

Engine Information Unit (Walter M601 Engines)



Thursday, July 20, 2006

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Overview

The Engine Information Unit (EIU) interfaces with various aircraft sensors in order to extract and make available reliable and accurate engine information to EFIS, Flight Recorders and other information users.

The EIU is able to monitor all engine and fuel parameters associated with gas-turbine operation and provide them as a serial data stream over RS-232. These measurements include:

- **Three Temperatures** using standard K-type thermocouple probes. Can be used for inner-turbine temperature (ITT), oil-temperature and outside air temperature (OAT).
- **Three Pressures** using standard 4-20mA pressure transducers. Can be used for torque, oil-pressure and fuel pressure.
- **Two Speeds** using tachometer generator signals. Can be used for gas-generator speed (N1) and propeller speed (N2).
- **Four Fuel Quantities** using any variety of either frequency based, voltage based or resistance based quantity probes.
- **One Fuel Flow** using industry standard pulse / frequency based flow sensors providing both flow rate as well as totalizing capability.
- **One Battery Voltage and Current** using a 50mV shunt. Measures current in both directions.
- **Eight Annunciation Switch Inputs** that can measure various conditions. On the Walter turbine they can be used for ISOL, EHT, Hydraulic Pump, Low Oil Press, Beta (propeller), Forward and Aft Chip detects as well as Gen Fail annunciation.

The EIU provides separate and independent powers to each sensor requiring external excitation. This prevents any single sensor (or wiring) failure causing the loss of more sensor measurements, which can be found on systems employing common sensor power busses. The power to each sensor is also limited in order to contain possible faults. Such faults whether caused by a bad sensor or faulty wiring are also detected and reported by the EIU and thus provides added confidence in the measurements made.

Installation is greatly simplified through the use of a single 50-pin standard d-sub connector on the side of the unit as well as through the Windows based EIU Link software which makes configuring, calibrating and verifying correct EIU operation easy.

Calibration (or mapping) of the four fuel tanks are done in one operation – filling an empty tank in stages (at user's discretion) until full only once.

Three Temperatures

The EIU is able to measure temperatures ranging between -60°C and $+1100$ degrees Celsius using standard K-type thermocouple probes. Thermocouples used for measuring turbine temperature (eg. ITT) are normally supplied with the engine, but thermocouples used for measuring Oil Temperature and OAT may need to be obtained separately.

Three Pressures

The EIU measures pressure using standard 4-20mA transducers. This method simplifies wiring by only requiring 2 wires (signal & ground) for each sensor instead of the usual 4 wires per sensor. They also provide excellent performance in noisy environments. These sensors are standard off the shelf items that can be obtained in various pressure ranges.

Two Speeds

Both the gas-generator speed (N1) and the propeller speed (N2) can be measured by the EIU. Tachometer-Generators provide signals in a fixed frequency-to-speed ratio and are normally supplied with its engine.

One Fuel Flow

Fuel flow sensors normally provide a fixed number of pulses per volume of fuel, which is also called the K-factor. These pulse or frequency based flow sensors can be read by the EIU to not only provide the flow rate, but additionally keep track of the total volume (gallons) of fuel that passed through the sensor.

Four Fuel Quantities

The EIU can measure four fuel tank quantities using any combination of frequency or voltage or resistance based fuel probes available.

One Voltage and Current

Both the aircraft battery's voltage and current can be measured by the EIU with the use of a 50mV shunt between the battery and the electrical bus. Shunts from as low as 5 Amp to as high as 300 Amp (@ 50mV) can be used (updating of EIU configuration is required). The EIU will measure currents into the battery (charging) to the value of the shunt in use (eg. 300 Amp with a 300 Amp shunt). Currents flowing from the batteries such as encountered when cranking the engine at startup can be measured to 5 times the value of the shunt in use (eg. 1500 Amp with a 300 Amp shunt). Reading of the cranking current provides useful feedback as to the battery's strength and health.

