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*1375 SE Wilson Ave. Suite 150  
Bend OR 97702, USA  
[scott.philiben@ciescorp.com](mailto:scott.philiben@ciescorp.com)  
541-408-1095*

STC SA02511SE Installation Manual & Instructions for Continued Airworthiness  
CC Series Fuel Level Sender

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# Revisions

LIST OF REVISIONS			
REV	DESCRIPTION	SIGNATURES	
N/C	Original Issue	March 8, 2017	STP CS
A	Page 9 revised sender designations to include the -3XX and -5XX for Resistive and Voltage senders. Page 14 revised the language to indicate that the resistor is now in the wire harness or incorporated in the sender, Page 16 added figures 5-8 and 5-9 for the Mooney and Beech Interface with the Garmin G1000 and the Piper Malibu indicating the current limiting resistor	March 16, 2018	STP CS
B	Page 8 added typical values for frequency. On page 18 Added Garmin Calibration procedure to bring Garmin Floor and Ceiling values in compliance with the fuel output specification, including figure 6-1 illustrating the Garmin calibration page. Page 19 Added a Rochester Gauges calibration procedure on as the method of adjusting the gage was non intuitive. These changes moved content further down	April 23, 2018	

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# 1. INTRODUCTION

This document provides the FAA-approved installation instructions for the installation of CiES fuel tank level sending units in accordance with STC SA02511SE on eligible aircraft models.

**CiES** CC-Series fuel senders are TSO certified to C55a and associated SAE AS405C.

They have met all the FAA Environmental Requirements & Complex Programmable Hardware Requirements for general aviation aircraft and the TSO.

**CiES** Fuel Senders are designed specifically for aircraft and the specific conditions encountered by aircraft. They are manufactured to precise standards and built to a quality system audited by the FAA.

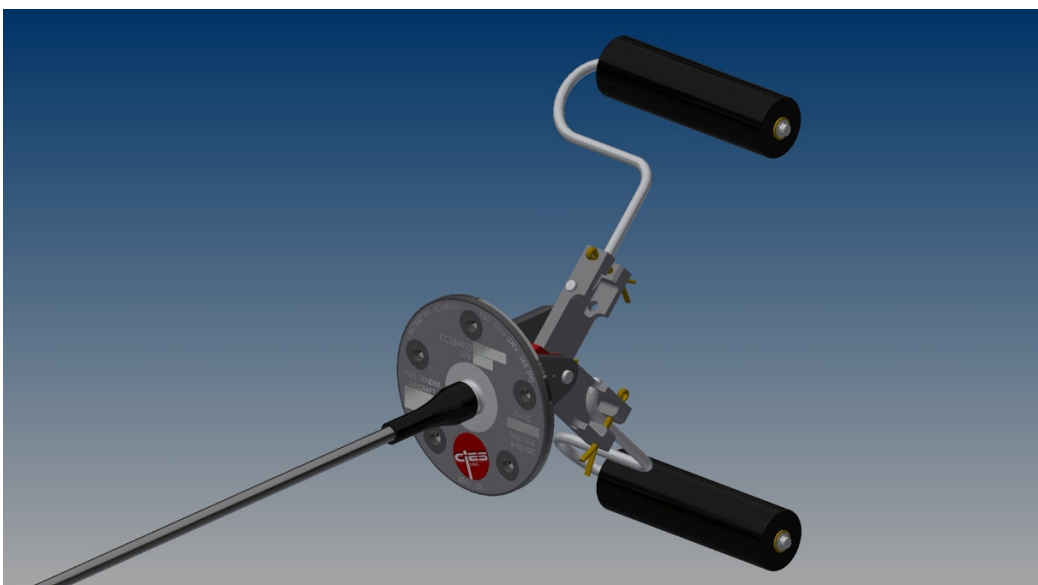
CiES Fuel Senders are patented and patent pending technology and are not offered by any other manufacturer.

**CiES** Fuel Senders operate on a different principle than traditional float senders and are designed specifically for aircraft applications. **CiES** fuel senders measure the direction of a generated magnetic field direction at the pivot point of the float arm rotor assembly. Internal inside the body of the sender and outside the fuel, is a high precision electronic compass that is sensitive to the magnetic field direction. It is essentially a compass that points to north – only in this case north is the fuel float.

By disconnecting the float and float arm from the electronics or any mechanical system, the float is free to find the fuel surface without any encumbrance to movement up or down. **CiES** then utilizes a denser float to achieve a measure of damping as the float doesn't need to be sized to overcome friction.

By measuring magnetic field, precision is maintained throughout the life of the sender as mechanical slop, vibration or misalignment have no bearing on the accuracy of measurement. This is a difficult concept to understand, but basically no matter how you jostle an electronic compass – North is always North.

By keeping the electronics out of the fuel, the **CiES** fuel quantity system is safer, as no stray voltage spikes caused by faulty wiring, HIRF or Lightning can ever enter the fuel volume.



*Figure 1-1 CiES Fuel Sender*

## 2. APPROVED CONFIGURATIONS:

The combination of the CiES fuel sender part numbers and indicators approved on each applicable airplane model are listed in the AML tables of STC SA02511SE

## 3. GENERAL SPECIFICATIONS:

### 3.1. Physical Dimensions:

Floats, arm lengths, and travel angles vary depending on Aircraft application.

Note: Mounting may be in any of the following clock formations 12 o'clock, 3 o'clock, 6 o'clock, 9 o'clock and are specific to the aircraft. Senders only mount 1 way. The new senders mount similarly to the replaced fuel senders and are designed for side or top mount configurations.

Some PMA parts utilized for aircraft fuel tanks have patterns that are not identical to the OEM factory produced components. Contact CiES, Inc. if PMA parts don't allow for correct installation of the new sender.

