PILOTS OPERATING HANDBOOK

COMPUTERIZED FUEL SYSTEMS

TURBINE AND PISTON ENGINES

SDI P/N 702313-(   )
SDI P/N 206406-1 OR -2

hoskins

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1.0 COMPUTERIZED FUEL SYSTEMS

The Computerized Fuel Flow Indicating Systems (CFS Models) are designed to maximize efficiency of fuel system monitering and management while bringing space-age capability and display technology to general aviation.

The CFS systems consist of a panel mounted main instrument, optional remote fuel flow indicator(s), and flow transducer(s) designed for installation in the aircraft's fuel line(s).

CFS MODEL DESIGNATION

AIRCRAFT TYPE	INSTRUMENT DISPLAYING FUEL FLOW:		
	REMOTE ONLY	MAIN ONLY	MAIN and REMOTE
Turbine, Single Engine	CFS 1012	CFS 1122	CFS 1212
Turbine, Twin Engine	CFS 2022	CFS 2112	CFS 2212
Piston, Single Engine	CFS 1022	CFS 1122	CFS 1222
Piston, Twin Engine	CFS 2022	CFS 2122	CFS 2222

These systems are designed for use in turbine powered fixed wing and rotor wing aircraft having a fuel consumption of 1000 pounds per hour or less per engine and in piston powered aircraft having a continuous fuel consumption of 60 gallons per hour or less per engine. The main instrument will display fuel quantity up to 9999 gallons, although the computer will process larger quantities.

1.1 PANEL MOUNTED MAIN INSTRUMENT

The panel mounted main instrument contains all system electronics, operating controls, and the digital readout display designed for mounting in a standard 3-1/8 inch instrument hole or a 3 inch ATI mount.

All digital readouts in the main instrument utilize incandescent mini lamps and seven segment displays which are automatically dimmed for optimum visibility under all lighting conditions.

The main instrument provides the following fuel management information: Fuel Flow (GALLONS/HR), Fuel Flow (LB/HR), Gallons Remaining, Pounds Remaining, Time Remaining, Gallons Used, Pounds Used, and two Clock Timers. In addition, a low fuel warning legend flashes whenever the flight time remaining at the current fuel consumption rate is 45 minutes or less.

The CFS fuel management systems are designed to count the number of pulses from a fuel flow transducer and convert this number to gallons. The computer has circuits which convert the "gallons" to "pounds" and, using a quartz crystal clock reference, compute rate of fuel flow and timer functions. The conversion of gallons to pounds is temperature compensated on Turbine CFS models.

The basic program is permanently "burned in" to the microcomputer chip while variable data and intermediate computation values are stored in a seperate memory. The aircraft's total useable fuel is programmed into the memory by the installer when the unit is initially installed in the aircraft. Power for the memory is supplied by three small batteries located in an external battery pack. A low battery warning legend on the main instrument face will illuminate when the batteries need to be replaced. The batteries typically last between 1 to 1 1/2 years and annual replacement is recommended.

1.2 OPTIONAL DIGITAL REMOTE FUEL FLOW INDICATORS

The optional 2" digital fuel flow indicators are solid state instruments which display fuel flow in gallons per hour or pounds per hour, depending on the mode selected in the main instrument. The digital remote indicators incorporate incandescent mini lamps for legend annunciators and seven segment displays for the digital fuel flow readout. The remote fuel flow indicators dim automatically on command from the main instrument for optimum visibility under all lighting conditions, and may directly replace existing 2" fuel flow gages in most aircraft.

1.3 FUEL FLOW TRANSDUCER

A fuel flow transducer is mounted in the fuel line near each engine. A rotor in the transducer rotates in proportion to the amount of fuel flowing past it.   A sensor in the transducer counts rotor revolutions and sends pulses to the computer which converts the pulses to the readings seen on the main and remote instruments.

2.0 OPERATING PROCEDURES

The Preflight (or programming) condition is automatically called up by the computer when the aircraft master switch is initially turned on.   During the Preflight condition the pilot updates or programs the computer to the current fuel status and verifies the computer is displaying the correct information, he then presses the "ENTER" button.. This action updates or programs the computer and automatically switches the system to the Inflight condition.   The main instrument incorporates legends which are red in color during the Preflight condition (located on the right side of the instrument) and amber or white during the Inflight condition (located on the left side of the instrument).