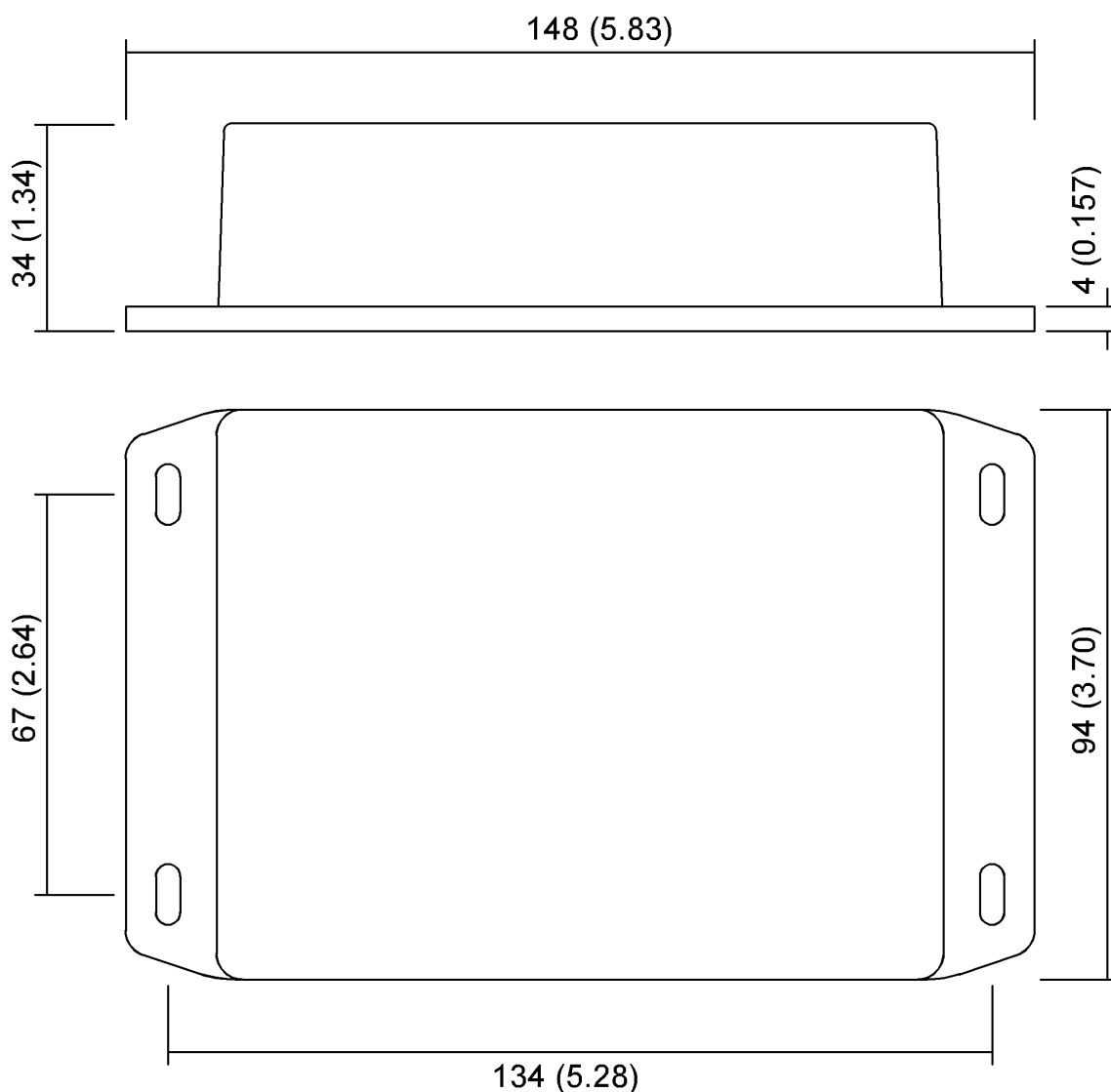
Eight Annunciation Switches

The EIU can detect 5 grounding switches as well as 3 positive (B+) switches. On the Walter turbine they can be divided as follows:

- Negative (grounded) detection - Oil Press, Beta (propeller), Forward and Aft Chip detects and Gen Fail.
- Positive detection - ISOL, EHT, Hydraulic Pump.

Electrical & Mechanical Specifications

Power Requirements	10 to 32 VDC (24 V nominal)
Supply Current	< 1 A
Operating Temperature	-40°C to +85°C
Storage Temperature	-55°C to +85°C
Weight	340g (12 oz)
Dimensions	5.83" x 3.7" x 1.34" (148 x 94 x 34mm)

Unit Dimensions

DIMENSIONS IN MM. (INCHES ARE IN BRACKETS)

Installation

Tools and Equipment

Tools and equipment required for installation (not included in the purchase) are:

- Wire cutters
- Wire strippers
- Wire (single core, Teflon insulated 20 AWG)
- Thermocouple wire (K-type)
- Connector crimp tool
- 50 pin female D-Sub connector with crimp contacts
- Personal computer running Windows 98 or higher, with a spare serial port. If no serial port, a USB port together with a USB-to-serial adapter will do.
- Standard RS-232 cable (DB-9 male to DB-9 female)

Description	Part Numbers		
Crimp contacts	M24308/10-1	M39029/63-368	AMP 205090-1
Crimp tool	M22520/2-01	AFM8 (DMC)	
Crimp tool positioner	M22520/2-08	K13-1 (DMC)	
Insertion tool	MS1969/1-02	DAK 145	
Extraction tool	MS1969/1-02	DAK 145	

Recommended wiring practices

NOTE: For all electrical connections, use correct splicing techniques, taking care to properly insulate any exposed wire. A short circuit between any of the wires may cause damage to the EIU and/or your airplane.

VR Avionics does not supply connectors or wire for wiring up your EIU. We recommend that standard aircraft grade wiring and connectors be used during installation. 20 gauge wire is sufficient for most lines to the unit. Make sure you protect the power lines with either a circuit breaker or fuse sized appropriate to the wire you select. We recommend you use wire meeting Mil Standard MIL-W-22759/16 (Tefzel insulation) which is available from various suppliers such as Aircraft Spruce. Another option is to use Teflon insulated wire (Alpha brand is available from Mouser electronics www.mouser.com) which is available in various colors.

Connectors: We recommend you use machined pin connectors to mate with the EIU connector. One source of the machined pins is B&C Specialty Products (www.aeroelectric.com/Catalog/BCcatalog.html) which also supplies the required crimp tool. Crimp connections have proven to be the most reliable in aircraft installations. D sub shells to hold the pins are available from various sources such as Mouser mentioned above. Purchasing high quality connectors is a very wise investment in your aircraft.

Installing: Make sure all connections are secure and all wires are routed and strain relieved to ensure the wires will not chafe against any other object in the aircraft.

Location of EIU and sensors

Most sensors are located in front of the firewall such as ITT, N1, N2, fuel-flow, Torque, Oil-temperature and Oil-pressure. It is thus advisable to mount the EIU near the engine to keep these wires short, but just behind the firewall to keep it within a more controlled temperature environment.

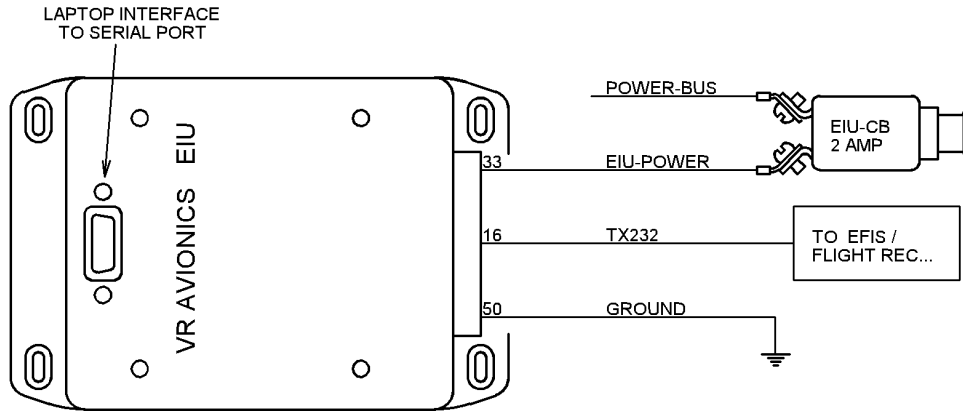
Shielding against EMI

When you have wires (to sensors) running close to radio and/or transponder cables, or a long distance from the EIU, you need to properly shield them against possible electro-magnetic interference (EMI).

An example would be an OAT or fuel quantity sensor mounted in the aft section of the aircraft, where their wires run almost the full length of the fuselage together with the radio and transponder cables on their way to their antenna's. If not properly shielded, they may cause slightly jumpy readings each time you transmit.

