Computerized Fuel Management Systems

for

Turbine Engine Aircraft

CFS—1002/2002

SDI P/N 702049

Pilot's Operating Handbook

SDI
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COMPUTERIZED FUEL SYSTEMS

1.0 General System Description

The Computerized Fuel Flow Indicating Systems, CFS-1002/2002, are designed to maximize efficiency 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 main instrument and remote fuel flow indicator(s) with a stainless steel transducer designed for installation in the aircraft fuel lines.

MODEL	AIRCRAFT TYPE	TRANSDUCERS REQUIRED	SYSTEM WEIGHT
CFS-1002	Single Engine	1	2.6 lbs.
CFS-2002	Twin Engine	2	3.5 lbs.

These systems are designed for use in all fixed wing and rotor wing turbine engine aircraft having a total fuel consumption of 2000 pounds per hour or less and a total fuel capacity of 67,000 pounds or less.

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" 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: Gallons Remaining, Pounds Remaining, Time Remaining, Gallons Used, Pounds

Used and Two Clock Timers. In addition, a low fuel warning system automatically illuminates whenever the fuel remaining drops below 45 min at the current fuel consumption rate.

The CFS-1002/2002 fuel managements systems are designed to precisely count the number of pulses from the fuel flow transducer and compute a temperature compensated conversion to pounds. A crystal controlled clock reference is then used to further compute the fuel flow rate and timer readout functions. All other displayed functions are routinely calculated and stored. These functions can be displayed by simply pressing the "Function" button.

The basic CFS computer program is permanently incorporated within the computer chip. A separate memory bank stores variable data and intermediate computation values including the aircraft usable fuel which is programmed by the installers prior to installation in the aircraft. Power to retain the aircraft usable fuel number is supplied by three miniature size batteries located in the rear of the main unit and are completely independent of the aircraft battery. A low battery warning legend located on the front panel will illuminate when the batteries become weak and 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 Indicator (Digital)

The remote digital fuel flow indicators are totally solid state and indicate fuel flow in gallons and pounds per hour depending on the mode selected in the main instrument. Similar to the main instrument, the digital remote incorporates incandescent mini lamps for legend enunciators and seven segment incandescent displays for the digital fuel flow readout. The remote fuel

flow indicator(s) dim automatically on command from the main instrument for optimum visibility under all lighting conditions.

1.3 Remote Fuel Flow Indicator (Analog)

The remote analog fuel indicator also indicates fuel flow in gallons or pounds per hour by two small mini lamps located in the lower section of the indicator. The main instrument selects the gallons or pounds mini lamp automatically when a gallons or pounds mode is selected in the main instrument. The analog (and digital) fuel flow indicators directly replace existing two inch fuel flow gauges in most turbine engine aircraft.

1.4 Fuel Flow Transducer

A stainless steel turbine transducer mounted in the fuel line produces pulses as the fuel flows through the turbine blades. The turbine rotates in precise proportion to the volume of fuel passing through the transducer. A sensor is attached to the flowmeter housing next to the turning rotor. The rotation of the turbine rotor sends pulses to the main instrument which represents a discrete volume of fuel. The main instrument counts the frequency and duration of these pulses and converts them to fuel flow and displays this information on the remote fuel flow gauges.

2.0 Operating Procedures

The preflight, or programming condition, is automatically called up by the computer when the aircraft's master switch is initially TURNED ON. During the preflight condition the pilot updates or programs the computer to the current verified fuel status. When the pilot is satisfied with the current fuel status and verifies the correct data has been entered into the computer he then presses the "enter" button. This action updates or programs

the computer and automatically switches the system to the in-flight condition. The words "pre-flight" and "in-flight" are silkscreened on the face so the pilot may readily identify these conditions. The legends of "pre-flight" are red in color as a subtle reminder of the "pre-flight" or programming condition. The "in-flight" legends are amber in color and are located on the left center of the main instrument.

2.1 Functional Controls

The CFS-1002/2002 systems are controlled through all modes of operation by the use of three push buttons, two for primary modes and one for the test mode. The principal operating button is in the center of the main instrument display and is labeled "Funct" for function. The mode of operation or function is shifted automatically through a sequence by pressing the function button in either the "pre-flight" condition or the "in-flight" 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 and timer modes, allowing measurement of a specific trip, holding pattern legs and 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 checking all legend lamps, the digital displays, and approximately 80% of the microcomputer.

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

The automatic functions of the low fuel warning system legend (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 45 min.

