

Fuel Management System SC14 SERIES

Installation and Maintenance Manual

Senior Aerospace Ketema
790 Greenfield Drive
El Cajon California 92021
619-442-3451 or 619-588-3373
Fax 619-440-1456 or 619-588-3381
www.sfketema.com

SC14 GENERAL INSTRUCTIONS

- Senior Aerospace Ketema designs, manufactures, and tests its products to meet many national and international standards. However, for these products to operate within their normal specifications, you must properly install, use and maintain these products. The following must be adhered to and integrated with your safety program when installing, using, and maintaining Senior Aerospace Ketema products.
- Read and save all instructions prior to installing and operating the product.
- If you do not understand any of the instructions, contact your Senior Aerospace Ketema representative for clarification.
- Follow all warnings, cautions, and instructions marked on and supplied with the product.
- Inform and educate your personnel in the proper installation and operation of the product.
- Install your equipment as specified in Senior Aerospace Ketema installation instructions and per applicable local/national codes. Connect all products to the proper electrical sources.
- Handle, move, and install each product using the appropriate number of personnel and equipment. Failure to do so could cause serious personal injury.
- To ensure proper performance, use qualified personnel to install and maintain the product.
- Equipment contains no user serviceable parts.
- When repair is required, ensure that the unit is sent to Senior Aerospace Ketema. For repair.
- **WARNING** This equipment may contain static sensitive devices. Failure to comply with the proper handling procedures may result in damage to the equipment. Unauthorized substitutions may result in fire, electrical shock, other hazards, or improper equipment operation.
- Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified personnel, to prevent electrical shock and personal injury.

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Revision History

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Retain this record in front of manual.

On receipt of revisions, insert revised pages in the manual and enter revision number, date inserted, and initials.

GENERAL CONDITIONS OF SALE FOR INSTRUMENTS AND PARTS

The conditions of sale stated herein shall be an integral part of any contract resulting from a purchase order placed upon Senior Aerospace Ketema, and hereinafter called KETEMA. Any statement made on any form issued by Purchaser shall not operate to defeat the intent of these conditions unless specifically agreed upon in writing by KETEMA.

CONDITIONS OF SALE:

1. **ACCEPTANCE:** All orders are subject to an authorized employee of KETEMA at its principal office.
2. **PRICES:** All prices pertaining to an order are quoted in the offering or will be quoted and confirmed by KETEMA in subsequent addenda thereto.
 - A. **FIRM OFFER:** Except as otherwise provided in the offering, all quoted prices are firm for thirty (30) days from date of offering. All prices are f.o.b. Shipping Point (transportation charges collect) unless expressly stated otherwise in the offering or agreed upon in writing by KETEMA.
 - B. **TAXES AND OTHER CHARGES:** All quoted prices are subject to additions which may be necessary to cover any duty, tax or charge, now existing or hereafter imposed by Government authorities upon equipment or services quoted by KETEMA, or upon the production, sale, distribution, delivery, import or export thereof, or upon other features related thereof; AND unless otherwise stated in the offering, prices not quoted in United States currency are based on the rates of exchange between the U.S. dollar and the quoted currency ruling at the date of offering and any variation greater than two per centum (2%) between such rates ruling at the date of offering and date of payment to KETEMA shall be for the Purchaser's account.
 - C. **ERRORS:** KETEMA reserves the right to correct all typographical or clerical errors or omissions which may be present in its prices or specifications.
 - D. **ESCALATION:** All prices quoted are based on deliveries as defined in the offering. KETEMA reserves the right to make partial deliveries of equipment as it becomes available, unless specified otherwise in the offering or agreed upon in writing by KETEMA. Delays caused by KETEMA beyond the Quoted Delivery shall not be subject to escalation. Delays and/or Scope Changes (in accordance with paragraph 4) caused by Purchaser shall be subject to escalation at a rate to be determined for each month in excess of the Quoted Delivery.
 - E. **RESALE PRODUCTS:** KETEMA does not offer price protection on resale products other than those contained in the KETEMA Price Book. Such products are quoted subject to price changes from the KETEMA suppliers between the date of the offering and the date of the KETEMA invoice.
 - F. **MAINTENANCE AND SPARE PARTS:** Maintenance service and spare parts are not included in the price of the product unless specified otherwise in the offering or agreed upon in writing by KETEMA. Orders for parts or repairs shall be subject to a minimum billing charge.
3. **PAYMENT TERMS:** Payment shall be made within thirty (30) days from the date of the invoice unless KETEMA specifies an irrevocable letter of credit in a specific currency placed on a specific bank. Partial payments shall be provided when so specified by KETEMA or as a result of Scope Changes (in accordance with paragraph 4) in which event KETEMA shall notify Purchaser in writing of the modified payment terms.
4. **SCOPE CHANGES:** All changes affecting the equipment configuration or otherwise affecting the scope of the order are to be documented in writing for approval and authorization to incorporate such changes into the order. All changes authorized by Purchaser are binding only if accepted by KETEMA, and may result in price, delivery, and/or condition changes. Pricing of changes shall be based on the then current prices. If an extension of delivery is required beyond the original schedule, escalation shall be agreed. Letter(s) of credit, if applicable, shall be extended and the values enhanced as necessary to reflect changes in price and payment arrangements.
5. **CANCELLATION:** Purchaser may cancel his order by written notice provided Purchaser pays cancellation charges on the basis of the percentage of work and/or materials completed on the date cancellation notice is received by KETEMA. Standard cancellation/restocking charges are published for standard instruments and such charges are available from KETEMA upon request. Resale products committed by KETEMA shall be paid for in full.
6. **TESTING:** Any additional tests or inspections requested by Purchaser beyond KETEMA standard manufacturing procedures shall be for the Purchaser's account, unless specified otherwise in the offering or agreed upon in writing by KETEMA.
7. **ON-SITE RECEIPT OF EQUIPMENT AND INSTALLATION:** Purchaser shall be responsible for receiving, installing, starting up, and maintaining all equipment, unless specified otherwise in the offering or agreed upon in writing by KETEMA.
8. **DELIVERY:** Title to the equipment and risk of loss or damage shall pass upon delivery by KETEMA to the possession of the carrier unless specified otherwise in the offering or agreed upon in writing by KETEMA. Any claims for loss or damage after risk of loss has passed shall be filed by Purchaser with carrier. KETEMA shall not be liable for loss or damage from delay in delivery or failure to manufacture. Delivery dates are approximate and are based on prompt receipt by KETEMA at its factory of all necessary information including final agreement on detailed specifications, on such date or with such lead times as may be specified by KETEMA. If delivery is delayed at the request of, or due to acts or omissions by Purchaser, KETEMA shall have the right to store the goods at a place of its own choice for Purchaser's account and risk and to invoice Purchaser in accordance with the original contractual terms and for such storage charges incurred as a result of the delay.
9. **DOCUMENTATION:** KETEMA will provide Purchaser with up to the following quantities of applicable standard Drawings and instructions unless specified otherwise in the offering or agreed upon in writing by KETEMA. Additional copies will be furnished at extra charge. All documentation will be in the English language unless expressly stated otherwise in the offering or agreed upon in writing by KETEMA.
 - A. **DRAWINGS:** Two prints or one print plus a sepia reproducible for installation and maintenance and two prints plus a sepia reproducible for approval, when applicable. Drawings for resale products shall be those provided by KETEMA suppliers.
 - B. **INSTRUCTIONS:** Two sets of standard instructions for installation, operation, and maintenance for standard products; one set for Resale Products and Parts, all as defined by KETEMA.
10. **SPARE PARTS AVAILABILITY:**
 - A. **ACTIVE PRODUCTS:** On all standard KETEMA products, it is KETEMA policy to provide functionally interchangeable replacement parts during the period of time that the product is offered for sale. On Resale Products, no future availability of spare parts or products is guaranteed.
 - S. **PRODUCTS WITHDRAWN FROM SALE:** It is KETEMA policy that functionally interchangeable replacement parts for standard noncomputer products will be available for at least five (5) years from the date of withdrawal from sale.
11. **WARRANTIES: KETEMA EXPRESSLY WARRANTS THE PRODUCTS MANUFACTURED BY IT AS MEETING THE APPLICABLE KETEMA PRODUCT SPECIFICATIONS. KETEMA MAKES NO OTHER WARRANTIES EITHER EXPRESS OR IMPLIED (INCLUDING WITHOUT LIMITATION WARRANTIES AS TO THE MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE). PURCHASER RETAINS RESPONSIBILITY FOR THE APPLICATION AND FUNCTIONAL ADEQUACY OF THE OFFERING. IN ADDITION, THE FOLLOWING SHALL CONSTITUTE THE EXCLUSIVE REMEDIES FOR ANY BREACH BY KETEMA OF ITS WARRANTIES HEREUNDER.**
 - A. **MATERIAL AND WORKMANSHIP:** KETEMA warrants to Purchaser that all products manufactured by KETEMA shall be free from defects in material and workmanship, and agrees to either replace or repair free of charge, any such product, component, or part thereof which shall be returned to the nearest authorized KETEMA repair facility within one (1) year from the date of delivery, transportation charges prepaid for the account of Purchaser. The cost of demonstrating the need to diagnose such defects at the job site, if required, shall be for the account of the Purchaser. Any product or component, or part thereof, so replaced or repaired shall be warranted by KETEMA for the remainder of the original warranty period. Any and all such replacements or repairs necessitated by inadequacy, preventative maintenance, or by normal wear and usage, or by the fault of the Purchaser or power sources supplied by others or by attack and deterioration under unsuitable environmental conditions shall be for the account of the Purchaser. KETEMA shall not be obligated to pay any costs or charges including "back charges" incurred by the Purchaser or any other party except as may be agreed upon in writing in advance by KETEMA.
 - B. **RESALE PRODUCTS:** Resale products shall carry only the warranty offered by the original manufacturer, unless specified otherwise in the offering or agreed upon in writing by KETEMA. KETEMA shall have no responsibility for the functioning of resale products specified by Purchaser or his agent.
 - C. **PATENTS:** KETEMA shall defend Purchaser and pay any award of damages assessed against Purchaser in any suit or proceeding so far as same is based on any claim that the equipment or any part thereof furnished hereunder (except for equipment basically of Purchaser's specifications) shall in design or construction infringe any patent of the country of its manufacture, provided Purchaser gives KETEMA prompt notice in writing of such claim and permits KETEMA to contest same through its counsel or, at its option, to settle by securing for Purchaser the right to continue to use such equipment or by modifying it to avoid infringement, or by reclaiming it and reimbursing Purchaser the sum paid therefor; and provided Purchaser gives KETEMA all necessary authority and assistance, at the expense of KETEMA, to enable KETEMA to do so.
 - D. **PARTS:** The warranties specified in paragraph 11 A are modified to three (3) months in the case of parts.
12. **FORCE MAJEURE:** Neither party shall be considered in default in performance of obligations hereunder to the extent that performance of such obligations, or any of them, is affected by Force Majeure. Force Majeure shall include, but not be limited to, hostilities, restraint of rulers or peoples, revolution, civil commotion, strike, epidemic, accident, fire, flood, wind, earthquake, explosion, blockade, or embargo, lack of or failure of transportation facilities or any law, proclamation, regulation or ordinance, demand or requirement of any Government or Governmental agency having or claiming to have jurisdiction over the work or with respect to materials purchased for the work, or over the parties hereto, or any Act of God, or other act of Government, or any cause whether of the same or different nature existing or future, which is beyond the control and without the fault or negligence of the parties hereto.
13. **INSURANCE INDEMNITY:** KETEMA will at Purchaser's request submit Certificates of insurance from Sureties chosen by KETEMA showing the limits of coverage. KETEMA agrees to indemnify and save harmless Purchaser only against liability imposed on Purchaser by law with respect to bodily injury or property damage to the extent such liability results from the performance of KETEMA under this contract. KETEMA does not agree to indemnify and save Purchaser harmless except as set forth herein. Purchaser agrees to indemnify and save harmless KETEMA for all loss, cost or damage incurred by KETEMA as a result of Purchaser's or third parties misuse or misapplication of KETEMA supplied products. IN NO EVENT, REGARDLESS OF CAUSE, SHALL KETEMA BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGE EITHER REAL OR ALLEGED.
14. **MISCELLANEOUS:** The validity, construction, and interpretation of these conditions or of any contract of sale including these conditions, and the rights and duties of the parties thereto, shall be governed by the laws pertaining to KETEMA in its country of domicile, notwithstanding the inclusion of any services in such contract. Any offering or contract of which these conditions are a part constitutes the final complete and exclusive statement of representations made by KETEMA, and KETEMA shall not be bound by any representations, promises or inducement of any kind unless set forth herein nor shall be bound to any representations made herein except to the designated recipient of any offering or contractual commitment. No waiver, alteration or modification of any of the provisions herein or of the provisions of any contract arising herefrom shall be binding on KETEMA unless in writing and signed by Purchaser and KETEMA.
15. "Seller hereby certifies that these goods were produced in compliance with all applicable requirements of Section 6, 7, and 12 of the Fair Labor Standards Act, as amended, and of regulations and orders of the United States Department of Labor under Section 14 thereof."