Power, Ground and Serial Output

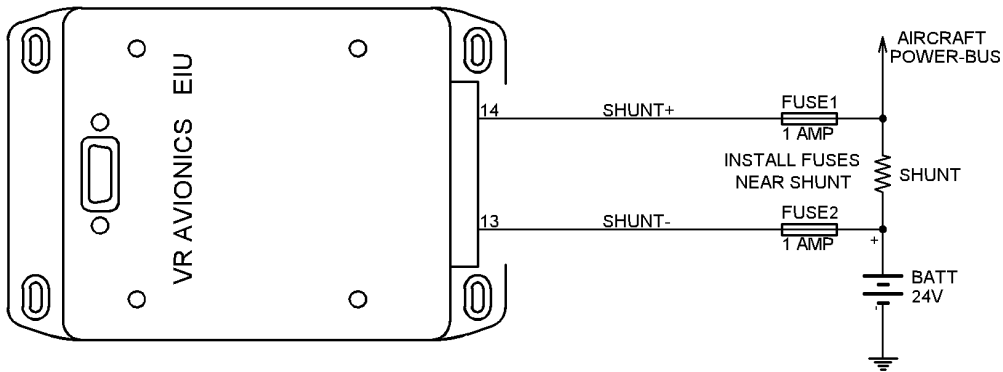
The EIU's power, ground and serial output hookup is as shown below. A circuit-breaker rating of 2 Amp would be sufficient.



The pin-50 ground wire (shown above) should go to the common ground-point of the aircraft. This wire should NOT be shared with any other device on its way to the grounding point.

Voltage and Current Sensing

The EIU measures both battery voltage (Volts) and current (Amps) through 2 wires as shown below. Both wires need to be protected by fuses mounted close to the shunt. A shunt is rated by the current (Amp) that needs to flow through it to create a 50mV voltage. The EIU can be configured with any shunt lower than or equal to 300 Amp.



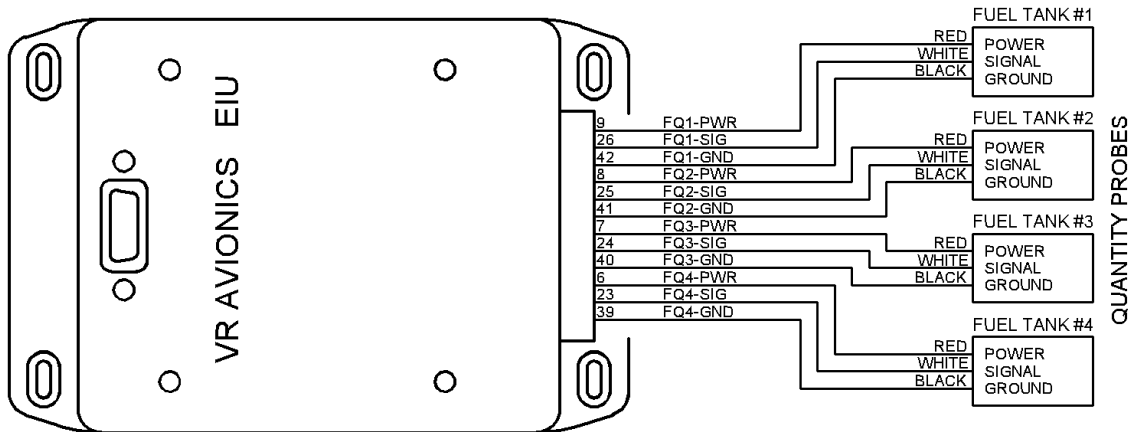
Note that the *Current shunt used (Amp @ 50mV)* configuration property needs to be set to the value of the shunt in use (see the Configuration chapter)

Fuel Quantities

The EIU can measure 4 fuel quantities using any of the following sensors / probes:

- 5 volt powered frequency output sensor (eg. capacitance probes from EI)
- 5 volt powered 0 to 5 volt output sensor
- Resistive – float type – sensor (2 wires)
- 12 volt powered frequency output sensor
- 12 volt powered 0 to 5 volt output sensor

Fuel probe types are assigned when they are calibrated (see Calibrating the Fuel Tanks (Quantities) Chapter). The fuel quantity probe hookups are shown below.



RESISTIVE PROBES REQUIRE
ONLY SIGNAL & GROUND WIRES

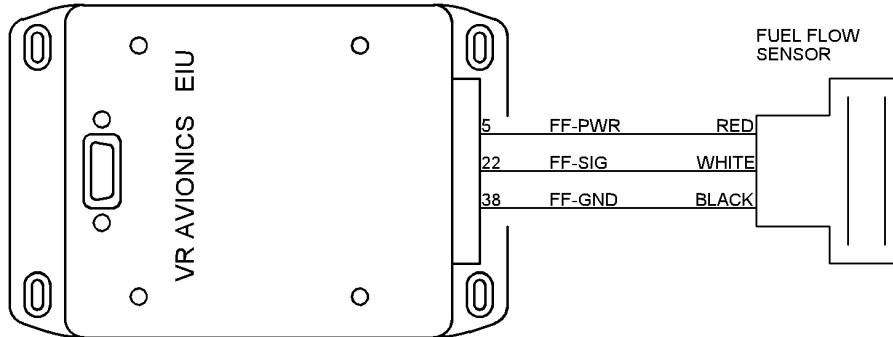


Resistive fuel probes requires only 2 wires – eg. fuel quantity #3 will only use FQ3-SIG and FQ3-GND.

When using frequency / pulse quantity sensors from EI (Electronics International) you do not require the little divider (divide-by-four) which is installed between the probe and EIU. The EIU is able to measure probe frequencies as high as 60 KHz.

Fuel Flow

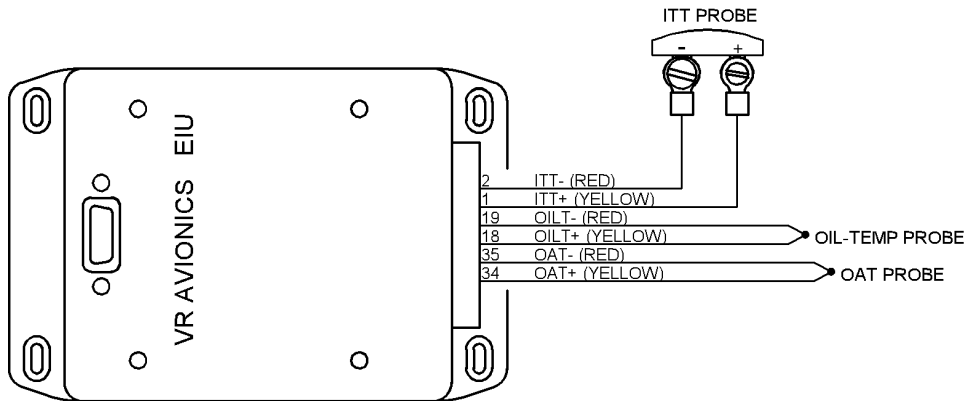
The EIU can measure any pulse / frequency based (k-factor) fuel flow sensor and also provide it with independent power (12V excitation). Fuel flow hookup is as shown below. The EIU can be configured to any K-factor (pulses per gallon) value.