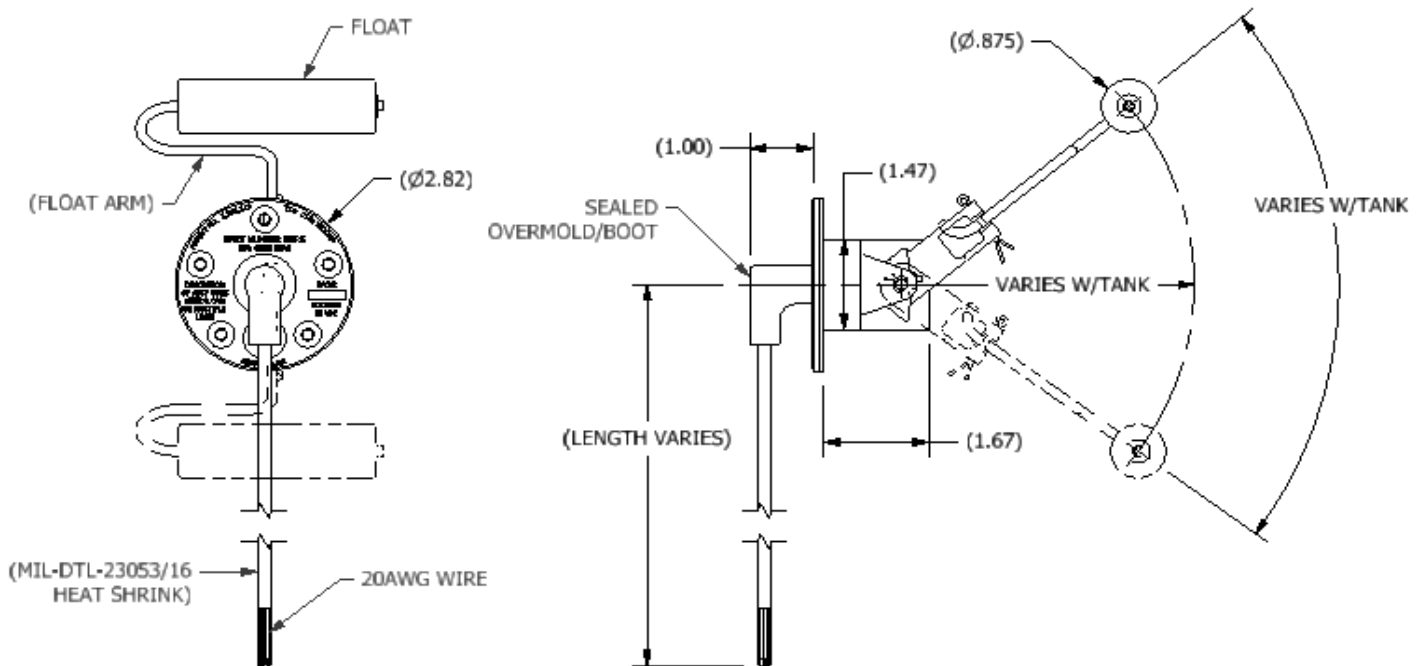


Figure 3-1 CiES Fuel Sender Dimensions

### 3.2. Mounting/Installation:

- \* Prior to installing each fuel level sending unit, visually inspect the interior of the fuel tank through the mounting hole and any other appropriate available access to verify that each installed sending unit will not contact any obstructions or otherwise be restricted in its full range of motion.
- \* Hardware is “NOT” supplied with senders unless requested. Use NAS or equivalent hardware as shown in the figure below. In retrofit applications, existing or equivalent hardware may be utilized to attach the sender body to the aircraft fuel tank. Reference the Aircraft Illustrated Parts Catalog for the appropriate hardware if you are in doubt of the appropriate hardware reference
- \* Senders that are installed in a metal aircraft or in a metal tank must be bonded to the aircraft structure in one of two methods described in Section 5.1. This bonding provision is critical to prevention of an ignition source in the event of a lightning strike.
- \* Reference the Aircraft Maintenance Manual for appropriate sender torque specifications and for applicable sealant installation requirements. Isolating washers are not required for CiES Fuel sender installations and are not desired or required. In a new installation or absent any specifications, Torque screws 18-22 in. lbs. using a crossing pattern. **Warning:** Over torquing or using a circular pattern may cause “damage” to gasket and/or sender.

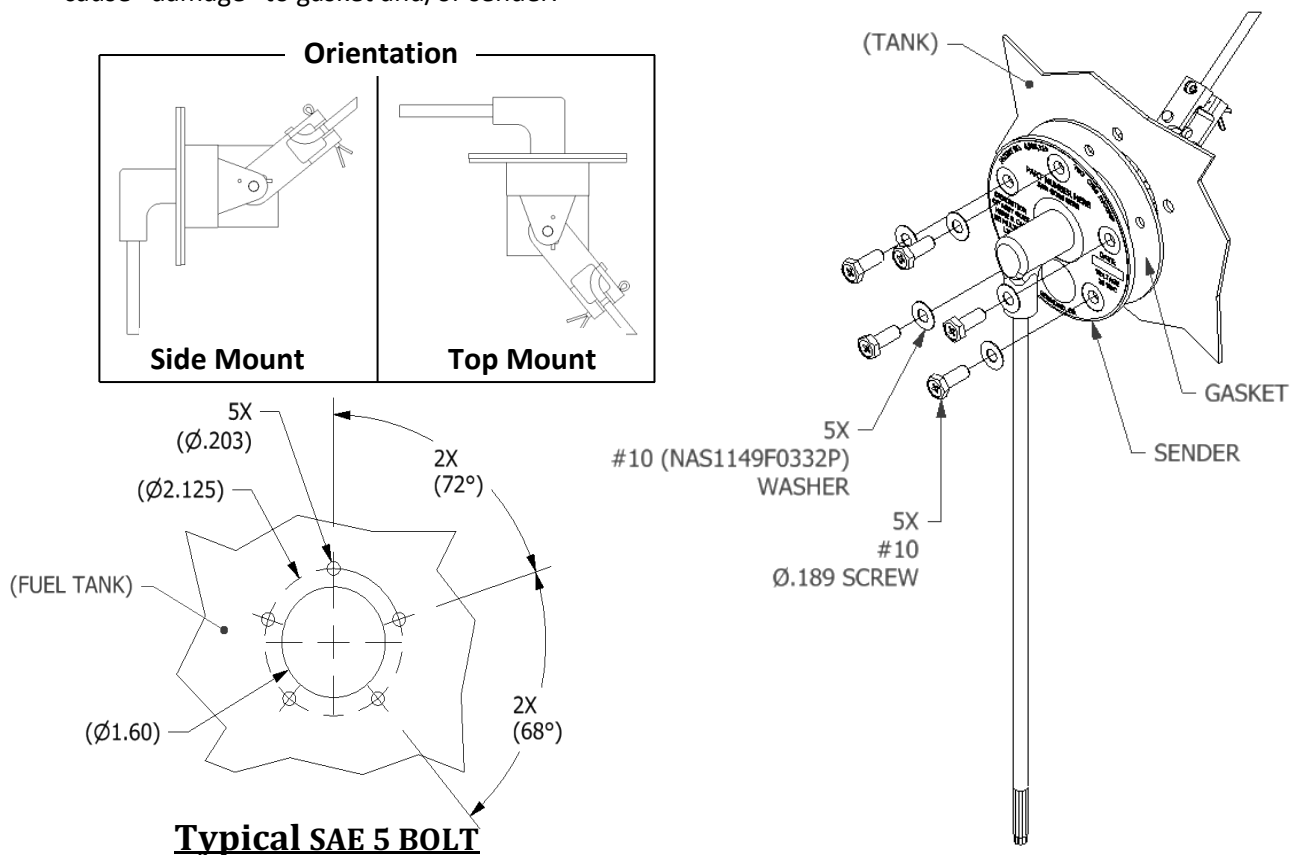


Figure 3-2 CiES Fuel Sender Mounting

### 3.3. Mounting Details

CiES Fuel Senders due to the patented sensor system allow far more travel than a traditional resistance sender. This travel range is a distinct advantage that makes CiES systems simpler to construct and install. However:

It is very important to ensure that the installed sensor arm is free to move after the sender is attached to the fuel tank. There is a potential to install the sender and trap the sender float and float arm against the aircraft fuel tank or internal fuel tank obstructions and rendering the sender incapable of measuring a change in fuel volume.