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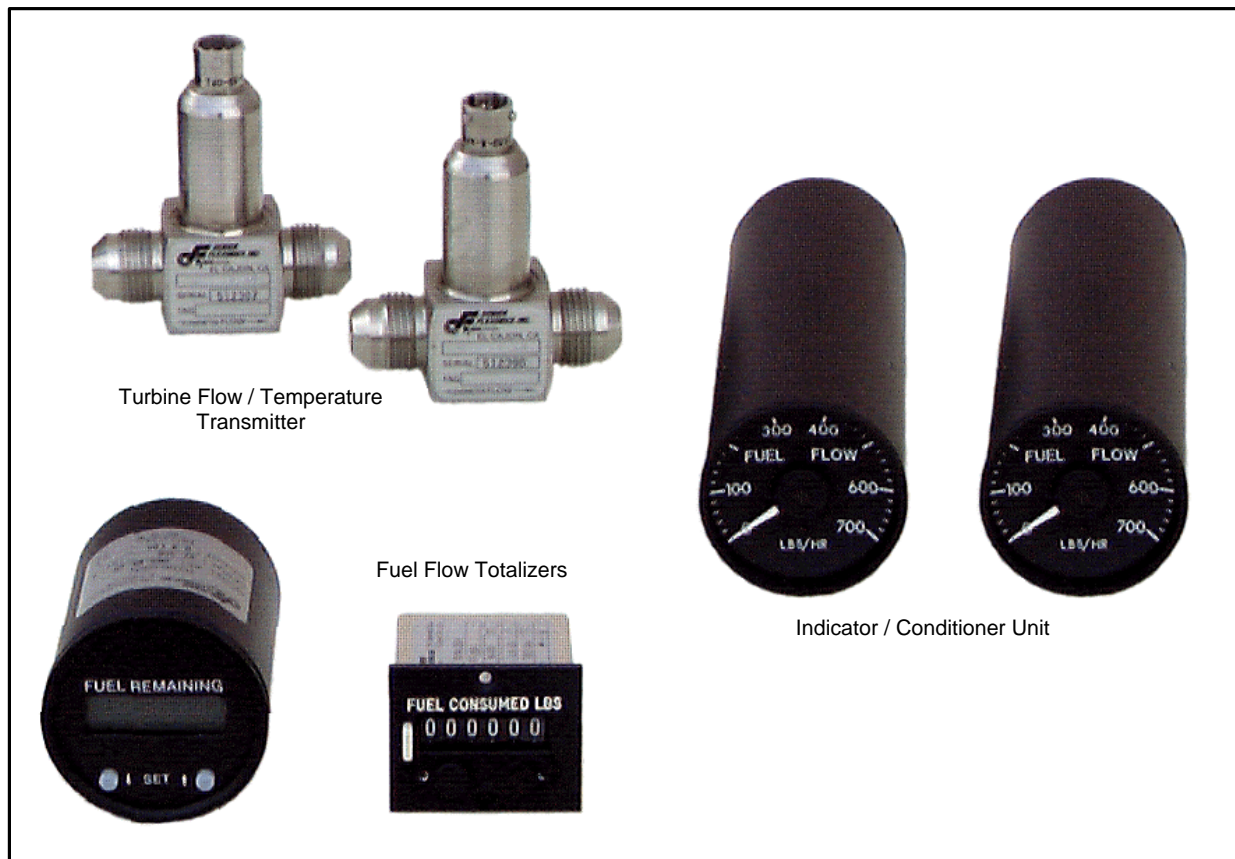
1. Purpose and Scope of Manual

This manual provides installation and instructions on the SC14 Series Senior Aerospace Ketema Fuel Management Systems. It includes information on operations, testing and troubleshooting a system. Typical systems components are illustrated in Figure 1. The information contained in this manual is for reference only and is not intended to replace the type certification or supplemental type certification.

2. Purpose of Equipment

The SC14 Senior Aerospace Ketema Fuel Management Systems precisely measure and display the rate at which the fuel is being consumed by the aircraft. The systems also compute and display the total fuel consumed (or remaining).

Figure 1. Typical System Components



3. Environmental Characteristics

The Fuel Management Systems are designed to conform to the environmental requirements of FAA Document TSO-C44a.

4. PC900 Series Indicator Conditioning Unit

4.1 Flow Sensor Input

Input Full Scale Frequency Range: 240 to 1500 Hz

Input Type: Balanced

Input Impedance: 20K ohms

Input Sensitivity: 7 millivolts RMS at frequencies less than 100 Hz

4.2 Temperature Sensor Input

Temperature Sensor Type: RTD, Nickel 270 Alloy

Temperature Sensor Resistance @ 25°C: 1000 ohms 1% Temperature Coefficient:
6 % per °C

Temperature Range: -67° to 158° F (-55° to 70° C)

4.3 Remote Input

Frequency Range: 0 to 100 Hz

Input Type: 5V CMOS level compatible

Input Pulse Width: 10 ms

4.4 Totalizer Output

Output type: Solid-state switch to ground

Current sink: 400 mA maximum

Totalizer Supply Source: +28 vdc fuse protected

Pulse Width: 50 ms

Rise/fall time: < 25,us

Output Frequency: Dependent on scaling, 10 Hz maximum

Accuracy: ±3% of indicated total with fuel at nominal density. Variations in fuel density from nominal will affect accuracy.

4.5 Remote Output

Frequency Range: 0 to 50 Hz

Output Type: Solid-state switch to ground with 5.1 K pull-up resistor to +5 vdc.

Output Amplitude: 5V

Pulse Width: 10 ms

Rise/fall Time: < 25 us

K-factor: 8 pulses per totalizer unit (0.1 or 1 EGU dependent on scaling).

4.6 Rate Indicator

4.6.1 Movement Specifications:

Movement: 250 degrees

Sensitivity Style B: 1.0 mA nominal full scale

Sensitivity Style C: 556 Steps nominal full scale

Accuracy: ±2% of full scale

Linearity: ±2% of full scale

Repeatability: ±1% of full scale

Scale: Characters: Matte White; Background: Flat Black

4.6.2 Indicated Flow Rate Specifications:

The rate indicator assembly contains an EEPROM which contains calibration information for the specific instrument. This calibration information includes specific meter non-linearity corrections. The following specifications apply after these corrections have been applied.

Accuracy: $\pm 3\%$ of full scale flow rate with fuel of nominal density. Fuel density variations from nominal will affect accuracy.

Linearity: $\pm 1\%$ of full scale

Repeatability: $\pm 1\%$ of full scale

4.7 Auxiliary Rate Outputs

4.7.1 Auxiliary Rate Indicator Output

The Auxiliary Rate Indicator Output does not have corrections for indicator nonlinearities. The external rate indicator should be linear within $\pm 1\%$. Refer to section 4.6 for specifications.

4.7.2 Auxiliary Analog Output

Type: Voltage output signal proportional to flow rate

Full Scale Voltage: 5 vdc (Units with 0-5.333 vdc output are scaled so that the output will be 5.00 vdc at a flow rate of 750 lb/hr regardless of the full scale flow rate on the meter.)

Slew Rate: < 0.5 s from zero to full scale

Accuracy: $\pm 2.0\%$ of full scale

Repeatability: $\pm 0.1\%$ of full scale

Linearity: $\pm 0.5\%$ of full scale

Temperature Drift: $\pm 0.01\%$ of full scale per $^{\circ}\text{F}$ ($\pm 0.02\%$ of full scale per $^{\circ}\text{C}$)

4.8 Power Requirements

Voltage: +19 to 32 vdc

Current Style B: 75 mA typical, 100 mA maximum, excluding totalizer current

Current Style C: 200 mA typical, 300 mA maximum, excluding totalizer current

4.9 Temperature Range

-22 $^{\circ}$ to +122 $^{\circ}$ F

-30 $^{\circ}$ to +50 $^{\circ}$ C

Figure 2. Outline Drawing for Rate Indicator

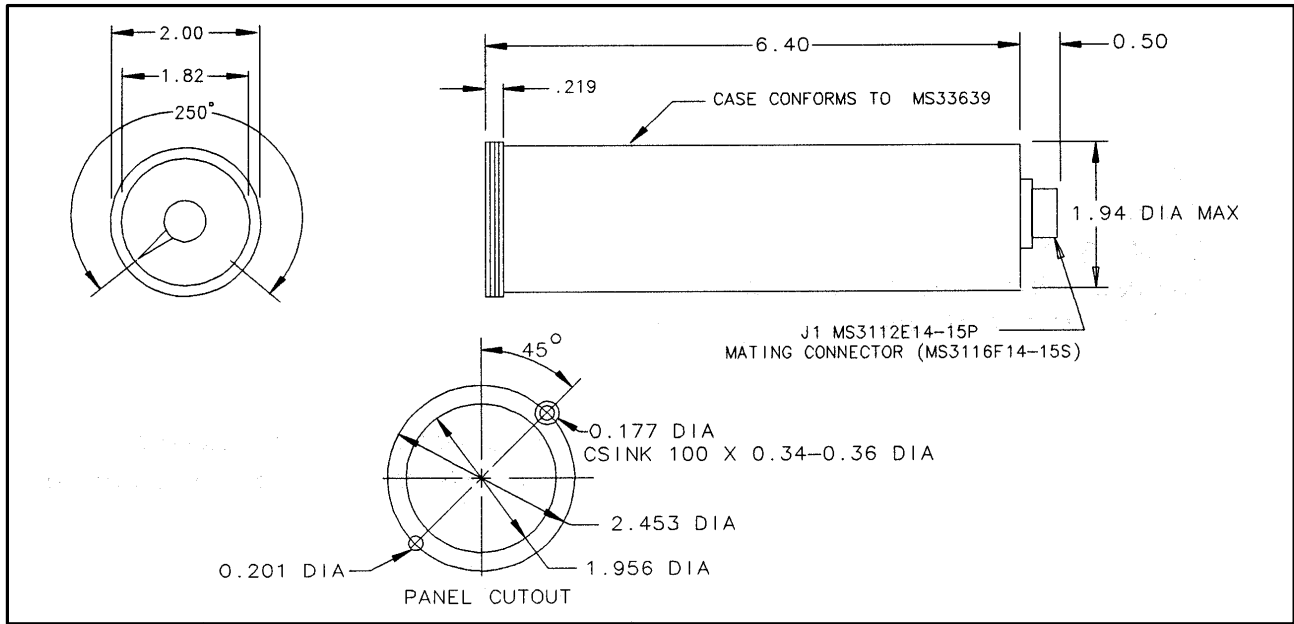
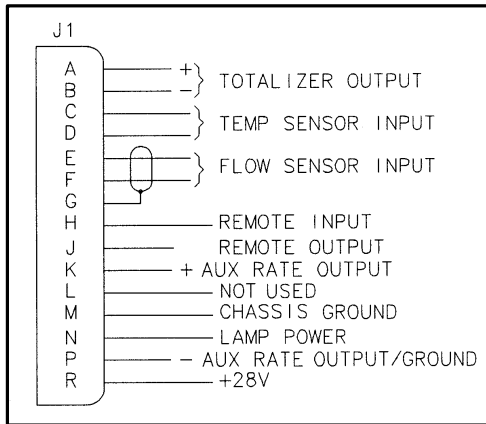


