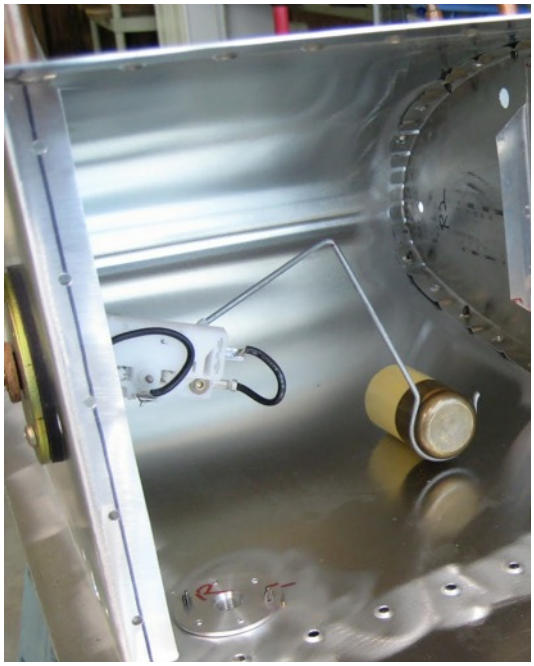
GRT AVIONICS

Calibrating Resistive Float-Type Fuel Senders

EIS and Sport EFIS Manual Supplement



Revision A1

07-Aug-2013

Supplement Revision Notes

Revision	Date	Change Description
A	28-Jun-2013	Initial Release
A1	07-Aug-2013	Corrected formula in Worksheet 2, Step 5 (scale factor calculation)

Table of Contents

Section 1: Introduction

1.1 About Resistive Float Senders

When aviation was new, fuel gauges consisted of a cork float connected to a wire shaped like an upside down L that ran up and out through a fuel cap visible to the pilot. The concept was simple: The cork floated on top of the fuel. As the fuel tank went from full to empty, the cork descended with the fuel level, causing the wire to slide down. When the upside down L rested on the cap, the cork was at its lowest, and tank was presumably empty.

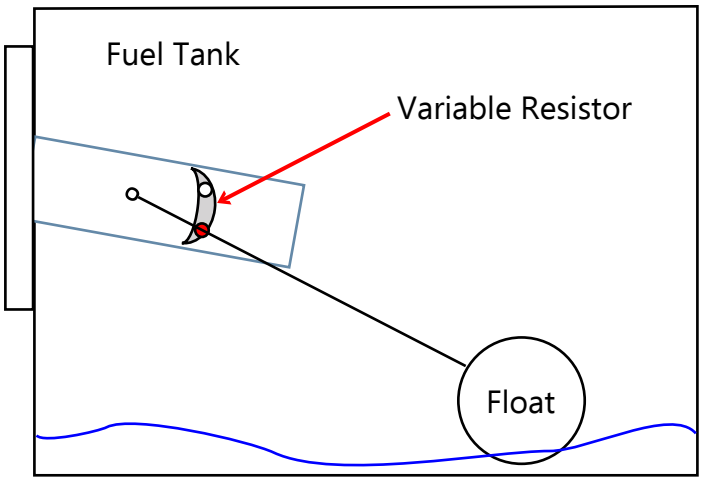
Resistive float senders are an electronic upgrade to this concept. The float is still there, but its rise or fall causes tiny changes in voltage which drive a fuel gauge instrument–In this case, an EIS or EFIS display.

The gauge, in this case the EIS unit, measures the voltage that comes out of the sender unit. Voltage enters the sender unit from the EIS as an "excitation" current. It passes through a resistor that cuts the voltage down to a consistent, known voltage level. As the float moves up and down along a slide contact, the electrical current flows through a variable resistor that further changes the voltage. The EIS then reads the voltage levels flowing from the senders. The sender and EIS must be calibrated so that the float position voltage readings can be converted into pilot-friendly readings of gallons or liters.

