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STC SA02511SE Installation Manual & Instructions for Continued Airworthiness

for the

CC284022 Series Liquid Level Sender

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REVISIONS			
Rev.	Reason/Description	Requested/ Changed By	Date
N/C	Original Issue	STP CS	March 8, 2017
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	STP CS	March 16, 2018
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 gauge was non-intuitive. These changes moved content further down	STP	April 23, 2018
C	Revised the wording and added emphasis to ensuring the float arm moves from the bottom to the top of tank and allowing the installer to bend the arm slightly to clear obstruction if present. Revised and renumbered Section 5 Revised Figure 5-6 to show voltage divider for analog is now internal to fuel sender body, Added Figure 5-9 to clarify and document Garmin G1000 interface for Mooney and G36 and G58 aircraft, Added Sections “Immersed Fuel Senders” and “JPI 9XX Analog Input”	CS	September 5, 2018
D	Added Warning, Caution and Note definitions to highlight key points in the manual with visual graphics. Added Section 5.6 providing a schematic for JPI 9XX installations. Added Section 7 TROUBLESHOOTING	STP	May 1, 2019
E	Revised Phone Number cover sheet, added schematics that illustrate connections to various aircraft tank configurations Section 5 renumbered illustrations, Made Green Wire Voltage more evident in table 4.3 and 4.4 and Figure 8 Added (7XX) to Section 4.4	CS	November 19, 2019
F	Revised Figures, 5-7 added mid sender Ground, In Electrical installation added note to confirm ground using battery negative terminal. Removed Note on Figure 5-18 Added Cessna 208 Caravan Calibration	STP	October 20, 2020

	procedure reference and Note for maintenance of Caravan maintenance procedure		
G	See CiES Problem Report CC-PR-2840-005.	CTA	November 6, 2023

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1.0 WARNING, CAUTION AND NOTE DEFINITIONS


WARNING

A warning is used to bring to the installer's immediate attention not only damage to the liquid level senders, but personal injury may if the instruction is disregarded.


CAUTION

A caution means damage to the liquid level senders or erratic fuel indication is possible if a procedural step is not followed.


NOTE

A note provides additional information.


WARNING: *Failure to properly configure the CiES Liquid Level Senders to the appropriate cockpit instrumentation could result in serious injury, damage to equipment, or death.*


NOTE: *CiES Liquid Level Senders are patented and patent pending technology which are not offered by any other manufacturer.*

1.1 Acronyms and Abbreviations

AML	Approved Manufacturers List
AWG	American Wire Gauge
FAA	Federal Aviation Administration
Hz	Hertz
mA	Milliamps
OEM	Original Equipment Manufacturer
PMA	Parts Manufacturer Approval
SAE	Society of Automotive Engineers
STC	Supplemental Type Certificate
TC	Type Certificate
TCDS	Type Certificate Data Sheet
TSO	Technical Standard Order
Vdc	Direct Current Voltage

2.0 INTRODUCTION

This document provides FAA-approved installation instructions for CiES Liquid Level Senders in accordance with STC SA02511SE on eligible aircraft models. For the rest of this installation manual, the use of the word "senders" refers only to CiES liquid level senders.

2.1 Quick Reference Guide

To navigate the manual, below is quick guide to following chapters, see the Table of Contents for specific pages:

2.0 Introduction

Introduces the manual, details a quick reference guide for ease of navigation, provides an overview of CiES liquid level sender function, and limitations for installing senders.

3.0 STC Instructions for Continued Airworthiness

Contains a more detailed description of senders, when to schedule servicing, a truncated troubleshooting subsection, the repair procedure, what to reference for calibration, other instructions, and requirements that CiES senders meet.

4.0 TSO C55a Compliance

Details the sender failure condition classification, environmental qualifications, electronic hardware qualifications, accepted deviations, approved configurations for CiES senders and requirements that CiES liquid level senders meet regarding TSO C55a.

5.0 Physical Specifications

Describes mounting pattern required for CiES senders, shows dimensions of an example sender, and differentiates sender parts.

6.0 Electrical Specifications

Details sender operating voltage range, how much power is drawn by an individual sender at given voltages, what output types senders can produce, the range of output signals, and what each color denotes on CiES sender wires.

7.0 Electrical Installation

Recommends performing electrical installation before physically mounting the sender, gives instructions for installation, provides a generic wiring diagram for senders, and details materials needed for electrical installation.

8.0 Physical Installation

Describes how to determine where senders need to be mounted, how to ensure sender mobility

within the tank, what clocking means in the context of mounting senders, how to affix senders to their respective mounting ports, and how to bond senders.

9.0 Calibration

Warns that calibration procedures must be done after completing sender installation, provides tips for calibration, and what to reference to successfully calibrate CiES senders.

10.0 Troubleshooting

Provides solutions to commonly encountered problems, flowcharts for more niche problems, and tests that can be performed to better diagnose difficulties.

11.0 Appendix 1: Liquid Level Sender Types

Shows what each liquid level sender type looks like as well as the use cases for the senders/wires. This appendix can be a helpful reference when going through the electrical installation.

12.0 Appendix 2: Environmental Qualification Form

Provides a greater detailed overview of the environmental tests performed on CiES CC Series liquid level senders.

2.2 Sender Overview

CiES liquid level senders measure the angle of a float arm from a pivot point. CiES senders are non-contact, meaning the circuitry is physically, electrically, and chemically isolated from the tank. Figure 2-1 shows an example liquid level sender with the float arm in two positions.

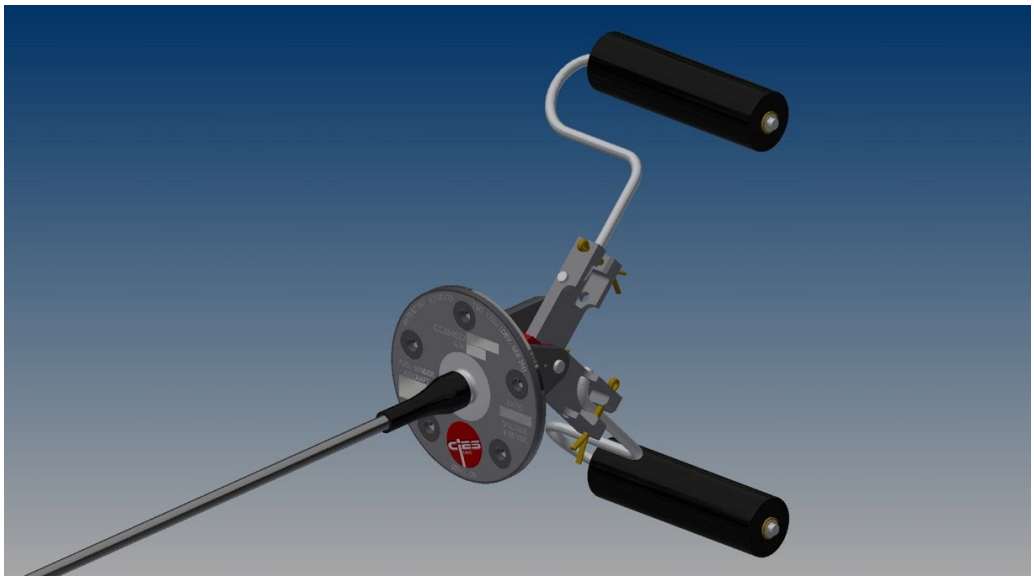

Figure 2-1 Generic Liquid Level Sender

2.3 Limitations

The conditions and tests required for TSO approval of this instrument are minimum performance standards. Those installing this instrument, on or in a specific type or class of aircraft, must determine that the aircraft installation conditions are within the TSO standards. TSO articles must have separate approval for installation in an aircraft. The instrument may be installed only according to 14 CFR part 43 or the applicable airworthiness requirements.

3.0 STC INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

3.1 General

This section constitutes the required Instructions for Continued Airworthiness. This document is found on https://ciescorp.net/documentation/installation-instructions/general-installation-instructions/#stc-instructions.

3.2 Format

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

3.3 Content

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

3.3.1 Airplane maintenance manual or section

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 while they are physically identical in utilizing the existing mounting locations hardware and gaskets.

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 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.

Operation

The sensor measures this angle in a nonelectrical contact manner using 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.

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.

3.3.2 Maintenance Instructions

Scheduling

Maintenance is to be performed on condition.

Troubleshooting

Each CiES fuel sender is capable of outputting a frequency signal (Hz) using the **blue** wire. Voltage senders have the additional ability of outputting an analog voltage signal (Vdc) using the **green** wire. For troubleshooting, the 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 absolutely necessary to determine fuel sender operation. For further information please see Section 10.0, Troubleshooting.

Repair Procedure

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

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.

Other Instructions

No other requirements for service or maintenance.

3.4 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".

3.5 Requirements

While CiES Inc. liquid level senders are FAA TSO C55a approved and have met a quality standard for a minimum resolution 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 liquid level sender with the appropriate FAA approved cockpit instrumentation this information is also found in Section 4.5 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 ±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 an 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 warning may be incorporated that meets the requirements of the aircraft POH or FAR mandated operational requirements.

4.0 TSO C55A COMPLIANCE

CiES liquid level senders are TSO certified to C55a and the associated SAE standard AS405C. Per AS405C, CiES liquid level senders are classified as Type I Float Based Senders.

4.1 Failure Condition Classification

A CiES liquid level sender as an individual component has a **MINOR** failure classification. Installed fuel quantity systems using CiES senders will require application specific failure classification. Contact CiES for any questions.

4.2 Environmental Qualifications

CiES Liquid Level senders have been tested using DO-160F with the following levels for non-potted and potted senders:

Non-Potted Senders: [B2X]BBA[SM]EXXXXXZ[BXX]BB[ZC][XX]B[XXXXX][XXXX]XAX

Potted Sender: [B2X]BBA[SM]AXXXXXZ[BXX]BB[ZC][XX]B[XXXXX][XXXX]XAX

For a more detailed overview of environmental qualifications, see Appendix 2.

4.3 Electronic Hardware Qualifications

Per CiES document No. CC-TR-2840-023, CiES liquid level senders design is in accordance with DO-254 Design Assurance Level D.

4.4 Deviations

TSO/Standard	Deviation
TSO-C55a	CiES was granted a deviation from SAE AS405C Paragraph 7.18 whereby the float used is not fireproof but does not add to the inherent hazard of utilizing flammable fluid for propulsion. Therefore, an equivalent level of safety was shown.