2.1 FUNCTIONAL CONTROLS

The CFS systems are controlled through all modes of operation by the use of three pushbuttons (two for primary modes and one for the test mode).   The principle operating button is near the center of the main instrument and is labeled "FUNCT" for function.   The mode of operation or function is shifted automatically through a sequence by pressing the "FUNCT" button in either the Preflight or Inflight condition.

The pushbutton located in the lower left of the main instrument is the "ENTER", "SET", or "RESET" button and is accompanied by a lighted legend system that indicates its applicable function. The legend appears automatically and is controlled by the computer. Use of this pushbutton accomplishes the following:

LEGEND READS:	ACTION:
"ENTER"	Push button to enter data into computer.
"SET"	Push button to set fuel amounts other than total useable fuel.
"RESET"	Push button to zero or reset gallons used, pounds used and timer values.

The test pushbutton is located on the lower right of the main instrument. When the test button is depressed all legends and digits will illumnate, checking all lamps, displays, and approximately 80% of the microcomputer.

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

2.2 PREFLIGHT OPERATION

NOTE: It is absolutely essential that the pilot enter into the computer the amount of useable fuel in the aircraft's tanks before each flight. The computer measures fuel flow and counts down from the value entered into the computer during the Preflight condition. As in all computers, the accuracy of the computed information is a direct result oi tne accuracy oi tne information originally entered. Complete supervision of the fueling operation is a must and will help assure accuracy. It is further recommended that the pilot assure the tanks are filled to the same visual reference each time they are topped -- and that the caps are securely fastened so as to prevent the venting of fuel overboard.

2.3   PREFLIGHT SYSTEM PROGRAMMING

Situation #1:   No fuel added

Turn on the aircraft master switch.   The CFS main instrument will display the Gallons Remaining from the previous flight in the top display of the main instrument and the "GAL REM" legend will appear on the right center section of the Instrument as will the "ENTER" legend on the lower center section. If the amount displayed is sufficient to satisfy your planned flight needs and no fuel is added to the aircraft, press the "ENTER" button.   This completes the Preflight condition programming for a "NO FUEL ADDED" situation.   The computer will now automatically switch to the Inflight condition, displaying the "GAL REM" legend in white (on the left center of the instrument) and the useable gallons remaining in the top display of the main instrument.   On starting the aircraft engine(s), fuel will begin flowing and the CFS main instrument and optional remote instruments will display fuel flow in gallons per hour.   The CFS System is now programmed and ready for flight.

Situation #2:   Aircraft Fuel Tanks Topped

Turn on the aircraft master switch.   The CFS main instrument will display the Gallons Remaining from the previous flight and the "GAL REM" legend will appear on the right center section as will the "ENTER" legend on the lower center section. Press the "FUNCT" button.   The legend "FILLUP" will appear on the right center section of the main instrument.   Simultaneously, the top display of the main instrument will show the actual aircraft useable fuel in gallons (as programmed by the installing agency). If you have verified that the tanks were topped off, press the "ENTER" button.   This completes the Preflight condition programming and automatically transfers the computer to the Inflight condition, displaying the "GAL REM" legend, in white, on the left center of the instrument and the useable gallons in the top display of the main instrument.   On starting the aircraft engine(s), fuel will begin flowing and the CFS main instrument and optional remote instruments will display fuel flow in gallons per hour. The CFS System is now programmed and ready for flight.

Situation #3:   Intermediate Quantity of Fuel Added or
               Subtracted

        Turn   on the aircraft master switch.   The CFS main in-
strument will display the Gallons Remaining from   the   previous
flight   and   the "GAL REM" legend will appear on the right center
section.   Press the "FUNCT" button.   The legend "FILLUP" will ap-
pear   on   the   center section of the display.   Press the "FUNCT"
button a second time.   The legend "+/- GAL" will appear   on   the
right   center   section of the display as will the "SET" legend on
the lower center section.   The top display of the main instrument
will read all zeros. The "+" sign will be flashing. If you wish
to add gallons, push the "FUNCT" button.   If you wish to subtract
gallons,   push   the   "SET"   button to change the "+" to "-" sign,
then push the "FUNCT" button.   This sequence selects the add   or
subtract   gallons   mode and shows the appropriate "+" or "-" sign
in the upper display of the main instrument.

