Pilot's Operating Handbook

For

HOSKINS

CFS—1000A/1001A & CFS—2000A/2001A

COMPUTERIZED FUEL MANAGEMENT

SYSTEMS
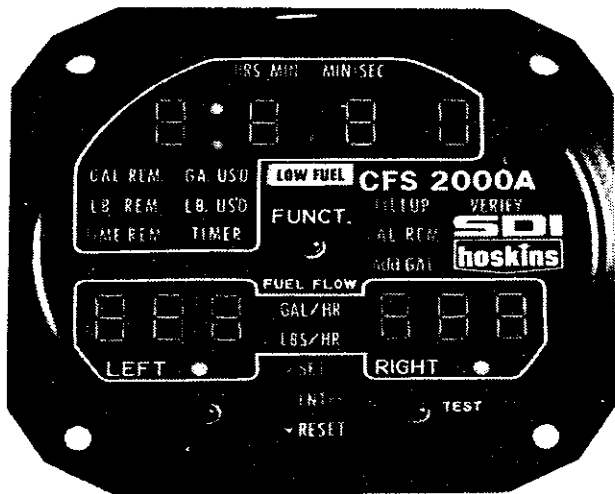
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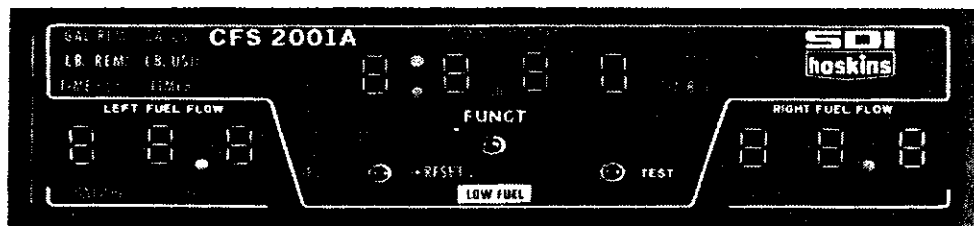
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Computerized Fuel Management Systems

CFS−1000A/1001A   −   SINGLE ENGINE

TWIN ENGINE   −   CFS−2000A/2001A

Round

Flatpack

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COMPUTERIZED FUEL SYSTEMS

1.0
GENERAL SYSTEM DESCRIPTION

The Computerized Fuel Systems, herein referred to as CFS, are designed to maximize efficency of fuel system monitoring and management and bring space-age capability and display technology to general aviation.

The CFS systems consist of a panel mounted instrument and fuel flow transducers which are designed for installation in the aircraft fuel lines.

MODEL	AIRCRAFT TYPE	TRANSDUCERS
CFS-1000A/1001A	Single Engine	One
CFS-2000A/2001A	Twin Engine	Two

These systems are designed for use in all single and twin engine aircraft having no more than 60 GAL/HR continuous consumption or 78 GAL/HR intermittent consumption (take off power).

1.1 PANEL MOUNTED INSTRUMENT

The panel mounted instrument contains all system electronics, operating and programming controls, and the digital readout display.

The digital readout utilizes incandescent, seven-segment displays and the function or mode legends incorporate mini-lamps. All digital readouts and legend displays are fully sunlight readable and feature automatic dimming for night and low light level flight conditions.

The systems' electronics are completly packaged in the panel mounted instrument on three rectangular circuit boards. The electronic design features the highest quality, solid state components available and a "single-chip" microprocessor.

The system computers are designed to precisely count the number of pulses from the fuel flow transducer(s) and convert the count to gallons. A crystal controlled clock reference is

used to compute the rate of fuel flow and the "TIMER" functions. The computer also routinely calculates all other displayed functions.

The basic program is permanently "burned-in" to the microprocessor chip, while variable data and intermediate computation values are stored by the computer in a separate memory bank. The aircraft's total usable fuel is programmed into this separate memory circuit by the computer in response to the installer's original instructions.

The panel mounted instrument and the flow transducer(s) are digital devices, therefore, there is no need for adjustment or calibration. The installer programmed "FILLUP" number, or usable fuel, is maintained in the computer memory even during aircraft shutdown. Electrical power for this function is provided by three small batteries mounted in the rear of the instrument case.

A low battery warning indicator is located on the front panel and will appear on the CFS-1000A/2000A as a minus sign in the upper display and on the CFS-1001A/2001A, a low battery legend will illuminate when the batteries become weak or need to be replaced. The batteries will typically last between 1 to 1 1/2 years and annual replacement is recommended.