A change in fuel volume directly below the float position of the CiES Fuel Sender should always change the frequency signal on the blue wire of the sender. Ensure that this is the case with either a visual inspection through the fuel filler or other fuel tank port, or by a measurement of frequency on the blue wire with power applied to the fuel sender.

Sender values on both fuel tanks and in mirrored positions should be have nearly identical blue wire frequency values.



*Figure 3-3 Clearance and Binding Illustration*

## 4. ELECTRICAL INSTALLATION

### 4.1. Operating Voltage:

Operating Voltage Range	
Voltage "VDC"	9 - 28

### 4.2. Power Consumption:

Voltage "Vdc"	Steady State Current "mA"
14	17.1
28	9.6

### 4.3. Signal Output Range(s):

See note 1:

Output Type	Signal	Range	Output Range
Temperature			
Option 1	0-5 Vdc Square Wave	-50°C to +50°C -58°F to 122°F	Frequency 1,200Hz – 490Hz
Fuel Level	Output to be one of the following		
Option 2 Frequency	0-5 Vdc Square Wave	5° to 175° Angular Travel	Frequency 10K Hz – 64 Hz Typically Between 30 Hz & 300 Hz
Option 3 Resistance	Resistance 0 - 280 Ohm	5° to 175° Angular Travel	Resistance 0 - 280 Ohm
Option 4 Voltage	Voltage 0 - 5 Vdc <sup>2</sup>	5° to 175° Angular Travel	Voltage 0 - 5 Vdc <sup>2</sup>

Note 1: Customer selects configuration based on the AML and Section 2 of this manual.

Note 2: Voltage can be varied up within 2 volts of VDC input



#### 4.4. Wire Color Designations

<i>WIRE DESIGNATIONS</i>		
<i>Wire Color</i>	<i>Designation</i>	<i>CiES Fuel Sender Type</i>
Red	Power	All CC284022 (XXXX)-(XXX)
Black	Ground	All CC284022 (XXXX)-(XXX)
Blue	Fuel Qty "OUT" in Hz	All CC284022 (XXXX)-(XXX)
Orange	Temp. "OUT" In Hz (Option) Or Low Fuel Annunciation	(Special Application only Contact CiES)
Gray	Fuel Qty "IN" Hz (Master/Slave)	CC284022 (XXXX)-(XXX) Master
Green	Fuel Qty "OUT" (0-5V)	CC284022 (XXXX)-(XX5) or (5XX) Only CC284022-(XXXX)-(XX6) Only
Purple	Fuel Qty "OUT" (0-280 ohms)	CC284022 (XXXX)-(XX3) or 3XX Only CC284022-(XXXX)-(XX4) Only

- Wiring: 20 & 22 AWG wires - M22759/11-20-X, M22759/16-20-X or M22759/16-22-X
- Heat Shrink - MIL-DTL-23053/16
- High performance elastomer Heat Shrink Boot with self-sealing adhesive, MS25171-1S Nipple, or Heat Shrink MIL-DTL-23053/16.

#### 4.5. Connectors:

CiES Inc. senders are not supplied with connectors unless specifically requested by customer. Reference each individual assembly for clarification, connector specifications, and/or pin assignments.

## 5. ELECTRIC INSTALLATION

CiES Inc. fuel quantity senders operate in a different manner than traditional resistive float senders even though they bare a slight resemblance.

CiES Inc. fuel quantity senders are powered, they require aircraft DC level voltage and a good aircraft ground connection to operate. This additional added power wire requires fault protection per the requirements in AC43.13-1B Section 4 Table 11.3.

As the power consumption is very low for CiES senders , you may provide less current than the recommendations in the Advisory Circular for 20 or 22 gauge wiring typically 1 to 2 Amps is sufficient. You will have to add the number of CiES senders installed in the aircraft to get a reasonable value of inflight current consumption.

Revise the aircraft electrical load analysis and ensure that consumption is only 80% of aircraft electrical load capacity.

Utilize wire types approved for the aircraft in the installation of the fuel level sender power and signal wires. If no listing of approved wire types is available, use M22759/11-20-X.

Follow the existing fuel sender signal wire routing for new power wire or new power wire and signal wire in the aircraft, ensure that lacing, wire ty wrap and wire support are maintained in the existing wire bundle.

**Ensure that the chosen aircraft ground connection is less than 0.3 Ohms to the aircraft battery.**

In tanks where two or more sensors are required, the most inboard sensor is the master, and the other senders are slaves. Slaves communicate with the master sender in digital or frequency mode only.

In a single sender tank configurations, the sender is the master.

Master sender output is a choice of digital or analog.

## 5.1. BONDING (Metal and Metal Tank Aircraft Only)

CiES Inc. fuel quantity senders that are installed in a metal aircraft or in a metal tank must be bonded to the aircraft structure in one of two methods:

1. Burnish one sender attachment position so that the protective anodize is removed. Ensure bonding by measuring resistance of the attachment screw to a known aircraft ground. The resistance should be less than 0.03  $\Omega$ .
2. Burnish one sender attachment position and attach a ground braid with a ring terminal and attach the other end of the braid to grounded aircraft structure as close as practical to the sender unit. It is acceptable to use an existing bonding connection if it exists from the sender unit being replaced. Ensure bonding by measuring resistance of the attachment screw to a known aircraft ground. The resistance should be less than 0.03  $\Omega$ .