Note that the *Fuel flow measurement K-factor* configuration property needs to be set to the appropriate value (see the Configuration chapter).

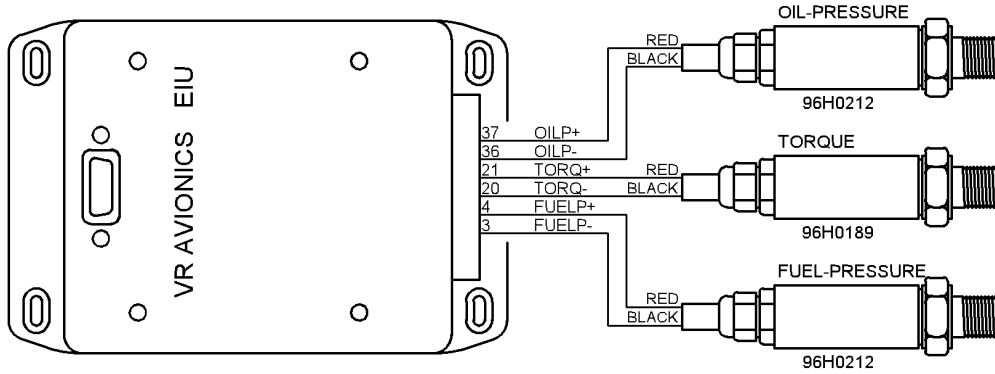
Temperatures

The EIU can measure 3 temperatures using standard k-type thermocouple probes. The diagram below shows the hookup for a Walter turbine, but the principle is the same on other engines.



Pressures

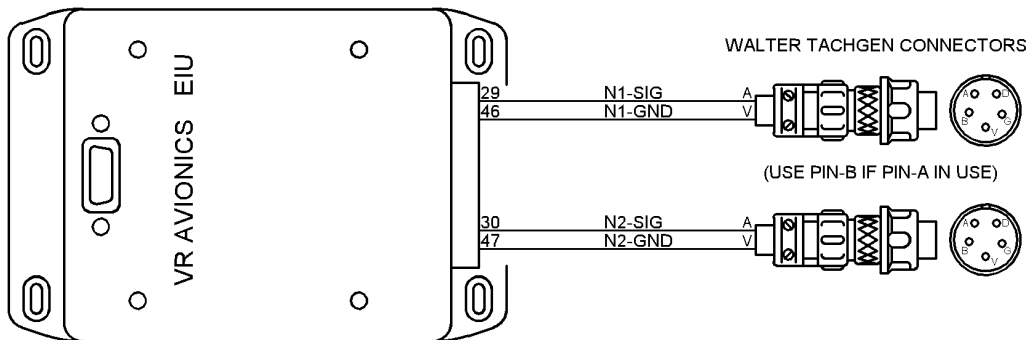
The EIU measures 3 pressures using 4-20mA transducers as shown below. The part numbers are for sensors used by the Walter turbine, but can be configured for any other engine.



Sensors for other pressure ranges can be selected by setting the relevant configuration property – eg. *Torque (pressure #1) sensor used* must be set to 2500 for a 0-250 PSI sensor, or to 1500 for a 0-150 PSI sensor.

Speeds

The EIU can detect tachometer-generator signals to measure 2 speeds. The figure below shows the hookup to a Walter turbine’s N1 and N2 tachometer-generators.



By changing the relevant configuration properties, the EIU can be configured to also measure other engines.

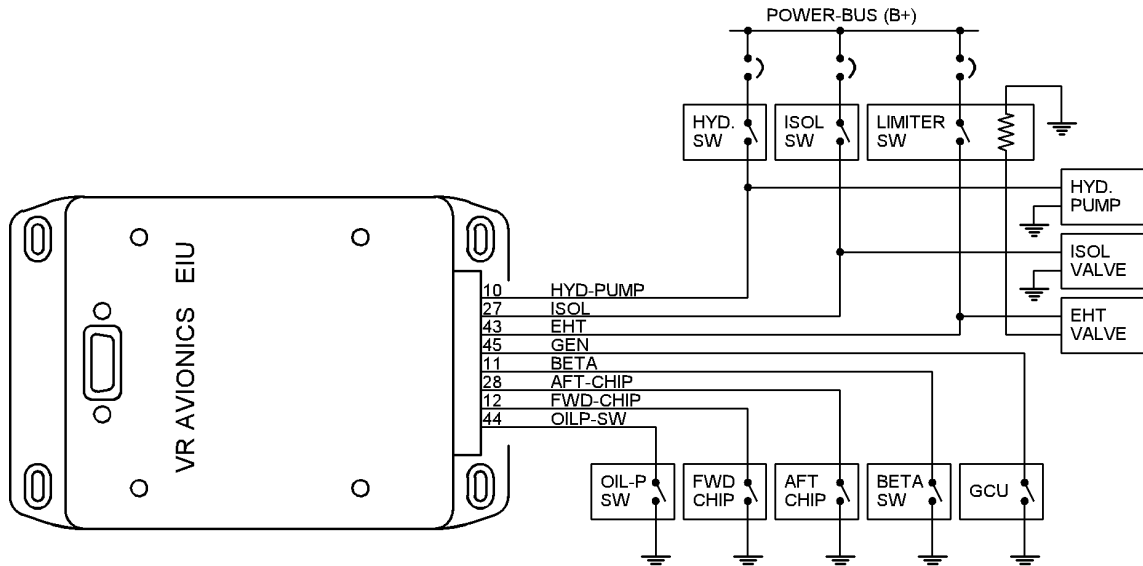
For example an engine’s tachometer-generator may generate a 70.33Hz signal at 2080 RPM reading. By entering the resultant value of the calculation below into the *Speed measurement @ 1KHz* configuration property, the EIU will have been correctly configured.

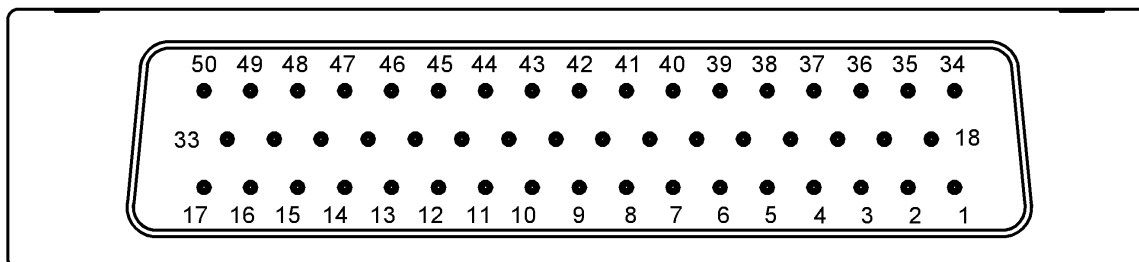
Multiply the reading (2080) by 1000 and divide by the signal frequency (70.33Hz). The result should be $2080 \times 1000 / 70.33 = 29574$.