1.2 FUEL FLOW TRANSDUCER

The flow transducer(s) are mounted directly in the fuel line, usually in the engine compartment. The transducer(s) measure flow of hydro-carbon fuel such as gasoline or kerosene. The transducer(s) are rated for a continuous operation to 60 gallons per hour and for intermittent flows in excess of 60 gallons per hour. In addition, the transducer(s) are precisely accurate down to 0.6 gallons per hour.

The transducer(s) supply the CFS computer with a pulse signal from a self contained opto-electronic pickup. A neutrally buoyant rotor spins with the liquid between V-jewel bearings. The rotor movement is sensed when notches in the rotor interrupt an infra-red light beam between a light emitting diode and a photo-transistor.

The transducer(s) are designed totally fail safe and complete rotor blockage cannot interrupt fuel flow. The transducer(s) life expectancy is 1,000 hours.

2.0 OPERATING PROCEDURES

The system operating procedures may be divided into two segments or conditions, Preflight and Inflight.

The Preflight, or program condition, is automatically called up by the computer when the aircraft's master switch is initially turned on. It is during the Preflight condition that the pilot updates or programs the computer to the current fuel system status.

When satisfied with current system status, the pilot verifies the accuracy of the data being entered into the computer and depresses the enter button. This action updates or programs the computer and automatically switches the system to the Inflight condition.

The words Preflight and Inflight condition do not appear in legend form on the face of the instrument. However, the legends of the Preflight condition appear on the right of the instrument and are a red color as a subtle reminder of the Preflight or program condition. The Inflight condition legends are located on the left side of the instrument and are amber in color.

2.1 FUNCTIONAL CONTROLS

The CFS systems are controlled through all modes of operation by the use of three push buttons. Two are for the primary modes, and one is for the test mode. The principal operating button is in the center of the instrument display and is labeled "FUNCT" for function. The mode of operation or function is stepped automatically through a sequence by pressing the function button, in either the Preflight or the Inflight condition.

The push button located in the lower left portion of the display instrument is not labeled by silk screen as are the "FUNCT" and "TEST" push buttons. However, this push button is accompanied by a lighted legend system that automatically indicates the correct mode of operation and is controlled by the

"FUNCT" push button. The three modes of operation are, "ENTER", "SET" and "RESET".

"ENTER" -- Push to enter data into computer.

"SET"   -- Set fuel amounts less than total usable.

"RESET" -- Reset button is used to zero or reset gallons used, pounds used or timer, allowing measurement of fuel and time for specific trips, holding pattern legs, or approaches.

The test push button is located on the lower right of the instrument display. When the test button is depressed, all legends and digits will illuminate for approximately three seconds, checking all legend lamps, the digital displays, and approximately 80% of the microcomputer. When the test button is depressed, all of the digits will illuminate as eights except the upper right digit which will illuminate as zero (8880). The microprocessor is programmed to automatically turn off the TEST circuit after three (3) seconds to assure no unnecessary heat build up.

The intensity of the digital displays and the lighted legends are automatically controlled to ease pilot workload and insure reliability in low and high intensity light conditions. The push-button controls have also been designed to ease pilot workload in all conditions of cockpit lighting and air turbulence.

The "Low Fuel" warning legend, located in the center of the instrument display, is designed to come on when, at current power setting, the time remaining to fly is less than one hour. When the time drops below 30 minutes, the legend blinks to further notify the pilot of a Low Fuel Status.

2.2 PREFLIGHT OPERATION

IMPORTANT NOTE: It is absolutely essential that the pilot program the computer to equal the amount of usable fuel in the aircraft's tanks before each flight. The computer measures fuel flow, and precisely counts down the remaining usable fuel from the programmed value provided during the Preflight condition. As in all computers, the accuracy of the resultant information

is a direct result of the accuracy of the information that was originally provided to the computer. Therefore, complete supervision of the fueling procedure is a must.

We further recommend a thorough visual inspection of tanks and caps. The fuel tanks should also be filled to the same visual reference each time they are topped off. Federal Air Regulations state that prudent and safe operating procedures be observed at all times.

2.3 PREFLIGHT PROGRAMMING

PREFLIGHT MODES

MODE	PROGRAMMING SITUATION USED
FILLUP	#1 Fuel Tanks Topped
GAL REM	#2 No Fuel Added
ADD GAL	#3 Tanks Not Topped
VERIFY	Verify correct information

Situation #1: Fuel Tanks Topped

Turn on the aircraft's master switch. The legend "GAL REM" will appear on the right section of the instrument, as will the legend "ENTER" on the lower portion. Simultaneously, the top section of the instrument will display the actual usable gallons of fuel remaining from the previous flight. Press the "FUNCT" button. The CFS systems will display the aircraft's total usable fuel (as programmed by the installing agency) and the legend "FILLUP" will appear in red on the right section of the instrument display. The legend "ENTER" will appear on the lower center section. If you have verified the tanks being topped off, press the "ENTER" legend button, thus programming the computer. This completes the Preflight programming for a full tank situation.