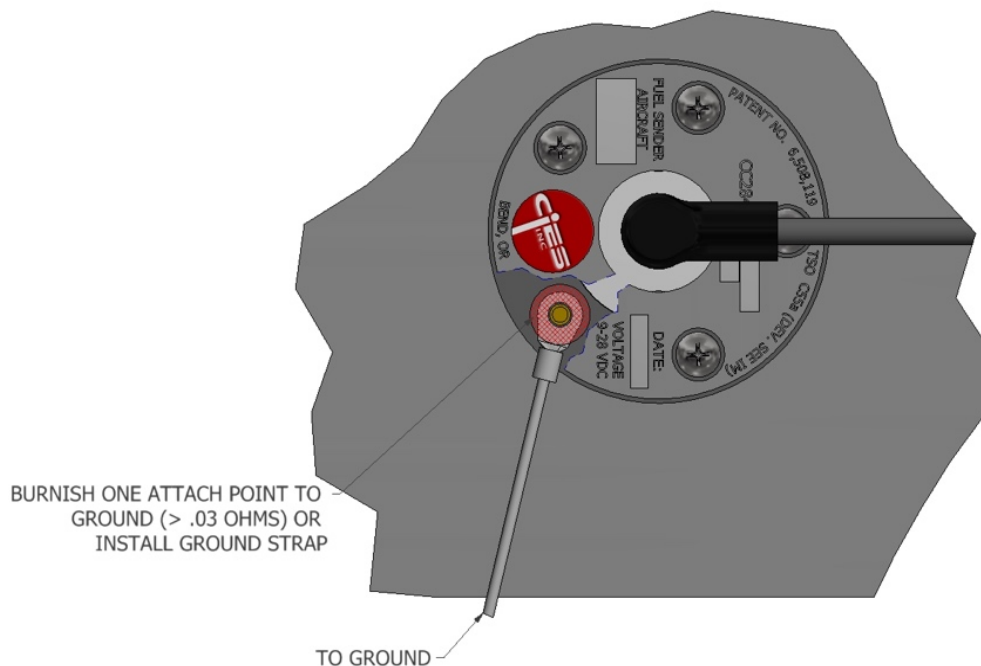


Figure 5-1 Bonding for Lightning Protection

## 5.2. GENERIC INSTALLATION SCHEMATICS - DIGITAL OUTPUT

### 5.3. Digital Output Senders *Fig Figure 8-1 Fuel Level Representation*

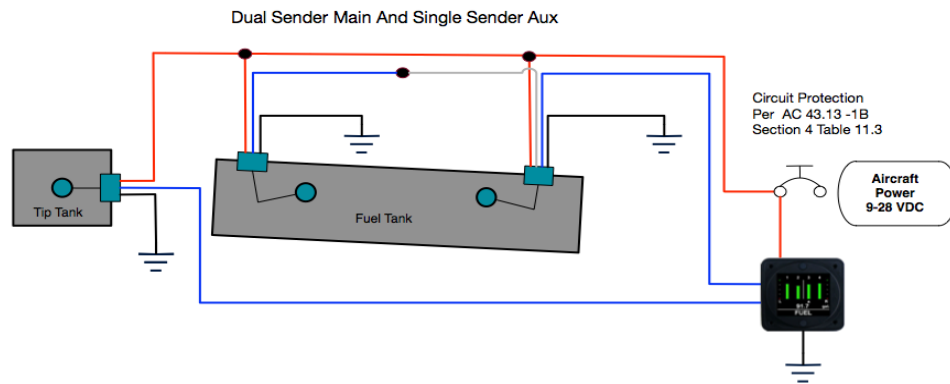


Figure 5-2 Fuel Sender Schematic: Dual Sender Main and Single Aux Tank

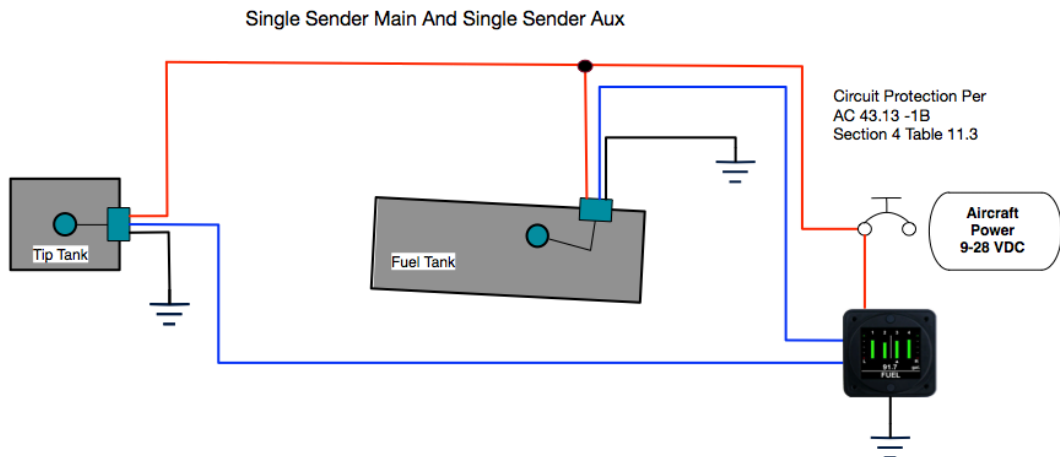


Figure 5-3 Fuel Sender Schematic: Single Sender Main and Single Aux Tank

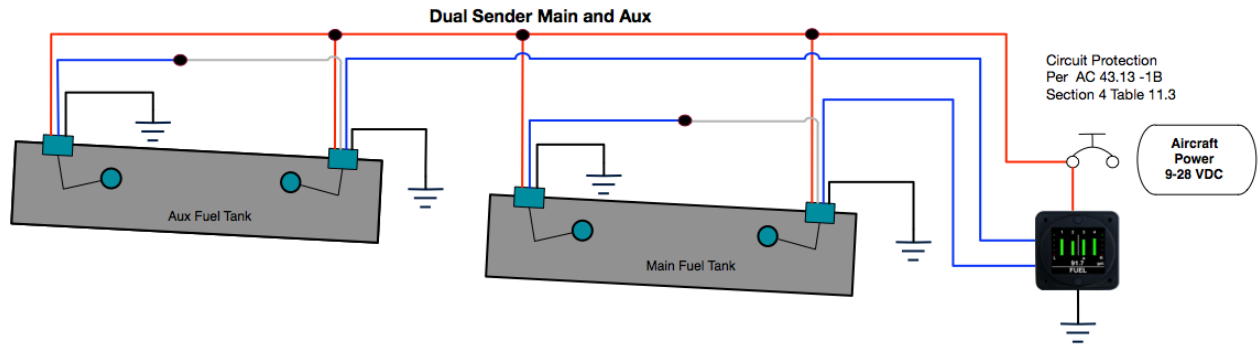


Figure 5-4 Fuel Sender Schematic: Dual Sender Main and Aux Tank