        SETTING THE DIGITS: The value equalling the amount   of
fuel   added   or   subtracted   from   the fuel tanks may now be set.
NOTE: The zero on the far left is flashing indicating that   this
is   the first digit that is to be "SET" and the "SET" legend near
the lower left pushbutton has illuminated.   Pressing   the   "SET"
button will change the value of the flashing digit, increasing it
by one each time the button is pressed.   If the amount   of   fuel
added   (or   subtracted)   is   less   than 1000 gallons,   press the
"FUNCT" button to proceed to the next digit and set as   explained
above.   Repeat this process until all four digits have been set.
NOTE: If setting less than 1000 gallons, pressing   the   "FUNCT"
button   after   the   4th   digit   has   been set will illuminate the
decimal and move the entire displayed number   one   place   to   the
left, allowing the tenths (.0) digit to be set.

        When   the   final   digit   has been set press the "FUNCT"
button again and note the legend "VERIFY" by   the   upper   display
and the legend "ENTER" by the lower left pushbutton. If the num-
ber displayed is the same as the amount of fuel added to (or sub-
tracted from) the aircraft,   press the "ENTER" button.   The com-
puter will switch to the Inflight condition,   the legend will in-
dicate "GAL REM" and the display will show a number equal to the
sum of the previous gallons remaining plus   the   fuel   added   (or
subtracted).   NOTE: If   the   number entered during the above
programming sequence is   in   error,   do   not   press   the   "ENTER"
button.   Continue to press the "FUNCT" button (3 times) until the
"+/- GAL" legend appears again.   Then   follow the   programming
sequence explained above.

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2.4 INFLIGHT OPERATION

CAUTION: It is imperative that the Preflight Programming as explained in the Preflight Operation section be accomplished prior to engine start each flight. Failure to perform this Preflight Programming before each flight will allow the CFS fuel management system to display invalid data.

Upon entering the data that was programmed during the Preflight Programming the computer will shift to the Inflight condition. Fuel flow will be displayed after engine start.

The CFS system has seven Inflight modes, each of which is selected in the sequence shown below by pressing the "FUNCT" button:

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

1st MODE: GAL REM. The main instrument displays fuel remaining in gallons and fuel flow is shown in gallons per hour.

2nd MODE: LB REM. The main instrument displays fuel remaining in pounds and fuel flow is shown in pounds per hour. If the weight of the fuel remaining exceeds 9999 LBS. the main instrument will display this number until enough fuel is burned to bring the fuel weight below 9999 pound.

3rd MODE: TIME REM. The main instrument displays the available time remaining to fly at the current power setting. Fuel flow is shown in pounds per hour on the CFS Turbine System and in gallons per hour on the CFS Piston System. Time remaining will vary if the power setting is increased or decreased. A "LOW FUEL" warning legend located near the center of the instrument is designed to flash when, at the current power setting, the time remaining to fly is 45 minutes or less.

4th MODE: GAL US'D. The main instrument displays fuel used in gallons and fuel flow is shown in gallons per hour. The "RESET" legend will appear by the lower left pushbutton which may be used to reset the GAL US'D display to zero, allowing measurement of fuel used for a specific event (such as fuel used during climb or from a particular set of tanks).

5th MODE: LB US'D. The main instrument displays fuel used in pounds and fuel flow is shown in pounds per hour. The "RESET" legend will appear by the lower left pushbutton which may be used to reset the LB US'D display to zero.

6th MODE: TIMER. The main instrument displays the time elapsed since the master switch was turned on. Fuel flow is shown in pounds per hour on the CFS Turbine System and in gallons per hour on the CFS Piston System.

7th MODE: TIMER. The main instrument displays the time elapsed since the master switch was turned on or since the "RESET" button was pressed. The "RESET" legend will appear by the lower left pushbutton which may be used to reset the time to zero, allowing specific times to be measured (such as for holding patterns or approaches).