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

We further recommend thorough visual inspection of tanks and caps, and pilot assurance that tanks are filled to the same visual reference each

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time they are topped off. It is a Federal Air Regulation, that prudent
and safe operating practice and procedure be observed at all times.

2.3 System Programming

Situation #1: No Fuel Added

Turn on the aircraft master switch. On activating the aircraft electrical
system the CFS 1002/2002 will display the Gallons Remaining from the previous
flight in the top section of the main instrument and the "Gal Rem" legend
will appear in red on the right center section of the display as will the
"Enter" legend on the lower center section. If the amount displayed
is sufficient to satisfy your planned flight needs, depress 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 amber (on the left
center of the instrument) and the usable gallons remaining across the top
section of the main display. On starting the engines, fuel will begin
flowing and the CFS 1002/2002 will display the gallons per hour fuel flow
on the remote fuel flow gauges, located in the engine cluster. The
CFS-1002/2002 is now programmed and ready for flight.

Situation #2: Aircraft Fuel Tanks Topped

Turn on the aircraft master switch. On activating the aircraft electrical
system the CFS 1002/2002 will display the Gallons Remaining from the previous
flight and the "Gal Rem" legend will appear in red on the right center
section. Press the "Funct" button. The legend "Fill Up" will appear on
the right center section of the main instrument as will the legend "Enter"
on the lower center. Simultaneously, the top section of the main instrument
will display the actual aircraft usable gallons of fuel (as programmed by

the installing agency). If you have verified that the tanks were topped off, press the "Enter" button. This completes the pre-flight condition programming and automatically transfers the computer to the in-flight condition displaying the "Gal Rem" legend, in amber, on the left center of the instrument and the usable gallons across the top section of the main instrument. On starting the aircraft engines, fuel will begin flowing and the CFS 1002/2002 remote fuel flow gauges will begin displaying fuel flow in gallons per hour. The CFS 1002/2002 is now programmed and ready for flight.

Situation #3: Intermediate Quantity of Fuel Added or Subtracted

Turn on the aircraft master switch. On activating the aircraft electrical system the CFS-1002/2002 will display the Gallons Remaining from the previous flight and the "Gal Rem" legend will appear in red on the right center section of the display as will the "Enter" legend on the lower center section. Press the "Funct" button. The legend "Fill Up" will appear on the center section of the display. Press the "Funct" button on a second time. The legend "± Gal" will appear in red on the right center section of the display as will the "Set" legend on the lower center section. The digital readout on the top section of the main instrument will read all zeros. The "+" sign in the left upper display will be blinking. If you wish to add gallons push the "Function" button. If you wish to subtract gallons, push the "Set" button to change the "+" sign to a "-" sign then push the "Function" button. This sequence selects the add or subtract gallons mode by selecting the appropriate "+" or "-" sign in the upper left section of the main display. You are now ready to set values into the computer equaling the amount of fuel you have added or subtracted from the fuel tanks. Note, the zero on the far

left will blink enabling you to observe the digit you are currently programming. Press the "Set" button until the blinking digit is incremented (one number per button push) to the desired value of the first digit. (Remember, you are setting thousands (1000) of gallons with 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. (Note: If the quantity of fuel added or subtracted is greater than 1000 gallons the fourth time the "Funct" button is depressed the "Verify" legend will illuminate. If the quantity is less than 1000 gallons (999 or less) the fourth time the "Funct" button is depressed the display will shift one place to the left and illuminate the decimal to set tenths of gallons (Example: 898.5). When all digits are set, press the "Funct" button, the blinking digit will stop and the legend "Verify" will appear on the right center of the main instrument and the legend "Enter" will appear on the lower center. If the amount of fuel displayed agrees with your computations and is verified, <u>press the "Enter" button.</u> The display will now equal the remembered "Gal Rem," plus the amount just entered into the CFS 1002/2002, or total usable fuel aboard. On pressing the "Enter" button the computer automatically transfers to the inflight condition and displays "Gal Rem" of usable fuel.

2.4 Inflight Operation for CFS 1002/2002

As indicated in the preflight or programming portion of this manual, the CFS 1002/2002 system incorporates three preflight programming capabilities. When entering any of these possible program situations, the computer automatically switches to the inflight condition. Fuel flow is displayed only after the engines have been started.

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There are seven 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	Legend	Mode
GAL REM	Gallons Remaining	GA US'D	Gallons Used
LB REM	Pounds Remaining	LB US'D	Pounds Used
TIME REM	Time Remaining	TIMER	Timer (elapsed time Non-resettable)
		TIMER	TIMER (Resettable)

During the automatic switching from the preflight to the inflight condition, 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.