Figure 3. Rear Connector Wiring

Style B



Style C

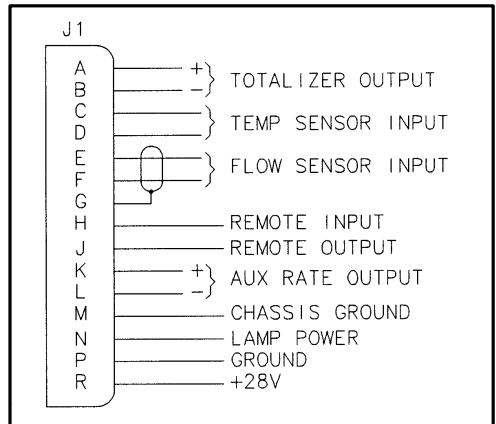


Figure 4. Mounting Clamp Outline Drawing Part No. A2029ST

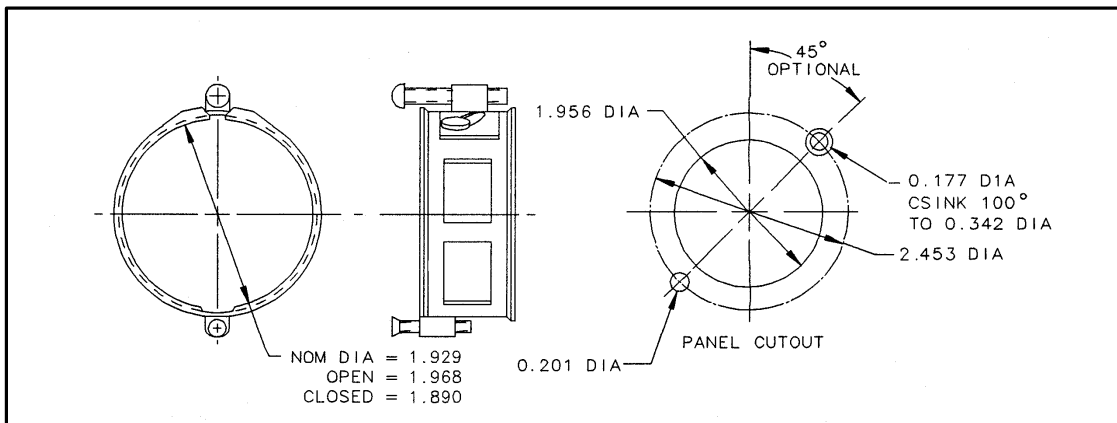


Figure 6. Outline Drawing for Flow Transmitter

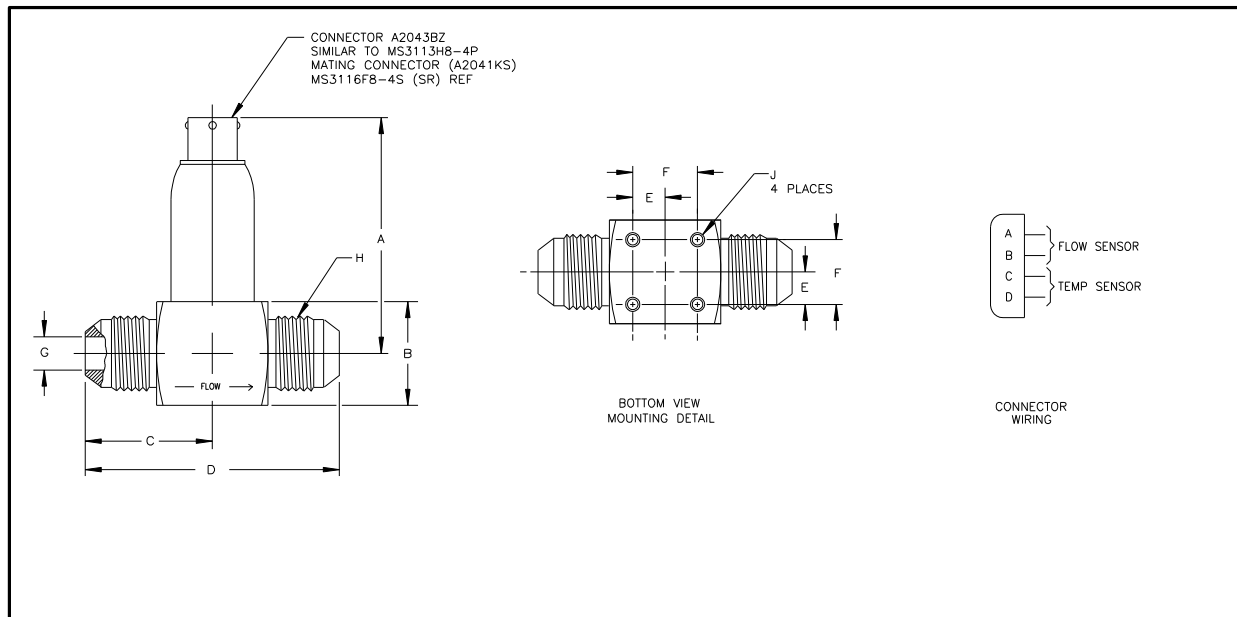


Table 1. Dimensional Chart

DIM	1/2-2-81-301,306	1/2-1-81-302	5/8-1-81-303	5/8-81-304	3/4-81-305
A	2.32 MAX	2.32 MAX	2.38 MAX	2.38 MAX	2.63 MAX
B	1.00 SQ	1.00 SQ	1.12 SQ	1.12 SQ	1.37 SQ
C	1.22	1.22	1.35	1.35	1.62
D	2.45	2.45	2.70	2.70	3.25
E	0.312	0.312	0.375	0.375	0.500
F	0.625	0.625	0.750	0.750	1.000
G	0.3125 ID	0.3594 ID	0.3907 ID	0.4687 ID	0.5938 ID
H	MS33656-E8	MS33656-E8	MS33656-E10	MS33656-E10	MS33656-E12
J	8-32UNC-2B Threaded 0.31 Deep	8-32UNC-2B Threaded 0.31 Deep	8-32UNC-2B Threaded 0.31 Deep	8-31 UNC-2B Threaded 0.31 Deep	10-32UNC-2B Threaded 0.37 Deep
WEIGHT	0.5 lb, 0.23 kg	0.5 lb, 0.23 kg	0.7 lb, 0.32 kg	0.7 lb, 0.32 kg	1.0 lb, 0.45 kg

6. AT-209 and AT-210 Series Fuel Totalizers

6.1 Input Signal

Type: High level single ended dc coupled pulse. Input protected by diode clamping.
Amplitude: 4.6 - 28 V peak, referenced to system ground
Pulse Duration: 10 ms min.
Frequency Range: 0-10 HZ

6.2 Display

Type: Backlit liquid crystal, avionics grade
Legend: 4 digit with internally programmable decimal point and engineering units label.
(LBS, GAL, OR KGS)

6.3 AT-209 Setting

Initial count setting is accomplished by the use of two momentary push buttons (set up/set down).

6.4 AT-210 Reset

Accomplished by pressing the reset button for approximately 3 seconds. This will reset the counter to zero.

6.5 Power Requirements

Voltage: 12 to 32 Vdc, referenced to system ground.
Current: 5mA maximum
Display lighting: 0-5 Vdc, 300mA
Optional: 0-28 Vdc, 100mA

6.6 Temperature Range

-22° F to 122° F (-30° to 50° C), operating

6.7 Model Code

AT 2XX-XX-05-5Vdc lighting
AT 2XX-XX-28-28Vdc lighting

Figure 7. AT-209 and AT-210 Rear Connector Wiring

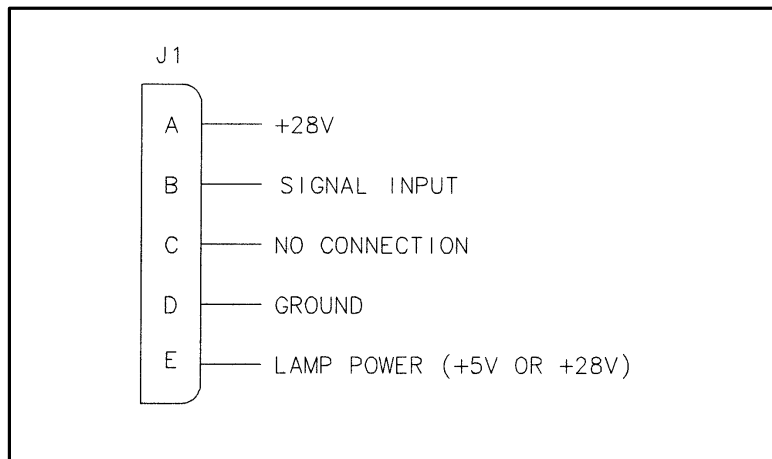


Figure 8. Mounting Clamp Outline Drawing Part No. A2029SW

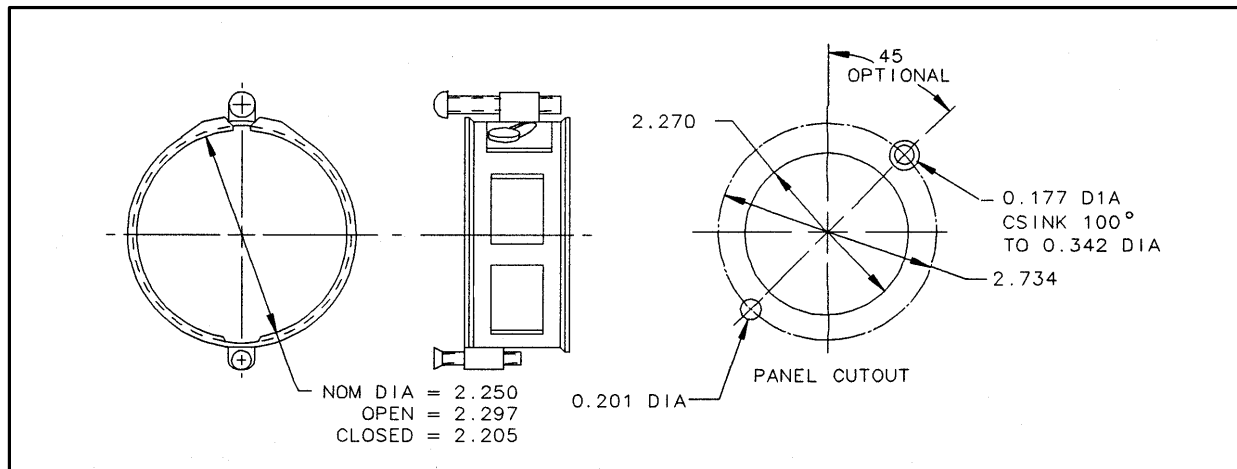
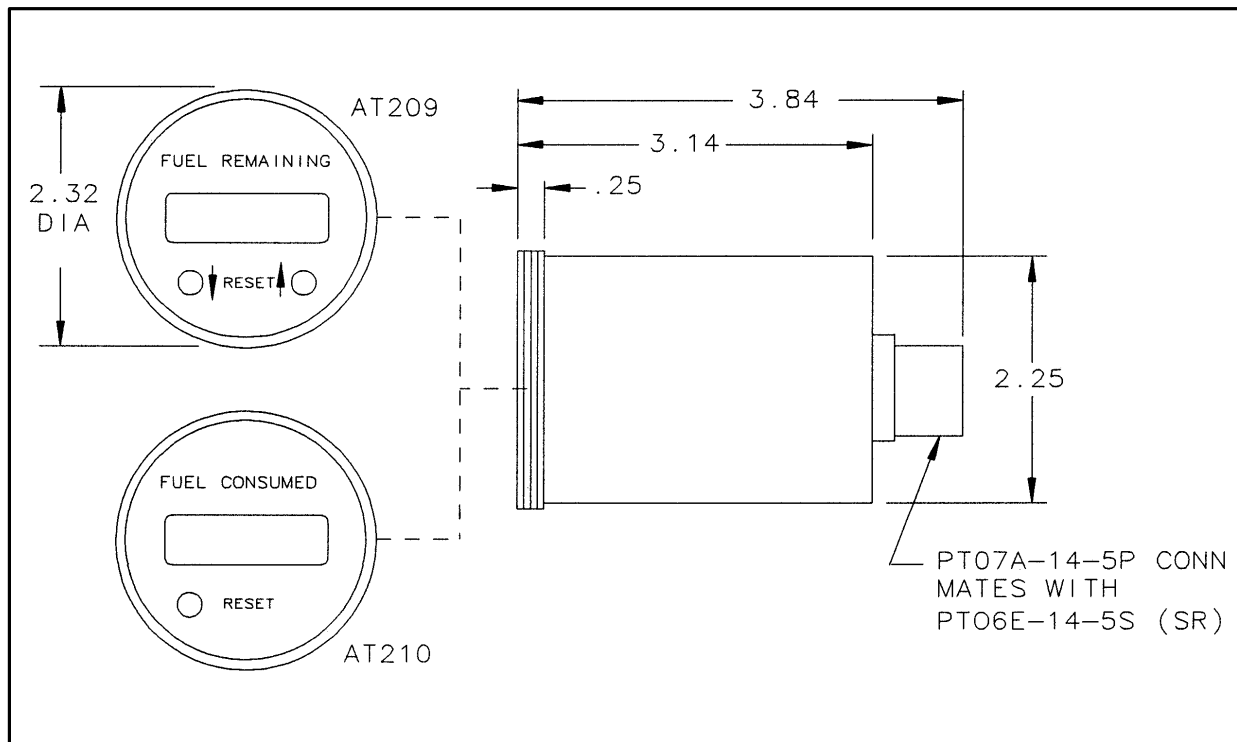


Figure 9. AT-209 and AT-210 Outline Drawing



7. AT-204 and AT-208 (Lighted) Series Fuel Consumed Totalizing Indicator

7.1 Input Amplitude

+ 26.4V ±15% pulse at 25 ms duration

7.2 Temperature Range

-22° to + 122° F (-30° to + 50° C), operating

7.3 Impedance

120 ohms minimum

7.4 Frequency Range

0 to 6 Hz

7.5 Weight

AT-204 4 digits .3 lb. (. 14 kg)

6 digits .4 lb. (. 18 kg)

AT-208 .4 lb (. 18 kg)

