 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. In the case of the Analog Caravan, two circuit breakers pertaining to the control of retractable landing gear on floats will be removed or added as appropriate. It should be noted that the left-hand column of circuit breakers in the Caravan are actually "bus feeders", which supply each row of equipment with power. In essence, pulling the first breaker of each row, such as "BUS 1 PWR" in the first row, is the same as pulling all the breakers in that row. Similarly, the first two rows of circuits are also connected to the standby alternator, which kicks in when loads on the starter-generator exceed a preset value, and the gas generator is operating above idle.

Multi-Function Volt/Amp Meter

A multi-function meter and associated rotary selector knob provides access to all the onboard electrical systems in the Caravan. The inner scale of the meter displays voltage, while the outer displays amperage. The selector knobs allows for monitoring of current (amps) being drawn or produced (positive or negative amps) from the starter-generator ("GEN"), the standby alternator ("ALT"), and the aircraft battery ("BATT"). To test the ammeter, try switching to the "ALT" setting while in-flight, and moving the generator control switch to the "TRIP" position. Current draw on the starter-generator should fall to zero, and the standby alternator and battery should momentarily take over to share the load. The last position on the selector switch is "VOLT", which allows for the monitoring of the main bus voltage, which should mirror the aircraft battery voltage. This setting is especially important during starting to ensure sufficient voltage remains in the battery for starting.

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. This Caravan is equipped with an additional "FAST ERECT" push button, which allows for the remote compass to be placed in fast erect mode, which will increase the speed at which the compass card seeks to the sensed magnetic heading, but will not increase the rate at which all signals are integrated to provide a robust magnetic heading.

Propeller Amps Indicator

The propeller ammeter gauge indicates the flow of current to the propeller hub during deicing.

Vacuum Indicator

The vacuum indicator shows the vacuum suction generated by the engine-driven vacuum pump on the engine's accessory gearbox. The scale on the gauge has indicators for appropriate vacuum suctions at various pressure altitudes of operation.

Oxygen Pressure Gauge

In the overhead panel of the Caravan, a recessed gauge indicates the oxygen pressure available in the onboard, refillable oxygen cylinder. This cylinder is normally pressurized to 1,850 PSI when serviced on the ground. Oxygen pressure will deplete as it is consumed by passengers and crew, when activated. To activate the Caravan's built-in demand-type oxygen regulators for crew, place the oxygen supply lever in the overhead panel in the "ON" position. Oxygen will be consumed by the crew 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.

Hobbs Timer

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.

Lighting Controls

Cabin Lighting

Cabin lighting in the Caravan is controlled via a single toggle switch on the lower-left main panel in the cockpit. 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.

Cockpit Lighting

Cockpit flood lighting is controlled by the dual concentric rheostats under the pilot's side yoke. Three overhead flood lights (pilot, co-pilot, and pedestal area) are controlled via the outer concentric knobs in this area of the panel. These floodlights are very bright, and should only be used during pre/post flight operations, or during an emergency. An additional floodlight is provided to illuminate the circuit breaker panel to the left of the pilot's seat. This light is controlled via an inner concentric knob, colocated with the pedestal floodlight dimmer.

Panel Lighting

Panel lighting is controlled by the dual concentric rheostats under the pilot's side yoke. The majority of panel lighting is provided through light posts placed on the panel, while some instruments have integrated lighting. The zones of panel lighting are; pilot's side panel, co-pilot's side panel, engine instruments, and radio backlighting. Care should be taken to always use the minimum amount of panel lighting necessary to clearly read instrumentation to retain crew night vision quality.

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.

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 air conditioning system in "VENTILATE" mode, which does not run the air condition compressor, but only the three ventilation fans. The rate at which temperature equalization, active heating, or active cooling can be achieved can be increased by placing the air conditioning switch in either the "COOL" or "VENTILATE" position, and positioning the "AC FAN" switches in their "HIGH" positions. Be aware that these 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 on the right side of the panel, above the co-pilot standby instrumentation, 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 "RADIO" light dimmer, along with the other avionics backlighting. In addition to this LCD display, two small LED's are located outboard of the prop-amps gauge 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

The primary environmental controls are located below the center of the main instrument panel behind the throttle quadrant. As discussed above, placing the air conditioning control switch in “VENTILATE” will begin equalizing the cabin temperature with the outside air temperature. Placing the switch in “COOL” position will activate the air conditioning compressor and begin to cool the cabin to the target air temperature so long as the engine’s gas generator RPM is above approximately 55%. Sometimes it is necessary to place the condition lever into high idle to active the air conditioning system, and it can also be used to increase the cooling rate while on the ground. The cooling rate can also be increased by positioning the “AC FAN” switches in their “HIGH” positions. To increase the cabin temperature, the RED “BLEED AIR HEAT” toggle switch must be placed in the “ON” position. This will provide hot bleed air from the running engine to the temperature control valve so long as the engine gas generator RPM is above 30%, which should be any time the engine is running.

NOTE: The Caravan has an extra manual step required to maintain bleed air heating control during all phases of operation. The “CABIN HEAT MIXING AIR” push valve should always be pushed into the “FLT-PUSH” position when the aircraft is in flight, and before starting. Failing to do so may result in a cabin vent over temperature, which will disable the bleed air heating system. The “GND-PULL” position should only be used on the ground when gas generator RPM is below 85% to increase the amount of heating air that is available during particularly cold ambient conditions.

The centrally located “TEMP HOT” control knob differs slightly in use from the real world aircraft as a matter of convenience to the user. In order to prevent temperature oscillations that require the toggling of the air conditioner between on and off states, the temperature control knob is used to set a target temperature for both the heating and cooling systems. The knob can rotate approximately 180° to select temperature targets from 50°F (10°C), to 100°F (38°C). When the proper heating or cooling system is activated appropriate to the outside air temperature conditions, the aircraft will heat or cool at varying rates determined by many other factors to the desired target cabin temperature.

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
MAIN FLAP MOTOR
STBY FLAP MOTOR
VACUUM PUMP
PITOT BLOCKAGE
STATIC BLOCKAGE
L BRAKE
R BRAKE
OXYGEN LEAK
L FUEL LEAK
R FUEL LEAK