The computer will automatically switch to the Inflight condition, displaying the "GAL REM" legend in amber on the left of the instrument and the usable gallons remaining across the top section. On starting the engine (or engines), fuel will

begin flowing and the CFS systems will digitally display the gallons per hour fuel flow on the lower section of the instrument. In addition, the legend "GAL/HR" will appear on the lower section of the instrument display. The instrument is now programmed and ready for flight.

Situation #2: No Fuel Added

Turn on the aircraft's master switch. The legend "GAL REM" will appear on the right section of the instrument, as will the legend "ENTER" on the lower portion. Simultaneously, the top section of the instrument will display the actual usable gallons of fuel remaining from the previous flight. If the amount displayed is sufficient to satisfy your planned flight needs, depress the "ENTER" button. This completes the Preflight programming for a "No Fuel Added" situation.

The computer will now automatically switch to the Inflight condition displaying the "GAL REM" legend in amber (on the left of the instrument) and the usable gallons remaining across the top section of the display. On starting the engine (or engines), fuel will begin flowing and the CFS instrument will display the gallons per hour fuel flow on the lower section of the instrument. Procedure #2, explained above, programs the CFS instrument with the "GAL REM" quantity from the previous or last flight.

The CFS is now programmed with "GAL REM" from the last flight. When the engine(s) is started the "GAL REM" display will count downward to zero (0).

Situation #3: Fuel Added -- Less Than Topped

Turn on the aircraft's master switch. The top section of the instrument will display the actual usable gallons of fuel remaining. If the amount displayed is insufficient to satisfy your planned flight needs, but you do not desire to take on a full load (due to altitude or weight restrictions) press the "FUNCT" button. The CFS instrument will display the aircraft's total usable fuel (as programmed by the installing agency) and the legend "FILLUP" will appear in red on the right section of the instrument. Press the "FUNCT" button. The legend "ADD GAL" will appear in red on the right of the instrument, and the legend "SET" will appear on the lower center. Simultaneously,

the digital readout on the top section of the instrument will read all zeros. You are now ready to set values into the computer equaling the amount of fuel you have added to the tanks (less than full). Note, the zero on the far left is blinking, enabling you to observe the digit you are currently setting. Press the "SET" button until the blinking digit is incremented (one digit step per button push) to the desired value of the first digit. Then press the "FUNCT" button to shift the blink to the next digit, and increment it with the "SET" button as before. When all digits are set, press the "FUNCT" button; the blinking will stop and the legend "VERIFY" will appear on the right of the instrument, and "ENTER" will appear on the lower center.

If the amount of fuel displayed does not agree with your fuel ticket, press the "FUNCT" button three (3) times to return to the "ADD GAL" mode. If the amount agrees with your fuel ticket, press the "ENTER" button. The display amount will now equal the remembered "GAL REM" plus the amount just entered into the CFS computer, or total usable fuel aboard. On pressing the "ENTER" button, the computer automatically switches to the Inflight condition. If you note an error made during the "ADD GAL" sequence and wish to revise the value on the display, press the "FUNCT" button until the "ADD GAL" legend again appears and repeat the setting procedure. The CFS instrument is now programmed and ready for flight.

NOTE: If an error was made and the wrong amount of fuel entered into the Inflight mode, the following sequence must be used to return the computer to approximately zero so the correct amount of fuel may be entered.

1. Turn master switch off, then on, to reset the computer to Preflight condition.

2. Observe the incorrect "GAL REM" number.

3. To obtain the correction number subtract the incorrect "GAL REM" number from 1001 for twin engine aircraft and 100 for single engine aircraft.

EXAMPLE FOR TWIN:

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1001  Overflow Amount
-178  Incorrect "GAL REM"
 823  Correction Number
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4. Press the function button twice to enter the "ADD GAL" mode. Enter the correction number as previously explained in Situation #3. This will return the "GAL REM" number to approximately zero.

5. Turn master switch OFF, then ON, and step to the "ADD GAL" mode by depressing the function button. The correct "GAL REM" number may now be entered as previously explained in situation #3. This completes the correction sequence.

2.4 INFLIGHT OPERATION

As indicated in the Preflight or programming portion of this manual, the CFS systems incorporate three preflight programming capabilities. When entering any one of these possible program situations, the computer automatically switches to the inflight condition. Fuel flow is displayed only after the engines have been started.