Table 4-1 Approved Deviations

4.5 Approved Configurations and Interfaces

New aircraft installations for OEM applications can utilize the TSO for approval when establishing a TC for new aircraft. The combination of the CiES liquid level sender part numbers and indicators approved on each applicable airplane model may be listed in the AML tables of appropriate STCs for installation in legacy aircraft.

5.0 PHYSICAL SPECIFICATIONS

5.1 Mounting Pattern

CiES liquid level senders typically use a SAE 5-bolt mounting pattern as seen in Figure 5-1. Please validate the mounting pattern of the sender you are going to install matches that of the tank or mounting plate.

NOTE: Though it may look possible, misaligned mounting patterns will not allow for complete or proper installation. There is only one way for CiES senders to be installed.

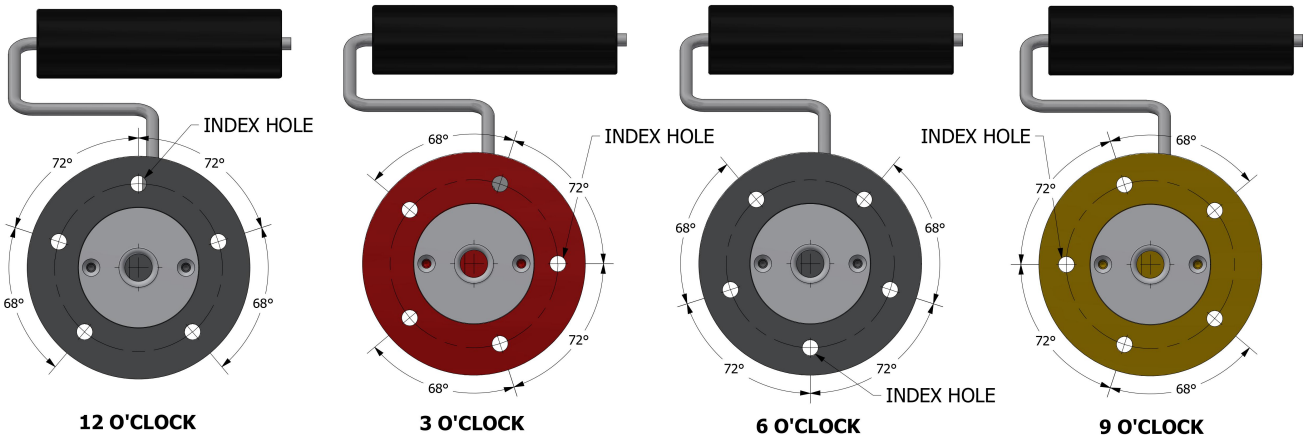

Figure 5-1 Allowable Mounting Patterns

5.2 Physical Dimensions

Figure 5-2 shows an example of the CiES Liquid Level Sender with a 12 O'clock mounting pattern and a 6 O'clock 90-degree bent wire harness. Based on the layout of the tank and location of the installation, CiES senders will have varying configurations. The most common difference among senders includes:

- Float arm length
- Float arm bend
- Wire harness orientation
    - 90-degree bend means the harness is parallel with the mounting face.
    - No bend means the harness comes straight out of the mounting face.
    - Clocking indicates which direction relative to the vertical plane the harness is oriented. Note, this only applies to bent harnesses.

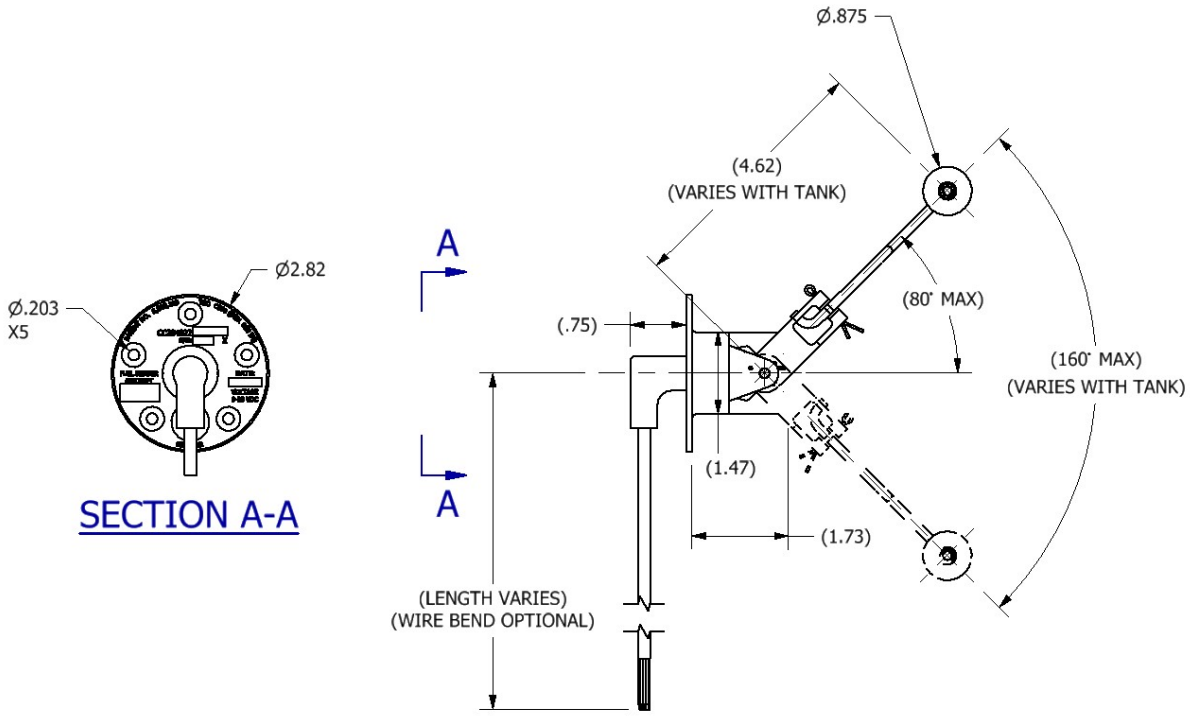

Figure 5-2 Example Liquid Level Sender Physical Dimensions

5.3 CiES Liquid Level Sender Parts

To differentiate the sender parts that will be interacted with, please see Figure 5-3.

WARNING: The electromechanical assembly is **never** to be removed from the sender during any part of the installation process.

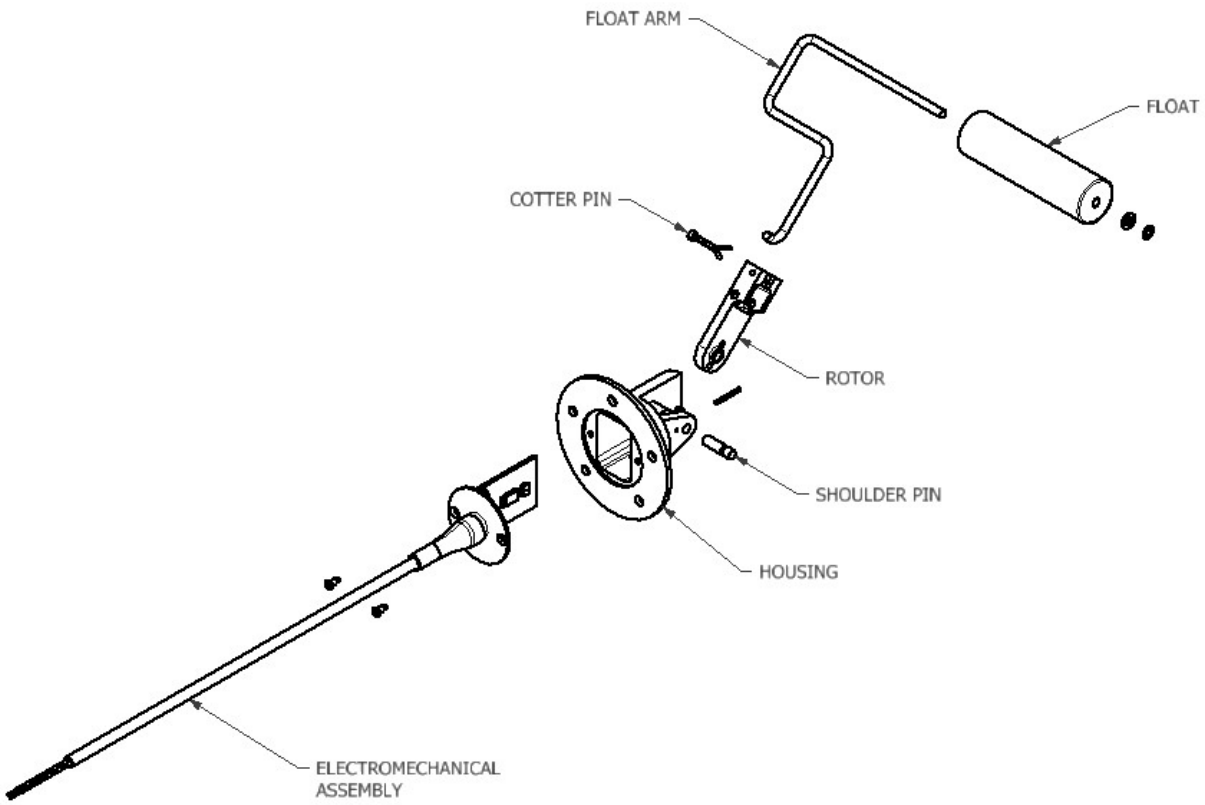

Figure 5-3 CiES Liquid Level Sender Parts

6.0 ELECTRICAL SPECIFICATIONS

6.1 Operating Voltage

CiES liquid level senders operate optimally from 12 to 28 V dc but can operate as low as 9 V dc.

6.2 Power Consumption

Voltage (V dc)	Steady State Current (mA)
14	40-50
28	20-25

Table 6-1 Power Consumption of Senders at Given Voltages

6.3 Output Modes and Ranges

Output Type	Signal	Range	Output Range
Liquid Level	Can send 3 signal types to inform liquid level		
Frequency	0-5 Vdc Square Wave	160° of Rotation	Frequency: 10 kHz – 64 Hz - Individual Sender Output
			Typical installations are from 30 Hz to 300 Hz
Voltage	Voltage 0-5 Vdc	160° of Rotation	Voltage: 0 - 5 Vdc
Resistance	Resistance 0-280 Ohm	160° of Rotation	Contact CiES for this application
Temperature	Uses solid orange wires to send signals.		
Option 1	0-5 Vdc Square Wave	-50°C to +50°C -58°F to 122°F	Frequency 1,200Hz – 490Hz

Table 6-2 Output Modes and Ranges for Senders

6.4 Wire Coloring

Wire Color	Designation
Red	Power (12-28Vdc)
Black	Ground
Blue	Fuel Qty “OUT” in Hz
Orange	Temp. “OUT” In Hz (Option) Or Low Fuel Annunciation
Orange/Red	Fuel Qty “IN” Hz (Primary/Secondary)
Gray	Fuel Qty “IN” Hz (Primary/Secondary)
Green	Fuel Qty “OUT” (0-5V) (note: voltage supplied to sender must be greater than or equal to output voltage desired from sender)

Table 6-3 Wire Color Designations

7.0 ELECTRICAL INSTALLATION

CAUTION: Not following the electrical installation correctly, particularly the wiring in Section 7.2, can result in damage to the senders.