Annunciation Switches

The EIU can detect 8 switch inputs which may be used to drive annunciation lights on EFIS screens, etc. Three positive switching (pins 10, 27, 43) and 5 negative (ground) switching (pins 45, 11, 28, 12, 44) sensors can be connected.

The figure below shows one possible installation – in this case for a Walter M601 engine:



Pin Assignments (for Walter Turbine)

PIN	DESC	PIN	DESC	PIN	DESC
1	ITT+	18	OILT+	34	OAT+
2	ITT-	19	OILT-	35	OAT-
3	FUELP-	20	TORQ-	36	OILP-
4	FUELP+	21	TORQ+	37	OILP+
5	FF-PWR	22	FF-SIG	38	FF-GND
6	FQ4-PWR	23	FQ4-SIG	39	FQ4-GND
7	FQ3-PWR	24	FQ3-SIG	40	FQ3-GND
8	FQ2-PWR	25	FQ2-SIG	41	FQ2-GND
9	FQ1-PWR	26	FQ1-SIG	42	FQ1-GND
10	HYD-PUMP	27	ISOL	43	EHT
11	BETA	28	AFT-CHIP	44	OILP-SW
12	FWD-CHIP	29	N1-SIG	45	GEN
13	SHUNT-	30	N2-SIG	46	N1-GND
14	SHUNT+	31	CAN-L	47	N2-GND
15	CAN-T	32	CAN-L	48	CAN-H
16	TX232	33	PWR	49	CAN-H
17	RX232			50	GND

Configuration

Using the EIU Link Software

This chapter will describe how to use the EIU Link Software running on a laptop computer to connect to the EIU to do the following tasks:

- Configuring the module
- Calibrating the fuel quantities
- Viewing the engine information
- Upgrading module's firmware

Laptop System Requirements

- Operating System: Windows 98 or higher
- One available serial port. If no serial port is available, a USB port together with a USB-to-Serial Converter can be used.

Downloading Software

Installing the EIU Link Software

You may download the latest software from our website (www.vravionics.com) onto your computer / laptop by doing the following:

- Click on the – EIU Link Software – link found at www.vravionics.com/eiu.htm
- Save the zip file to your computer at a location you desire – e.g. My Documents
- Execute the zip file by double-clicking on it
- Start the installation by executing the setup.exe file in the newly opened folder
- Go through the installation options mostly selecting NEXT at each window and FINISH at the end.

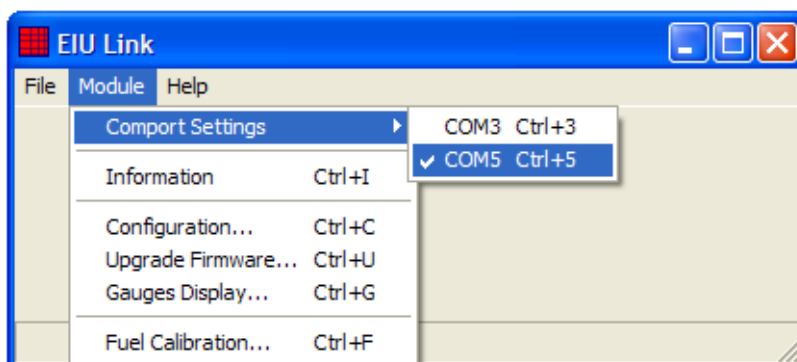
Running the EIU Link Software

A separate connector (9-pin female) on the EIU module is used for linking with your computer / laptop. Using a standard RS-232 serial cable, the module connects directly to your computer's serial port. If your computer is not equipped with a serial port and you have a spare USB port available, you can use a USB-to-Serial converter (which you can buy from RadioShack) to perform the same task. Do the following:

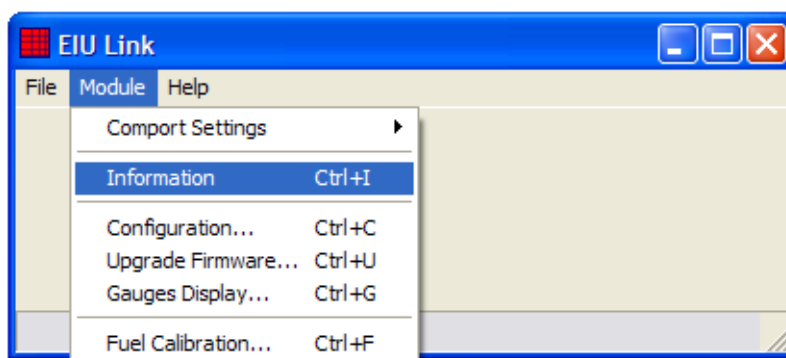
- Plug in your USB-to-Serial converter (if you are using one)
- Connect your computer's own or the USB-to-Serial converter's serial port to the EIU
- Run the EIU Link Software (Start → All Programs → VR Avionics → EIU Link)
- Power the EIU module (Switching on the master)

Selecting the Serial port

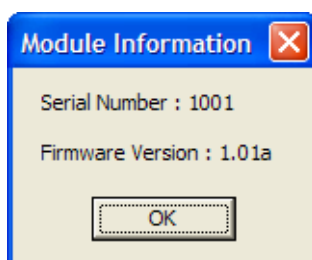
After running the EIU Link software on your computer that is connected to the EIU via a serial port, you need to select which comport to use. As the following illustration shows, select from the main menu.. Module → Comport Settings ...followed by the relevant serial port number.



You may now verify that you have good communication with the EIU module by selecting from the main menu: Module → Information. Remember that the EIU module needs to have power applied to it beforehand (master on).

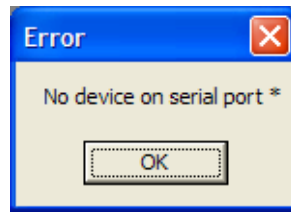


The following message should appear if the communication link is good...



(This message displays the EIU serial number as well as its firmware version number)

If the following message is displayed you know some kind of problem is causing a communication failure...