1.2 Data Port and Hardware Requirements

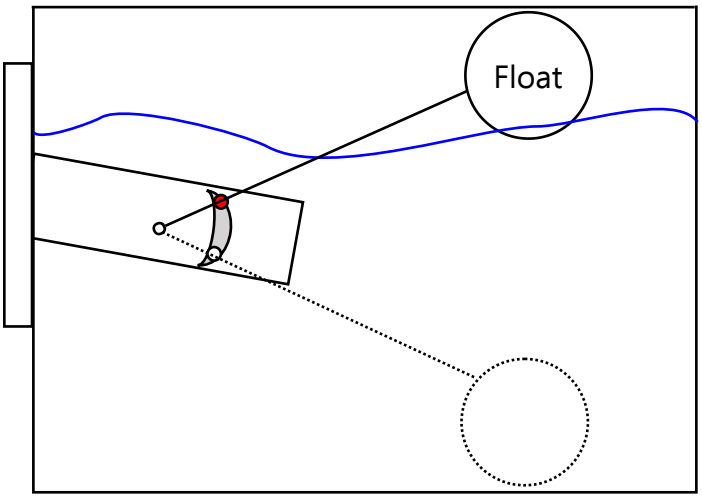
EIS Data Port	Requires (1) AUX function per fuel tank sender.*
Power Connections	Power is provided from the EIS unit.
Hardware Required	(1) float sender per fuel tank
	(1) 470 ohm (¼-½ watt) resistor per sender; available from GRT, Radio Shack or other electronics supply source

***NOTE:** EIS Model 2000 units have two user-definable Aux inputs. EIS Model 4000/6000/9000 units have 6 user-definable Aux inputs. Any of these can be used for fuel senders.



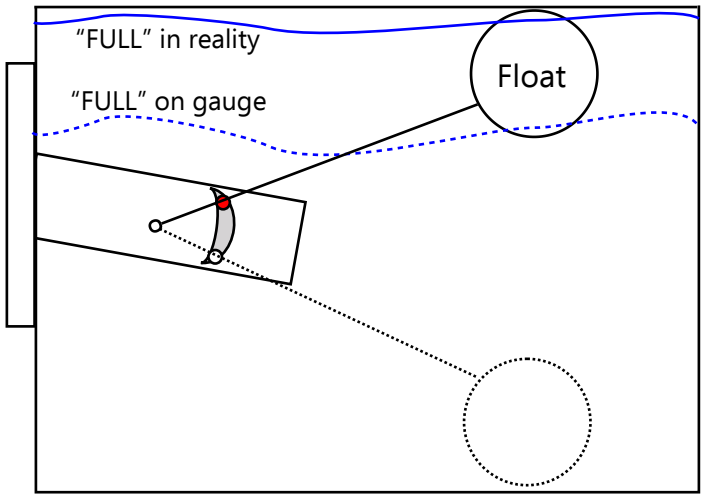
How Does It Work?

The Variable Resistor and float stem are wired to send a signal to the fuel gauge in the form of a precise level of voltage that depends on the position of the float. As the float rises, the voltage of the signal changes. Most of the time, the signal voltage is the lowest when the tank is empty, and the highest when it is full. (Not always-sometimes the opposite is true. This is where the Forward/Reverse Sensing adjustment will come into play later in this process.)



Converting Voltage to Gauge Readings

The voltage level created by the float position is sensed by the EIS. But we don't care about voltage levels, we care about gallons (or litres) in the tank. This is where Scale Factor comes in. The voltage range is somewhere between 0 and 5. If the EIS senses 1 volt, where is the float position? How many gallons does 1 volt represent? **Scale factor** converts raw voltage to a value we can use on the EIS. This is done by calibrating the system. Horizon EFIS users can take advantage of automatic calculations by the EFIS to simplify the calibration process.



Float Sender Limitations

Sometimes the float hits the top of the fuel tank before the tank is full. This causes the gauge to read FULL when the tank is not truly full. Airplanes with dihedral run into this problem often because there is much more fuel uphill from the float. The same is true when it reads empty. Usually there is a small amount of fuel that remains in the tank when the float is at its lowest position. Irregularly-shaped tanks provide unique calibration challenges because the relationship of quantity to float position is not linear- The tank may contain more or less fuel at certain float levels. That's why it's important to add fuel in many small increments while calibrating the fuel senders to get a more accurate picture of reality.