The fuel flow window(s) on the lower section of the instrument will remain blank until a fuel flow is established. If the fuel flow is below 2.8 gallons per hour, the computer will blink the flow window to show a low flow situation. If at any time the flow is stopped or interrupted, the flow window will blank-out after approximately ten (10) seconds to indicate a no flow status.

The fuel flow window is updated on every 1024Th pulse. This method provides the pilot with a very stable fuel flow indication at the cruise power settings. A typical display update rate, at a fuel flow of 20 gallons per hour, would be every 2.178 seconds.

There are six inflight modes. Each mode is selected in sequence by pressing the "FUNCT" button.

The following chart indicates the mode sequence and the legend key.

LEGEND	MODE
GAL REM	Gallons Remaining
LB REM	Pounds Remaining
TIME REM	Time Remaining
GA. US'D	Gallons Used
LB. US'D	Pounds Used
TIMER	Timer (elapsed time)

During the automatic switching from the Preflight to the Inflight mode, the computer calls up the initial mode "GAL REM". From this initial mode the pilot may change modes (in the above sequence) by pressing the "FUNCT" button.

During the transfer from the Preflight to the Inflight condition, the CFS computer goes through an adjusting or rounding routine and may add or subtract, from the "GAL REM" number, two tenths (2/10) for a single engine aircraft or up to one (1) gallon for a twin. This automatic adjustment compensates for the "K" factor setting of the instrument and does not affect the accuracy.

As noted in the Functional Controls Section the first three Inflight modes, "GAL REM", "LBS REM", and "TIME REM" are nonresettable in the Inflight condition. This protects the pilot from accidental changes during flight. The second three Inflight modes can only be reset by depressing the "RESET" button while in each mode. However, the "GAL US'D" and "LBS US'D" will be reset together because the "LBS US'D" quantity is computed from the "GAL REM" number. The conversion factor for this computation is 5.82 pounds per gallon.

In the first mode, "GAL REM", the upper display indicates fuel remaining in gallons, and the lower display indicates fuel flow in gallons per hour. The lower display also includes a legend that automatically indicates GAL/HR in all gallon modes and LB/HR in all pound modes.

The upper display includes a legend that automatically indicates "HR:MIN" or "MIN:SEC" depending on which is appropriate in a given situation.

The <u>second</u> mode in sequence is the "LB REM" mode. When operating the system in this mode, the upper display will indicate pounds of fuel remaining, and the lower display will indicate fuel flow in pounds per hour.

The <u>third</u> mode is "TIME REM" mode. When operating the system in this mode, the upper display will indicate time remaining to fly at the current power setting, and the lower display will indicate fuel flow in gallons per hour.

During operation in the "TIME REM" mode the time remaining display will vary as the power settings are increased or decreased.

The "LOW FUEL" warning legend located in the center of the instrument is designed to come on when the current power setting results in a "TIME REM" of less than one (1) hour. If the "TIME REM" drops below thirty (30) minutes the legend will blink to further notify the pilot of a <u>Low Fuel Status</u>.

The <u>fourth</u> mode is the "GA US'D" mode. When operating the system in this mode, the upper display will indicate gallons used and the lower display will indicate fuel flow in gallons per hour. This mode may be reset to zero by pressing the "RESET" button; however this will also reset the "LBS US'D".

The <u>fifth</u> mode is the "LB US'D" mode. When operating the system in this mode, the upper display will indicate pounds used and the lower display will indicate fuel flow in pounds per hour. This mode may be reset to zero by pressing the "RESET" button; however this will also reset the "GAL US'D".

The <u>sixth</u> mode is the "TIMER" mode. While operating the system in this mode, elapsed time is indicated. The "TIMER" mode indicates minutes and seconds up to nine minutes and fifty-nine seconds and hours and minutes beyond that point. The elapsed time is indicated in the upper display and the lower display indicates fuel flow in gallons per hour. When the "TIMER" mode is selected the elapsed time may be reset by pressing the "RESET" button.

During aircraft shutdown the "GAL REM", and "LBS REM" quantities will be retained by the computers internal memory. All other inflight functions are reset to zero (0) when the

aircaft power is turned off.

3.0 SYSTEM MAINTENANCE

The Fillup number is normally held for a period of one year by the three small Eveready MS-76 batteries in the rear of the instrument. These batteries should be replaced once each year. During installation and after replacing the batteries, the Fillup number (aircraft total usable fuel) may need to be reprogrammed. The following procedure will explain the steps necessary to change or reprogram the Fillup number.