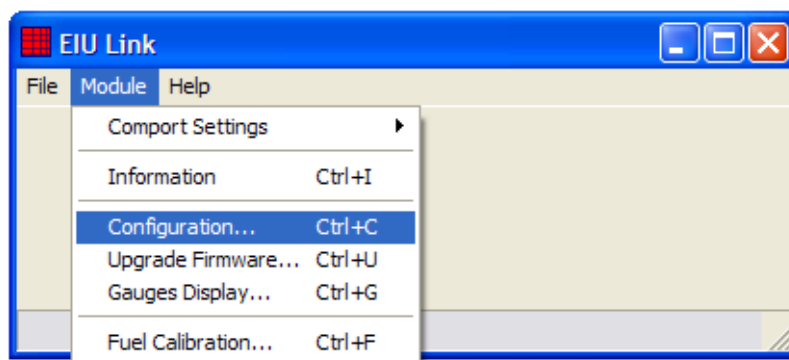


Causes of this communication failure can be as follows:

- Power was not applied to the EIU module correctly, or
- The serial cable between the module and the laptop is not connected properly, or
- The wrong serial port was chosen in the EIU Link software.

Viewing & Changing the EIU Configuration

The EIU have some settings that can be configured to suit different installations. Additionally some valuable information can be viewed by means of the configuration window. By selecting: Module → Configuration ...the user can access the EIU module configuration as illustrated below...



The Configuration window now appears...

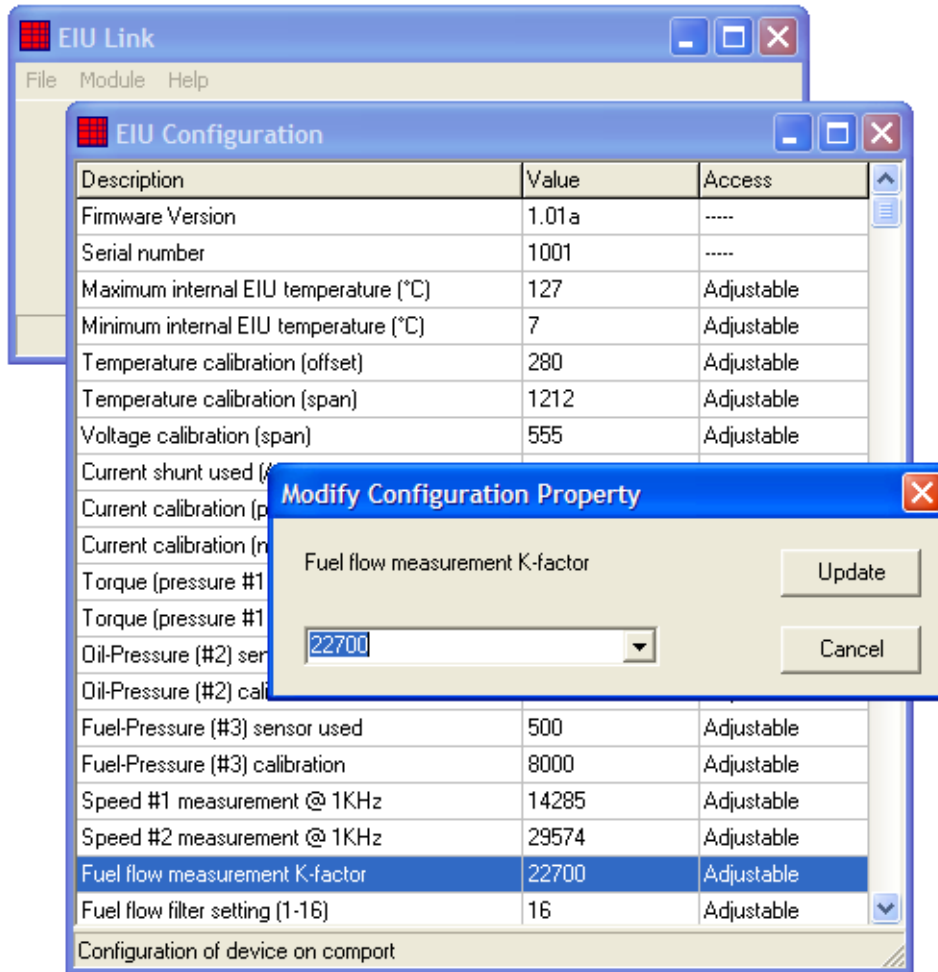
 A screenshot of the 'EIU Configuration' window. It displays a table with three columns: 'Description', 'Value', and 'Access'. The table lists various parameters such as Firmware Version, Serial number, and various calibration and sensor settings. The 'Access' column indicates whether each parameter is adjustable.

Description	Value	Access
Firmware Version	1.01a	-----
Serial number	1001	-----
Maximum internal EIU temperature (°C)	127	Adjustable
Minimum internal EIU temperature (°C)	7	Adjustable
Temperature calibration (offset)	280	Adjustable
Temperature calibration (span)	1212	Adjustable
Voltage calibration (span)	555	Adjustable
Current shunt used (Amp @ 50mV)	300	Adjustable
Current calibration (positive span)	1000	Adjustable
Current calibration (negative span)	10000	Adjustable
Torque (pressure #1) sensor used	2500	Adjustable
Torque (pressure #1) calibration	8000	Adjustable
Oil-Pressure (#2) sensor used	500	Adjustable
Oil-Pressure (#2) calibration	8000	Adjustable
Fuel-Pressure (#3) sensor used	500	Adjustable
Fuel-Pressure (#3) calibration	8000	Adjustable
Speed #1 measurement @ 1KHz	14285	Adjustable
Speed #2 measurement @ 1KHz	29574	Adjustable
Fuel flow measurement K-factor	22700	Adjustable
Fuel flow filter setting (1-16)	16	Adjustable

Configuration of device on comport

Here you can view the adjustable and non-adjustable configuration.

To modify a specific configuration item, you scroll to that item and hit <ENTER>. A dialog box will appear where you can assign a new value to a configuration property as shown next...



When done, just hit the Update button and the configuration is changed.

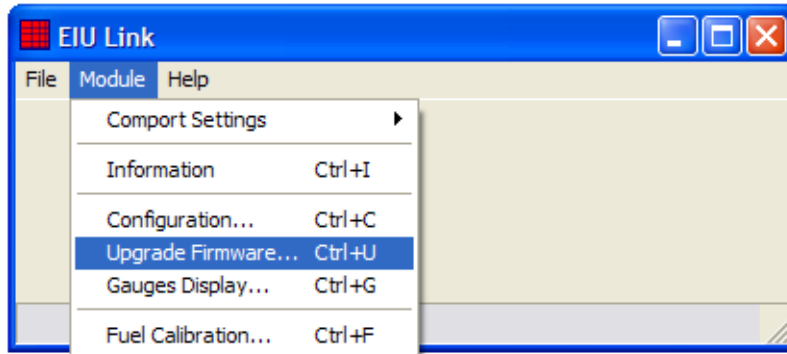
Saving your Configuration to file

After a successful configuration check (as described in the previous section) has been done, you may save the configuration to a file by selecting: File → Save Configuration File As.. All configuration (including fuel quantity calibration) settings will be saved. This is very useful if you have a query relating to your configuration, since you can attach it to an email and send it off to one of our technical support centers (see www.vravionics.com/contact.htm for who they are).