Section 2: Installation & Wiring

2.1 Mechanical Installation

Every airplane is different, so mechanical installation of senders is not covered in this Supplement. Use the airplane kit and/or sender instructions to properly install each sender.

2.2 Assigning Aux Inputs in the EIS

Fuel senders wired to the EIS utilize the Auxiliary (Aux) functions. These are user-configurable data ports that can be used for a wide variety of sensors. They are labeled AX1, AX2, etc. and are found on EIS pages 12 and 13. (We call them "Aux" functions but the EIS label skips the "u" to save space.) Start your installation by deciding which Auxiliary inputs you will use for your fuel senders. If you are planning to mount the EIS in view on the instrument panel, keep in mind the position of the auxiliary input functions on the various EIS "pages". Referring to figure 1b in the EIS installation manual, you will note that Aux 1, 2, & 3 appear on page 12, and Aux 4, 5 and 6* appear on page 13. It is advisable to wire the fuel senders to two Aux inputs that are on the same page. For example, Left Tank on Aux 1, Right Tank on Aux 2, and Fuel Flow on Aux 3.

You may fill in the My System table below to record the Aux inputs and other information for each sender to aid in creating your wiring diagram or schematic for your airplane. Refer to Figure 5a, Connector A wiring diagram, in the EIS manual to find pin assignments and suggested wire colors. This will come in handy later on if it becomes necessary to troubleshoot.

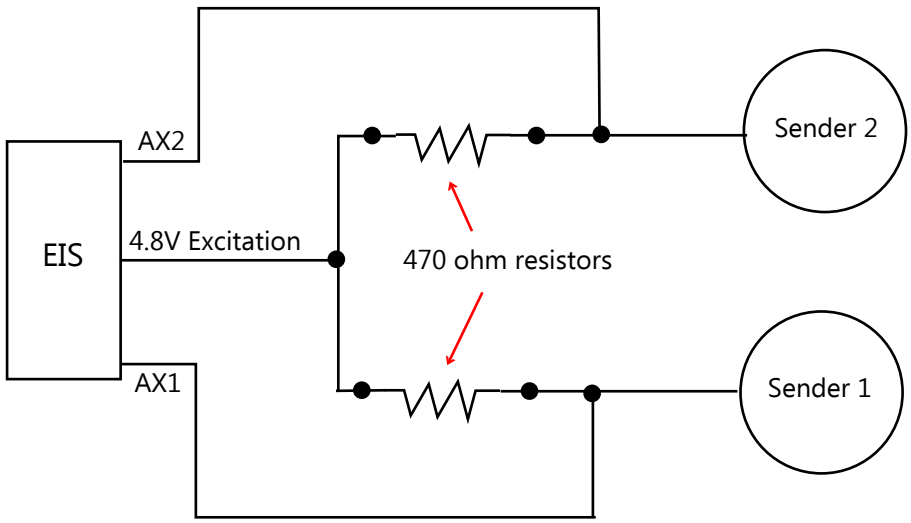
*Model 2000 units have only 2 Aux inputs. Model 4000/6000 units with software versions prior to xxx46 only have 4 Aux inputs unless otherwise noted on the EIS data tag.

My System- Fuel Sender Wiring Information

Fuel Tank	EIS AX Input	EIS Pin	Wire Color	Notes
–	–	A25	Blue	4.8V Excitation Output

2.3 Wiring the EIS and Senders

Follow the instructions presented in Section 5.2 of the EIS installation manual for wiring the EIS and its components. Wire the senders to the EIS using standard aircraft wiring practices. The general schematic for float-type fuel senders looks like this. The black dots represent wire splices. Follow the instructions for the senders to ensure that they are properly grounded.