CAUTION: Perform these steps prior to affixing senders to tanks. Doing so will avoid many problems and difficulties that can result from wiring the senders after they are physically installed.

7.1 Instructions

1) Use AC43.13 Chapter 11 as well as any other applicable electrical best practices to perform these steps.
2) Connect the signal wires to the instrument panel or gauge per the drawing in Figure 7-1.

WARNING: UNDER NO CIRCUMSTANCE SHOULD THE GREEN OR BLUE WIRES BE CONNECTED DIRECTLY TO POWER. ONLY USE RED WIRES FOR POWERING SENDERS.

- Instrument panels or gauges will take **green** (voltage) or **blue** (frequency) sender output wires from Primary Senders.
- The number of primary senders for each side is equal to the number of inputs needed for the display.

WARNING: Contact display manufacturer if unsure what output signal type (voltage or frequency) is needed from the sender to the display.

3) Connect any secondary senders. Secondary senders will always output using the **blue** wire.
- Primary senders will accept the secondary output signals using the **gray** wire.
- If there are two secondary senders, an **orange**/**red** striped wire will be used to accept the additional secondary output signal.

4) Connect **black** (ground) wires. Ensure they share a ground to the aircraft bus.
5) Connect a 1 amp circuit breaker to the 12-28 Vdc aircraft bus power line.
6) Once all senders inputs, outputs, and grounds are connected, connect the **red** (power) wires downstream of the 1 amp circuit breaker.
7) Cap and stow any unused wires.
8) Connect **red** (power) wires. Immersed senders will need extra steps, see Figure 7-1 Generic Wiring Diagram.
9) Turn on aircraft bus power.
10) Check functionality of all senders, both primary and secondary, by moving the sender arms and observing the instrument panel or gauge.

NOTE: Contact CiES if unsure of any steps outlined in this section.

7.2 Generic Wiring Diagram

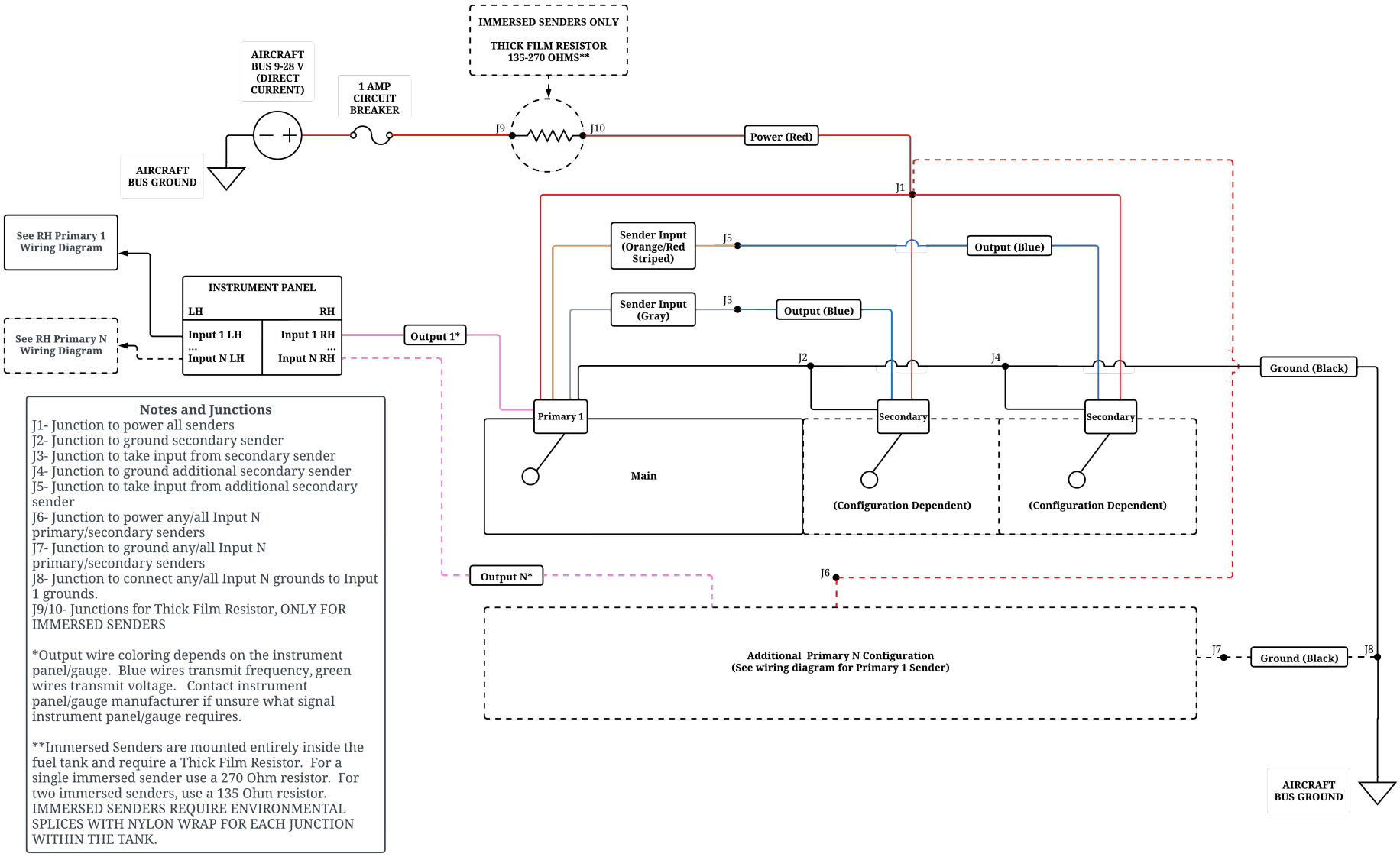

Figure 7-1 Generic Wiring Diagram

7.3 Materials for Electrical Installation

1) 1 Amp Circuit Breakers: For protecting CiES senders from current surges from aircraft bus power.
2) 18-22 AWG Shielded Wire: To Military Specifications M22759.

NOTE: CiES senders do not come with explicit connectors (i.e.: Molex, D-Subminiature, Deutsch, etc.) for interfacing with the instrument panel or gauges. Installers needing to use these connectors must make their own harness.

3) FOR UNUSED WIRES:
    a. Stub splices: To be used for capping and stowing non-red wires that were not used after completing Steps 1-6 of Section 7.1.
4) FOR IMMERSED SENDERS:

NOTE: If unsure whether or not a sender is immersed, please see Section 7.4

    a. If there is only one immersed sender per tank, please use either a 135 Ohm or a 270 Ohm Film Power Resistor between junctions J9 and J10.
    b. If there are two immersed senders per tank, please use only a 135 Ohm Film Power Resistor between junctions J9 and J10.
    c. Nylon Spiral Wrap (applicable product, but not limited to: 11-12316 Spiral Wrap from Eastern End Electronics) or tube that protects splices and wires.
    d. Environmental Splices for electrical junctions inside the tank.

7.4 Immersed and Wall Mounted Sender Differentiation

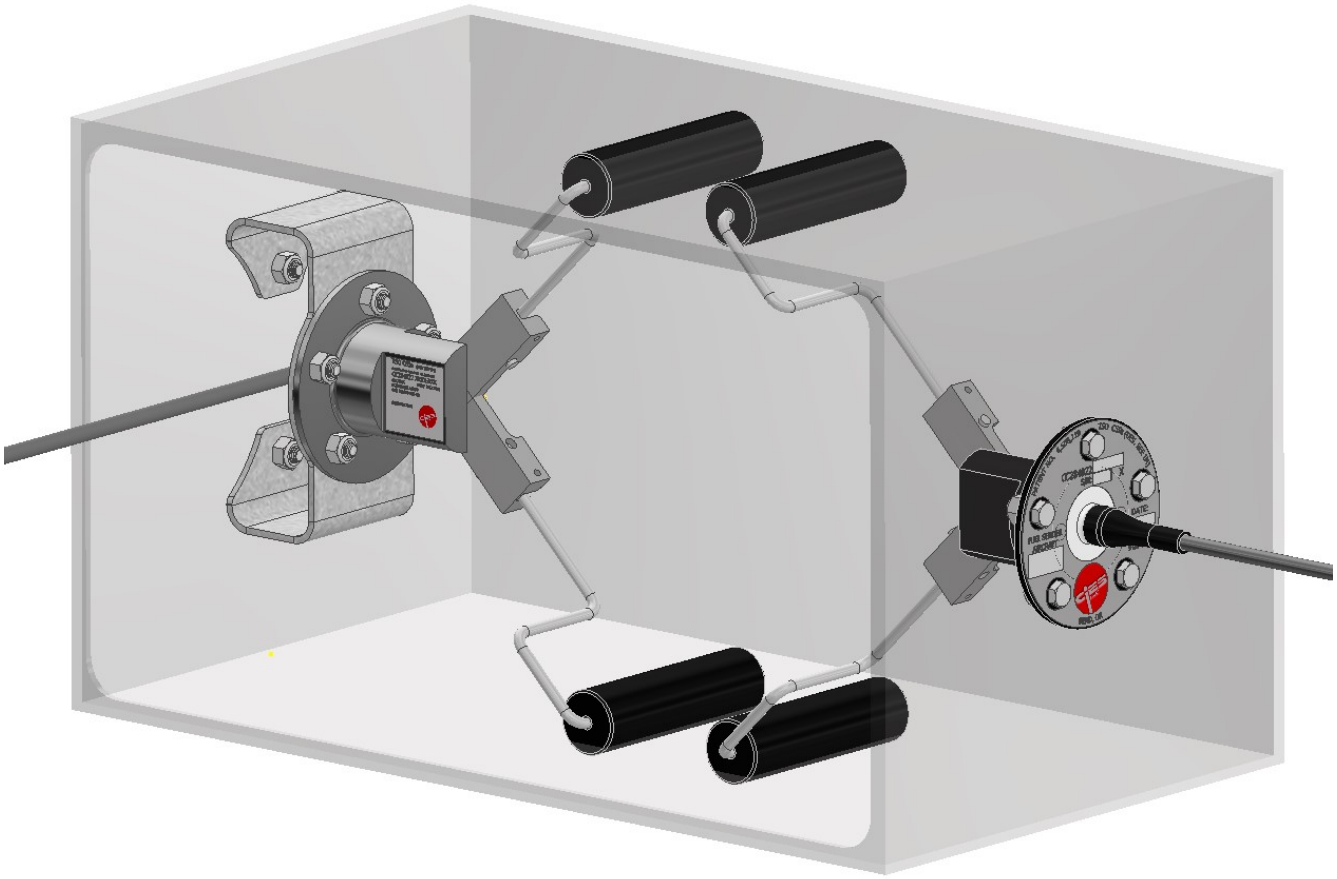

Figure 7-2 Immersed and Wall Mounted Sender Differentiation

- The sender on the left is an immersed sender. It is mounted entirely inside the tank, has information engraved on the side of the housing and will require nylon spiral wrap and environmental splices for any wire junctions.
- The sender on the right is a wall mounted sender. It is mounted on the tank wall has a placard on the housing facing the outside of the wall.