Electrical Bus Failures

ELEC BUS 1-1
STBY POWER 1
ELEC BUS 2-1
STBY POWER 2
ELEC BUS 1-2
ELEC BUS 2-2
ELEC BUS 1-3
ELEC BUS 2-3

Circuit Breaker Protected Failures

IGNITION
STARTER CONTROLLER
GEN CONTROLLER
GEN FIELD
AUX FUEL PUMP
ANNUNCIATOR PANEL
FIRE DETECTOR
AP ANNUNCIATOR PANEL
REMOTE COMPASS GYRO
L TURN COORDINATOR
R TURN COORDINATOR
ITT GAUGE
OIL TEMP GAUGE
FUEL FLOW GAUGE
L FUEL QUANTITY
R FUEL QUANTITY
OVERSPEED TEST
BLEED AIR VALVE
L PITOT HEAT
R PITOT HEAT
WSHLD ANTI-ICE
WSHLD ANTI-ICE CONTROL
DE-ICE BOOTS
PROP ANTI-ICE
PROP ANTI-ICE CONTROL
FUEL CONTROL HEATER
L LANDING LIGHT
R LANDING LIGHT
STROBE LIGHT
BEACON LIGHT
TAXI LIGHT
NAV LIGHTS
MAP LIGHTS
INSTRUMENT LIGHTS
RADIO LIGHTING
CABIN LIGHTS
WING ICE LIGHT
AMPHIB GEAR CONTROL
AMPHIB GEAR PUMP
L VENT BLOWER
R VENT BLOWER
AFT VENT BLOWER
STALL WARNING
AIR CONDITIONING
BLIND ALT ENCODER
STBY HORIZON
ALT ENCODER
ELEC TRIM
COMM 1
NAV 1
XPNDR
GLIDESLOPE 1
ADF
HSI
GYRO MAG SLAVING
AUDIO PANEL
AP ACTUATORS
AP CONTROLLER
COMM 2
NAV 2
GLIDESLOPE 2
DME
RNAV
RADAR ALT
AVIONICS FAN
AUDIO AMPLIFIER
FUEL SELECTOR WARN
WX RADAR CONTROLLER
WX RADAR ANTENNA

Miscellaneous Systems

Audible Warning Tones

This version of the Caravan 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:

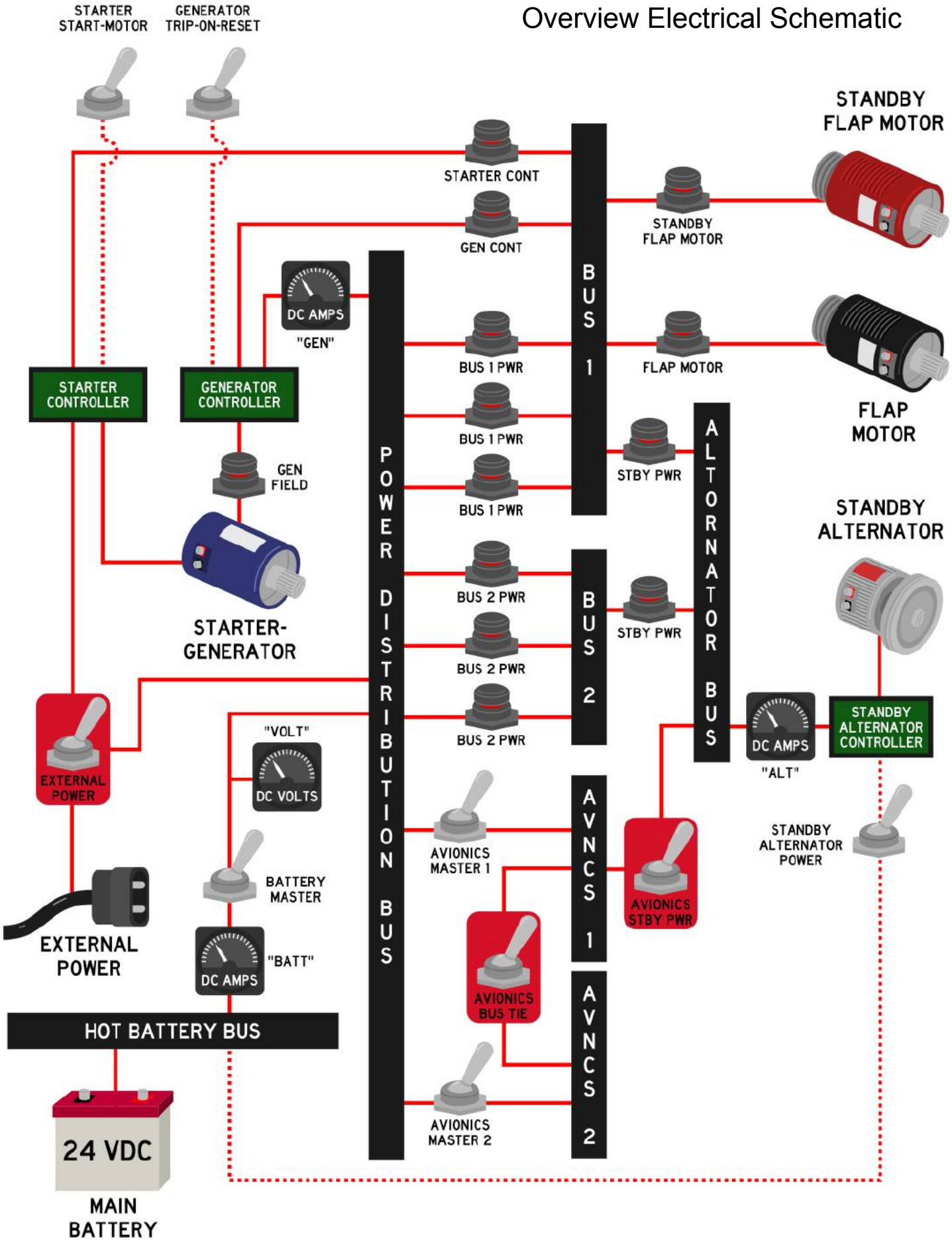
- Altitude Alerter Tone: A beeping tone will sound five times quickly when the aircraft is within 1,000 ft of the selected altitude displayed on the KAP140 Autopilot.
- Autopilot Disconnect Tone: Whenever the autopilot is disconnected via the autopilot master push button, the control yoke mounted disconnect buttons, or automatically disconnects when overpowered, a soft warning chime 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.
- Engine Fire Siren: When a fire is detected in the engine, a loud siren will sound to alert the pilot to take immediate action. This tone cannot be canceled or silenced except by extinguishing the engine fire, or pulling the fire detector circuit breaker. Through completing the engine fire checklists, the pilot will close the firewall valve of the affected engine, and disable the aircraft's power sources. This will cease the warning sound should. The fire warning siren can be tested by pressing the red fire detector test button adjacent to the annunciator panel. This warning siren will be accompanied by the RED "ENGINE FIRE" annunciator.
- Fuel Selector Off Tone: Added to later model Caravans as the result of early accidents, a warning tone is incorporated to alert the pilot of when the engine has been disconnected from all potential fuel supplies, either by the overhead fuel selectors, or by the firewall valve pull handle on the lower throttle quadrant. The warning system is also activated anytime either fuel selector is off during engine starting, or when only one fuel tank is feeding, and that fuel tank's quantity is less than approximately 25 US gallons.

  This warning tone can be disabled by pulling the fuel selector warning circuit breaker at the bottom of the circuit breaker panel, but the annunciator will continue to indicate normally. The system can be completely disabled by pulling both the fuel selector warning circuit breaker, and the starter controller circuit breaker. The tone can be tested by pressing the annunciator test button when Avionics Bus #1 is receiving power. This warning tone will be accompanied by a RED "FUEL SELECT OFF" annunciator.