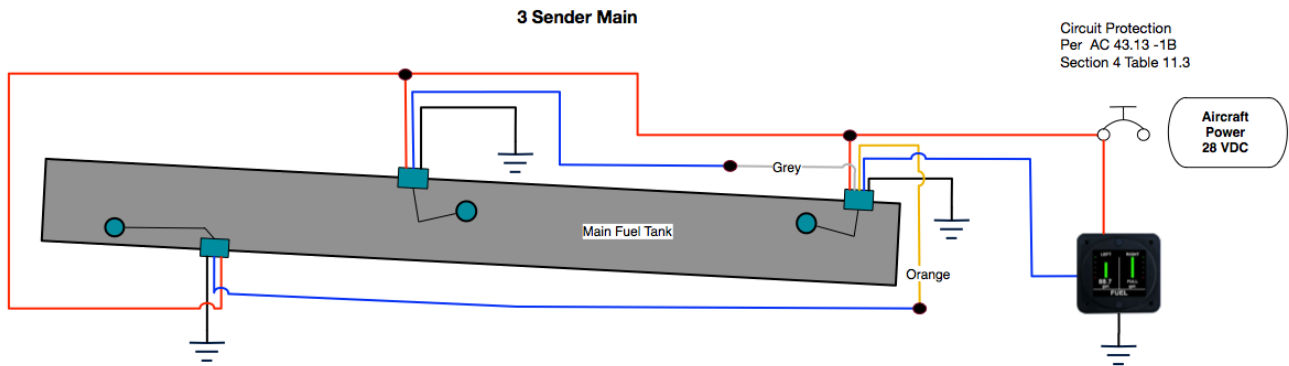
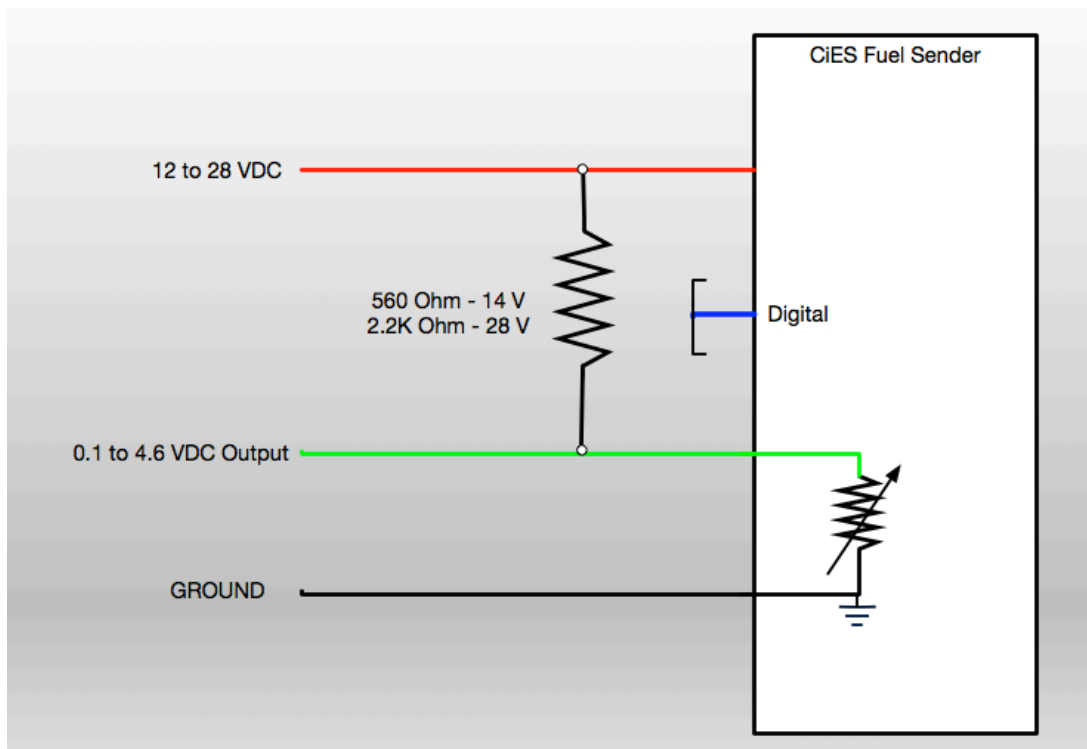


Figure 5-5 Fuel Sender Schematic: Three Sender Main

## 5.4. ANALOG VOLTAGE OUTPUT



*Figure 5-6 Analog Voltage Out Illustration*

For an analog output the fuel sender operates similarly to a variable resistor to ground in analog voltage mode and will create a 0.1 to 4.7 volt output. This output is the normal input for a JPI or EI display that previously had resistive senders and a conversion box attached. This resistor is incorporated into the wire harness or sending unit