NOTE: All immersed senders are engraved with sender details on the side of the housing, but not all senders with details engraved on the side. For further information on immersed senders, please see Appendix 1 Liquid Level Sender Types.

8.0 PHYSICAL INSTALLATION

CAUTION: Proceed with Physical Installation after performing Electrical Installation functionality test. It is easier to troubleshoot the senders outside of the tank than inside the tank.

This chapter details the steps necessary to ensure mobility of the float arms, correct mounting position, and keeping the sender housing properly grounded during physical installation.

8.1 Determine Mounting Location

If a sender is installed in the incorrect mounting location, the sender will likely not have the physical dimensions necessary to fulfill its role.

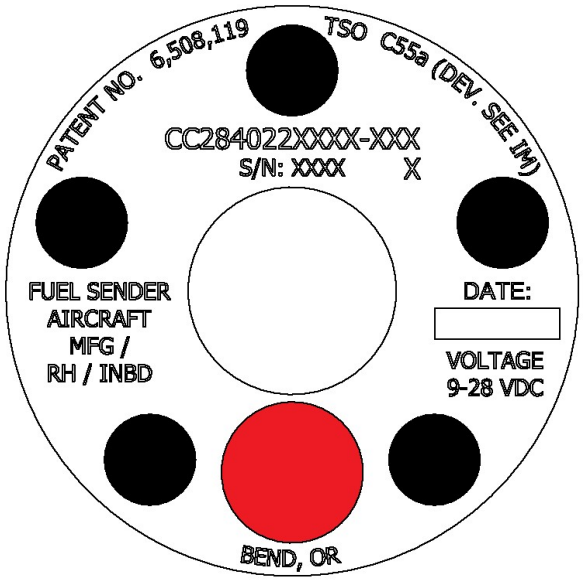

Figure 8-1 Right-Hand Inboard Example Placard

CiES liquid level senders have a placard that describes which wing they are installed on, and in which tank position, seen in Figure 8-1.

NOTE: Immersed senders do not have a placard and will have the following information engraved on the side of the sender.

- RH/LH refers to the wing specification, where RH is for the right wing and LH is for the left wing looking in the direction of aircraft travel. If there is no wing specification, the sender can be installed in either wing for the given mounting location specification.
- INBD/MID/OUTBD are the mounting location specifications, where INBD denotes inboard senders and OUTBD denotes outboard senders. MID denotes midspan senders, which are only found in tank configurations with 3 senders and are installed in the position between inboard and outboard. Inboard senders are typically located closest to the fuselage. For wiring purposes, inboard senders will be the senders that carry the output to the instrument panel or gauge. Outboard senders are on the main tank, but do not carry a signal directly to the instrument panel or gauge.
- AUX senders are on the auxiliary tanks and carry the signal to the instrument panel or gauge. If more than one sender is needed for the auxiliary tank, the placards will specify inboard or outboard. Additionally, if the auxiliary senders are different on each wing, and there are multiple senders on the auxiliary tank, the placard will specify AUX, RH/LH and INBD/OUTBD.

8.2 Visually Inspect Fuel Tank through Mounting Port

Before the sender is mounted, it is the responsibility of the installer to ensure that the float arm can sweep the entire usable fuel range without contacting obstructions or entrapments. Minor bends to the float arm are allowed to avoid any obstructions or entrapments of the float. If minor bends don't provide a clear path for the float arm assembly, the installer must contact CiES for further instructions.

8.3 Mounting the Liquid Level Senders

8.3.1 Sender Clocking

CiES senders use the SAE Standard 5 bolt pattern, which by design, may only be installed in 1 orientation. Please see Section 5.0 for the dimensions of the SAE 5 Bolt Pattern that both the tank port and senders adhere to. The sender clocking and associated color can be seen in Figure 8-2.

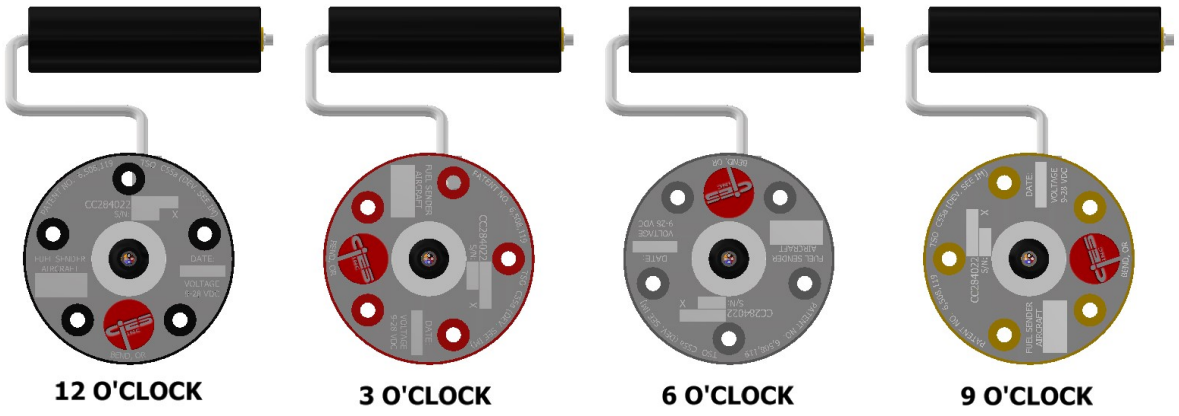

Figure 8-2 Sender Clocking and Coloring

Placard orientation <u>IS NOT</u> an indication of correct sender orientation. When the housing index hole is aligned with the mounting port index hole, the sender is oriented correctly, even if the writing is upside down.

Some PMA parts utilized for aircraft fuel tanks have patterns that differ from OEM factory produced components. If the mounting plate pattern is different than the SAE 5 mounting bolt pattern, such as in Figure 8-3, contact CiES, Inc.

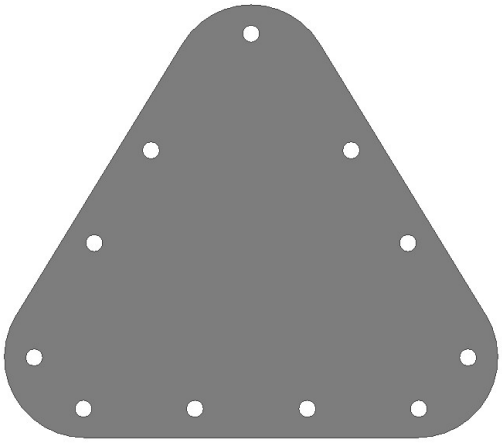

Figure 8-3 Incompatible Tank Port Mounting Pattern

8.3.2 Fastening the Sender to the Tank Port

After determining the correct mounting location on the tank using the sender's placard and understanding sender clocking, proceed through the following to fasten the senders to the tanks.

WARNING: Ensure that the gasket *and* the sender index holes are aligned with the mouting index hole before fastening. A properly aligned gasket will not need to be forced or stretched to fit mounting pattern. Forcing or stretching the gasket is a sign of misalignment and can result in leaking.

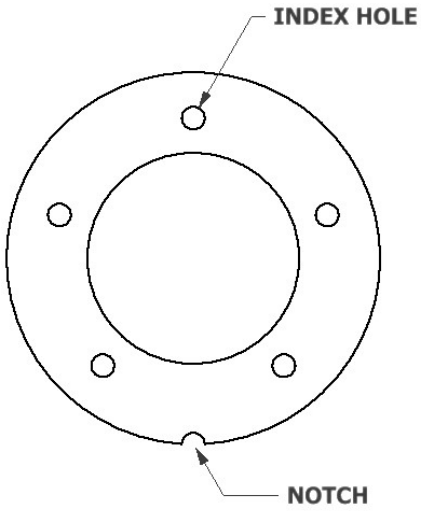

Figure 8-4 Sender Gasket

Once the index holes of the sender, gasket, and mounting port have been aligned, and the correct mounting port for the sender is determined, fasten the sender to the tank. The housing holes for the senders are designed to accommodate #10 hardware. Hardware is not supplied with CiES liquid level senders.

Bolt	Torque (in-lbs)
AN 3-5a, size 10	18-22

Table 8-1 Mounting Hardware

WARNING: The bolts must be torqued within a range of 18-22 in-lbs. Outside of this torque specification range, the housing is liable to leak, either from overtightening or undertightening.

8.4 Bonding the Liquid Level Sender Housing

For metallic tanks, bond the sender to aircraft ground. This is not to be confused with grounding for the electronics of the CiES liquid level sender. Bonding the sender's housing to aircraft ground prevents electrical ignition sources. CiES liquid level senders that are installed in a metal aircraft or in a metal tank must be bonded to the aircraft structure. CiES recommends two methods for bonding described in Section 8.4.1 and Section 8.4.2.