Figure 10. AT-204 Rear Connector Wiring

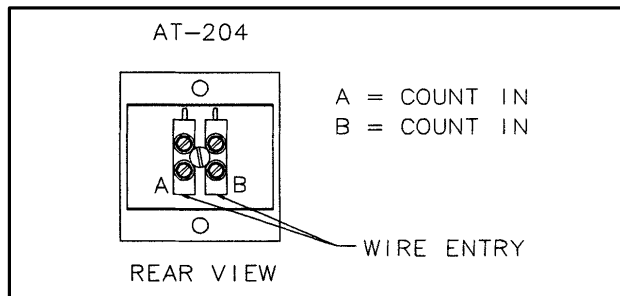


Figure 11. AT-208 Rear Connector Wiring

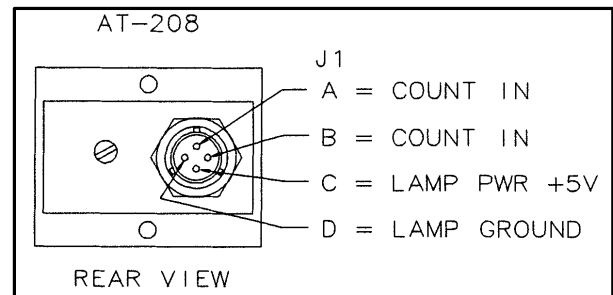


Figure 12. AT-204 Outline Drawing

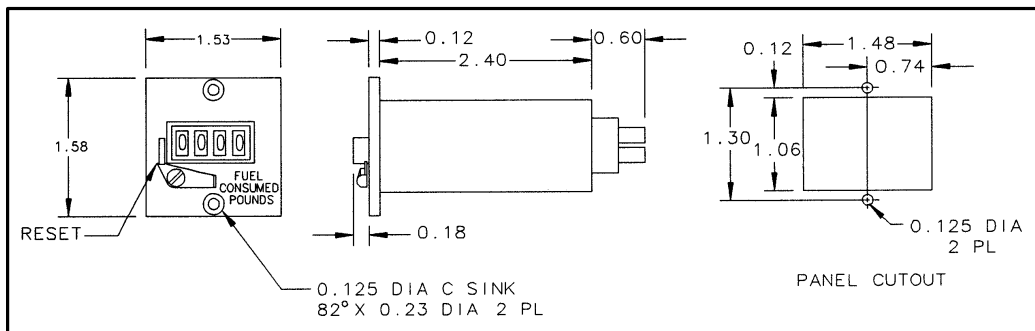
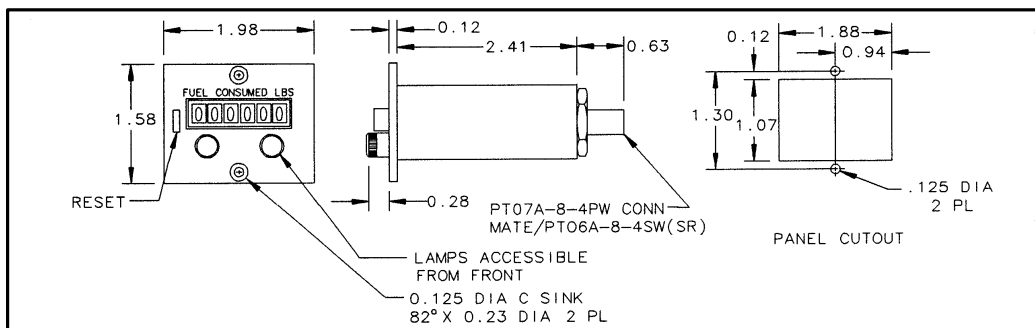


Figure 13. AT-208 Outline Drawing



8. General Description

Senior Aerospace Ketema Fuel Management Systems using a PC-900 Series Signal Conditioner and a 81-300 Series Turbine Flow/Temperature Transmitter (Figure 14) allow precise measurement of fuel flow with outputs proportional to flow rate.

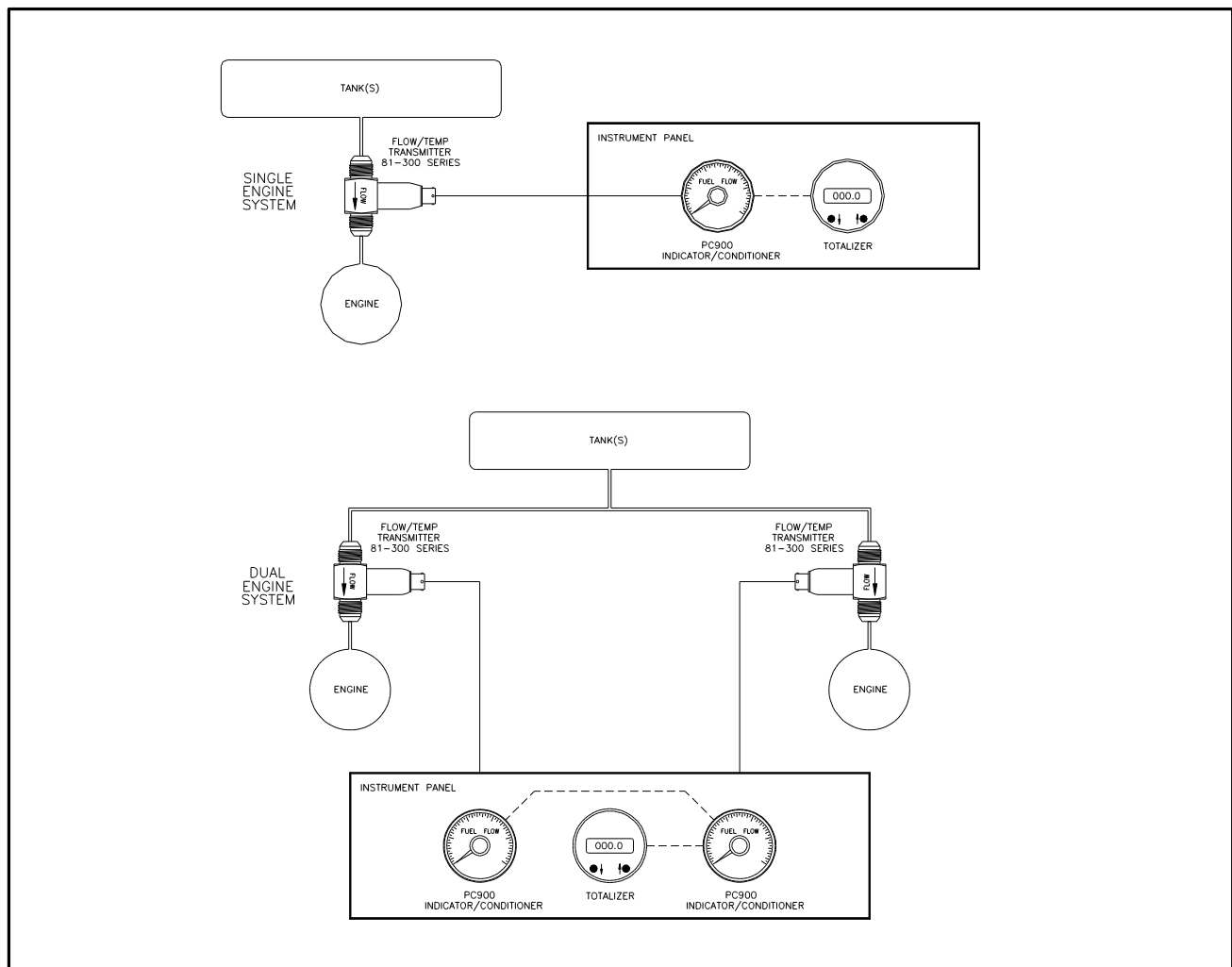
Fuel flow rate indication is provided for single or dual engine application on panel-mounted instruments. Panel display of total fuel consumed or remaining as described is optional.

9. System Components

The systems are composed of the following components:

- 1) 81-300 Series Turbine Flow/Temperature Transmitter -- one per engine
- 2) PC-900 Series Indicator Conditioning Unit -- one per engine.
- 3) AT-200 Series Fuel Consumed or Remaining Totalizer -- optional

Figure 14. Typical SC14 Series System



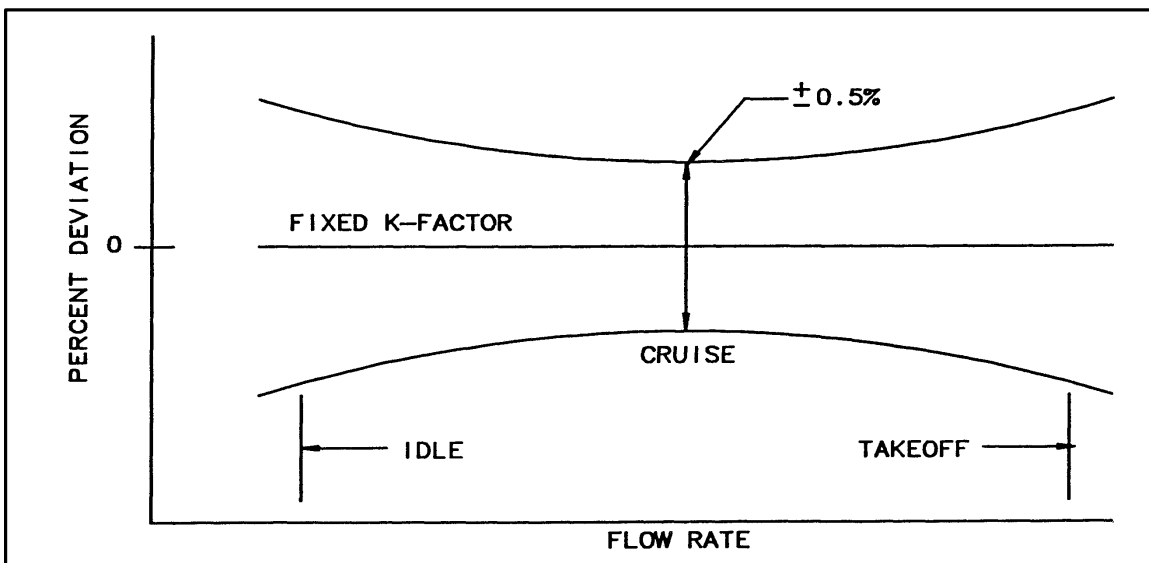
10. Functional Description

10.1 Turbine Flow/Temperature Transmitters

The turbine flow/temperature transmitter contains a turbine rotor which rotates at a speed proportional to the volume of fuel passing through it. The turbine rotor produces a sinusoidal voltage in a magnetic pickup coil installed in the body of the transmitter. This output signal frequency is directly proportional to the volume of fuel flow. A temperature sensor mounted in the body of the transmitter senses the temperature of the fuel passing through it and provides a variable resistance output signal proportional to the fuel temperature.

The transmitter is calibrated to yield a fixed K-factor over a normal operating range with a minimum deviation at the cruise point of the aircraft (see Figure 15).

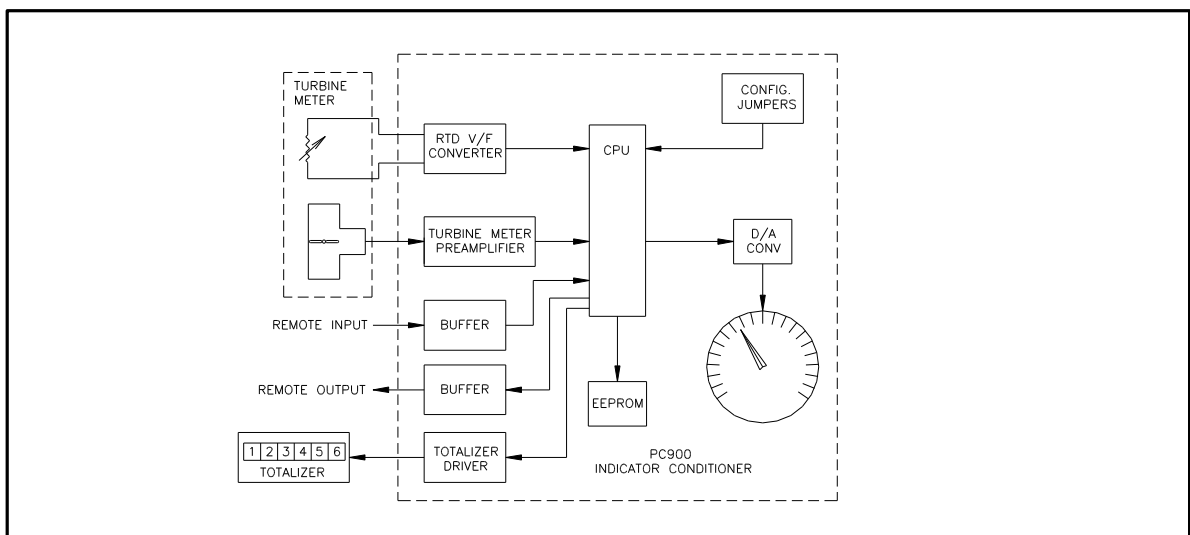
Figure 15. K-Factor Characteristics



10.2 Indicator Conditioner Unit

After reset, the microcontroller reads a fixed memory contained within the analog rate display and the switch settings on the CPU card. This information allows the microcontroller to determine the correct engineering units, the full scale value of the analog rate display, the model of turbine meter used, fuel type, and the resolution of the totals information. This information along with basic system information is resolved into two variables. The first is the theoretical fractional EGU amount of fuel per turbine meter pulse at -60 Celsius known as the 'base'. The second is the decrease in density of the fuel per RTD count per turbine meter pulse known as the gain. These two variables are maintained in RAM memory and used by the 40 millisecond task to calculate the fuel flow rate.

Figure 16. Indicator Conditioner Block Diagram



Each pulse from the turbine meter results in an interrupt to the microcontroller. The interrupt firmware increments a memory location, used as a turbine meter pulse accumulator, once for each interrupt.

An internal interrupt occurs each 10 milliseconds (msec). This interrupt is used to establish the shape of the remote totalization output pulse, read and reset the turbine meter pulse accumulator, read and reset the RTD input counter, schedule the flow rate computation, and schedule the total pulse output check. If the remote total output counter is non-zero, a 40 msec, 50% duty cycle pulse is generated on the remote total output.

The remote totals input also results in an interrupt. As with the turbine meter pulse, this interrupt firmware also increments a memory location (the remote total output counter) to record that the input has occurred.