In the "GAL REM" mode the main instrument display indicates fuel remaining in gallons and the remote fuel flow gauges indicate fuel flow in gallons per hour.

NOTE: The remote fuel flow gauges include a legend that automatically indicates GAL/HR in all gallon modes and LB/HR in all pound modes.

The second mode in sequence, is the LB REM mode. When operating the system in this mode the main display is indicating pounds of fuel remaining, and the remote fuel flow gauges indicate pounds per hour. If the weight of the fuel exceeds 9,999 lbs the main display will remain on this number until enough fuel is burned to drop the weight below 9,999 lbs.

The third mode is the TIME REM mode. When operating the system in this mode the main display is indicating time remaining to fly at the current

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power setting and the remote fuel flow gauges indicate fuel flow in pounds per hour.

The fourth mode is the GA US'D mode. When operating the system in this mode, the main display is indicating gallons used and the remote fuel flow gauges indicate fuel flow in gallons per hour.

The fifth mode is the LB US'D mode. When operating the system in this mode, the main display is indicating pounds used and the remote fuel flow gauges are indicating fuel flow in pounds per hour.

The sixth mode is the TIMER mode. While operating in this mode elapsed time is indicated from the time the master switch is turned on. This mode is NON resettable in flight and is reset when the master switch is turned off.

The seventh mode is also a timer. This timer starts at zero when the master switch is turned on and counts upward but is resettable in flight by depressing the reset button.

NOTE: During operation in the TIME REM mode the time remaining will vary as power setting is increased or decreased. As noted in the functional controls section, the CFS 1002/2002 incorporates a RESET capability. The RESET function is available only in the GA US'D, LB US'D, and second TIMER modes. This allows precise measurement of those functions during climb out, holding patterns or approaches.

NOTE: The automatic function of the low fuel warning system legend (legend located in the top center of the display instrument) is designed to come on when at current power setting, the time remaining to fly is less than 45 min.
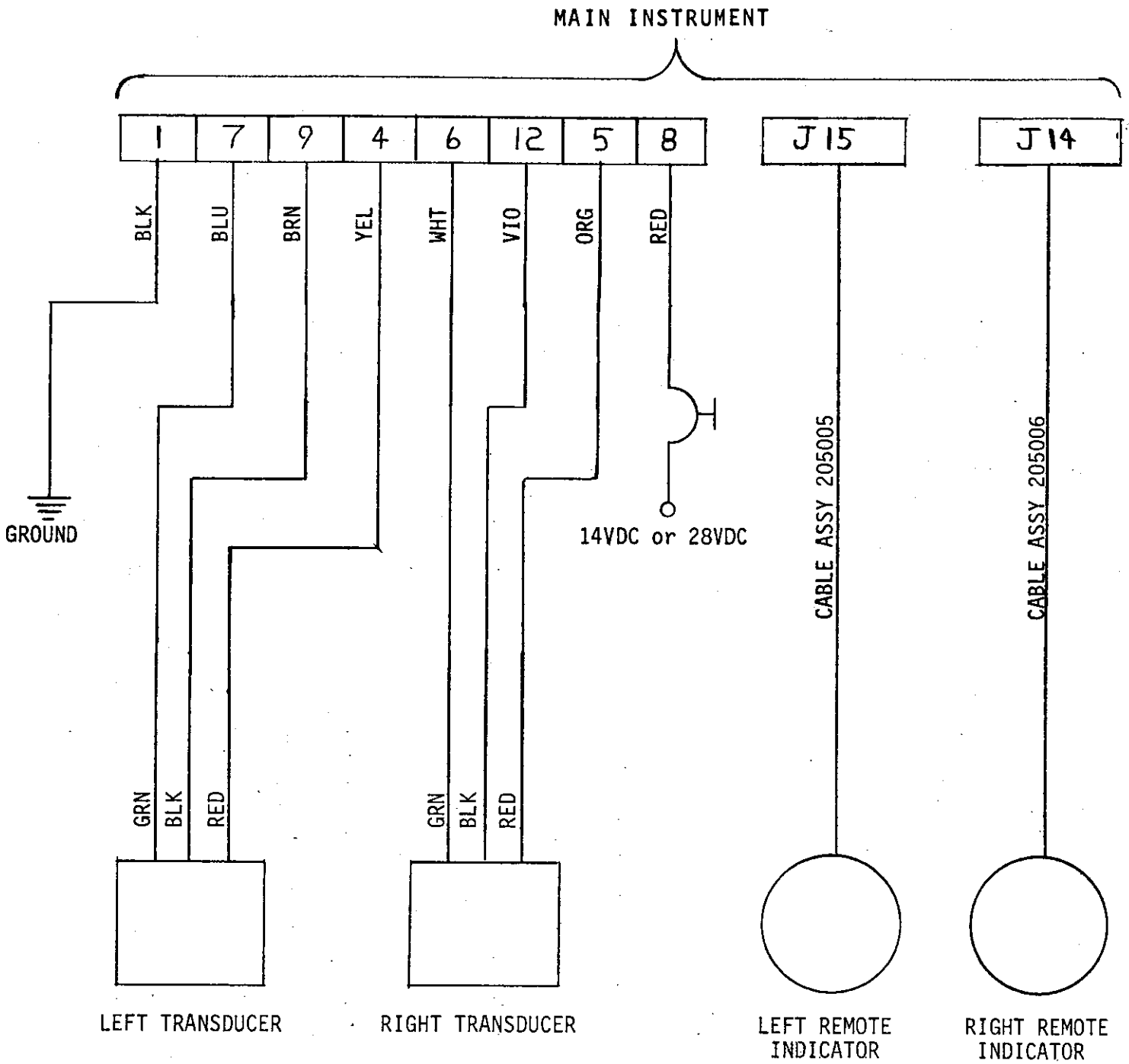
NOTE: CAUTION: This system is scaled for type Jet A and Jet A-1 fuels with Specific Gravity of 6.76 lbs/gal @ 15^{0}C (59^{0}F). If a lighter (less dense) aviation fuel is used than Jet A or Jet A-1, the indicators will read at a higher consumption rate than the fuel is actually being consumed.