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.


STARTER START-MOTOR
GENERATOR TRIP-ON-RESET
STARTER CONT
GEN CONT
STANDBY FLAP MOTOR
STANDBY FLAP MOTOR
DC AMPS
"GEN"
BUS 1 PWR
BUS 1 PWR
BUS 1 PWR
FLAP MOTOR
FLAP MOTOR
STARTER CONTROLLER
GENERATOR CONTROLLER
GEN FIELD
STBY PWR
STANDBY ALTERNATOR
STARTER-GENERATOR
BUS 2 PWR
BUS 2 PWR
BUS 2 PWR
STBY PWR
"VOLT"
DC VOLTS
EXTERNAL POWER
AVIONICS MASTER 1
BATTERY MASTER
DC AMPS
"ALT"
STANDBY ALTERNATOR CONTROLLER
STANDBY ALTERNATOR POWER
EXTERNAL POWER
"BATT"
AVIONICS STBY PWR
AVIONICS BUS TIE
HOT BATTERY BUS
24 VDC
AVIONICS MASTER 2
MAIN BATTERY
POWER DISTRIBUTION BUS
BUS 1
BUS 2
ALTORNATOR BUS
AVNCS 1
AVNCS 2

Using the KNS-80 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-80 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-80. On the right side of the unit, you will find the "DATA" push button, and the adjacent data entry knob. Between the two exists a marking, reading, "FREQ-RAD-DST", to remind you of the order in which data should be entered, frequency first, then radial, and finally distance. At any given time, either "FRQ", "RAD", or "DST" is shown on the LCD screen 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

Below the data entry area on the screen, there are two numbers shown, 1-4, in either the "USE" or the "DSP" (Display) positions. The KNS-80 can hold up to four different combinations of frequency, radial, and distance data at one time. This can be greatly useful while planning a flight on the ground. The data channel being edited is indicated by the "DSP" number, and the data being used by the computer and subsequently displayed on the HSI is indicated by the "USE" number. To cycle through the two numbers, press the "USE" or "DSP" push buttons to the left of the "DATA" push button. Whenever the two numbers are different, indicating that one data channel is being edited, but another is being displayed on the navigation equipment, the "USE" numeral will flash continuously.

Distance Measuring Equipment

On the top left-hand side of the LCD display is a traditional Distance Measuring Equipment (DME) display, with a nautical mile distance to the virtual VOR station, a current speed of the aircraft relative to the 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. 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. Pressing the "HOLD" push button will place the unit in DME hold mode, which will hold the current DME frequency and information on the unit's display while allowing

the user to change the tuned NAV frequency. This can be useful for some specific instrument approaches. This feature cannot be used in RNAV modes of operation.

Modes of Operation

Lastly, in the bottom left-hand corner of the LCD display, the KNS-80's many modes are annunciated. The KNS-80's modes fall into two categories; VOR and RNAV, and are activated by the "VOR" and "RNAV" push buttons. Further subcategories of modes are activated by pressing the appropriate push button multiple times. 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). Pressing the VOR button again will enter 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. Pressing the RNAV push button will enter the RNAV modes, where the CDI deflection is based on the displaced virtual VOR shown in the "USE" numeral. There are two RNAV modes, "RNAV/ENR" (Enroute), which drives the CDI with linear deflections of +/- 5 nm full-scale, and "RNAV/APR" (Approach), which drives the CDI with linear deflections of +/- 1.25 nm full-scale. Finally, when an ILS frequency is tuned in the currently USEd RNAV data, "ILS" will annunciate on the screen.

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.

RNAV/ENR: Linear course deviation, 5 nm full-scale deflection, displaced VOR waypoints.
RNAV/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.

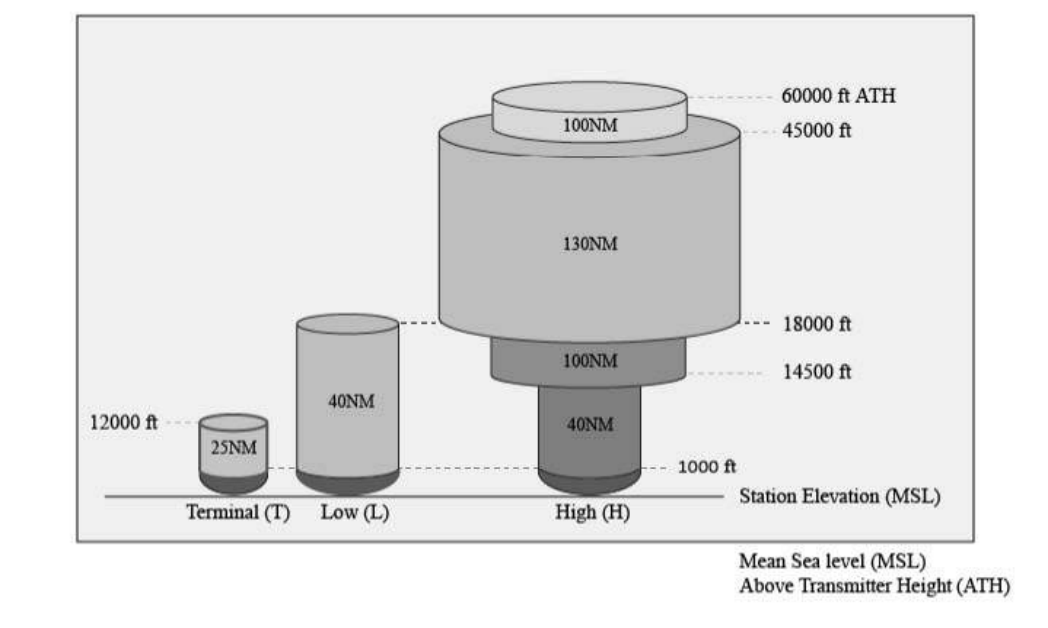

Nearby Navigation Aids

ID	Name	Freq	Radial / Range
LWM	LAWRENCE	112.50	154° 12.3
BOS	BOSTON	112.70	029° 14.0
NZW	SOUTH WEYMOUTH	133.40	017° 26.1
MHT	MANCHESTER	114.40	145° 26.3

ID	Name	Freq	Bearing / Range
OW	STOGE	397	198° 29.4
MJ	FITZY	209	302° 31.9
ESG	ROLLINS	260	005° 38.4
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-80 RNAV computer. Once the KNS-80 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-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 RNAV/ENR for enroute operation, unless we need increased precision for some reason. Press the “RNAV” push button until “ENR” and “RNAV” are annunciated above the button. 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 with the DME information provided on the KNS-80. 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, this system is usually precise enough to place your route of flight inside the airport perimeter fence at your destination.