Each 40 msec, the flow computation is performed. The turbine meter counts from the current 40 msec interval are summed with the counts from the previous 19 intervals and multiplied by the base. Likewise, the product of the turbine meter counts and RTD counts, in this interval, are summed with the products of the previous nineteen intervals and multiplied by the gain. The gain result is subtracted from the base result to give the appropriate engineering units flow rate as a percent of full scale flow. This value is then used to set the 0 to 5 volt output proportionately. The result is then further adjusted to provide a 0 to 1 milliamp output customized to the analog rate display meter for best accuracy. The final function of this task is to determine if a sufficient amount of fuel has been consumed to output a remote totalization pulse. If this is the case, the remote total output counter is incremented.

Each 50 msec the primary totalization task is executed. Its purpose is to determine if eight remote output pulses have occurred and, if so, to output a totals pulse.

10.3 Totalizing Indicator

Fuel flow systems are supplied with one of two types of totalizing indicators; one type indicates fuel consumed and the other fuel remaining. The scales on both types of indicators read out in pounds, gallons, kilograms or liters, depending on the scaling requirements on the system.

The fuel consumed indicator has a mechanical reset, used to set the indicator to zero when the fuel is loaded. As the fuel is consumed, the quantity is displayed on the indicator:

The fuel remaining indicator has electrical preset switches which allow the pilot to manually set in the amount of fuel loaded in the aircraft. As fuel is consumed, the indicator subtracts the amount from the preset value.

11. Operation

11.1 Indicators

The operation or use of the rate indicators), requires only the observation of the engine fuel flow rate indicators).

11.2 Fuel Consumed Totalizing Indicator

After the fuel is loaded, perform the following:

Move the reset button guard away from the reset button (AT- 204/208 only).

Press the reset button until all digits read zero. The AT-210 Totalizer will reset approximately three seconds after the reset button has been maintained.

Place reset guard in position to prevent accidental resetting of the indicator during operation (AT-204/208 only).

11.3 Fuel Remaining Totalizing Indicator

After fuel is loaded, perform the following:

Press set up/down switches on the front of the indicator until the digits indicate the total pounds, gallons, kilograms or liters, as applicable, loaded on the aircraft.

12. PREPARATION FOR USE

12.1 General

This section contains information on unpacking or repacking and inspection of the instruments before installation in the aircraft.

12.2 Unpacking and Inspection

Unpack the system components and inspect for physical damage, such as broken indicator glass, dented cases, etc. If there is any apparent damage, file a claim with the carrier.

12.3 Configuration

While the PC900, Style C, electronics are configured for each application with a custom PROM, the PC900, Style B, electronics may be configured in the field for various fuel types, flowmeter sizes and totalizer resolution. There are nine configuration jumpers which are shown in figure 17.

W1 sets the type of auxiliary output. With W1 in position 0, the auxiliary output is a 0 to 1 mA output for an auxiliary rate indicator. With W1 in position 1, the auxiliary output is a 0 to 5 volt analog output for sending fuel flow rate information to an external device like a navigation system. Units with 0-5.333 volt auxiliary output have W1 soldered in position 1.

W2 through W9 set the flowmeter size, fuel type, and totalizer resolution as shown below: W9 is always set in position 0.

Table 2. Jumper Setting for Flowmeter Size

W4	W3	W2	Flowmeter Size
0	0	0	Special
0	0	1	1/2-2-81-301
0	1	0	1/2-1-81-302
0	1	1	5/8-1-81-303
1	0	0	5/8-81-304
1	0	1	3/4-81-305
1	1	0	1/2-2-81-306

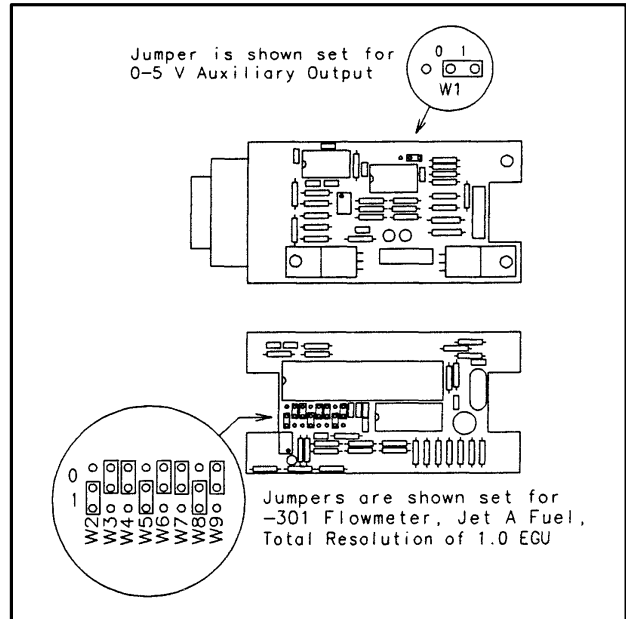
Table 3. Jumper Setting for Fuel Type

W7	W6	W5	Fuel Type
0	0	0	Special
0	0	1	Jet A,A1,JP-8
0	1	0	Jet B,JP-4
0	1	1	JP-5
1	0	0	AVGAS

Figure 17. PC900 Jumper Locations Style B only

W8 sets the totalizer resolution. With W8 in position 0, one totalizer pulse will be output for each 0.1 EGU. With W8 in position 1, one totalizer pulse will be output for each 1.0 EGU.

Units received from the factory will be configured to customer's specifications. If an electronics assembly is replaced, the jumpers will need to be checked for proper configuration.



12.4 Model Numbers

Record the model number of each unit in the place provided below. The model number information may be found on the data label which is permanently attached to each unit. See the model number coding information in Figure 5.

13. Storage Instructions

13.1 General

Some components of the SC14 System are shipped from Senior Aerospace Ketema in clear moisture proof/vapor proof bags with desiccant and a moisture indicator card. It is recommended that this equipment be stored in these heat sealed bags.

Store the components of the Fuel Management System in their original shipping containers in a dry area with temperature 13° C (55° F) to 35° C (95° F), if they are not to be installed immediately.

If the components are to be stored for a lengthy period of time, they should be sealed in airtight plastic bags. The turbine flow transmitter bearings and the connectors of the electronic components could corrode from moisture in the air over a long period of time without proper packaging.

13.2 Shelf Life

The shelf-life of the system components is 5 years with proper packaging.

13.3 Repacking For Shipment

The following steps are a general guide for repacking units for shipment.

NOTE: If units are to be shipped to Senior Aerospace Ketema, attach a tag to each unit identifying the owner and service or repair required.

If possible, use original shipping containers. Wrap each unit in heavy paper or plastic before placing in the shipping container.

Place packing material around each unit until there is no free space.

Seal the container using heavy tape.

Mark the container with suitable "handle with care" type cautions.

14. INSTALLATION

14.1 General

This section contains installation instructions for the SC14 Fuel Management Systems.

14.2 Turbine Flow/Temperature Transmitter

CAUTION: The flow/temperature transmitter must be installed with the arrow on the case pointing in the direction of fuel flow. Failure to observe this caution will result in loss of system accuracy.

Some engine manufacturers have made provisions for the installation of a fuel flow transmitter in their engine fuel line by installing a spool piece. If a spool piece has been installed in the engine fuel line for this purpose, remove the spool piece and replace it with the transmitter.

If the engine manufacturer did not install a spool piece in the fuel line, the installer will have to select a location in the engine fuel line to install the flow transmitter or contact the engine manufacturer for their recommendations. Installing the flow transmitter in the fuel line will result in some pressure drop; however, the Senior Aerospace Ketema flow transmitter has been designed to minimize this pressure drop. The maximum pressure drop which will result from installing the flow transmitter in the fuel line, locked rotor pressure drop, is shown in section 5.4.

Normally the best location in the fuel line to install the flow transmitter is downstream from a fuel filter and the high pressure engine driven fuel pump, if space is available. The location selected should also be downstream from any fuel system accessories or fuel lines which may bypass a portion of the fuel and result in some of the fuel passing through the flow transmitter a second time. Fuel passing through the flow transmitter twice will result in erroneous readings.

If space is not available downstream from the high pressure engine driven fuel pump to install the flow transmitter, a location should be selected downstream from a fuel filter and the low pressure engine driven fuel pump. If the aircraft is not equipped with a low pressure pump, then the flow transmitter should be installed downstream from a fuel booster pump. The flow transmitter should always be located where the fuel line pressure is a minimum of 15 psi greater than the vapor pressure of the fuel at the maximum fuel temperature.

After the location for the transmitter has been selected, install the transmitter using mating AN894 bushing, AN818 nuts and AN819 sleeves and reducers as required. To complete the flow transmitter installation, it may be necessary to provide structural support for the transmitter. The four threaded holes located on the bottom on transmitter housing can be used to secure the transmitter to a support bracket fabricated by the installer.

If Magnetic Shield(s) has been included as part of the fuel system kit to eliminate AC interference, install as described in section 14.3.

14.3 Installation Instructions for Optional Magnetic Shield

14.3.1 Installing Magnetic Shield on 1/2-x-81-3xx Flowmeter

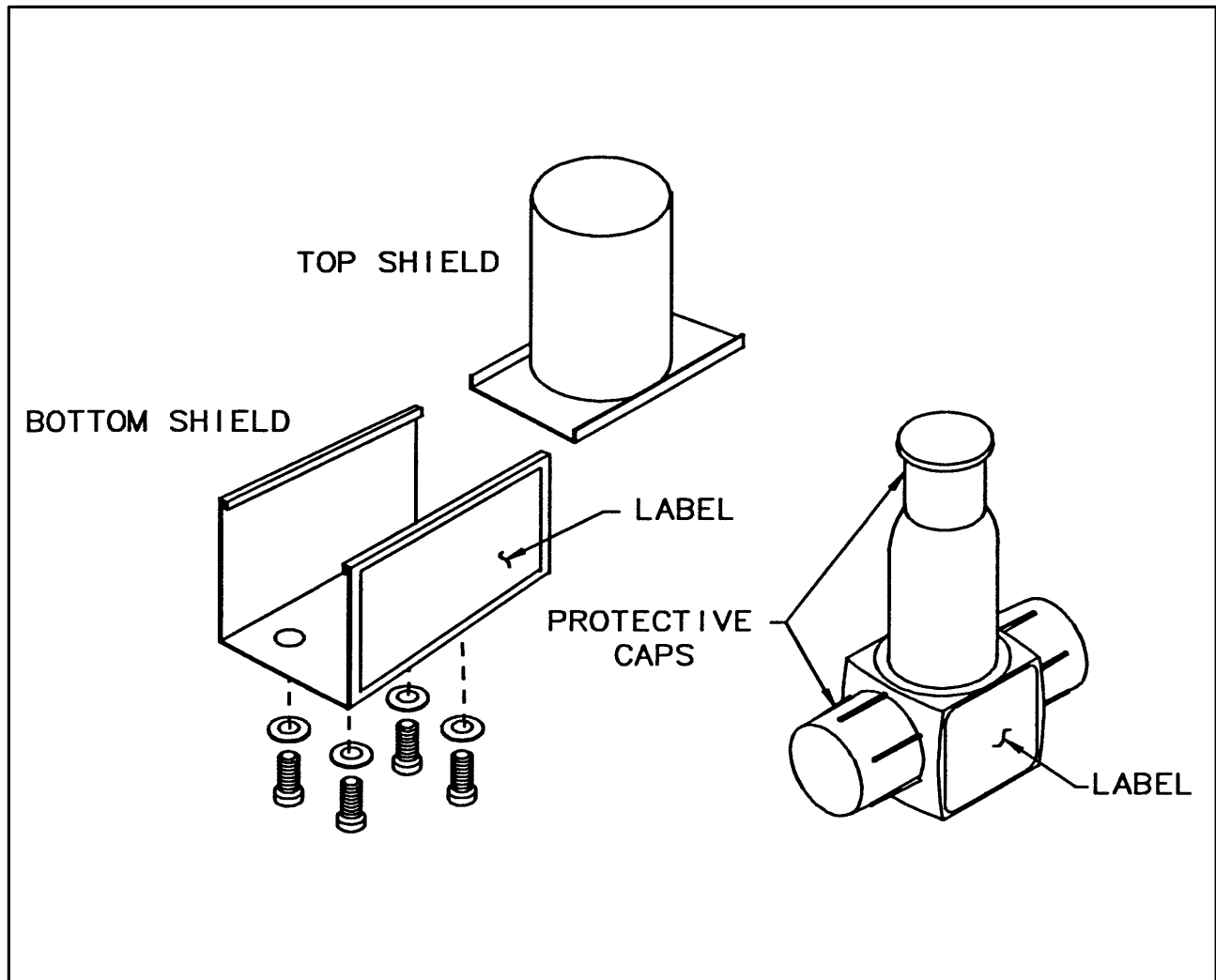
Place the top half of the shield over the pick-up coil of the flowmeter. Before installing the bottom half of the shield over the flowmeter, align the flow arrows of the data labels of the shield and the flowmeter in the same direction. This will prevent installing the flowmeter in the fuel line in the reverse direction of fuel flow, which would result in an incorrect flow measurement.

Slide the bottom half of the shield over the runners of the top half until the four holes in the bottom of the shield align with the four holes in the bottom of the flowmeter. Secure the bottom shield with the washers and screws provided. Install the flowmeter in the fuel line after safety wiring the screws.