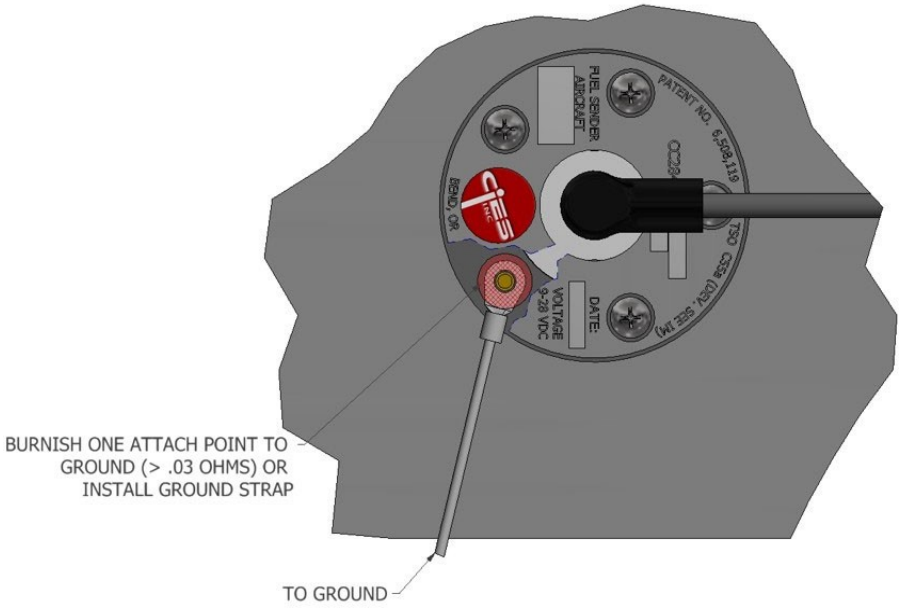

Figure 8-5 Bonding for Electrostatic Discharge Protection

8.4.1 Attachment Screw Method

Burnish one sender attachment position so that the protective anodization is removed. Ensure bonding by measuring resistance of the attachment screw to a known aircraft ground. The resistance should be less than 0.03 Ω.

8.4.2 Ring Terminal Method

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 Ω.

9.0 CALIBRATION

Once the senders have been wired then physically installed, the installer will need to perform calibration on the senders.

WARNING: Calibration proceedures must be successfully completed for each tank on each aircraft after installing CiES liquid level senders.

To successfully calibrate the installed CiES liquid please see the applicable gauge or instrument panel user's manual. For multi-function displays and for dedicated fuel quantity indicators installed under an 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.

9.1 Calibration Tips

WARNING: The following are tips for calibration and are not a substitution for calibration procedures found in appropriate cockpit fuel indicator manuals.

1) See applicable gauge/inst panel installation manual then use calibration method called for by applicable STC.
2) Calibration procedures typically included in either installation manual for display device or aircraft maintenance manual.
3) Unusable Fuel level is normally listed in the FAA type certificate data sheet.
4) To achieve FAA compliant fuel quantity indication required by part 91 and 135 operating rule, the fuel gauge is to read from full to zero usable fuel quantity for each tank.
5) The aircraft will be jacked and leveled.
6) The aircraft will be emptied of fuel.
7) The applicable unusable fuel quantity listed in the TCDS will be added to the tank.
8) Confirm the cocpit display reads EMPTY and are within tolerances established by the FAA Approved Aircraft Maintenance Manual.
9) 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.
10) Fuel level at FULL will be checked in a similar manner to tip 9.
11) For Rochester Gauges, DO NOT force potentiometers outside 280 Ohm range.
12) For Rochester Gauges, gauge responds slowly, lightly tap on the rim of the gauge and allow for about 1 minute between each adjustment.

10.0 TROUBLESHOOTING

This section begins with the most common difficulties encountered with CiES senders with Table 10-1, moves on to more specific issues that can be solved with decision flowcharts, then ends with tests that you can perform once Sections 10.1 and 10.2 have been attempted. As CiES senders are thoroughly circuit tested, burnt in, and retested before delivery – the likelihood that something is inherently wrong with your sender is rare.

10.1 Common Issues

Issue	Cause	What to Check
No Indication, Erratic Indication, or Partial Indication.	You have no or insufficient power to the sender.	Check power directly at the sender – Do not assume that wire attachment to the circuit breaker panel or that a new wire run ensures power at the sender, check that sender is being power.
Not reaching Full or Empty.		Check that the ground is attached and there is less than 0.03 Ohms resistance to ground.
Fuel Quantity does not change with addition of fuel.	The sender is physically restrained in the tank.	Check that the float is not bound against the bottom of the tank, tank sealant, structure in the tank or wiring.
Not reaching Full or Empty.		
Display is erratic or does not appear.	Improper display configuration or wrong input pin location.	Consult with the display manufacturer.
Fuel Quantity Indication is not correct.	Signal wire is not wired correctly or secondary senders are not wired correctly.	Check if signal wire is outputting a signal (**blue** wires output frequencies [Hz], **green** wires output voltages [Vdc]). Check if output signal changes once powered secondary senders are connected to the primary sender.