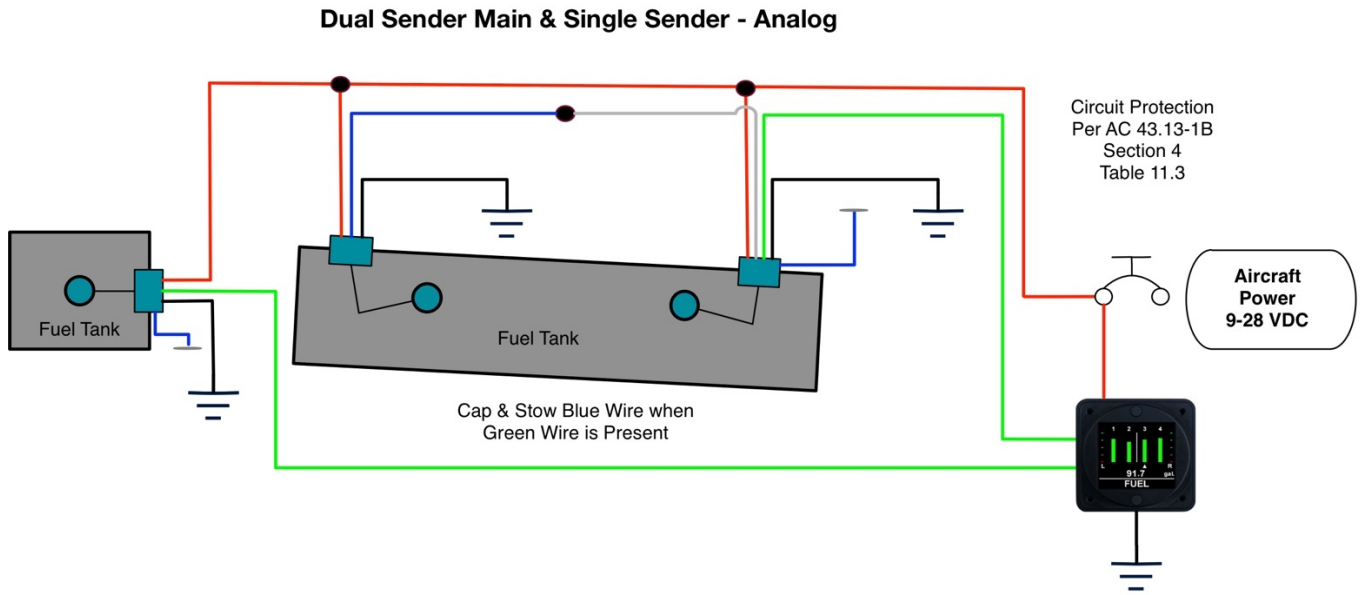


Figure 5-7 Fuel Sender Schematic: Dual Sender Main and Aux Tank Analog

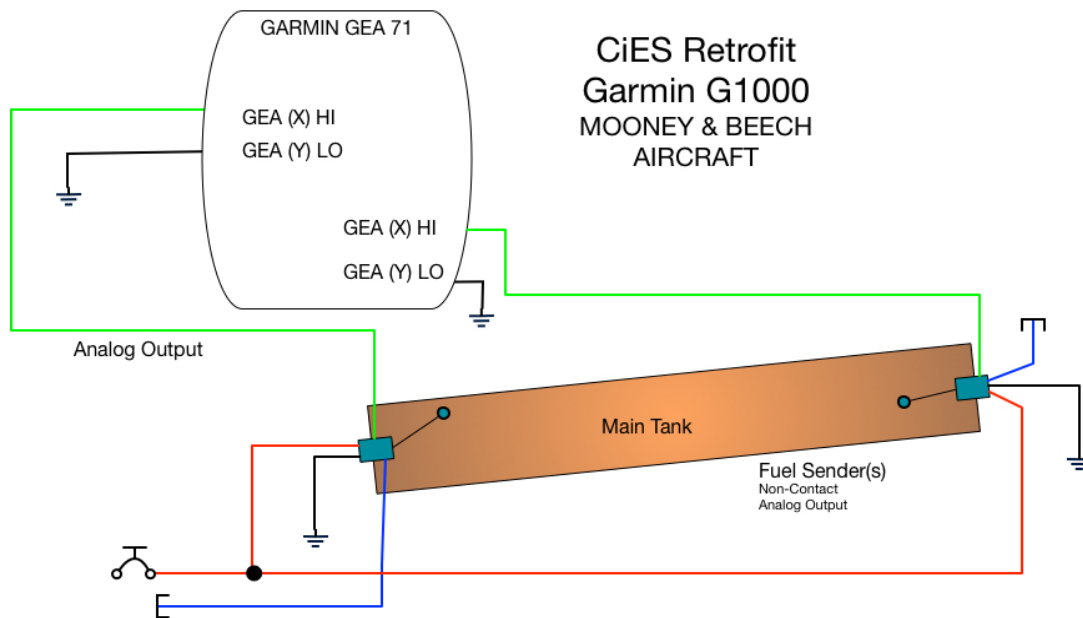
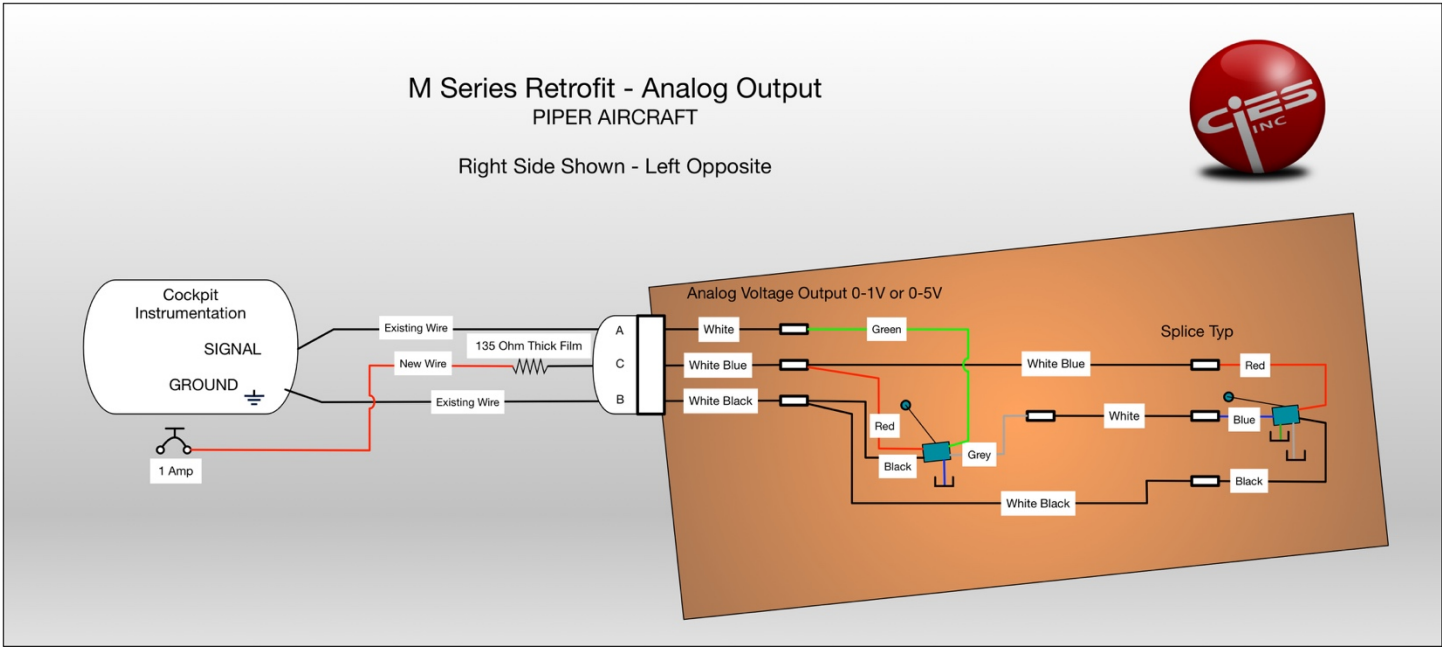


Figure 5-8 Fuel Sender Schematic: Garmin G1000 Interface Mooney and Beech



*Figure 5-9 Fuel Sender Schematic: Piper Malibu*

**5.5. ANALOG RESISTANCE OUTPUT:**

(Future Reference - Not utilized at this time)



## 6. CALIBRATION

The following calibration procedures must be successfully completed for each tank on each aircraft after installing the CiES sending unit and prior to returning the aircraft to service.