Normal Checklists

Before Starting Engine

Preflight Inspection	Complete
Passenger Cabin Doors	Unlocked
Cabin Doors	Latched
Parking Brake	Set
Control Lock	Removed
Seats & Seatbelts	Secure
Switches	Off
Ignition Switch	Norm
Circuit Breakers	All In
Fuel Selectors	Both On
Oxygen Pressure	1850 psi
Ventilation & A/C	Off
Bleed Air Heat	Off
Cabin Mixing Air	FLT-PUSH
Emergency Power Lever	Normal
Power Lever	Idle
Propeller Lever	Full Forward
Fuel Condition Lever	Cutoff
Fuel Cutoff	Pushed In
Firewall Valve	Pushed In
Battery Switch	On
Annunciators	Test
Fire Detector/Warning	Test
Flap Lever	Up
No Smoking/Seatbelt Lights	As Required

Engine Start (Battery)

Beacon Light	On
Avionics Switch 1	On
Bus Volts	24V Min.
Emergency Power Annun	Extinguished
Propeller Area	Clear
Fuel Boost Pump	On
Fuel Press Low Annun	Extinguished
Fuel Flow	None
Starter Switch	Start
Oil Pressure	Rising
Ng RPM Stable	Greater than 12%
Fuel Condition Lever	Low Idle
Fuel Flow	90 to 140 lb/hr
ITT	1090 max. 2s
Ng RPM	Greater than 52%
Starter Switch	Off
Starter Engaged Annun	Extinguished
Engine Instruments	Check
Generator Switch	Reset
Generator Load	Positive
Battery Charging Current	Negative
Gen Off Annun	Extinguished
Fuel Boost Pump	Off
Fuel Boost Pump Annun	Extinguished
Weather Radar	Off/Standby
Avionics Switch 2	On
Nav Lights	As Required
Suction	Check
Remote Compass	Slaved & Aligned
Ventilation & Defrost	As Required
Radios	Check

Engine Start (External Power)

Beacon Light	On
Avionics Switch 1	On
Battery Volts	20V Min.
External Power	Bus
Bus Volts	24-28.5V
Emergency Power Annun	Extinguished
Propeller Area	Clear
Fuel Boost Pump	On
Fuel Press Low Annun	Extinguished
Fuel Flow	None
Starter Switch	Start
Oil Pressure	Rising
Ng RPM Stable	Greater than 12%
Fuel Condition Lever	Low Idle
Fuel Flow	90 to 140 lb/hr
ITT	1090 max. 2s
Ng RPM	Greater than 52%
Starter Switch	Off
Starter Engaged Annun	Extinguished
Engine Instruments	Check
Generator Switch	Reset
Generator Load	Positive
Gen Off Annun	Extinguished
External Power	Off
Battery Charging Current	Negative
Fuel Boost Pump	Off
Fuel Boost Pump Annun	Extinguished
Weather Radar	Off/Standby
Avionics Switch 2	On
Nav Lights	As Required
Suction	Check
Remote Compass	Slaved & Aligned
Ventilation & Defrost	As Required
Radios	Check

Taxi

Flight Instruments	Set & Check
Cabin Lights	Off
Cockpit Lighting	Dim for Taxi
Taxi/Recog Light	As Required
Inertial Separator	As Required
Parking Brake	Release
Brakes	Test
Remote Compass	Aligned

Before Takeoff (Runup)

Parking Brake	Set
Seats & Seatbelts	Secure
Flight Controls	Free & Correct
Standby Alternator	On
Standby Alternator	Check Zero Amps
Generator Load	Load to 30-60 Amps
Generator Switch	Trip
Standby Alternator Load	Positive
Generator Switch	Reset
Fuel Boost Pump	Norm
Fuel Selectors	Both On
Fuel Quantity	Check
Fuel Cutoff	Push In
Trims	Set for T/O
Flaps	10 (Norm) 20 (Short Field)
Power Lever	400 ft-lbs
Suction	Check
Bus Volts	24V Min.
Inertial Separator	On
ITT	Check Increase
Inertial Separator	Off
Engine Instruments	Check
Power Lever	1800 RPM
Overspeed Governor	Press & Hold
Propeller RPM	Check (1750 +/-60 RPM)
Power Lever	Idle
Pitot Heat	On
Generator Load	Increase
Pitot Heat	Off
Windshield Anti-Ice	On
Generator Load	Increase
Windshield Anti-Ice	Off
Propeller De-Ice	On
Propeller Amps	20-24 Amps
Propeller De-Ice	Off
Airframe De-Ice	On
Airframe De-Ice Annun	Observe Cycle
Airframe De-Ice	Off
Pitot Heat	On if OAT less than 4c
Ice Protection	As Required
Heading Bug	30 Degrees Left
Autopilot Heading Mode	Engage
Yoke Movement	Observe
Heading Bug	30 Degrees Right
Yoke Movement	Observe
Autopilot Disconnect	Test
Autopilot	Set for Climb
Battery Charging Current	Less than 10A
Weather Radar	As Required
Strobe Lights	As Required
Annunciators	Test & Consider
Flight Instruments	Set & Check
Storm Windows	Closed
Cabin Mixing Air	FLT-PUSH
Fuel Condition Lever	High Idle
Parking Brake	Release

Takeoff

Transponder	ALT Mode
Landing Lights	On
Inertial Separator	As Required
Power Lever	Set for T/O (See POH)
Annunciators	Check
Engine Instruments	Green
Brakes	Release
ITT	805 max
Flaps	Retract at 95kts

Max Performance Climb

Propeller Lever	1900 RPM
Power Lever	1865 ft-lbs
ITT	Less than 765
Air Conditioning / Heat	As Required

Enroute Climb

Pitot Heat	On if OAT less than 4c
Ice Protection	As Required
Propeller Lever	1600-1900 RPM
Power Lever	1865 ft-lbs
ITT	Less than 740
Air Conditioning / Heat	As Required

Cruise

Landing & Taxi Lights	Off
Pitot Heat	On if OAT less than 4c
Ice Protection	As Required
No Smoking/Seatbelt Lights	As Required
Oxygen	As Required
Inertial Separator	As Required
Propeller Lever	1600-1900 RPM
Power Lever	Set for Cruise (See POH)

Descent

Pitot Heat	On if OAT less than 4c
Ice Protection	As Required
No Smoking/Seatbelt Lights	On
Propeller Lever	1600-1900 RPM
Power Lever	Reduce

Before Landing

Seats & Seatbelts	Secure
Fuel Selectors	Both On
Oxygen	Off
Landing Lights	On
Inertial Separator	As Required
Condition Lever	High Idle
Propeller Lever	Full Forward
Flaps	As Required
Autopilot	Disconnect

Landing

Flaps	Full
Power Lever	Beta after Landing
Brake	As Required
Power Lever	Idle before 25kts

Balked Landing

Power Lever	Set for T/O (See POH)
Flaps	20 Degrees
Airspeed	80kts min.
Flaps	Retract when Safe

After Landing

Flaps	Up
Pitot Heat	Off
Ice Protection	Off
Strobe Lights	Off
Taxi/Recog Light	On
Landing Lights	Off
Condition Lever	Low Idle
Weather Radar	Off/Standby
Inertial Separator	As Required