Table 10-1 Common Issues

10.2 Troubleshooting Decision Flowcharts

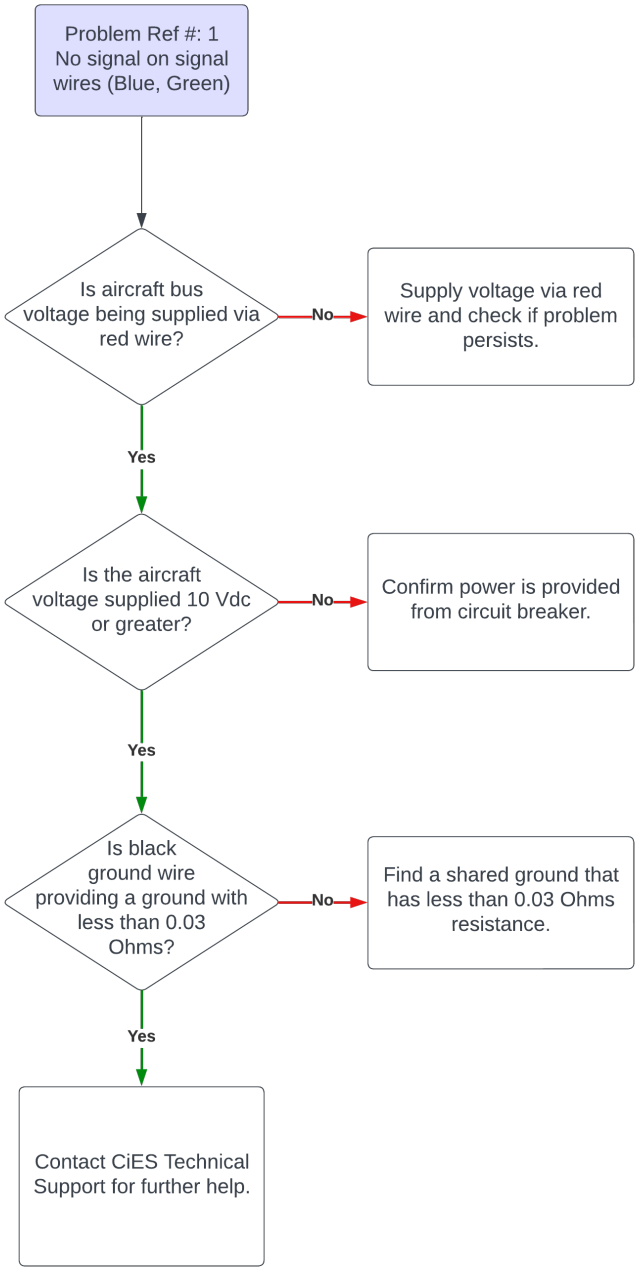

Figure 10-1 No Signal on Signal Wires

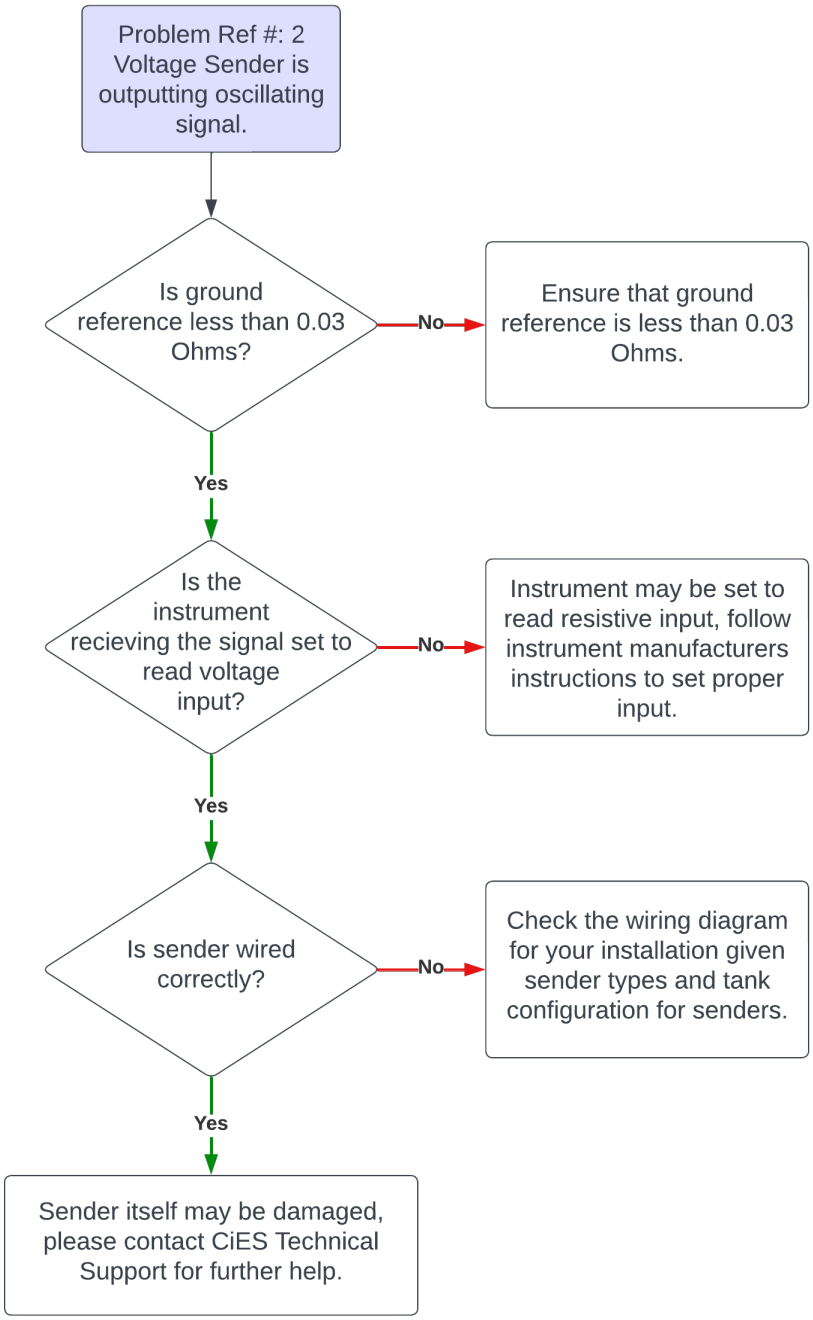

Figure 10-2 Voltage Sender Outputs Oscillating Signal

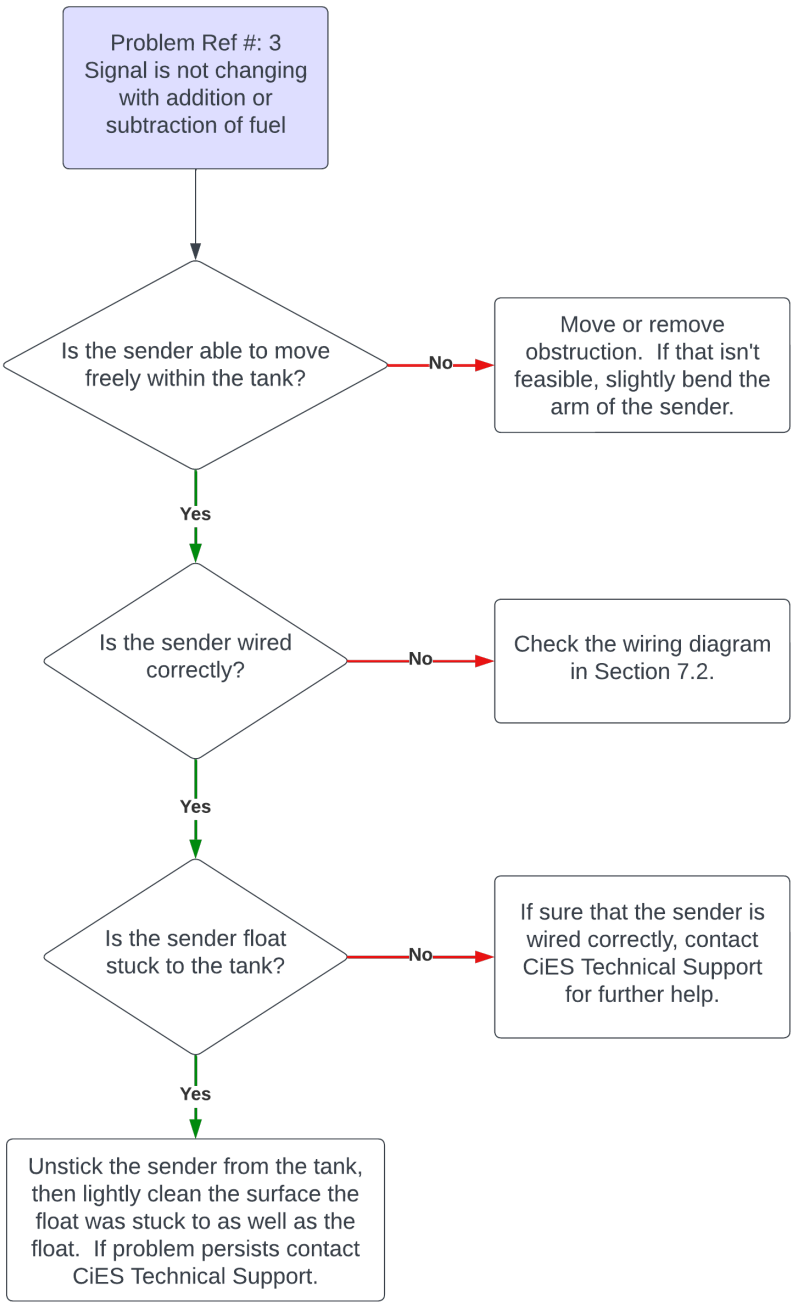

Figure 10-3 Signal Not Changing with Fuel Quantity Change

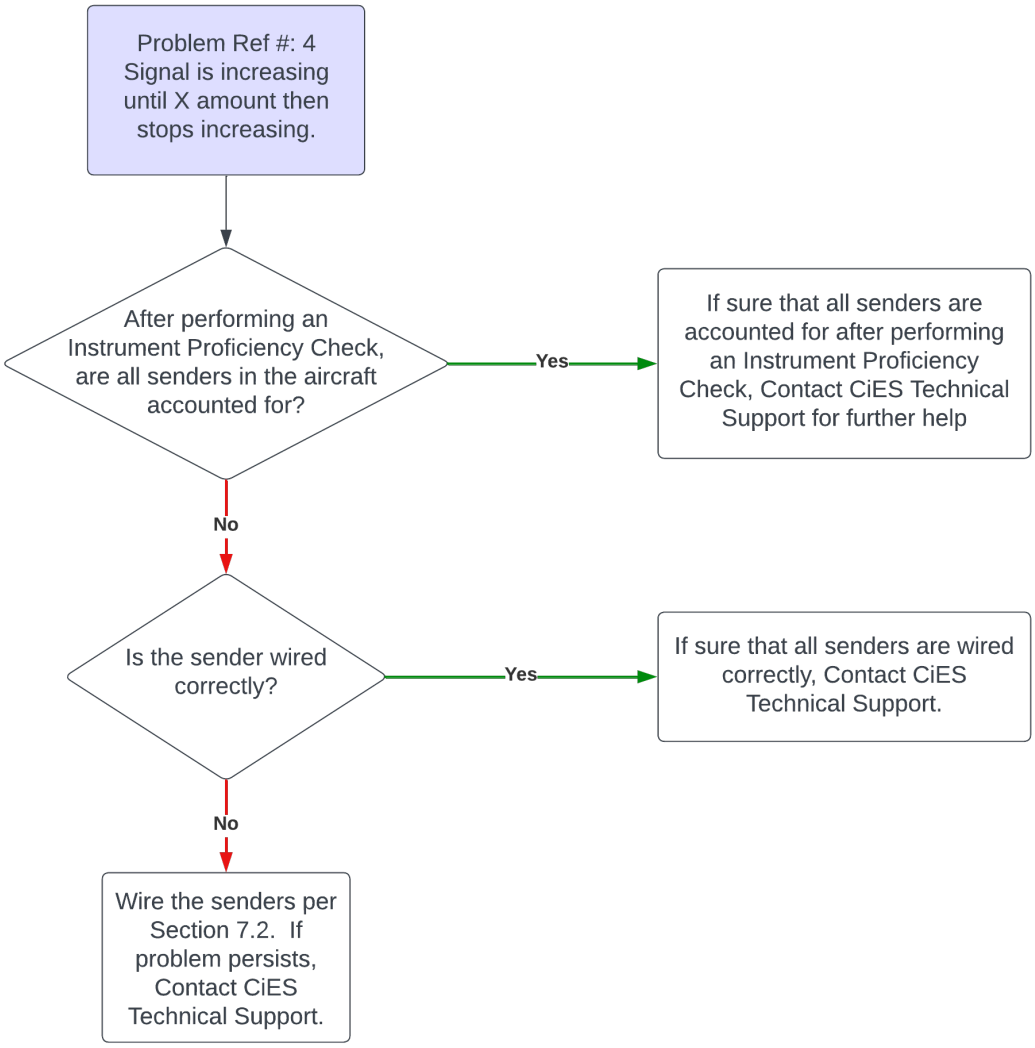

Figure 10-4 Signal Increases to X Amount, Then Stops Increasing

10.3 Advanced Troubleshooting

CiES senders always have a **red** (power) wire, a **black** (ground) wire, and a **blue** (frequency output) wire. Voltage output senders will also have a **green** (voltage output) wire. This section will detail the tests you can perform with a digital multimeter to troubleshoot. You will only be using **red**, **black**, and **blue** wires.

10.3.1 Stable Voltage Output Test

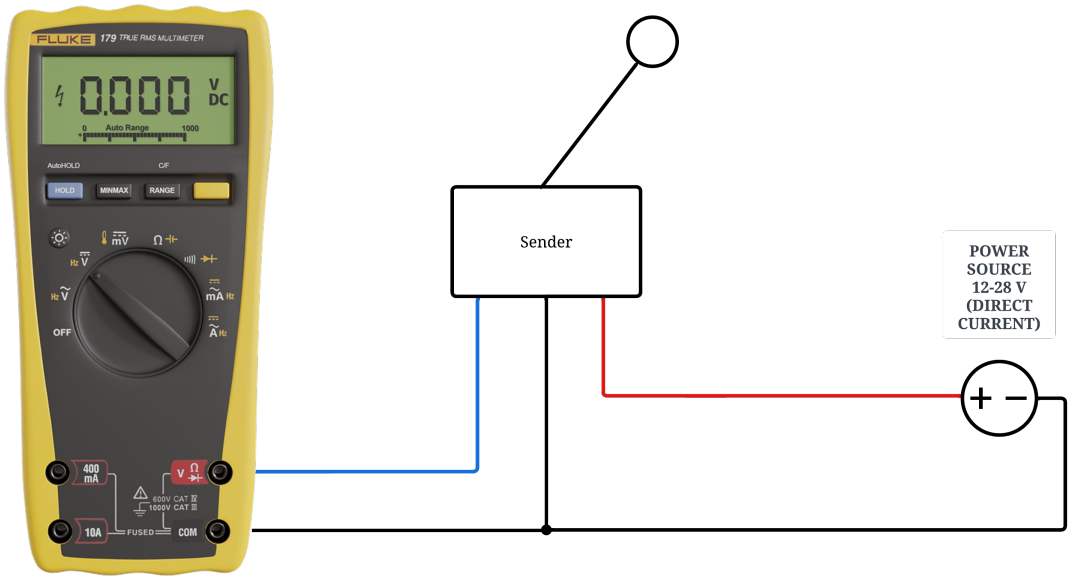

Figure 10-5 Stable Voltage Output Test

The Stable Voltage Output Test checks if the liquid level sender is outputting a signal at the expected voltage. Use the following procedure:

1. With the sender installed in the aircraft and powered from the aircraft or removed from the aircraft and powered with an external power supply, connect the COM (ground reference of multimeter) of the multimeter to sender ground.
2. Connect the DC voltage measurement port of the multimeter to the **blue** wire of the sender.
3. Validate the DC voltage with the sender powered is 2.5 Vdc.
    a. If this value is 0.7 Vdc or less, it is likely that the **blue** wire touched power at some point and will no longer work.
    b. If the value is between 0.7 Vdc and 2.3 Vdc, confirm the power source is 28 Vdc.
    c. If the value is between 2.3 Vdc and 2.7 Vdc, continue troubleshooting.
    d. If the value is greater than 2.7 Vdc, contact CiES.