Refer to Figure 18.

CAUTION: Using excess force, such as hammering or bending the bottom half of the shield during installation, will greatly reduce the magnetic shielding effect of the shield.

Figure 18. Magnetic Shield on 1/2 in Flowmeter

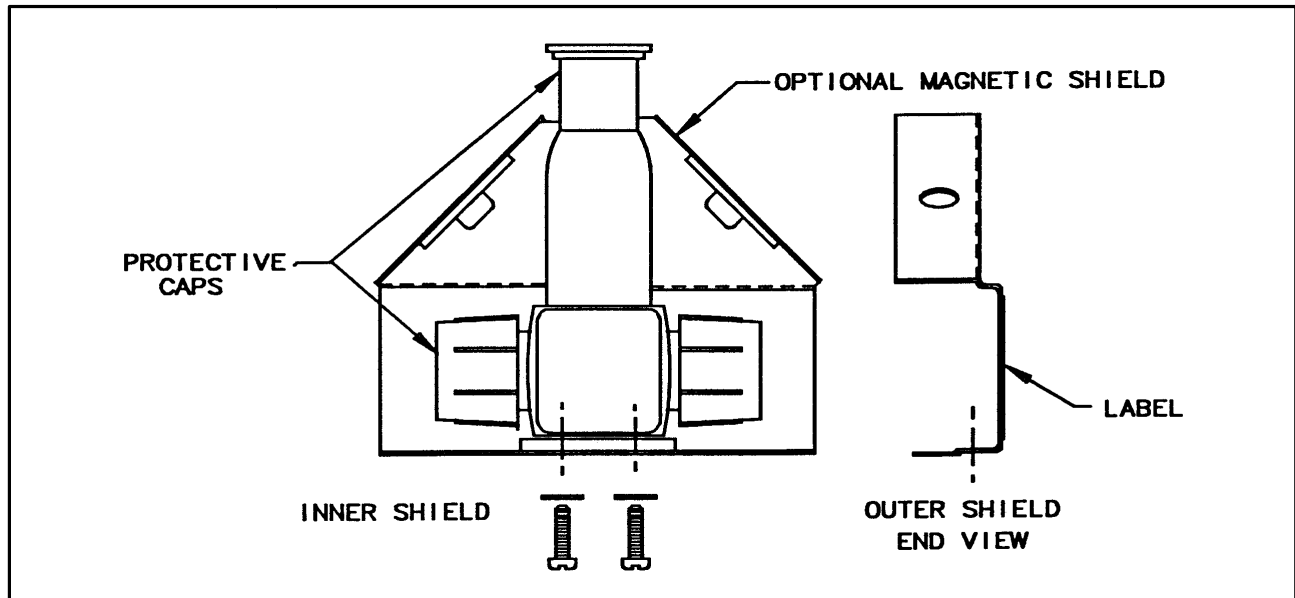


14.3.2 Installation Magnetic Shield on -5/8-x-81-3xx Turbine Flowmeters

The turbine meter should be installed in the fuel line per section 14.2. Align the flow arrow on the data label of the shield and the flow meter in the same direction. Position the back half of the shield around the flow meter until the two holes in the bottom of the shield align with the two holes in the bottom of the flowmeter. Secure the back half of the shield with washers and screws provided. Slide the front half of the shield over the shield back half. Secure the front half of the shield to the turbine meter at the remaining two holes in the bottom of the turbine meter. Install the remaining two screws and washers in the shield's side holes.

Refer to Figure 19.

Figure 19. Magnetic Shield on 5/8 in Flowmeter



14.4 Indicator Conditioning Unit

Select a convenient location on the instrument panel and drill mounting holes for the indicator(s) and the two mounting clamp screws, as shown in Figures 2 and 4, and mount the unit. Be sure to leave room for the mating connector which will be installed later.

14.5 Totalizing Indicators

Select a convenient location on the instrument panel and drill cutout and mounting screw holes. Drawings of required cutouts for different totalizers are shown in Figures 9, 12, and 13. When an AT-208, AT-209, or AT-210 totalizer is used, be sure to allow room for the mating connector, which will be installed later. No mating connector is used on the AT-204 totalizer.

14.6 Interconnection Wiring

- 14.6.1** Refer to the Typical Wiring Diagram For Single Engine Systems in Figures 20, 21 and 24 and for Twin Engine Systems in Figures 22, 23 and 25.
- 14.6.2** Refer to the model number information for the PC900 as recorded in section in 12.4. Compare this PC900 model code with the PC900 model code chart in Figure 5, to determine if the unit is equipped with the lighting option.
- 14.6.3** If the PC900 does not have the lighting option, then skip sections 14.6.4 and 14.6.5.

- 14.6.4** If the unit is equipped with the lighting option, then determine by the model code if the lamp power is + 5V (-1-LIGHTED (+ 5V)) OR + 28V (-3-LIGHTED (+ 28V)).
- 14.6.5** During the fabrication of the interconnection cables in step 14.6-12, the connection from connector pin N of the PC900 to the aircraft lamp power circuits is to be made; see NOTE 2 in Figures 20 thru 25. On twin engine aircraft, the connection to pin N of both PC900 units needs to be made. Insure this connection is made to the appropriate aircraft lamp power circuit as determined in section 14.6.4 above.
- 14.6.6** Refer to the model number information as recorded in section 12.4 and determine if this system uses a fuel totalizer.
- 14.6.7** If the system does not include a fuel totalizer, then skip section 14.6.8 through 14.6.11.
- 14.6.8** If the system includes an AT-204 or AT-208 Fuel Consumed Totalizer, then during the fabrication of the interconnection cables in section 14.6.12, the connection from the fuel consumed totalizer pin A to pin A of the PC900 is to be made. See note 4 in Figures 20 thru 25. The connection from pin A to the 28V power therefore must not be made; see note 3.
- 14.6.9** In systems which use an AT-208 Totalizer, the interconnection cable must include the connection from pin C of the totalizer to the aircraft lamp power circuit. See note 2 in figures 20 thru 25.
- 14.6.10** If the system includes an AT209 or AT210 Fuel Totalizer, then during the fabrication of the interconnection cables in section 14.6.12, the connection from the fuel totalizer pin A to the 28V power is to be made. See Note 3 in Figures 20 thru 25. The connection from pin A of the PC900 therefore must not be made. See Note 4.
- 14.6.11** The connection from pin E of the fuel totalizer to the aircraft lamp power circuits is to be made; see Note 2 in Figures 20 thru 25. Insure this connection is made to the appropriate aircraft lamp power circuit as determined in section 14.6.4.
- 14.6.12** Using the supplied mating connectors, fabricate the interconnection cables (wire supplied by customer). Refer to Figures 20 thru 25 for the appropriate connections.
- 14.6.13** Wiring to the flow/temperature transmitter should be 20 or 22 AWG, 4 wire shielded cable. Shields should be maintained through bulkheads and grounded only at the signal conditioning unit as shown in Figures 20 thru 25.

- 14.6.14** Wiring from the indicator conditioning unit to the totalizing indicator should be 20 or 22 AWG stranded wire. In the multiengine configuration, the interconnecting wiring between units should be 20 or 22 AWG stranded or equivalent wire. A 2 amp fast blow fuse or circuit breaker should be installed between the signal conditioning unit and the 28VDC power source.
- 14.6.15** Install the cable assembly in the aircraft and secure with appropriate cable clamps.
- 14.6.16** Connect the mating connector to the Indicator Conditioning unit.
- 14.6.17** Connect the appropriate mating connector(s) to the flow transmitter(s).
- 14.6.18** Connect the appropriate mating connector to the totalizing indicator as shown on the system drawing. (NOTE: AT-204 Series Totalizing Indicator does not use a mating connector. Dress the wires and make connection to the totalizing indicator by tightening the preset screws.)
- 14.6.19** Perform on-aircraft test procedure to verify proper installation.

Note: See Figures 20 Thru 25 for Typical Wire Diagrams for Single and Twin Engine Systems

Figure 20. Wiring Diagram for Single Engine Systems with 0-5 V Analog Output Style B Only.

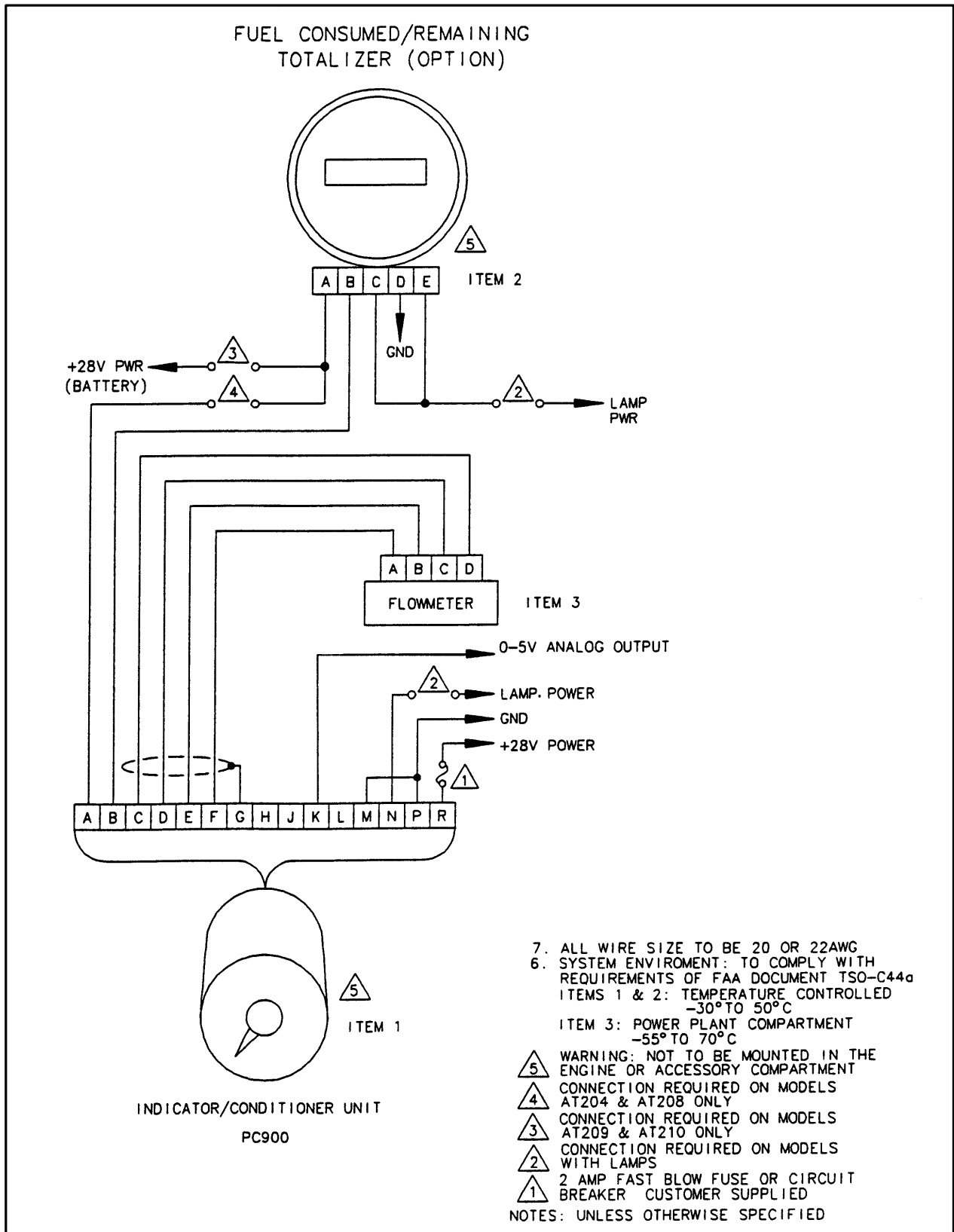


Figure 21. Wiring Diagram for Single Engine Systems with 0-5 V Analog Output Style C Only.