Shutdown & Securing

Parking Brake	Set
Avionics	Off
Standby Alternator	Off
Fuel Boost Pump	Off
Heat & A/C	Off
Power Lever	Idle for 1 min
Propeller Lever	Feather
Condition Lever	Cutoff
Exterior Lights	Off
Battery Switch	Off
Fuel Selectors	Both Off
Oxygen	Off
Inertial Separator	Off

Instrument Markings & Colors

Propeller Torque:
0-1970 ft-lbs (GREEN)
1865 ft-lbs (RED)
1970 ft-lbs (RED)

Propeller RPM:
1600-1900 RPM (GREEN)
1900 RPM (RED)

Interstage Turbine Temperature (ITT):
100-740 °C (GREEN)
765-805 °C (YELLOW)
805 °C (RED)
1090 °C (RED)

Gas Generator RPM (Ng):
520-102% (GREEN)
102% (RED)

Oil Pressure:
40-85 psi (YELLOW)
85-105 psi (GREEN)
105 psi (RED)

Oil Temperature:
-40-40 °C (YELLOW)
40-104 °C (GREEN)
104 °C (RED)

Fuel Flow:
0 PPH (MINIMUM)
500 PPH (MAXIMUM)

Fuel Quantity:
0 lbs / 0 gal (MINIMUM)
1100 lbs / 160 gal (MAXIMUM)

Oxygen Pressure:
0-500 psi (YELLOW)
1550-1850 psi (GREEN)
1950-2000 psi (RED)

Vacuum Suction:
4.5-5.5 inHg to 15,000 ft (GREEN)
4.0-5.5 inHg to 20,000 ft (GREEN)
3.5-4.0 inHg to 25,000 ft (GREEN)
3.0-3.5 inHg to 30,000 ft (GREEN)

Propeller Ammeter:
20-24 amps (GREEN)

Airspeed Indicator:
SEE V-SPEEDS

Abnormal & Emergency Checklists

Starter Does Not Disengage

Battery Switch	Off
External Power	Off
Condition Lever	Cutoff

Hot or Hung Start

Condition Lever	Cutoff
Starter Switch	Motor
Starter Switch	Off when ITT less than 400

Engine Clearing

Propeller Lever	Feather
Condition Lever	Cutoff
Power Lever	Idle
Starter Switch	Motor
Starter Switch	Off after 30s

Fuel Control Unit Failure

Power Lever	Idle
Emergency Power Lever	As Required
Ng RPM	Greater than 65%

Battery Overheat (AMBER Annun.)

Battery Switch	Off
Battery Charging Current	If Charging...
Generator Switch	Trip
Standby Alternator	Off
Bus Circuit Breakers	Pull Off (6)
Avionics	Off
Standby Alternator	On
Standby Avionics Power	On
Standby Bus Tie	On
Standby Alternator Load	Monitor

Battery Hot (RED Annun.)

Battery Switch	Off
Generator Switch	Trip
Standby Alternator	Off
Bus Circuit Breakers	Pull Off (6)
Avionics	Off
Standby Alternator	On
Standby Avionics Power	On
Standby Bus Tie	On
Standby Alternator Load	Monitor

Generator Failure

Bus Volts	If less than 25V...
Circuit Breakers	Check In
Generator Load	If Zero...
Generator Circuit Breakers	Check In
Generator Switch	Reset
Generator Load	If Zero...
Generator Load	Reduce
Avionics 2	Off
Air Conditioning / Heat	Off
Ice Protection	Off
Exterior Lights	Off
Generator Circuit Breakers	Pull Off
Standby Alternator	On
Standby Alternator Load	Monitor

Engine Fire

Power Lever	Idle
Propeller Lever	Feather
Condition Lever	Cutoff
Fuel Cutoff	Pull Out
Firewall Valve	Pull Out
Cockpit Vents	Push Off
Ventilation Fans	Maximum
Overhead Fans	Maximum
Flaps	20 Degrees

Electrical Fire

Battery Switch	Off
Generator Switch	Trip
Standby Alternator	Off
Cockpit Vents	Push Off
Air Conditioning / Heat	Off
Oxygen	On & Use
Avionics	Off
Bus Circuit Breakers	Pull Off (8)
Restore Essential Power	Bus by bus
Restore Essential Power	Circuit by Circuit

Severe Icing Encounter

Ignition Switch	On
Inertial Separator	On
Ice Protection	All On
Ice Inspection Light	On
Ice Build-Up	Monitor
Propeller Lever	1900 RPM
Bleed Air Heat	On
Temperature Control	Maximum
Defrost & Mixing Air	Full On

Air Start with Starter (Preferred)

Generator Load	Reduce
Standby Alternator	Off
Avionics	Off
Ignition Switch	Norm
Air Conditioning / Heat	Off
Emergency Power Lever	Normal
Power Lever	Idle
Propeller Lever	Minimum RPM
Condition Lever	Cutoff
Fuel Cutoff	Push In
Fuel Selectors	Both On
Battery Switch	On
Fuel Boost Pump	On
Aux Fuel Pump Annun	Illuminated
Fuel Press Low Annun	Extinguished
Altitude	Less than 20,000 ft
Starter Switch	Start
Ignition Annun	Illuminated
Oil Pressure	Rising
Ng RPM Rising	Greater than 12%
Condition Lever	Low Idle
ITT	1090 max. 2s
Ng RPM	Greater than 52%
Starter Switch	Off
Ignition Switch	As Required
Fuel Boost Pump	Off
Condition Lever	High Idle

Air Start Windmilling

Generator Switch	Trip
Standby Alternator	Off
Avionics	Off
Air Conditioning / Heat	Off
Emergency Power Lever	Normal
Power Lever	Idle
Propeller Lever	Minimum RPM
Condition Lever	Cutoff
Fuel Cutoff	Push In
Fuel Selectors	Both On
Battery Switch	On
Fuel Boost Pump	On
Aux Fuel Pump Annun	Illuminated
Fuel Press Low Annun	Extinguished
Ignition Switch	On
Airspeed	Greater than 100 kias
Altitude	Less than 20,000 ft
Ng	Non-Zero
Condition Lever	Low Idle
ITT	1090 max. 2s
Ng RPM	Greater than 52%
Ignition Switch	As Required
Fuel Boost Pump	Off
Condition Lever	High Idle
Generator Switch	Reset

Flap Failure

Flap Circuit Breakers	Check In
Standby Flap Mode	Standby
Standby Flap Motor	As Desired

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

Tips on Operation within MSFS & Limitations

Turboprop Engine Simulation

As many users of MSFS are aware, the native turbine engine simulation is flawed. This product makes numerous adjustments to the natively driven turbine values displayed on the cockpit instrumentation to provide a more realistic experience, but still not without its flaws. Mainly, users will notice the following:

- Ambient temperature has a larger effect on idle ITT than it should
- Beta range not properly gated or simulated
- Propeller drag is insufficient at flight idle

Engine Limits and Failures

When you operate an engine beyond its limits, damage to the aircraft is accumulated according to the level of the limit exceedance, and the type of limit exceeded. For instance, exceeding starting ITT limits will destroy an engine in seconds, while a slight exceedance of the maximum governed propeller RPM would not cause an engine failure for quite some time. When engine health is reduced to 25% of its initialized value, the CHIP DETECT annunciator light will illuminate. If engine parameters are not brought back within limits soon, the engine will fail.