10.3.2 Amperage Draw Test

The Amperage Draw Test helps determine if the sender is drawing too much or too little current. It is important to keep in mind that at different supplied voltages, the sender will necessarily draw different currents.

For this test, only the power and ground wire are used. Per Table 10-2, at the stated supplied voltages, a functioning sender will draw the associated steady state current.

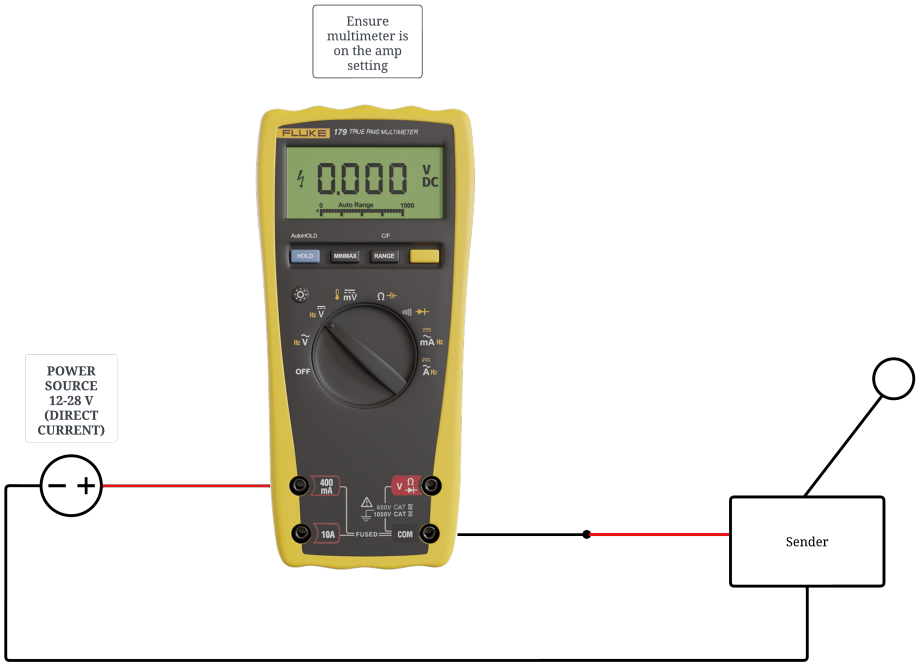

Figure 10-6 Amperage Draw Test

Voltage Supplied (VDC)	Steady State Current (mA)
28	9.6
14	17.1
12	22.0

Table 10-2 Power Consumption of Senders at Given Supplied Voltage

If the steady state current at the supplied voltages is not within the ranges specified contact CiES.

10.3.3 Frequency Stability Test

This test determines if the output of the liquid level senders is stable across being powered on and off. If a sender's output varies by more than 10 Hz.

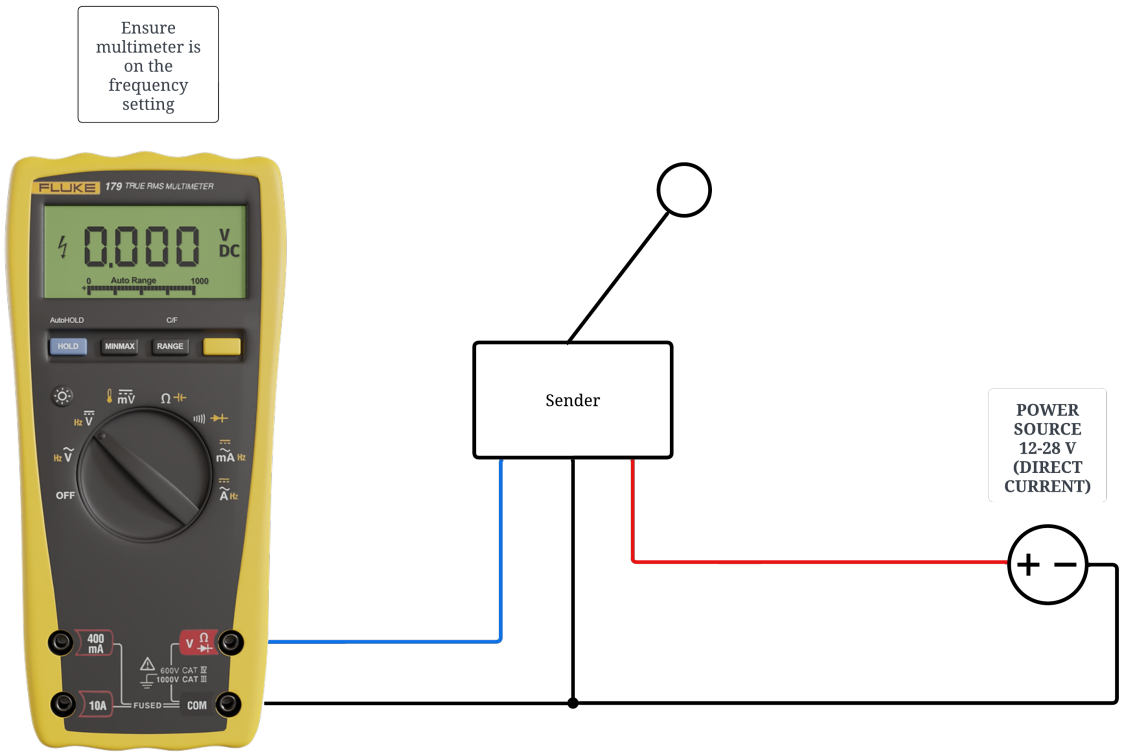

Figure 10-7 Frequency Stability Test

The electronics diagram is the same as the Voltage output test, however the multimeter must be set to measure the frequency output of the sender.

1. Ensure that the sender arm will not move during this test. As CiES senders change frequency output with float arm position, even a very small movement can generate more than 10 Hz of difference between test outcomes.
2. After the sender has been positioned to provide stable frequency readings independent of float arm position, power on the sender by carefully connecting the power wire.
3. Wait for the frequency reading to stabilize.
4. Record the frequency reading. Then shut off.
5. Wait 10 seconds.
6. Repeat steps 2-5 until 10 readings have been recorded. If there is more than a 10 Hz difference across readings, contact CiES.

APPENDIX 1: LIQUID LEVEL SENDER TYPES

This appendix describes a majority of senders that an installer may encounter. Senders with temperature output capabilities (in other words, the sender includes a solid **orange** wire, see Table 6-3) are not depicted in this appendix.

A.1 3 Wire Frequency Senders

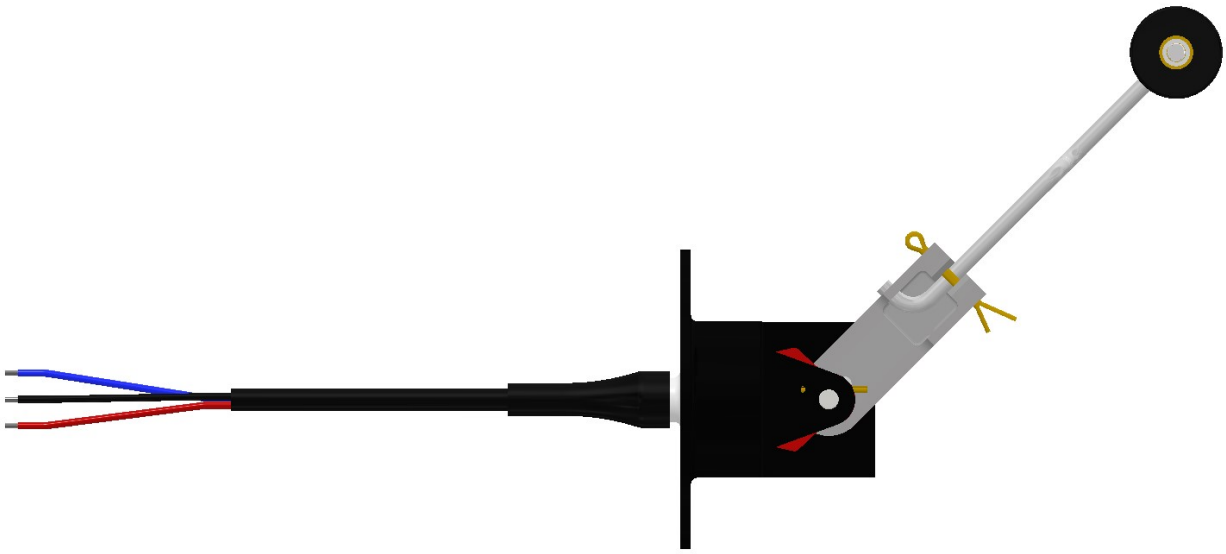

Figure A 1-1 3 Wire Frequency Sender

3 Wire Frequency Senders have the wiring code: 3WF and will always have a **blue** signal wire. 3WF senders will never have a green wire. This type of sender has two use cases.

Use Case 1: There is only one sender in a tank, and the **blue** signal wire sends signals directly to the instrument panel/gauge. In this first case, it is acting as a primary sender.

Use Case 2: The 3WF sender outputs its signal via the **blue** signal wire to the primary sender. The primary sender accepts this signal using the **gray** sender-to-sender input wire if there is only one secondary sender. If there is an additional secondary sender, the primary sender will accept this signal using the **orange**/**red** sender-to-sender input wire.