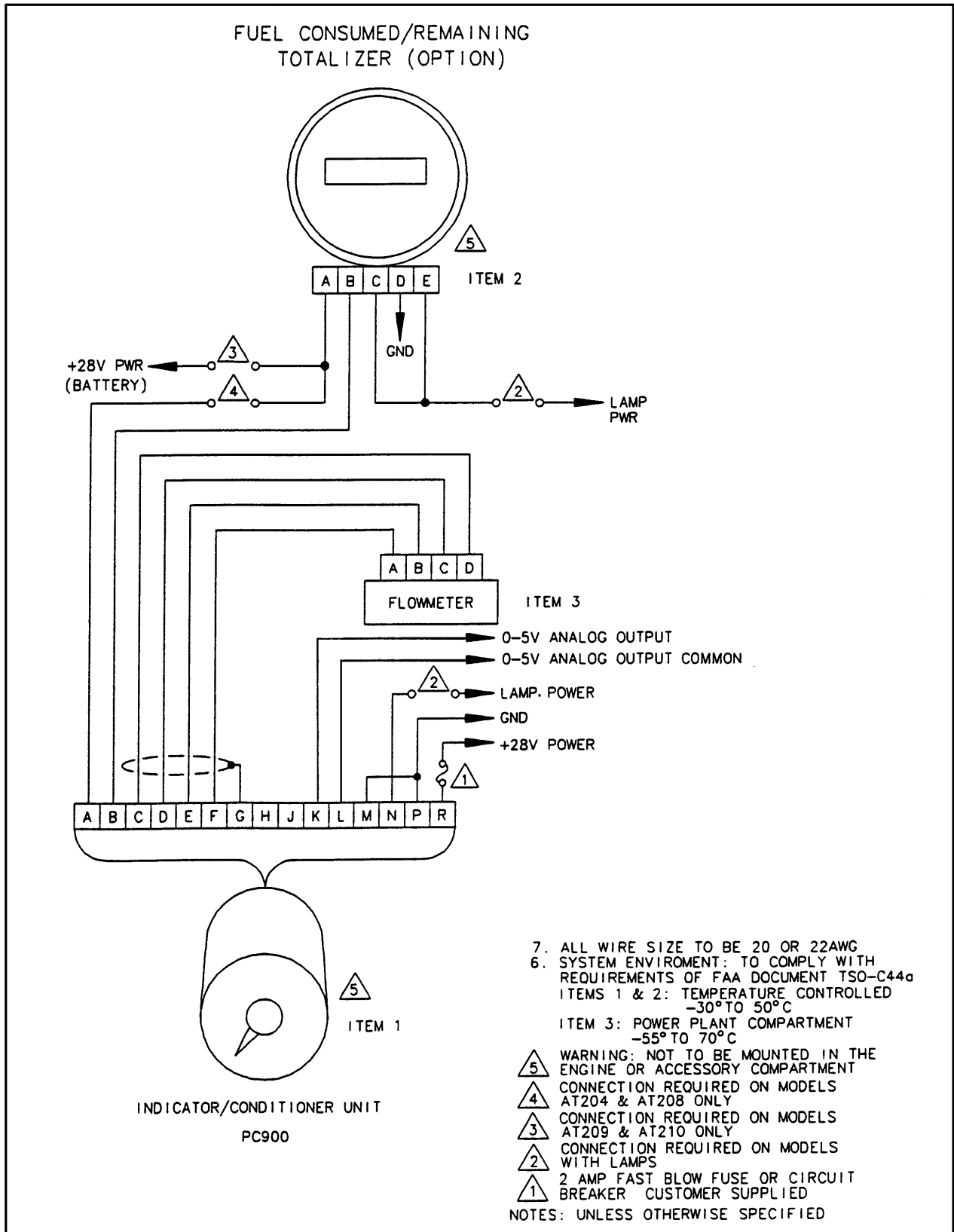


Figure 22. Wiring Diagram for Twin Engine Systems with 0-5 V Analog Output Style B Only.

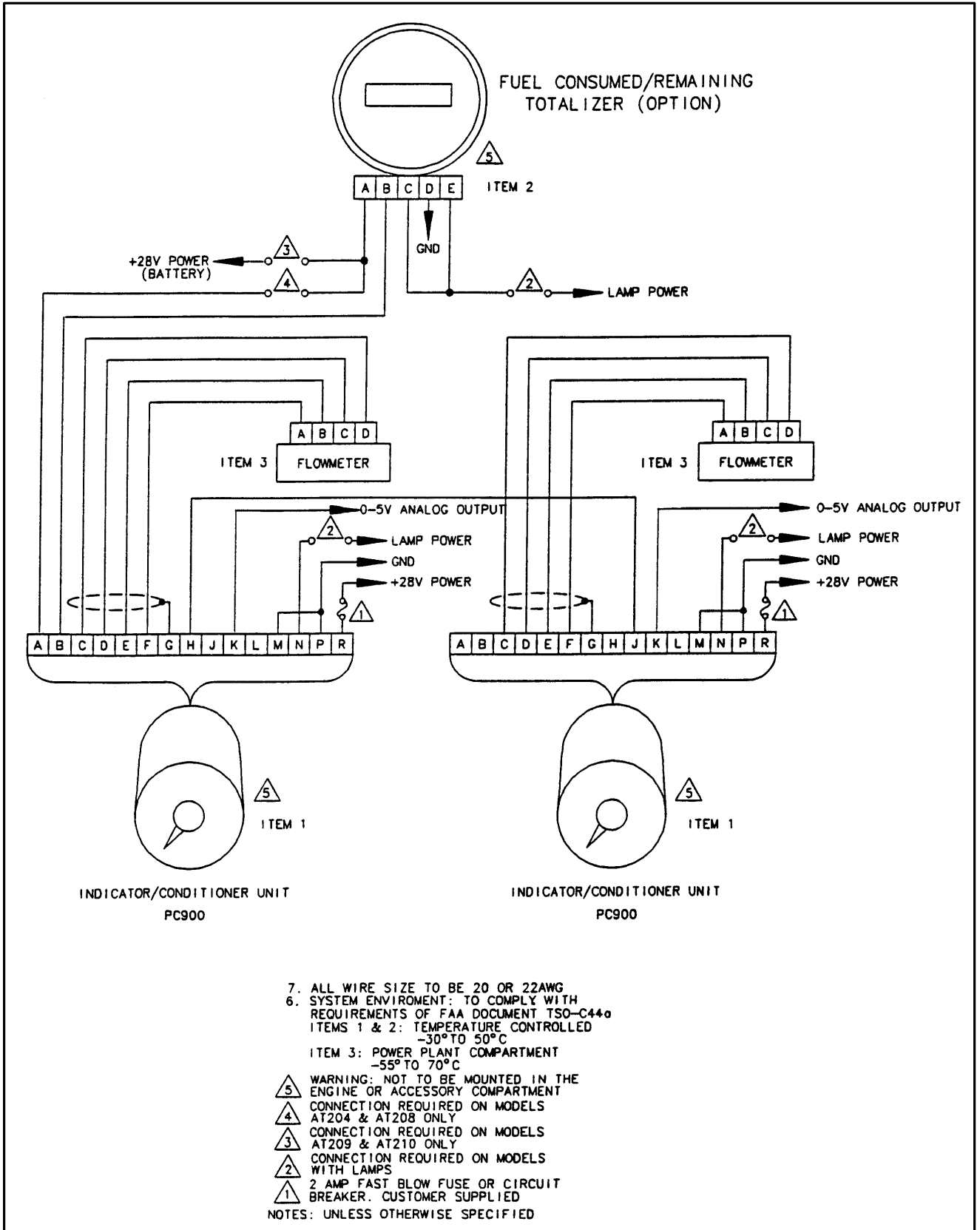


Figure 23. Wiring Diagram for Twin Engine Systems with 0-5 V Analog Output Style C Only.

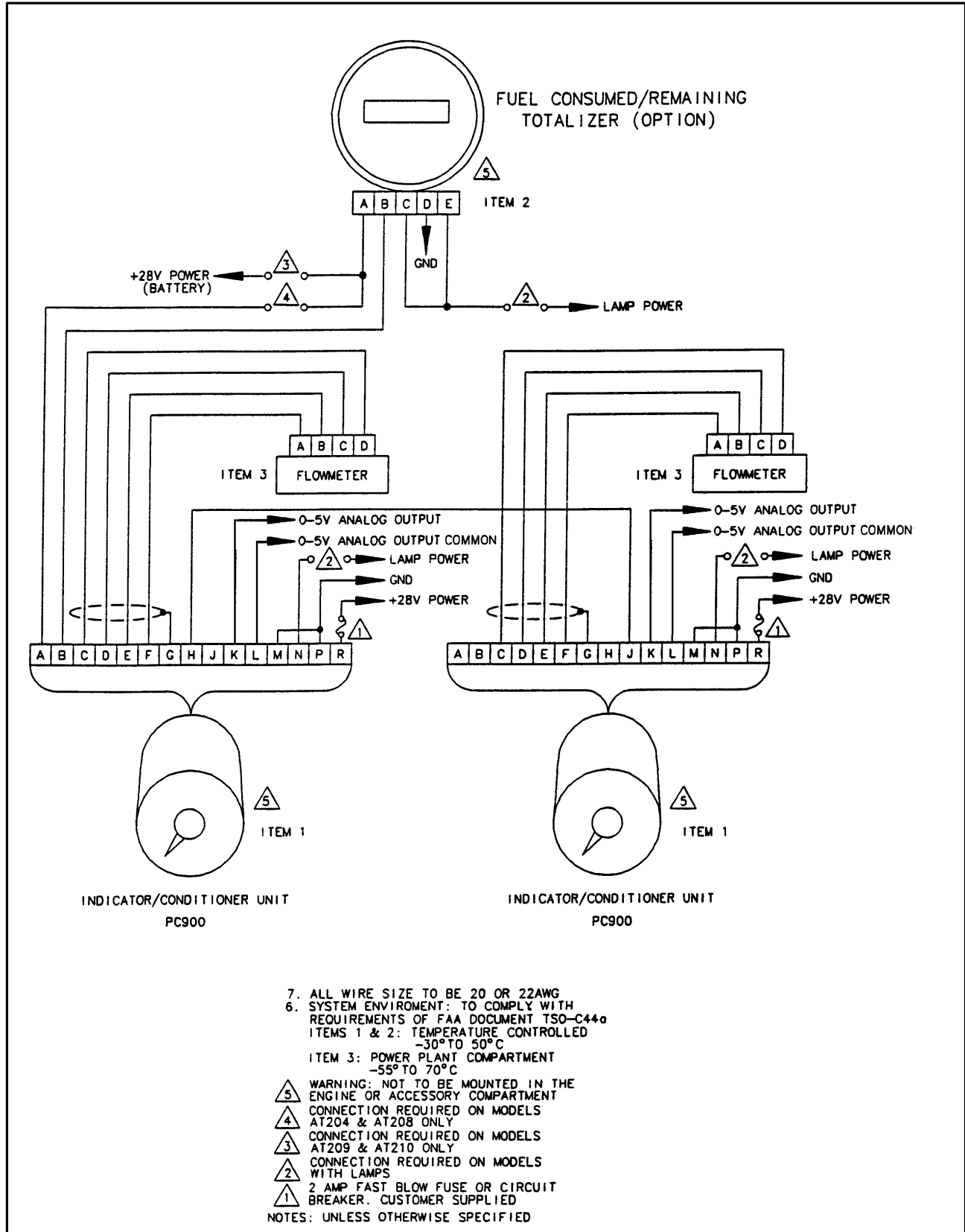


Figure 24. Wiring Diagram for Single Engine Systems with 0-1 mA Remote Rate Indicator Style B & C.