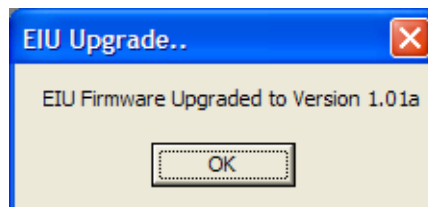
Upgrading EIU Firmware

Should new firmware that provides additional functionality become available, the EIU can be easily upgraded. The new firmware would probably be emailed to a customer in the form of a single firmware file. A good idea is to copy this file to the EIU folder first. This folder normally reside at: C:\Program Files\VR Avionics\EIULink\Firmware Files.

By selecting → Module → Upgrade Firmware,

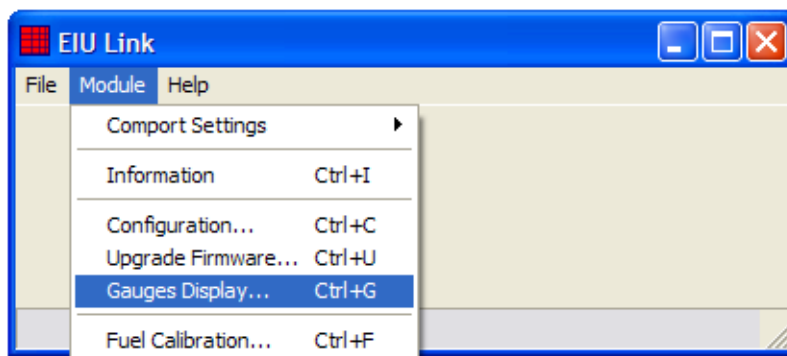


a dialog box will appear from where the firmware file can be selected. After the file has been selected, the firmware upgrade will commence if power is applied to the unit, else the EIU Link software will wait for the user to apply power to the EIU module. When the message 'Upgrading Firmware...' with a running counter is displayed in the status bar, the upgrading is under way. When complete the following message (identifying the firmware version) should appear...

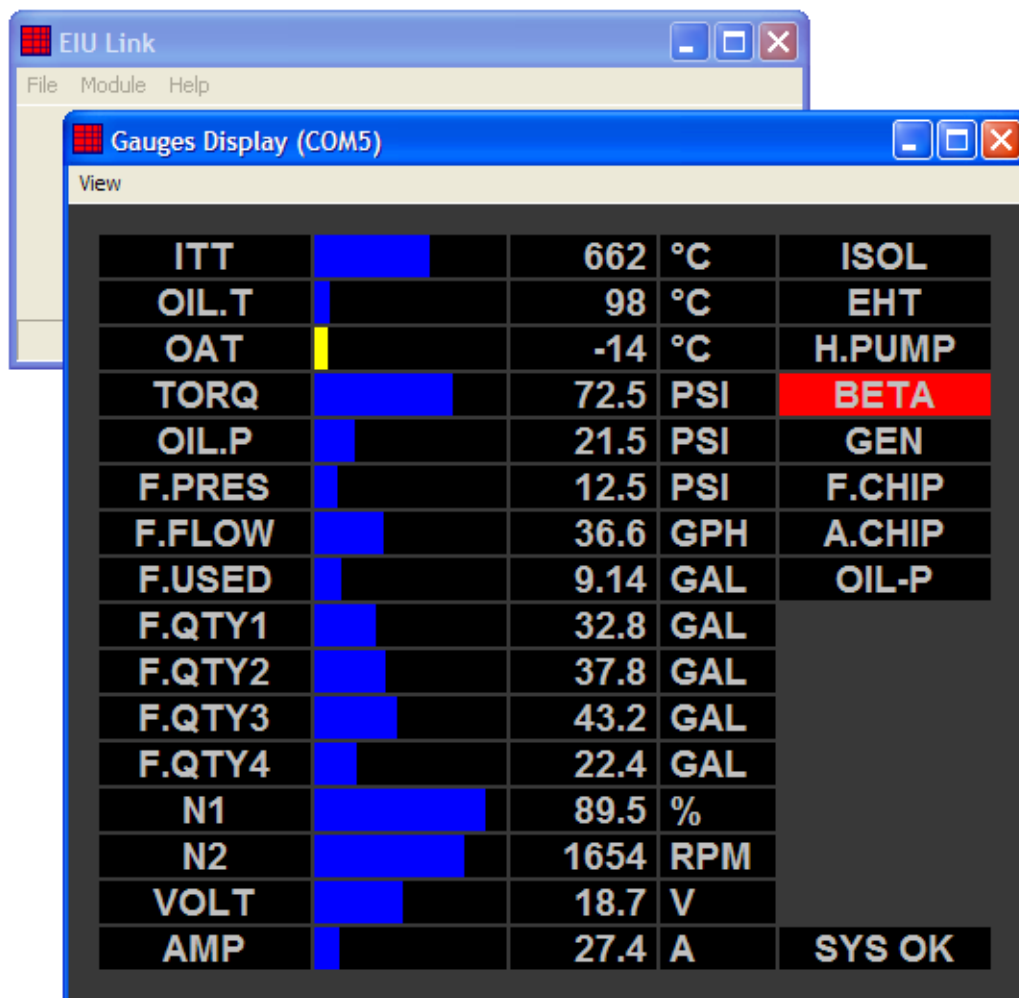


Viewing Engine Information (Gauges Display)

To view the engine information stream transmitted from the EIU you may select: Module → Gauges Display



A new window should appear that shows every parameter measured by the EIU in an easily readable format...



The following characters may be displayed in a parameter's number space to provide extra status information concerning its sensor..

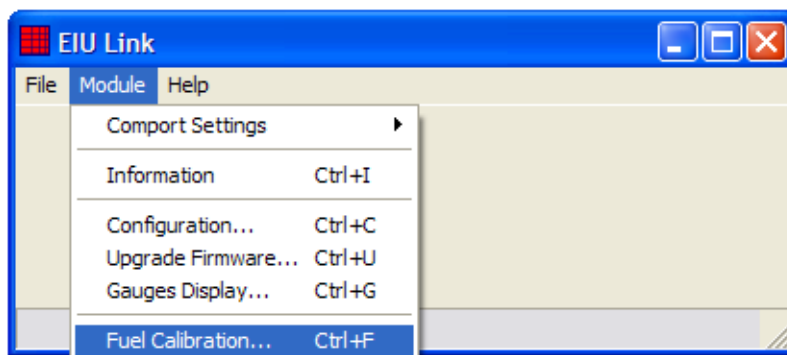
Description	Explanation
N/CON	Sensor is not connected / installed.
N/CAL	Used for Fuel Quantities to indicate that the sensor has not been calibrated (mapped) or is not in-use (disabled).
FAULT	A fault has been detected with this sensor or with the sensor's wiring.