2.4 Sport EFIS Fuel Sender Calibration Options

The Sport EFIS does not have Analog inputs, so Sport users must wire the fuel senders to the EIS Aux inputs. However, if you have a Sport, you do not have to calibrate the senders using the EIS. You have the option to send the raw voltage data from the sender over the EIS-EFIS serial connection, using internal EFIS calculations to calibrate the senders instead. This method will eliminate the math necessary for EIS calibration described in the next few pages. However, it will also keep the EIS Aux fuel quantity readouts in raw format, so it is mainly recommended for builders who have chosen to blind-mount their EIS behind the instrument panel.

To calibrate your senders using the Sport: After wiring the senders as described in Section 2 of this manual, skip ahead to Section 3.2 of the *Resistive Float Senders Calibration Supplement for* ***Horizon EFIS*** for instructions on calibrating the fuel senders. Disregard Sections 3 and 4 of this manual.

Section 3: EIS Setup & Programming

3.1 Set Up EIS Auxiliaries for Fuel Senders

To access EIS configuration menu: Press and hold Center and Right buttons. The "Save Lean Point?" page will appear initially, but keep holding the buttons until they disappear and the first configuration page appears.

1. Optional: Refer to Section 7.1.1 in the EIS manual to create custom labels for the fuel tank Aux inputs (such as LF for Left Fuel, RF for Right Fuel).

2. Decide if you would like to display fuel with a resolution of 0.1 (decimal) or 1 (integer). We generally recommend a resolution of 1 for fuel tanks, however, some EIS 2000 Aux resolutions are preset to display decimals. See Section 7.1.6 of the EIS manual for instructions on how to set up the Aux resolutions.

3. Choose one tank to begin. **For our example, we will use Aux 1 as the Left Tank and Aux 2 as the Right Tank.**

4. Access the EIS configuration menu. Press NEXT until you see 1SF. This is the Scale Factor for Aux 1, the left fuel tank in our example. Press UP key to set 1SF to 100.

5. Press NEXT key until you see 1OFF. This is the Aux 1 offset. Set 1OFF to 0.

6. Press NEXT key until you see +/- in the upper left corner of the EIS screen. This is the Forward/Reverse sensing we mentioned on Page 5 of this supplement. The symbols in the line represent all of the Aux functions, from 1-6, left to right. For now, set the first two symbols in the line to +. This means Aux 1 and Aux 2 are set to Forward sensing. (See Section 7.1.5 in the EIS manual for more on this.)

7. Press and hold the Center and Right keys on the EIS to roll quickly through the rest of the settings and exit the Configuration Pages. If the sender is wired correctly, Aux 1 should now read something other than zero, as the voltage from the sender is now being read by the EIS.

8. Repeat Steps 4 and 5 above for the right tank, if applicable (Aux 2 in our example).

3.2 Calibrate Fuel Senders

Preparation: Begin with empty fuel tanks. This operation is easiest to accomplish with a helper to watch the EIS readout. Have a fitting with a rubber hose handy for easy draining of fuel into an approved fuel container. (Most fuel tank sumps can be unscrewed and replaced with a fitting for easy draining.) Level the aircraft so that it sits on the ground at an angle close to a straight & level cruise flight attitude to provide the most accurate fuel level reading in flight.

NOTE: Due to the limitations of float senders described in Section 1.1 of this manual, it is not recommended to use the tank capacity as the "FULL" indication. The EIS should read the actual fuel level at the upper range limit of the float sender. For example, in a 15 gallon tank, the float sender may reach its upper limit at 12 gallons. When more than 12 gallons are in the tank, the EIS will display 12; however, the gauge will read more accurately below 12 gallons, where sharper accuracy is most desired.

1. Fill a clean fuel can (5 gallons will work for most kitplanes) with a known quantity of fuel. Record this quantity in Worksheet 1. Empty the can into the first tank to be calibrated; in this example, we'll use Aux 1, Left Tank. The fuel level at this stage must be enough to raise the float off the bottom stop.

2. Notice the numbers displayed on the EIS Aux 1 reading. As the float rises, the number should increase in value. If it decreases in value as fuel quantity increases, repeat Step 6 in Section 3.1 and set Aux 1 to Reverse Sensing.