3.1 PROGRAMMING THE FILLUP NUMBER

The CFS-1000A/1001A cannot be programmed for a "FILLUP" number greater than 99.9 gallons unless switch #3 is turned to the ON position.

FILLUP programming may be performed on the bench with a 14V or 28V DC power source or in the aircraft with aircraft power.

A. On the CFS-1000A/2000A, remove the one screw attaching the instrument battery cover. The seven mini-switches will now be exposed. On the CFS-1001A/2001A the battery cover need not be removed. The battery compartment will be directly below on the CFS-1000A/2000A only. Locate the far left switch marked #1 and push to the ON or CLOSED position. All other switches are pre-set at the factory. Do not change their position. In the event their position is changed, refer to the Switch Table to reposition them.

B. Turn the aircraft master switch ON. Note all the digits on the top display have gone to zero and the far left zero is blinking. The minus sign on the right hand side of the display is the low battery indicator in the CFS-1000A/2000A only.

C. Press the "SET" button to advance the blinking digit to a number equaling the first number in the aircraft's usable fuel. Press the "FUNCT" button once and observe that the second digit is now blinking. Press the "SET" button to advance the blinking digit to the desired second number of the aircraft's usable fuel.

Press the "FUNCT" button again. This will cause the third
and final digit to blink as did the first two digits. Press the
"SET" button, advancing the third digit to the desired final
figure in the aircraft's usable fuel. Press the "FUNCT" button
and note the legend "VERIFY". Press the "ENTER" button if this
number corresponds to the aircraft's usable fuel. The
programmed number may change or blank out. This is normal,
continue programming with step D.

D. Locate the mini-switch marked #1 and push to the OFF or OPEN
   position. (CFS-1000A/2000A Only: Reinstall the three small
   batteries and the battery cover.

E. Turn the power switch off.

F. Turn the aircraft master switch on and press the "FUNCT"
   button. The "FILLUP" legend will be illuminated and the number
   displayed should agree with the aircraft usable fuel or the
   number just programmed. If the number agrees, push the "ENTER"
   button. If the number does not agree, repeat steps A, B, C, D,
   E & F.

G. "GAL REM" should equal the aircraft usable fuel. Finally, push
   the "TEST" button to assure that all legends and digits
   illuminate properly. The digital displays will read eight (8)
   in the test position with the exception of the far right which
   will read zero (0). (After the "TEST" button has been depresed
   for 3 seconds, the CFS-1000A/2000A or 1001A/2001A will
   automatically cycle out of the test mode to avoid overheating).

H. Turn off the power switch. This completes the programming of
   the Fillup number.

3.2 SWITCH TRUTH TABLE

The programming switches in the rear of the CFS instruments are normaly preset at the factory. In the event their position is changed refer to the table below to reposition them.

If a CFS-1000A or CFS-1001A is to be programmed for over 100 gallons, switch #3 should be turned to the ON position.

Switch #4 will change the Pounds conversion factor from 5.82 ppg to 6.7 PPG. This switch is used only if the aircraft is burning Kerosene fuel. This switch changes the Pounds Readings Only!

SWITCH TRUTH TABLE FOR "A" MODELS

SWITCH #

#1   FILLUP   PROGRAMMING SWITCH

#2   OFF   ---   Not Used

#3   Less Than 100 Gal OFF --- MORE THAN 100 Gal ON

#4   ON for gas   ----   OFF for kerosene

#5   OFF   ---   Not Used

TRANSDUCER CALIBRATION SWITCHES

	LOW 'K'	MIDDLE 'K'	HIGH 'K'
#6	ON	ON	OFF
#7	ON	OFF	ON

4.0 SYSTEM SPECIFICATIONS "A" MODEL

CFS SYSTEM SPECIFICATIONS

INPUT VOLTAGE RANGE	11-32 VOLTS DC
INPUT CURRENT	1.5 AMPS MAXIMUM
MAXIMUM PROGRAMMABLE FUEL	790 GALLONS
OPERATING TEMPERATURE RANGE	-30°C TO +55°C
ALTITUDE	-1000 TO 40,000 FT
VIBRATION	5 G'S
SHOCK	10 G'S
CRASH SAFETY	15 G'S
HUMIDITY	UP TO 95% @ +55°C
TRANSDUCER	201B 0.6 TO 60 GPH
ACCURACY	+/- 2% @ +15°C
WEIGHT: INSTRUMENT CFS-1000	23 OZS.
CFS-2000	23 OZS.
TRANSDUCER	5 OZS EA
BATTERIES:	3EA EVEREADY MS-76