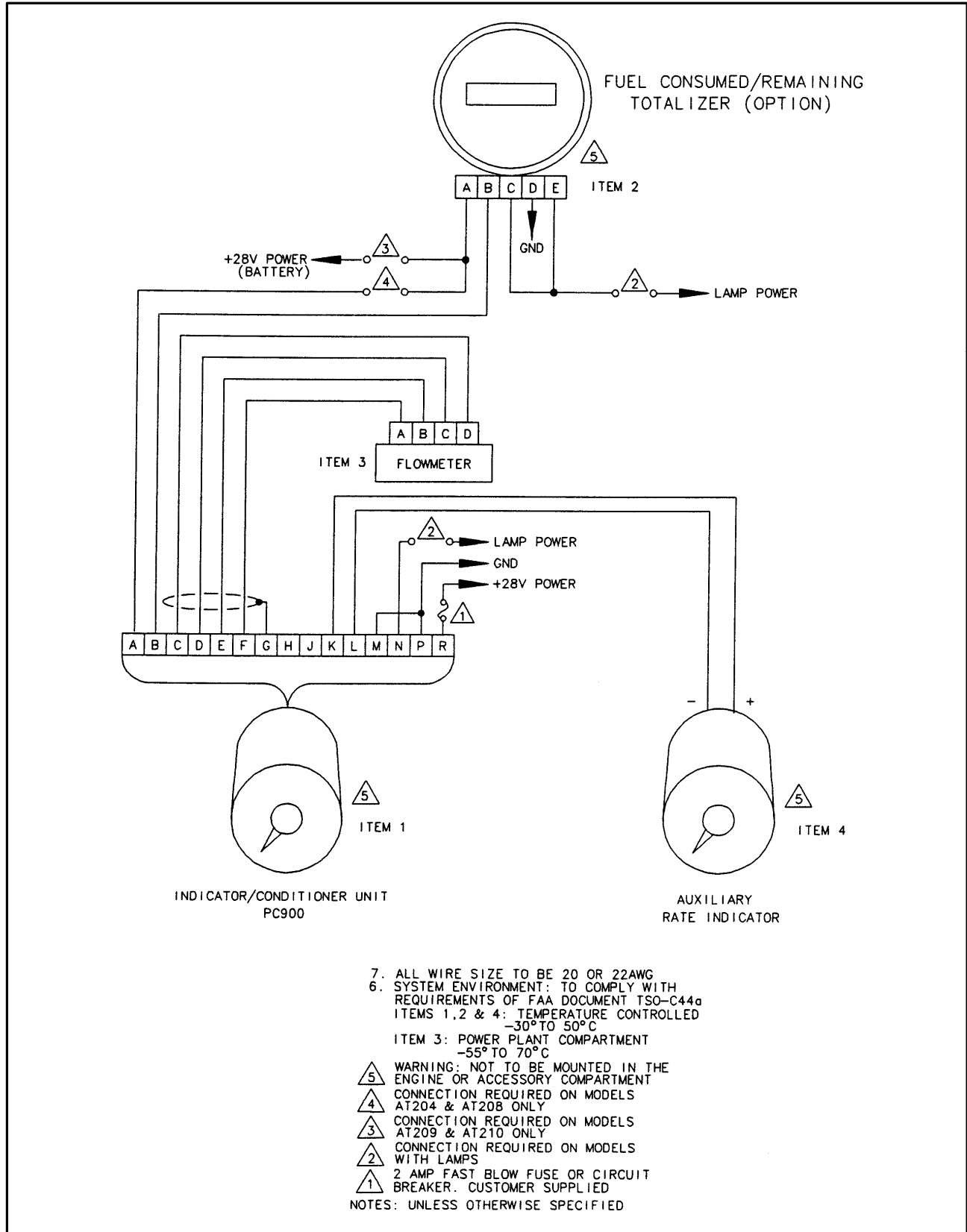
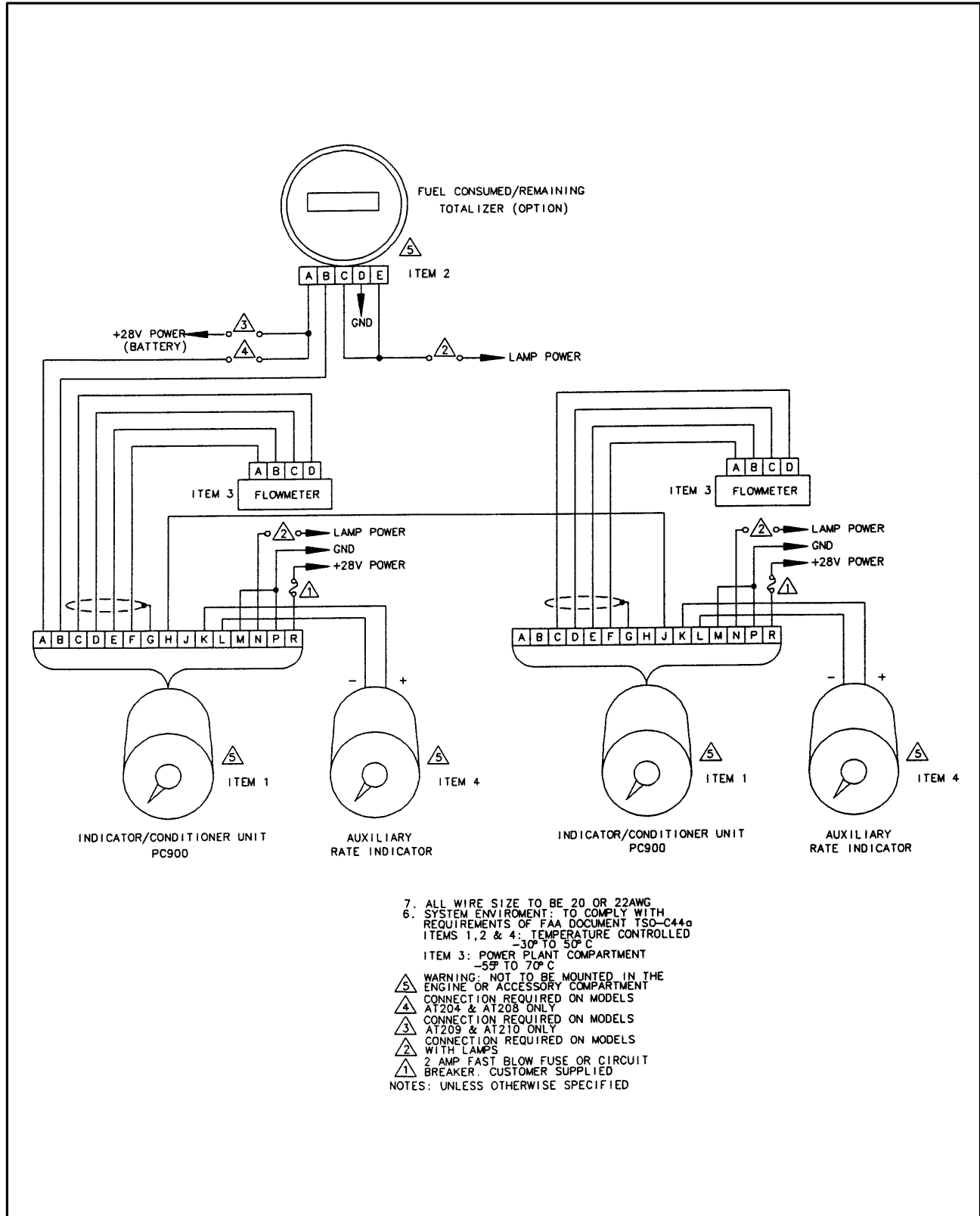


Figure 25. Wiring Diagram for Twin Engine Systems with 0-1 mA Remote Rate Indicator Style B & C.



15. TESTING

15.1 General

This section contains on-aircraft test for the units of the Fuel Management System. The on-aircraft test is used to check out the system after installation and as an aid when troubleshooting a system.

15.2 Test Equipment Required for Testing

Senior Aerospace Ketema. Test Instrument, Model PC-89.
Stop watch.

15.3 Description and Use of The PC-89

The PC-89 illustrated in Figure 26 is a hand-held battery powered instrument which provides a precision pulse output signal which is substituted for the output signal of the turbine flow transmitter during test. It is used for on-aircraft testing or troubleshooting of a system without requiring engine(s) turn-up and provides the following system checks:

System wiring

Functional check of instrument units operating as a system (excluding turbine transmitter).

Locating a faulty instrument unit of the system (excluding turbine transmitter).

Verifies scaling of signal conditioner.

16. Test Procedure

16.1 Preliminary

Calculate values for R_O and T_O (sample calculations found in section 16.4). After calculating value for R_O and T_O , insert these values in space provided below. These values will be used each time this system is checked.

R_O = _____

T_O = _____

Check the condition of the PC-89 battery by activating its test switch. If green light glows, PC-89 is ready for use. (Light cannot be seen in direct sunlight.)

Remove the wire connector from one of the flow transmitters (if twin engine system) and connect it to the PC-89 output connector.

Turn frequency switch on PC-89 to F_t frequency value used to calculate R_O and switch on PC-89 power.

Place the temperature switch on the PC-89 to the REF position.

Turn on aircraft 28 Vdc power supply.

16.2 Rate Indicator Check:

The rate indicator should indicate the calculated R_o value within $\pm 2\%$.

If indicator does not indicate or indicates a value other than R_o , refer to Troubleshooting Table for possible cause of malfunction.

Check the compensating circuit of the signal conditioner by placing the temperature switch on the PC-89 to the ELEV position. The rate indicator should indicate a value 5% less than the calculated R_o value. If indication did not change in value, the compensating circuit is not operating and the signal conditioner must be repaired.

Return temperature switch to REF. position before proceeding.

16.3 Totalizing Indicator Check:

Observe the number of counts on the totalizer taken over a 10 minute time interval. The counts on the totalizer should be within ± 2 counts of the predetermined value of T_o .

If the totalizer does not count or the number of counts over the time period do not agree within the limits of T_o , refer to Troubleshooting, Table 4, for possible cause.

If system being checked is a twin engine system, disconnect PC-89 from first transmitter cable connector and connect it to the other transmitter cable connector and repeat the above steps.

If system checks out using the PC-89 test unit, turn up aircraft engine(s) and observe whether or not the system indicator(s) are operating.

If any of the indicators are not operating or operating erratically, refer to Troubleshooting, Table 4, for possible cause of malfunction.

16.4 Calculating R_o and T_o Values

$$R_o = \frac{F_t \times D}{F_s}$$

$$T_o = \frac{R_o}{6}$$

Where:

F_t = Test frequency. The F_t frequency selected should be lower than the F_s frequency

F_s = System full scale frequency setting.

D = Full scale dial calibration (Rate Indicator dial), see Figure 2

R_o = Dial reading, calculated

T_o = Totalizer, count per 10 min, calculated

Sample Calculation:

Assume $F_s = 523$ Hz

$F_t = 400$ Hz,

$D = 600$ lbs/hr

$$R_o = \frac{F_t \times D}{F_s} = \frac{400 \times 600}{523} = 459 \pm 2\%$$

$$T_o = \frac{R_o}{6} = \frac{459}{6} = \frac{76.5 \text{ counts}}{10 \text{ min}} = \pm 2 \text{ counts}$$

17. TROUBLESHOOTING

This section provides information in locating and replacing faulty fuel system units. If a system malfunction occurs, reference should be made to the Troubleshooting Table 4, to determine probable cause.

After the faulty unit has been located, the unit should be replaced with a spare unit and the faulty unit returned to Senior Aerospace Ketema for repair.

Table 4. Troubleshooting

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Erratic indications	Signal conditioner inputs referenced to DC potential	Check input wiring for correct connections and for shorts to shielding; repair as required.
	Foreign material obstructing flow transmitter rotor movement.	Flush flow transmitter as Outlined in section 18.3.
	Defective flow transmitter bearings	Replace with spare unit and return faulty unit to Ketema for repair
	Heavy vapor in fuel system causing flow transmitter deviations.	Rework or repair fuel system.
	Low fuel pressure causing flow transmitter deviations.	Check fuel system pressure and repair as required.
No rate indication, totalizer output is normal.	Defective rate indicator.	Replace with spare unit and return faulty unit to Ketema for repair.
	Defective signal conditioner	Replace with spare unit and return faulty unit to Ketema for repair.
Totalizer inoperative	Defective totalizer AT-210	Apply 28 Vdc to pin 2 and the 28 Vdc common to pin 3. Push the reset switch. The display should be all zeros. Apply a 0 to 5V, 1Hz square wave to pin 1. The display should count up at a 1 Hz Rate. If a malfunction is detected, the totalizer should be replaced.
	Defective totalizer AT209	Apply 28 Vdc to pin 2 and the 28 Vdc common to pin 3. Push the up/down set switches for a display of 1000. Apply a 0 to 5V, 1 Hz square wave to pin 1. The display should count down at a 1 Hz rate. If a malfunction is detected, the totalizer should be replaced.

18. MAINTENANCE

18.1 General

This section provides information on the maintenance requirements for the instrument units of the Senior Aerospace Ketema, Fuel Management Systems.

18.2 Indicator/Conditioning Unit

No periodic maintenance of this instrument is required. If a malfunction occurs, the faulty unit should be returned for repair to Senior Aerospace Ketema, 790 Greenfield Drive, El Cajon, Ca, 92021. FAA Approved Repair Station F8XR824N.

18.3 Totalizing Indicator

18.3.1 Fuel Consumed Totalizer, AT-204 and AT-208 Series Models:

No periodic maintenance of these totalizing indicators are required. Should a malfunction occur, the faulty unit must be replaced with a spare unit as it is not repairable. If the faulty unit is still under warranty, return it to Senior Aerospace Ketema, 790 Greenfield Drive, El Cajon, Ca, 92021 for replacement.

18.3.2 Fuel Remaining Totalizer, AT-209 and AT210 Series Models:

No periodic maintenance of these totalizing indicators are required. If a malfunction occurs, the faulty unit should be returned to Senior Aerospace Ketema for repair.

18.4 Turbine Flow Transmitter

The recommended maintenance of this instrument consists of replacing the bearings and shaft every 5000 hours and recalibration.

Bearing wear or failure is indicated by erratic or zero flow rate indication.

When bearing replacement is required, the transmitter must be returned to Senior Aerospace Ketema for replacement of bearings, shaft and recalibration.

Transmitter rotor failure may, on some occasions, be due to excessive dirt in the fuel. Rotor operation can sometimes be restored by flushing. To flush rotor assembly, use the following procedure:

Remove flow transmitter from fuel line, noting flow direction by arrow on case. (Re-install transmitter with arrow on case pointing in direction of fuel flow.)

CAUTION: DO NOT USE AIR HOSE TO SPIN ROTOR AS EXCESSIVE PRESSURE WILL CAUSE ROTOR TO OVERSPEED, DAMAGING BEARINGS.

Blow lightly into the transmitter housing and observe rotor movement. (If the transmitter is in good condition, the rotor will spin freely for several seconds.)

Flush transmitter with isopropyl alcohol.

Blow lightly into transmitter housing and observe rotor movement. If no improvement is observed, flush transmitter again with isopropyl alcohol.

If rotor does not spin freely, new bearings are required and transmitter should be returned to Senior Aerospace Ketema for repair.

The flow transmitter pickup coil is manufactured to insure greatest possible life. Failure is unusual, but may occur as a result of internal wire damage caused by thermal effects. To test coil, use the following procedure:

Check resistance between pins A and B with an ohmmeter (normal resistance is 3100 ohms \pm 10% at 25° C). If the ohmmeter shows the pickup coil has failed by opening or shorting, the flow transmitter must be returned to Senior Aerospace Ketema for repair.

Check resistance between pin A and turbine meter housing. The pick up coil must be isolated from the housing by 20 meg. ohms minimum.

Check the resistance pins C and D with an ohmmeter (normal resistance is 1000 ohms \pm 2% at 25° C). If the ohmmeter shows the temperature sensor has failed by opening or shorting, the flow transmitter must be returned to Senior Aerospace Ketema for repair.

Figure 26. PC-89 Precision Oscillator



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