3.0 MAINTENANCE

Under normal conditions the CFS fuel management systems provide years of trouble free operation. Normal maintenance ("FILLUP" number programming and battery replacement) procedures are explained below.

3.1 PROGRAMMING THE FILLUP NUMBER

CAUTION: The CFS memory will not retain the existing "Gallons Remaining" number during "FILLUP" value reprogramming. If the main instrument is to show the same "Gallons Remaining", write the value down and re-enter it after programming by following the steps outlined in Preflight Programming Situation #3: Fuel Added or Subtracted.

The CFS main instrument incorporates a front programming feature that allows easy changing of the preprogrammed "FILLUP" number. If it is desired to change the number (or if the memory has "lost" the number due to low battery voltage), locate the small programming hole in the instrument faceplate just above center on the right side. Insert the CFS PROGRAMMING TOOL (similar to a small paperclip) into the hole. Once inserted, turn on the aircraft master switch (or recycle the switch "OFF" and back "ON" if it was previously on). Note the display is showing all zeros, the left zero is flashing indicating that this is the first digit to be "SET", and the "SET" legend has appeared by the lower left pushbutton. The desired "FILLUP" number may be set and entered in the manner described in Preflight Programming – Situation #3: SETTING THE DIGITS. Once the "FILLUP" value has been entered into the computer, first remove the programming tool, then turn off the aircraft master switch. This completes the "FILLUP" programming operation.

Turn the aircraft master switch back "ON". The "GAL REM" legend will appear and the display will show zero. Press the "FUNCT" button and note the "FILLUP" legend apppears and the display shows the number set during the above procedure. If the aircraft currently contains this amount of fuel, press the "ENTER" button. If the airplane contains a different amount of fuel, press the "FUNCT" button again and note the "+/- GAL" legend appears. The correct number may now be set as described in Preflight Programming, Situation #3: Fuel Added or Subtracted.

INSERT PROGRAMMING TOOL HERE
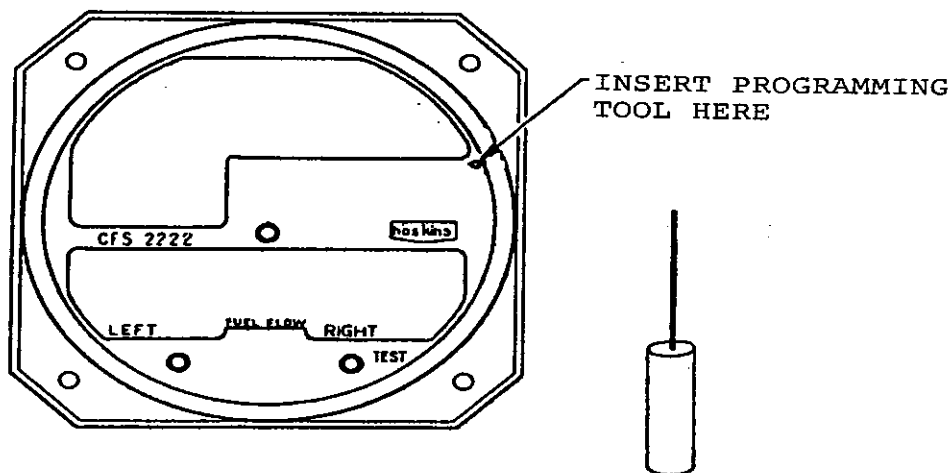
3.2 BATTERY REPLACEMENT

The CFS System has a memory which stores the "FILLUP" value (normally the aircraft useable fuel) as programmed into the computer during installation. The memory also retains the fuel remaining value between flights. Power for the memory is supplied by three Mallory MS-76 (or equivalent) batteries. Although these batteries will normally last 1 1/2 years, THE BATTERIES SHOULD BE REPLACED ANNUALLY. Failure of the batteries to supply the needed voltage will result in loss of the memory function necessitating reprogramming the "FILLUP" number. (NOTE: The "LOW BAT" legend will illuminate when the batteries need replacing).