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

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

Stalling Speed

Keep in mind that MSFS does not properly simulate propeller beta range. Although the propeller pitch does not reduce when power levels are placed below the flight idle position, the engine power is further reduced. On the ground, this means that turboprop aircraft are less likely to creep forward when throttle is reduced fully, though due to reduced engine power, not reduced propeller pitch. In flight, this seems to result in beta-like propeller drag when the power levers are reduced below flight idle, for which there is no gate. For proper stall performance in-flight, it seems that maintaining a throttle setting at where the flight idle gate would be (on the in-cockpit throttle quadrant), is necessary.

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, and there

is no real sense of AC power, or inverters. There are also some obvious bugs, most of which are mitigated by this product. The result is not a perfect electrical simulation, but should follow the indications expected by the included checklists.

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, eventually triggering an amber “BATTERY HOT” annunciator. If the battery is not disconnected from the power source, or the rate of charging reduced, a red “BATTERY OVERHEAT” annunciator will illuminate, indicating that the generator bus has been tripped, disconnecting it from the battery. 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.

Propeller Governors

This aircraft is equipped with an overspeed governor test, which should be performed on the first flight of the day. The overspeed governor test reduces the maximum governed speed from 1,900 RPM to approximately 1,750 RPM. Instructions for performing the test are provided in the Before Takeoff checklist; however, the static thrust produced by this simulation is enough to overpower the brakes at the required 1,800 RPM power setting. While it is not represented in the checklist, the overspeed governor can be tested in flight. Be aware that the propeller RPM will decrease extremely rapidly when the test button is pressed; therefore, the test should only be conducted at RPM’s very close to the reduced maximum governed RPM of 1,750.

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 Caravan is equipped with propeller deicing, pitot heat, stall warning heat, airframe deicing boots, inertial separators, and windshield heat. Windshield and pitot-static deicing work continuously, and slowly. Airframe deicing is provided by pressurized boots, which are toggled with the “Boot Press” switch. The “Auto” position will continuously cycle the airframe boots and clear ice (this was not working before), and the “Manual” position will clear ice only once.

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 have compounded the difficulty.

Existing customers of the Analog Caravan may have noticed undesired behavior with the publicly available beta of the Working Title GNS 530/430 available for free in the MSFS Marketplace. Reconciling all the issues created with the new capabilities of this GPS has been a long process, and we thank you for your patience. The Analog Caravan should now be fully compatible with these products with version 1.3. 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.

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-80 Navigation System, and the RDR 1150XL, additional resources are available online for the real world counterparts of these units. In particular the **"KNS-80 Pilot's Guide"**, available on Bendix/King's website, and the **"Weather Radar Pilot Training DVD"** on Bendix/King's YouTube channel.

Frequently Asked Questions

Will I still be able to fly the default G1000 Grand Caravan?

Absolutely! The default G1000 Caravan 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 Grand Caravan 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.

Why do the KAP 140 vertical speed buttons not work?

If you do not have the most up-to-date version of the Analog Caravan, you may still be using the default implementation of the KAP 140. The Analog Caravan now comes with a custom implementation of the KAP 140, which behaves much closer to reality. No mods are required or suggested to replace the KAP 140 anymore. For more information on using the custom implementation of the KAP 140, see the Systems Guide section of this manual.

Why won't the autopilot track to the KNS-80 RNAV waypoint?

Unfortunately, it is not possible to drive the stock MSFS autopilot system with a custom navigation source without implementing a whole new autopilot (to the best of my knowledge). It is recommended that you simply steer the autopilot via the heading bug with reference to the RNAV course deviation shown on the CDI.

Why is there an amphibious gear handle but no floats?

Since the scope of this product was to overhaul the Caravan's interior, it does not include an amphibious exterior model; however, I wanted the interior to be compatible with future community mods for the Caravan There are at least two amphibious Caravan mods already in development. When they are released to the public, I will ensure that this product is compatible with them, and release a new version of the product, if necessary.

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 Caravan, 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 right 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.

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. As of v1.4 of the Analog Caravan, these systems should all be working well together. Please see the changelog and “Third Party Navigation & GPS Systems" section of this manual for more information.

Change Log

v1.0 - Initial Release

v1.1 - Failures, Environmental Control, and Engine Performance

New Features:

- RANDOM & SCHEDULED FAILURE OPTIONS & MORE STATE SAVING ~ By popular request, 91 unique failures ranging from catastrophic engine failure to fuel leaks, and all electrical failures, can now be set, reset, toggled, and scheduled via a period accurate interface on the "MAP and "LOG" screens of the in-panel weather radar. Mean Time Between Failure (MTBF) can be set for each failure, saved between sessions, and accelerated up to 1024x real-time. Failures of nearly every on board system now force you to use in-game checklists for guidance, and are saved between flights for you to discover on your next flight. Engine condition is now viewable and repairable, and is saved between flights. Oxygen pressure is also now saved between flights and requires manual refill.
- Added Cabin Temperature Gauge and complete environmental control system. Cool things off by opening a window, or watch the airplane heat up in the sun. See manual for details on heat, A/C, and ventilation systems.
- Added Outside Air Temperature Gauge above windshield near pilots head upon request. OAT is also available on the transponder via the "FUNC" button.
- Inertial separator reduces torque by ~7% (125 ft-lbs at max Tq.)
- Cabin bleed air heat increases ITT
- Starter lag reduced, and new Ng calculation implemented.
- Revised KI-256 Attitude Indicator model upon request. Now includes raised angle markings.
- Included some easily accessible L:Vars in AnalogCaravan.xml for cockpit builders and 3rd party product integration.
- Removed "simulator limitations" from the manual for "ITT should be more limiting at high altitude", and "Torque Bloom not simulated", as these have been added to the Black Square Turbine Dynamics Simulation.

Bug Fixes:

- Significantly improved aerodynamics and performance, especially on takeoff. Engine performance more closely matches the PT6-114A (675 SHP). Takeoff distances tested with POH values. More realistic TAS in cruise. ITT and FF reduced to match real world performance samples.
- Turbine engine response to rapid power increase at low airspeeds improved.
- Reduced fuel flow spike when going from low to high idle.
- Opening storm window now affects sound attenuation.
- Autopilot annunciator lights no longer white, but amber, as they are incandescent.