3. Anytime after the float begins to rise, drain the fuel from the tank, paying close attention to the point at which the EIS readout stops moving. This means the float is at the bottom of its range. Note the amount of fuel left in the tank at this point and write it in Worksheet 1. This will become your "reserve" fuel amount that is in the tank after the gauge reads zero.

4. Write the lower-limit float sender value as shown on the EIS Aux 1 on Worksheet 2, Line 1.

5. After the original "known quantity" is all back in the tank, add to it, preferably using a metered fuel pump or dispenser marked in one-gallon/liter increments. Slowly fill the tank until the EIS Aux 1 readout stops changing. This is the upper limit of the float sender. Note the amount of fuel in the tank at this time and write it in Worksheet 2, Line 4. This quantity will be used as your FULL fuel gauge reading.

6. Write the upper float sender value as shown on the EIS Aux 1 in Worksheet 2, Line 2.

7. Keep filling the tank to capacity and note the quantity difference between the upper limit of the fuel sender and the actual full quantity. Record it in Worksheet 1. This value will be useful for flight planning and documenting the actual quantity of the tank.

8. Use Worksheets 1-3 on the next page to determine Scale Factor and Offset values for Aux 1, then program these values into the EIS. The EIS should now show an accurate fuel quantity in gallons or liters. Repeat Steps 1-8 for the other fuel tank(s).

Worksheet 1: General Notes		**Left Tank**	**Center Tank**	**Right Tank**
	Known quantity of fuel in container			
	Fuel qty remaining below lower float limit			
	Fuel qty added after upper float limit			

Worksheet 2: Calculate Scale Factor (AuxSF)		**Left Tank**	**Center Tank**	**Right Tank**
1	EIS Empty Reading			
2	EIS Full Reading			
3	RANGE= (Line 2) - (Line 1)			
4	Fuel QTY (gal or L) at upper limit of float sender			
5	Divide Quantity by Range; (Line 4)÷(Line 3)			
6	AuxSF = (Line 5) x 100. Round to nearest whole number.			

Worksheet 3: Calculate Auxiliary Offset (AuxOff)		**Left Tank**	**Center Tank**	**Right Tank**
7	(Line 1) x (Line 5); Round to nearest whole number. Multiply this by 10 if the Aux resolution is 0.1 (decimal reading instead of integer)			
8	(Line 7) x 2			
9	AuxOff = (Line 8) - 1 Note: Must be an odd number.			

Section 4: Set Up EFIS Fuel Gauge Display (EIS Aux Inputs)

4.1 Configure EFIS Fuel Bar Graphs

The EFIS engine page is configurable for many instrument display options. In this step, you will program it to show fuel quantity for each tank on a bar graph. This bar graph will appear on the ENG page and on the PFD or Map "split screen" views. On the HXr, you can also program one of the PFD engine dials to show fuel quantity for one or all tanks.

1. Go to the main menu of the Set Menu page. Scroll to and select Graphical Engine Display.
2. Scroll down toward the middle of the page until you see Aux Functions. Select the Aux Function that corresponds with the EIS Aux input that is programmed for fuel quantity in one of the tanks. In this example, we are using EIS Aux 1 for the Left Fuel tank.

Setting	**Value**	**Notes**
Aux1 Function	Left Fuel	Choose Left, Center or Right Fuel. Must match EIS Aux input.
Left Fuel Integer/Decimal	Integer	Recommended for fuel quantity; decimal is an option, but integer gives a more stable fuel level reading.
Left Fuel Graph Min Level	3	These values specify the range of the bar graphs. For best results, enter the fuel quantities indicated at the upper and lower limits of float travel- in this example, 3 and 12 gallons in a 15-gal tank.
Left Fuel Graph Max Level	12	

3. Repeat for the rest of the fuel tanks.
4. For more information and options for displaying fuel quantity on Sport or Horizon EFIS displays, please see Section 3 of the Resistive Float Sender Calibration Supplement for Horizon EFIS.

Congratulations, you are done!