Fuel volume measurement methods used in all steps of the calibration process must be accurate to within 3%. Graduated fluid volume measurement containers are preferred for measuring fuel quantity. If you choose to measure fuel by weight, you must accurately determine the density of the fuel and convert the measurements to volume measurements. Do not rely on indications from fuel dispensing equipment. Use appropriate ignition prevention practices when draining and filling tanks.

### **Calibration Procedures:**

For multi-function displays and for dedicated fuel quantity indicators installed under a supplemental type certificate (STC), use the fuel quantity indicator calibration method that is called for by the applicable display system or indicator STC. The calibration procedure will typically be contained in the installation manual for the installed display device.

For displays and indicators provided as original equipment on an aircraft, use the calibration procedure contained in the aircraft maintenance manual.

If you are unsure of the correct calibration procedure to use, contact CiES for assistance.

### Setting the Unusable Fuel Quantity:

The calibration process at some point will call for the fuel loaded in the tank being calibrated to be equal to the unusable fuel quantity determined for that tank. That quantity is the unusable fuel quantity determined for that tank by test under § 23.959 or its predecessor regulations. The fuel quantity indication system will be calibrated to read “zero” or “empty” at this fuel quantity when the airplane is in a level flight attitude. The unusable fuel level is normally listed in the FAA type certificate data sheet (TCDS) for each airplane model. If the unusable fuel is not listed in the applicable TCDS, you must contact CiES for assistance in determining the unusable fuel level that was established by the original manufacturer. An acceptable method for setting the fuel quantity in the tank at the identified unusable fuel quantity is to drain the tank as fully as possible using the tank drains (this is usually most effective with the airplane at the normal ground attitude), and then to add the unusable fuel quantity listed in the TCDS for that tank. Other methods may be used if accepted by the FAA inspector or designee that returns the airplane to service.

To achieve a FAA compliant Fuel Quantity indication in the cockpit as required by Part 91 and 135 operating rules. The fuel gauge is to read from full to empty for each tank.

Information, including FAA Approved Installation Manuals and FAA Pilot Handbooks that indicates that general aviation fuel quantity is only to be accurate at “Zero” is erroneous and a misstatement of the regulations.

These regulations require the pilot to accurately determine all usable fuel in the aircraft from **EMPTY** to **FULL**.

- Where **EMPTY** is the FAA flight test determined and Type Certificate Data Sheet, or aircraft Maintenance Manual published aircraft “**zero usable fuel quantity**”.
- Where **FULL** is the published maximum fuel level indicated on the TCDS and fuel tank placard.

A FAA compliant fuel quantity system is to accurately read remaining **Usable Fuel** quantity per the aircraft FAA Approved Maintenance Manual requirements in any position between **FULL** and **EMPTY** values in level flight.

The FAA compliant display will drop consistently from **FULL** to **EMPTY** with the draining of the fuel tank in normal flight attitude in still air.

Calibration is achieved by the TSO and/or STC Instrumentation Requirements, listed in the specific FAA Approved Instrument Installation Manual or procedures listed in the Aircraft Maintenance Manual. Absent a listed procedure the following applies:

- The aircraft will be jacked and leveled.
- The aircraft will be emptied of fuel.
- The applicable unusable fuel quantity listed in the TCDS will be added to the tank.
- Confirm the cockpit display reads **EMPTY** and are within the tolerances established by the FAA Approved Aircraft Maintenance Manual if provided.
- Any numerical value on the cockpit display will be confirmed and checked by adding that value of fuel to the tank in addition to the unusable fuel.

**FULL** fuel will be checked in a similar manner where the gauge will read Full.

**For example:**

If the gauge has markings at 5, 10, 15 gallons - that amount of fuel will be added and the cockpit display checked to ensure that gauge accuracy is maintained. (within the tolerances established by the FAA approved Aircraft Maintenance Manual).

**Garmin** - All CiES senders interfacing with Garmin G1000 systems are produced to factory specification, if values shown on the Garmin Fuel Tank Calibration Page for CiES fuel sender inputs fall below the floor level at empty and or above the ceiling level at full, place the cursor over the values and adjust the floor and ceiling levels to be the input CiES sender value shown on the "Sensor Inputs" utilizing a value -10% shown for floor values and +10% for ceiling values.

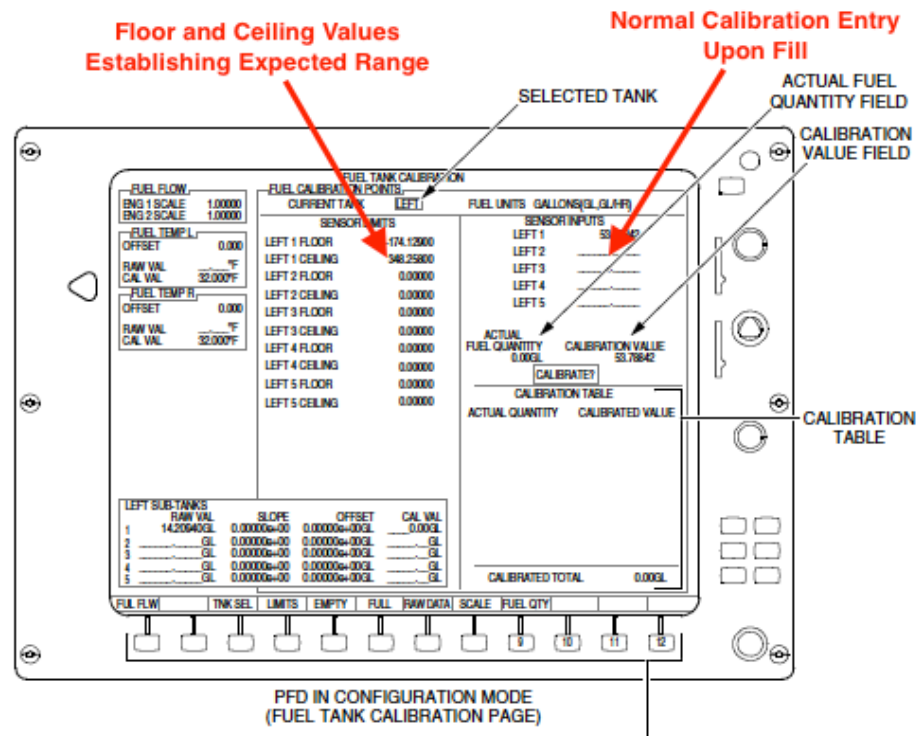


Figure 6-1 Garmin Fuel Calibration Page

**Rochester Gauges** – First adjust the low gain fully counterclockwise prior to calibration.

**CAUTION:** DO NOT press down hard or force potentiometers outside 280 range during adjustments. Doing so will damage potentiometers resulting in physical damage to the fuel quantity gage.