Turn the aircraft master switch ON when changing the batteries. This keeps power to the memory while the batteries are out of their container. The cylindrical battery pack is connected to the end of two 24 inch wires coming from the wiring harness at the rear of the main instrument. The batteries go into the container with the flat (+) side facing the removeable cap. At the completion of the battery installation, verify the "LOW BAT" legend is not illuminated.
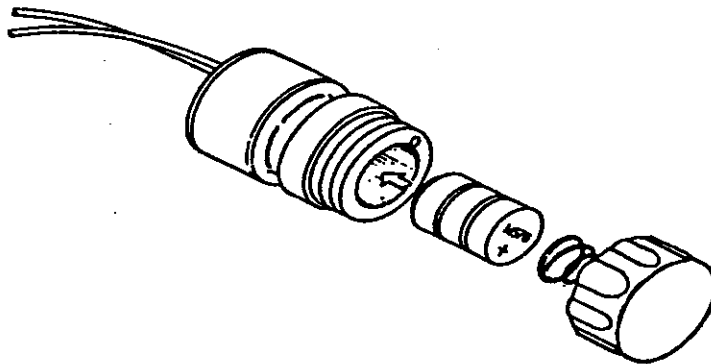
3.3 TRANSDUCER REPLACEMENT

Replacement transducers may be purchased from Symbolic Dipslays, Inc. Under some conditions the Turbine Systems transducers (SDI P/N 204788-002) may be refurbished. Contact Customer Service at SDI for details.

4.0 SWITCH TABLE

The Programming Switches (located under the cover at the rear of the main instrument) are set at the factory and program the proper fuel density into the computer. The table below shows the switch positions and corresponding fuel density. The fuel density program affects the LB REM, LB US'D, and LB/HR readings only; the tranducer is a volumetric device and measures volume regardless of density.

SWITCH TABLE

FUEL TYPE	FUEL DENSITY LB/GAL	SW1	SW2	SW3	SW4	SW5	SW6	SW7
JET A*	6.75	OFF	OFF	ON	OFF	OFF	OFF	OFF
JET B	6.45	OFF	OFF	OFF	ON	OFF	ON	ON
JP-5	7.07	OFF	OFF	ON	OFF	ON	OFF	OFF
AVGAS**	5.83	OFF	ON	OFF	OFF	OFF	OFF	ON

* CFS Turbine instruments are set for JET A or A-i fuel. If less dense fuels are used the instrument will display higher than normal readings. With the switches set for JET A, the CFS instruments will read 4.8% high when using JET B and 4.6% low when using JP-5. If either of these fuels will normally be used the switches may be reset per the table above to obtain accurate readings.

** CFS Piston instruments are set for AVGAS. The density of AVGAS is based on an average of densities supplied by U.S. refineries.

4.1 SYSTEM SPECIFICATIONS

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                    CFS 1012,  2012,  1022,  2022
                    CFS 1112,  2112,  1122,  2122
                    CFS 1212,  2212,  1222,  2222
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TECHNICAL SPECIFICATIONS

INPUT VOLTAGE   10 to 32 VDC

INPUT CURRENT	AT 14VDC	AT 28 VDC
Normal Mode	0.6 AMP	0.3 AMP
Test Mode	1.8 AMP	0.9 AMP

MAXIMUM PROGRAMMABLE   9,999 GALLONS
USEABLE FUEL

OPERATING TEMPERATURE
   Instrument   -30 C to +70 C
   201B Transducer   -40 C to +100 C
   204788-002 Transducer   -40 C to +120 C

ALTITUDE   -1000 to +50,000 feet

VIBRATION   INSTRUMENT 3G'S
                                              TRANSDUCER 20'S

SHOCK   10 G'S

HUMIDITY   UP TO 95%

201B TRANSDUCER
   Flow Range   0.6 to 60 GPH
   Accuracy   +/- 2%

704288-002 TRANSDUCER
   Flow Range   4 TO 150 GPH
   Accuracy   +/- 2% 4-15 GPH
                                              +/- 1% 15-150 GPH

WEIGHT
   Instrument w/cable   1.4 LBS
   Digital Remote w/cable   0.5 LBS (EACH)
   201B Transducer   0.3 LBS (EACH)
   704288-002 Transducer   0.8 LBS (EACH)

BATTERY   3 EA MS-76 MALLORY OR EQUIV.