- Radar Altimeter upper bounds reduced by ~500ft.
- KNS-80 labels tweaked.
- Added Propeller Governor Test to Checklist.
- Added Cabin Mixing Air operation to Checklist.
- Fixed NAV3 & NAV4 not working on SU10 Beta.
- Manual updated with all new features. Now over 70 pages!

v1.2 - Sounds & Warnings

New Features:

- CUSTOM SOUNDS & AURAL WARNINGS ADDED: A method by which to add custom sounds outside of the default WWISE package and retain all functionality in the default aircraft has been devised and implemented. This adds the iconic annunciator testing tones comprising the fire warning siren, and fuel selector off warning. Custom sounds have been added to the environmental control system to better represent the operation of fans, their speed, and the air conditioning compressor. Small ambient sounds have been added to better create the illusion of analog systems, such as relay/contactor clunks, and warning sound chirps when power is applied to their circuit. Lastly, oxygen system sounds have been added. For more information on the operation of these alert systems, see the “Audible Warning Tones” section of this manual.
- Added support for WTT Autopilot Mod, and WTT KAP140 implementation. A separate package is required to use WTT mode, available at pms50.com/msfs/. This mode limits radio equipment selection to the PMS50 GTN-750 GPS, which is a limitation of the WTT Autopilot System.
- New aerodynamics tweaks from JayDee. Updated fuel flow, turbine torque tables, SU10 ground handling parameters, and global constant adjustments. High altitude performance is also improved by virtue of torque bloom bug fix (see below).
- Radio background materials. Unlit digits and segments are now visible when equipment is off, and vary in appearance with viewing angle. Individual electrical traces are also visible.
- New custom implementation of the KX155B. Now supports changing frequency spacing (25 kHz for US, and 8.33 kHz for Europe) by pressing the COM volume knob, and active NAV frequency tuning by pulling the inner NAV radio tuning knob. Also displays a “T” symbol when transmitting on the appropriate COM radio. The display is also more crisp, uses a superior 7-segment display font, and the background glows with digit intensity.
- New custom implementation of the KR87. The correct font is now used for annunciator text, and placement is more accurate. The text is larger, easier to read, matches the size of other custom 7-segment displays in the aircraft, and the font now has the correct aspect ratio. The display is also more crisp, uses a superior 7-segment display font, and the background glows with digit intensity.
- Inertial separator actually reduces torque when applied and functions as engine anti-icing.
- Added more easily accessible L:Vars in AnalogCaravan.xml for cockpit builders and 3rd party product integration.

Bug Fixes:

- RANDOM GEOGRAPHICALLY SPECIFIC CRASH TO DESKTOP (CTD) FIXED: Special thanks to forum user Nicotine70 for volunteering the countless hours required to isolate this bug. A note to other developers: Apparently, MSFS does not play well with the Simulation Variable “WINDSHIELD WIND VELOCITY”. Although it is documented in the SDK, it is not used anywhere in the vanilla codebase. There are several suitable alternatives for this value, such as “RELATIVE WIND VELOCITY BODY Z”.
- KAP140 Altitude Holding and Capture modes reliability improved.
- Torque bloom calculations were causing artificially limited torque at high dynamic pressures. This is now fixed, and has improved fuel flow and climb rate at high altitudes.
- Improved Ng calculation to reduce startup lag.
- Fixed possible CTD with the new failure system when over ten failures were active at once. This is unrelated to CTD’s experienced with any aircraft while running Sim Update 10 Beta, or the “WINDSHIELD WIND VELOCITY” bug noted above.
- Exterior camera HUD correctly displays engine power setting and flap setting degrees.
- Improved variable choices for more accurate access to underlying free turbine simulation.
- GNS and GTN volume knobs now turn GPS power on and off.
- Fixed incorrect ITT variable for cockpit builders (L:BKSQ_CARAVAN_ITT).
- Fuel Flow adjusted and in-cockpit gauge now shows correct value.
- Improved Ng calculation again. Now includes secondary injectors on startup, and scales more accurately at low idle.
- Higher quality grunge texture (scratches & fingerprints) on windshield.
- Improved font and spacing on KDI572 DME unit.
- Fixed photocell texture on all avionics bezels.
- Added missing button press sounds to navigation source select buttons.
- Added missing sounds for radio knob pulling/pushing.
- Added missing sound and animation for GTN 750 push buttons.
- Manual updated with all new features.

v1.3 - Autopilot

New Features:

- New custom implementation of the KAP140 Autopilot. The previously recommended mod presented an incompatibility with the TDS GTN 750 after Sim Update 10 that resulted in modes getting stuck, and altitude hold mode failing to maintain altitude. No autopilot mod is required or recommended for the Analog Caravan any more. Existing autopilot mods installed in the Community folder can remain installed without affecting the Analog Caravan. Instructions on adding the 3rd party KAP140 mod have been removed from this manual. See the updated KAP 140 Autopilot section of this manual for instructions on use.

- Battery voltage drop now simulated. Large DC loads will pull down voltage.
- Altitude alerting tone when 1000ft remaining until altitude, and when leaving 200ft safe boundary around selected altitude.
- Original software architecture from v1.1 has been restored until MSFS exe.xml bug is fixed.
- Millibar setting window added to both altimeters.
- All Bendix/King radios now have 3D modeled knobs to match new aircraft releases.
- Equipment screenshots updated in the manual to reflect current appearances.

Bug Fixes:

- KR87 timer fixed. Press the set/reset push-button to cycle through “Start > Stop > Reset”.
- Missing KR87 tuning knob pull animation added.
- Autopilot knob animations corrected to fix broken default code.
- WTT mod implementation main panel autopilot annunciators corrected.
- Fixed screen flickering when adjusting interior lighting intensity. Note for developers: this may have had something to do with the cycle time of the Coherent environment.
- Default passenger loading reset to crew-only. Vestigial from aerodynamics testing.
- Trim wheel neutral position “TD” marking correct to “TO” to correct inherited default decal.
- Decision height indicator brightness adjusted.
- One more photocell texture fixed.
- Manual updated with all new features.

v1.4 - Working Title GNS Support, Autopilot II, HTML Failures, Nav Signal Degradation & Aesthetics

New Features:

- **Full Working Title (WT) GNS 530/430 compatibility.** The new WT GNS entered public beta via the in-game marketplace shortly after version 1.3 of the Analog Caravan was released. This replacement GNS GPS system offers many advanced features that will be enjoyed by many serious simmers. Unfortunately, these features proved difficult to integrate fully with the Black Square aircraft due to their hot-swappable avionics. After several months of incremental patches, this aircraft now fully supports the new GPS. **This was a laborious joint effort between TDS, PMS50, and Working Title developers. Thank you for your patience, and thank you to those who made it possible.**. Black Square and Working Title will continue to work together to ensure that there is as little interruption to service for this fabulous new GPS offering as possible should more changes become necessary. See the “Third Party Navigation & GPS Systems” section of this manual for more information.

  IMPORTANT: Please be sure to update all three GPS addons before trying to use this aircraft! If any of the three GPS addons are outdated, they may affect the others, even if they are not currently selected in the cockpit.