Calibrating the Fuel Tanks (Quantities)

Before calibrating a fuel tank one has to first determine the following:

- Determine the excitation voltage required by the sensor - either 5 Volt or 12 Volt excitation are supported.
- Determine the output-type of the sensor - either frequency, voltage (0-5V) or resistance output.
- Determine to which fuel quantity pins the sensor are connected – eg. fuel quantity #1 uses FQ1-PWR (pin 9), FQ1-SIG (pin 26) and FQ1-GND (pin 42).
- Estimate the total amount of fuel the tank will hold and that you have enough fuel available to fill it through a metered fuel dispenser (either US Gallon or Liters). Ensure the tank is empty.

Select form the menu: Module → Fuel Calibration



The window shown below should appear. From the first dropdown menu select the tank that you wish to calibrate.

Point	Reading	Quantity

If a sensor has already been assigned to a fuel quantity, the following message will be displayed.

A 5 volt powered 0 to 5 volt output sensor is currently assigned to fuel quantity #3.
Is this fuel sensor type still installed to the fuel quantity #3 pins?

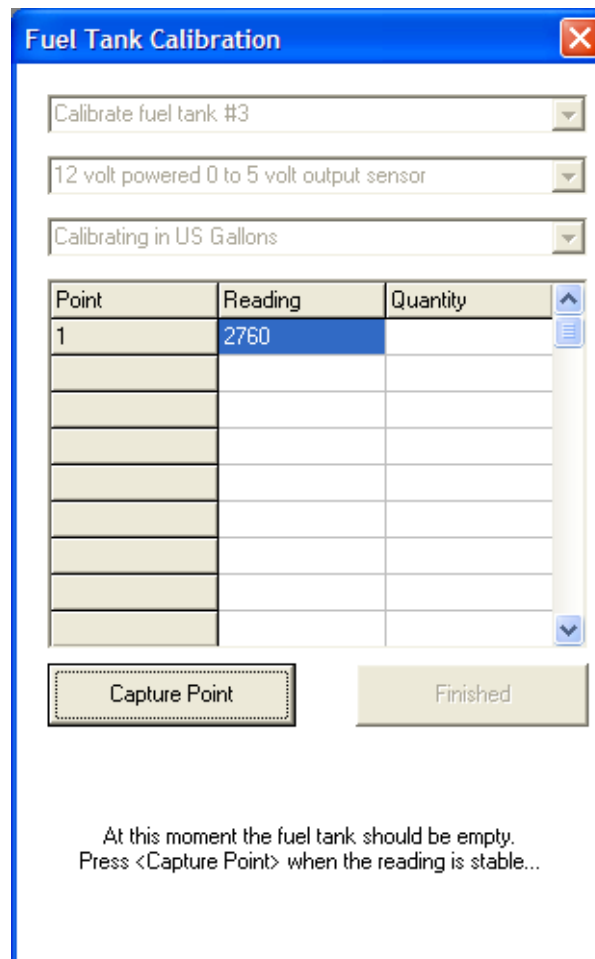
By selecting NO you can alter the sensor type used or disable this fuel quantity measurement.

To select the type of sensor, click on the second dropdown menu. The options are as follows..

Should you wish to disable a given fuel quantity measurement (since you don't require it), you may click on the first item in the dropdown list.

The third dropdown menu allows you to select the units of measurement that your fuel pump / dispenser uses.

The calibration points will now be entered as we fill the tank in increments. Once the value in the reading column as shown below settles, you may hit the “Capture Point” button and enter the quantity in the pump’s units that represents that point.



Point	Reading	Quantity
1	2760	

At this moment the fuel tank should be empty.
Press <Capture Point> when the reading is stable...

As you fill the tank, the fuel calibration table will include more points.

Point	Reading	Quantity
1	2760	1.2
2	3320	3.3
3	3320	

When full (with the last quantity entered showing the tank's capacity) you may hit the "Finished" button. This will transfer the calibration information for that fuel tank to the EIU's memory. Calibration for this tank is complete when the following message is displayed.

The EIU has been updated with the calibration information.

Appendix

Sensor Table for Walter Turbine

IND TYPE	RANGE	SOURCE	PART NUMBER	EXCITATION VOLTAGE	OUTPUT SPECIFICATIONS	EST. COST
CURRENT	-1500 to +300 Amp	Electronics Int.	300A SHUNT	NONE	50mV @ 300A	
	-1000 to +200 Amp	N/A	200A SHUNT	NONE	50mV @ 200A	
VOLTAGE	0 to 50 Vdc	NONE	NONE	NONE	NONE	
OAT	-50 to +1000 °C	Electronics Int.	N/A	NONE	Thermocouple (K)	
TORQUE	0 to 250 PSI	Newark	96H0189	10-30Volt	4 to 20mA	\$135.00
N1	0 to 110 %	Walter/Diemech	TACH GEN	NONE	70Hz @ 100%	
N2	0 to 2400 RPM	Walter/Diemech	TACH GEN	NONE	70.33Hz @ 2080	
ITT	-50 to +1000 °C	Walter/Diemech	ON ENGINE	NONE	Thermocouple (K)	
FUEL FLOW	0 to 180 GPH	Electronics Int.	FT-180	12 Volt	22700 pulses / gallon	
FUEL PRESSURE	0 to 100 PSI	Newark	96H0214	10-30Volt	4 to 20mA	\$105.00
	0 to 50 PSI	Newark	96H0212	10-30Volt	4 to 20mA	\$105.00
OIL TEMP	-50 to +1000 °C	Electronics Int.	N/A	NONE	Thermocouple (K)	
OIL PRESSURE	0 to 100 PSI	Newark	96H0214	10-30Volt	4 to 20mA	\$105.00
	0 to 50 PSI	Newark	96H0212	10-30Volt	4 to 20mA	\$105.00
FUEL QUANTITY.. TANKS 1 TO 4	0...450 Gal	Electronics Int.	P-300 C *	5 Volt*	CALIBRATE	
		Westach	0-5V WEST*	12 Volt*	CALIBRATE	
		Westach	0-250OHM*	NONE	CALIBRATE	

* Any of the three types of sensors can be used on each of the four tanks