A.2 4-Wire Frequency Senders

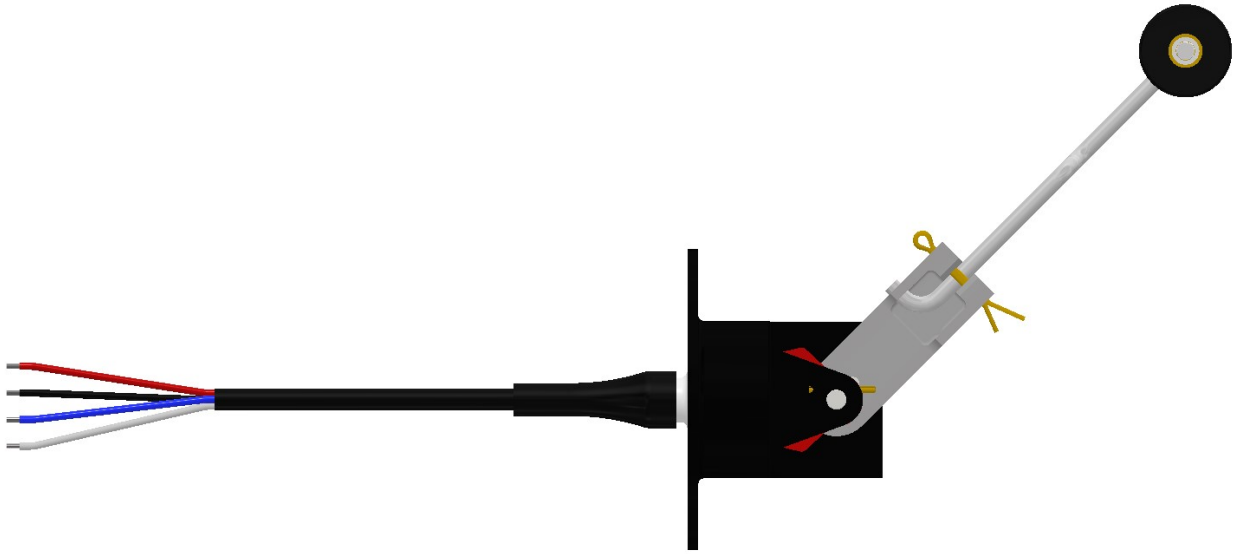

Figure A 1-2 4-Wire Frequency Sender

4 Wire Frequency Senders have the wiring code: 4WF and will always have a **blue** signal wire and a **gray** sender-to-sender wire. This sender has one use case.

Use Case 1: The 4WF sender acts as the primary sender in the configuration, receiving signals from the secondary sender using the **gray** sender-to-sender input wire and outputting its signal using the **blue** signal wire to the instrument panel.

A.3 5-Wire Frequency Senders

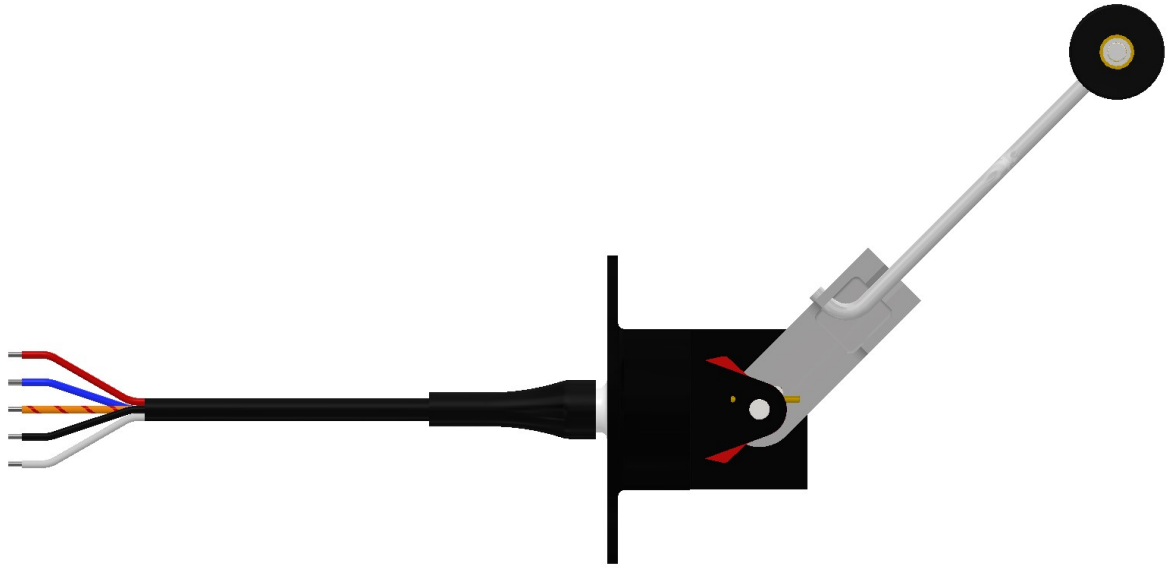

Figure A 1-3 5-Wire Frequency Sender

5 Wire Frequency Senders have the wiring code: 5WF and has a **blue** signal output wire, a **gray** sender-to-sender input wire, and an **orange**/**red** sender-to-sender input wire. This type of sender has one use case:

Use Case 1: The 5WF sender acts as the primary sender in the configuration, outputting its signal through the **blue** signal wire to the instrument panel. The 5WF sender will accept a signal from one secondary sender from the **gray** wire. For an additional secondary sender, the 5WF sender will accept the additional signal from the **orange**/**red** wire.

A.4 5-Wire Voltage Senders

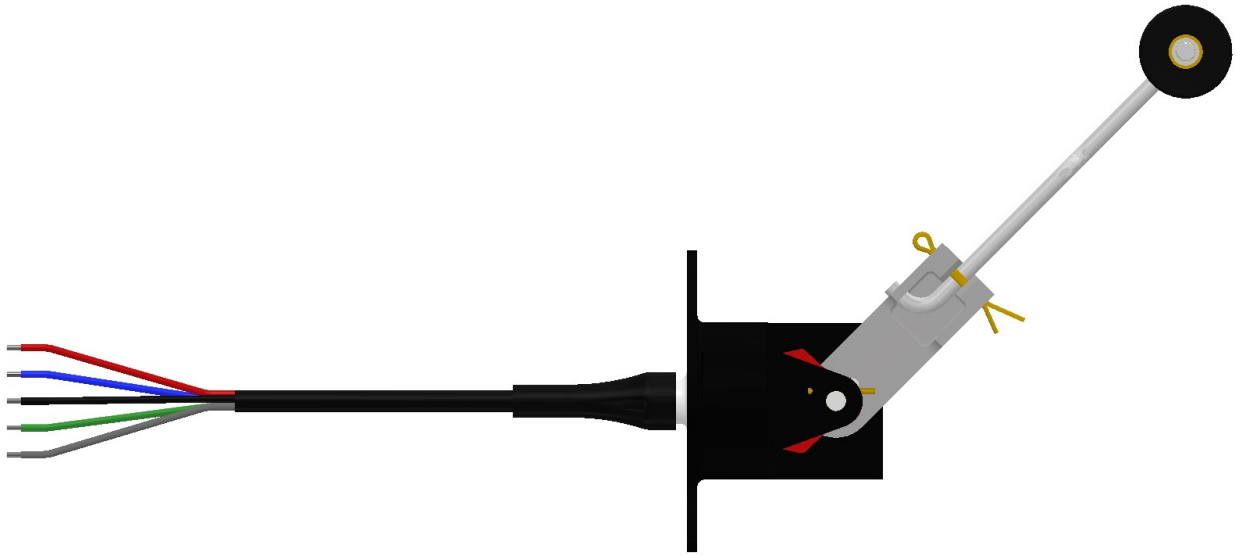

Figure A 1-4 5-Wire Voltage Sender

5 Wire Voltage Senders have the wiring code: 5WV and will always have the **gray** sender-to-sender wire and both **green** and **blue** signal wires. This type of sender has four use cases.

Use Case 1: The 5WV sender acts as the primary sender in the configuration and is the only sender in the tank. The 5WV sender outputs its signal using the **green** signal wire and caps/stows the **gray** and **blue** wires.

Use Case 2: The 5WV sender acts as the primary sender in the configuration, receiving signals from the other sender using the **gray** sender-to-sender input wire and outputting its signal using the **green** signal wire.

Use Case 3: The 5WV sender acts as the primary sender in the configuration, receiving signals from the other sender using the **gray** sender-to-sender input wire and outputting its signal using the **blue** signal wire.

Use Case 4: This instance is rare, the 5WV sender acts as a secondary sender outputting its signal through the **blue** signal wire to another sender.

For a majority of installations, voltage senders will be using the **green** wire to send the signal to the instrument panel or gauge. For such installations the **blue** wire will be capped and stowed.

APPENDIX 2: ENVIRONMENTAL QUALIFICATION FORM

This appendix contains the environmental qualification form as filled out per DO-160F, Appendix A.
Nomenclature: **CiES CC Series Liquid Level Sender**
Type/Mode/Part Number: **CC284022XXXX-XXX**
TSO Number: **C55a**
Manufacturer's Specification and/or Other Applicable Specification: **AS405C**
Manufacturer: **CiES, Inc**
Address: **1375 SE Wilson Ave Ste #150 Bend, OR 97702**
Revision & Change Number of DO-160 (F):
Date(s) Tested: **2013**

Conditions	Section	Description of Tests Conducted
Temperature and Altitude	4.0	Equipment tested to Category B2.
Low Temperature	4.5.1	
High Temperature	4.5.2 & 4.5.3	Equipment identified as Category X, no test performed for cooling.
In-Flight Loss of Cooling	4.5.4	
Altitude	4.6.1	
Decompression	4.6.2	
Overpressure	4.6.3	
Temperature Variation	5.0	Equipment tested to Category B.
Humidity	6.0	Equipment tested to Category B.
Operational Shock and Crash Safety	7.0	Equipment tested to Category A.
Vibration	8.0	Equipment tested to Category S, curve M. See Other Tests for further vibration testing information.
Explosive Atmosphere	9.0	Equipment previously tested to Category A for fully potted units and through the use of design showed an equivalent level of safety to satisfy testing requirements of Category E for non-potted units.
Waterproofness	10.0	Equipment identified as Category X, no test performed.
Fluids Susceptibility	11.0	Equipment identified as Category X, no test performed.

Sand and Dust	12.0	Equipment identified as Category X, no test performed.
Fungus	13.0	Equipment identified as Category X, no test performed.
Salt Fog Test	14.0	Equipment identified as Category X, no test performed.
Magnetic Effect	15.0	Equipment tested to Category A, unit met requirements of Category Z and is identified as Category Z.
Power Input	16.0	Equipment tested to Category BXX at both 14VDC and 28VDC.
Voltage Spike	17.0	Equipment tested to Category B.
Audio Frequency Susceptibility	18.0	Equipment tested to Category B.
Induced Signal Susceptibility	19.0	Equipment tested to Category ZC.
Radio Frequency Susceptibility	20.0	Equipment identified as Category X, no test performed.
Radio Frequency Emission	21.0	Equipment tested to Category B.
Lightning Induced Transient Susceptibility	22.0	Equipment identified as Category X, no test performed.
Lightning Direct Effects	23.0	Equipment identified as Category X, no test performed.
Icing	24.0	Equipment identified as Category X, no test performed.
Electrostatic Discharge	25.0	Equipment tested to Category A.
Fire, Flammability	26.0	Equipment identified as Category X, no test performed.