- KAP140 will now automatically display vertical speed setting for three seconds when the vertical speed is edited via external hardware, or key bindings. It will also engage the autopilot master when any of the mode buttons are pressed when the autopilot is not already engaged. When doing so, the unit will default to vertical speed hold mode. This greatly improves the ease of activating the autopilot after takeoff. After setting an altitude, pitch the aircraft for the desired vertical speed, and then press the desired lateral mode button. The autopilot will activate with the selected lateral mode, and will maintain the current vertical speed until capturing the set altitude.

- **A new interface into the failure system** has been provided in all Black Square aircraft for those wishing to trigger failures from external applications. Simple HTML events can now be sent from Air Manager, Axis and Ohs, and many more, including payware instructor stations, and even your own custom web interfaces. To learn more about this new feature see the “Failure System HTML Interface” section of this manual.

- **VOR and ADF receivers now exhibit mathematically accurate signal attenuation and noise** based on the aircraft’s height above the terrain and distance from the transmitter. This should greatly improve the feel of radionavigation in a flight simulator. For more information, see the “VOR & ADF Signal Degradation” section of this manual.

- **Custom propeller disk textures**. Vast improvement over default FSX-style textures. The default G1000 Caravan is not affected, and livery mods require no change.

- **New handcrafted 4K window surface imperfections.** Scratches and smudges are slightly less pronounced than default, but the high resolution results in minimal tiling, and a much more pleasant experience during low sun angles.

- 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.

- 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.

- New fuel pump cycling sound when the boost pump switch is set to “NORM”.

- Panel.noreg now included in the main package folder for livery creators. If you wish to create a livery mod that does not use the default tail number, simply use the line, “Panel = \..\..\bksq-aircraft-analogcaravan\panel.noreg” in the livery’s aircraft.cfg.

- WTT Autopilot mod now supports GPS vertical deviation from the PMS GTN 750 on the CDI. Keep in mind that this is only applicable to certain RNAV minima, such as LNAV/VNAV, LNAV+V, and LPV, but not LNAV, or LP.

- Electric trim switches will now only actuate trim when the “PITCH TRIM” circuit is functional. Electrical current draw is now indicated when the electric trim and other autopilot servos are in use. Disrupting power to the pitch trim or autopilot actuator circuitry will also cause the autopilot to disconnect, and it will not engage again until power is restored to both circuits. A continuous “TRIM” indication on the autopilot mode annunciator panel when the autopilot master is not engaged indicates a servo failure.

- Checklists updated with a procedure for testing the function of the autopilot roll actuators in the runup checklist. When the autopilot is engaged on the ground, heading mode will attempt to follow the selected heading with yoke movement, just like in the real aircraft.
- A method has been created to add engine and wind sounds to the cockpit when doors and windows are open for Steam Gauge Overhaul aircraft. The Analog Caravan was only in need of wind noise, but engine sounds have been added to the Analog King Air, and future Steam Gauge Overhaul aircraft.
- New autopilot disconnect sound to replace the inherited default G1000 sound.
- Rain and ice now appear on the outside of the storm window, instead of the inside.
- GTX 330 Transponder screen and bezel adjusted for more true to life appearance.
- Emergency toggle switch covers will now return the protected switch to its normal position when the cover is closed.

Bug Fixes:

- Windshield and Airframe deicing is verified to be working properly in SU11 Beta. Windshield and pitot-static deicing work continuously, and slowly. Airframe deicing is provided by pressurized boots, which are toggled with the “Boot Press” switch. The “Auto” position will continuously cycle the airframe boots and clear ice (this was not working before), and the “Manual” position will clear ice only once. Notes on ice mitigation have been added to the “Tips on Operation within MSFS” section of this manual.
- The fuel selector warning annunciator and alarm now sound under three conditions: when both fuel selectors are in the off position, or the fuel cutoff handle is pulled; when either fuel selector is in the off position and the starter is engaged; and when only one fuel selector is on, and the selected tank contains less than approximately 25 US gallons. The warning alarm can still be disabled by pulling the fuel selector warning circuit breaker, but the annunciator will still illuminate normally. The system can be fully disabled by pulling both the fuel selector warning circuit breaker and the starter controller circuit breaker. The red “FUEL SELECT OFF” annunciator will remain continuously illuminated to indicate that the system has been disabled, but no alarm will sound.
- New failure menu blinking cursor method. On some systems, there is an HTML rendering bug that will not blink the cursor with CSS animations, despite this being the recommended method used throughout MSFS. There is a workaround, and cursors should blink regardless now.
- The fuel boost pump will extinguish the low fuel pressure annunciator light so long as fuel is available to the engine, and the light will now cycle with the fuel boost pump sound when the switch is set to “NORM”.
- Thanks to the aircraft’s new persistent airspeed code, overspeed warnings will now activate at the correct indicated airspeed.
- Fixed missing button sounds on GNS430.
- SU10 ground handling parameters are now in the correct section of flight_model.cfg.
- Engine Fires are no longer recalled at the beginning of a flight like the rest of the failures, so alarms will not sound if you had an unresolved engine fire at the end of your last flight.

- Increased the polygon count of the glareshield and associated gap seal.
- Audio amplifier sound now connected to audio amplifier circuit instead of audio panel.
- SU11 localization compatibility.
- A possible bug in the RNAV system was explored. In summary: The RNAV behavior is accurate to the real world, and matches the indications from a simultaneously monitored VOR. The apparent angular error is introduced by VOR stations with declinations where the real magnetic variation has drifted significantly since their installation. In the real world, this is most likely disregarded as a wind correction angle, but absolutely affects real aircraft. This is not an error in the operation of the RNAV system, and the courses to RNAV waypoints should be flown as they would be to any physical VOR in the real world. For VOR's with inaccurate magnetic declinations, the actual magnetic bearing to the station is the flown course that produces a centered CDI in zero wind conditions, regardless of the OBS setting. More information is available in the Analog Caravan topic on the official MSFS forums.

Credits

Analog Caravan	Nicholas Cyganski
Publishing	Just Flight
Manual	Nicholas Cyganski
Testing	Just Flight Testing Team

Dedication

My second aircraft for Microsoft Flight Simulator is dedicated to John A. Orr, a close family friend, and the man without whom I would likely only have had a small fraction of the adventures and experiences in aviation that I have been fortunate enough to have. Soon after getting my pilot's license, John was willing to share fractional ownership of his Piper Warrior with me, potentially risking disaster by letting a newly minted pilot enjoy the freedoms of aircraft ownership. Rather than obsessing over my every move, John taught by example, and I credit him with many of my safe flying strategies. Going far beyond the role of a pilot mentor, John introduced me to all aspects of aircraft ownership, which I've done my best to pass onto others since. As an increasing number of flight schools become disinterested in renting their aircraft, most new pilots find themselves with the ability to fly, but suddenly without anything *to* fly, lacking a personal introduction to aircraft ownership. My other influences, to whom several of my products are now dedicated, have inspired me to pursue certain skills in life, but John inspired me to be generous with those skills and resources, and to share them with the next generation of pilots, engineers, and software developers.

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