3.0 System Specifications

CFS 1002/2002 TECHNICAL SPECIFICATION

INPUT VOLTAGE RANGE	10-32 VOLTS DC
INPUT CURRENT	2.2 AMPS MAX
MAXIMUM PROGRAMMABLE USABLE FUEL	9,999 GALLONS
OPERATING TEMPERATURE	-30°C TO +50°C
ALTITUDE	-1000 FEET TO 40,000 FEET
VIBRATION	1.5 G'S
SHOCK	10 G'S
HUMIDITY	UP TO 95%
TRANSDUCER	1.5 - 150 GAL/HR Per Engine
ACCURACY	+2%
WEIGHT	3.5 LBS
BATTERY	3 EA-MS 76 MALLORY EQUIV.

3.0 System Schematic

MAIN INSTRUMENT

| 1 | 7 | 9 | 4 | 6 | 12 | 5 | 8 | J15 | J14 |

BLK BLU BRN YEL WHT VIO ORG RED

GROUND

14VDC or 28VDC

CABLE ASSY 205005

CABLE ASSY 205006

GRN BLK RED

GRN BLK RED

LEFT TRANSDUCER · RIGHT TRANSDUCER

LEFT REMOTE INDICATOR

RIGHT REMOTE INDICATOR
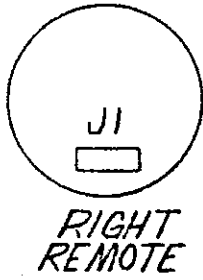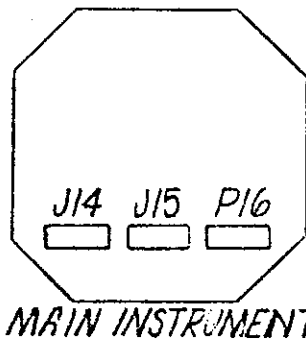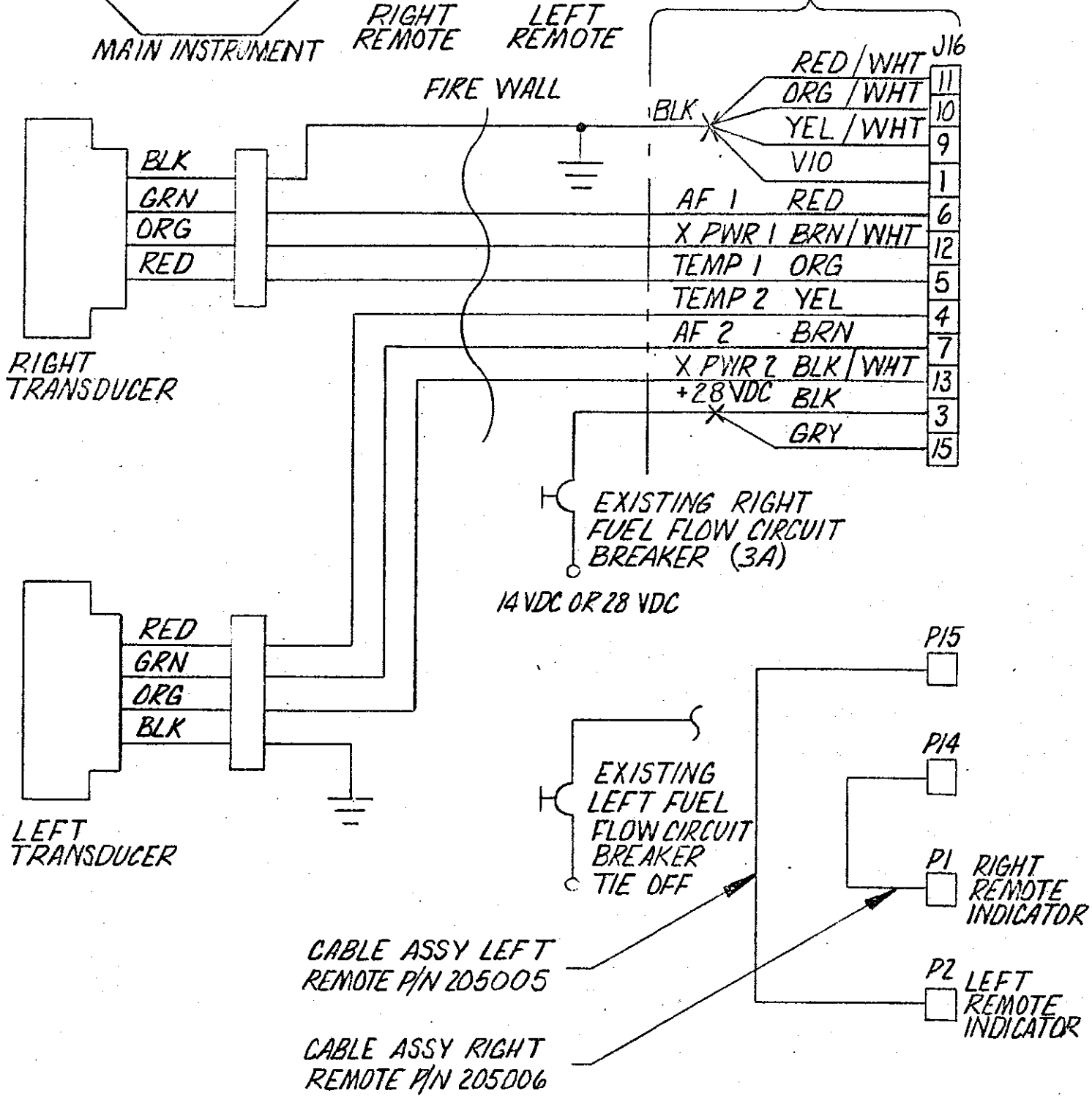
NOTE:

Please obtain a copy of the STC installation manual for your specific type of aircraft.

REAR VIEW ARRANGEMENT

J14 J15 P16

MAIN INSTRUMENT

J1

RIGHT REMOTE

J2

LEFT REMOTE

WIRE HARNESS P/N 205010

FIRE WALL

BLK

	J16
RED / WHT	11
ORG / WHT	10
YEL / WHT	9
VIO	1
AF 1 RED	6
X PWR 1 BRN / WHT	12
TEMP 1 ORG	5
TEMP 2 YEL	4
AF 2 BRN	7
X PWR 2 BLK / WHT	13
+28 VDC BLK	3
GRY	15

BLK
GRN
ORG
RED

RIGHT TRANSDUCER

EXISTING RIGHT FUEL FLOW CIRCUIT BREAKER (3A)

14 VDC OR 28 VDC

RED
GRN
ORG
BLK

LEFT TRANSDUCER

EXISTING LEFT FUEL FLOW CIRCUIT BREAKER TIE OFF

CABLE ASSY LEFT REMOTE P/N 205005

CABLE ASSY RIGHT REMOTE P/N 205006

P15

P14

P1 RIGHT REMOTE INDICATOR

P2 LEFT REMOTE INDICATOR

USE EXISTING FUEL FLOW WIRING FROM ENGINE COMPARTMENT TO FUEL FLOW INDICATORS OR USE MIL-W-5086A 20 AWG WIRE.

SYSTEM SCHEMATIC