**NOTE:** Adjust FULL trim potentiometers to center travel prior to making EMPTY adjustment. Failure to do so may result in FULL trim potentiometers running out of travel before FULL adjustment can be obtained.

- Adjust FULL trim potentiometers to center travel.
- Slowly adjust Empty trim potentiometer for each tank with zero fuel onboard until needle indicates zero gallons

**NOTE:** The Rochester Gauges Fuel Level gage responds slowly, lightly tap on rim of gage and allow approximately 1 minute between each adjustment.

- Turn off power to the fuel gage
- Fill both tanks to full fuel level quantity
- Restore power to the fuel gauge
- Slowly adjust full trim potentiometers until needle indicates full for both tanks



*Figure 6-2 Rochester Fuel Gage*

## **REQUIREMENTS:**

While the **CiES** Inc. fuel sender is FAA TSO C55a approved and has met a quality standard of 0.75% of tank capacity, that standard can only be met in the aircraft installation **if and only if**, the aircraft instrumentation, whether that instrumentation is TSO'd C55a or not, has the capability of accurately displaying at that level of sender accuracy. The AML STC SA02511SE prescribes the correct pairing of the CiES fuel sender with the appropriate FAA approved cockpit instrumentation and this information is also found in Section 2 of this manual.

A fuel quantity installation that meets the requirements of this manual must be able to effectively move between zero fuel and full providing an accurate representation of usable fuel in the cockpit.

Oscillations of fuel quantity  $\pm 4\%$  of tank capacity in level flight & still air will require a replacement/refurbishment of the cockpit indication system to achieve an FAA compliant installation.

A fuel quantity installation that meets the requirements of this manual must be able to effectively meet the numerical, warning or cardinal indications present on the cockpit display or requirements of the POH or Service Bulletin. Absent a Aircraft Maintenance Manual tolerance indication, cockpit indicated values found in the POH and on the cockpit indication itself will fall within +1% and -3% of full tank capacity.

A low fuel annunciated warning may be incorporated that meets the requirements of the aircraft POH or FAR mandated operational requirements.

## 7. **STC INSTRUCTIONS FOR CONTINUED AIRWORTHINESS**

### **G23.1 General**

This section constitutes the required Instructions for Continued Airworthiness

This document is found on <https://www.ciescorp.net/instructions-for-continued-airworthiness.html>

### **G23.2 Format**

This manual section forms the CiES CC284022 Series Instructions for Continued Airworthiness.

### **G23.3 Content**

The contents of this manual is presented in the English language.

(a) *Airplane maintenance manual or section.*

#### (1) Introduction

This system is a modification to the aircraft fuel quantity system. The system utilizes a float or floats to detect the fuel level surface and transmits this data electronically to an FAA Approved fuel quantity instrument in the cockpit. All the maintenance manual aircraft requirements for fuel quantity accuracy requirements still apply.

CiES fuel quantity senders require aircraft power for operation and while they are physically identical in utilizing the existing mounting locations hardware and gaskets. (Reference Section 3)

#### (2) Description

The fuel indication system measures the fuel in the tank by transmitting an angular position of the of float or floats from a fixed position of the sender in the tank. These floats ride on the surface of the fuel and in some instances the senders linearize that angular output to integrate to the existing fuel quantity indication. The sensor measures this angle in a non-electrical contact manner using a magnetic field detection.

The wiring location run in the installed aircraft for the additional power wire and the ground wire attachment should be noted in the box below. The signal wire to the cockpit is in the same wiring location as indicated in the aircraft wiring diagram. The additional power wire should follow the same wiring run as the original signal wire in the aircraft. A local ground can be utilized in metallic aircraft, otherwise the ground wire should follow the same wiring run as the original fuel quantity signal wire.

### (3) Operation

The sensor measures this angle in a nonelectrical contact manner using a magnetic field detection. The magnetic field is located at the pivot point of the sender body. This position may be transmitted by a 5 Volt square wave frequency signal or a linearized analog voltage or current (resistive) output. (Reference Section 4.3)

### (4) Servicing

The fuel level senders have no maintenance requirements or needs. The sensors function and require no re-calibration for sensor output. If a sensor has failed or fails to provide reliable or accurate fuel quantity output in the cockpit it needs to be replaced. Reference the aircraft maintenance manual for sender location.

## **b) Maintenance Instructions.**

### (1) Scheduling

- On Condition

### (2) Trouble Shooting

Each CiES fuel sender outputs a frequency including analog output senders (blue wire) and operation of the individual sender can be determined if a frequency output exists when power is applied to the sender with the ground wire attached. Power (Red), Ground (Black), and Frequency (Blue) are the only wires necessary to determine fuel sender operation.

- a) No Reading – check power to the sender unit, check blue signal wire for frequency output Hz with power on the sender, if an analog wire is connected check analog output, with power on the sender. Remove sender and inspect sender for proper working condition and potential interference from a foreign object in the tank.
- b) Incorrect Fuel Qty Level – check blue signal wire for frequency output Hz with power on the sender, if an analog wire is connected check analog output, with power on the sender. if there are multiple senders in the tank check each sender and check that connecting the slave senders to the master sender (Typically the inbd sender) changes the blue wire frequency output with power on all senders. Remove sender and inspect sender for proper working condition and potential interference in the tank.
- c) Unstable or Erratic Fuel Level Reading – insure that aircraft power is supplied to the sender and that the ground connection has less than 0.03 ohm resistance to a known airframe ground like the aircraft engine mount or exhaust

### (3) Repair Procedure

If the fuel sender is found to either not produce a digital frequency Hz output or an analog output, or the signal is erroneous or erratic replace the sender and re-calibrate the cockpit instrument.

#### (4) Procedural Instructions

Utilize the fuel quantity calibration procedures found in the aircraft FAA approved maintenance manual or FAA approved aircraft instrumentation. The aircraft should be leveled and jacked to prevent movement when fuel is added or subtracted. (Reference Section 6)

#### (5) Other Instructions

No other requirements for service or maintenance.

### **G23.3 Airworthiness Limitations**

- No Mandatory Replacement.
- No Time Limitation.

**The Airworthiness Limitations section is FAA approved and specifies maintenance required under Sections 43.16 and 91.403 of the Federal Aviation Regulations unless an alternative program has been FAA approved” (required by regulation)**

**“There are no new (or additional) airworthiness limitations associated with the equipment and/or installation”**