**EFOY**

The ASFS are powered by a system designed by Simark, the EFOY Pro 2400 Duo. This system consists of a Hardigg case housing batteries, power distribution, a power generation source, and fuel. The batteries are two 12 VDC Valve Regulated Lead Acid (VRLA) (Absorbent Glass Mat (AGM) type) batteries wired in series (i.e., 24 VDC). These batteries are charged by the power generation source, which is a Direct Methanol Fuel Cell (DFMC) manufactured by EFOY. The fuel cell converts chemical potential energy into electrical current directly using a proton exchange membrane to control a hydrogen oxidation reaction. The EFOY fuel source is methanol; we use two 60 L jugs. The system is rated for 110 W and we nominally use about 67 W. (There is also a system for managing solar panels in the case, but is unused). We colloquially refer to the complete power system as the “EFOY”.

**Turning the system on:**

Plug in the main power on the EFOY front panel. Turn on the breaker switch on the center console. Turn on the interface box switch.

**Turning the system off:**

Press and hold for 3 seconds the “On/Off Reset” button on the EFOY front panel. The LCD screen will change from “Automatic” to “Off”. Unplug the main power from the panel. Turn off the breaker switch on the center console. Turn off the interface box.

**Settings:**

The EFOY is configured using the LCD panel. When the system is connected to the batteries, this panel will display the status of the system. These settings are retained if the system is power cycled, but you will need to set them if a replacement EFOY is installed (e.g., if one fails or becomes frozen).

*From the main menu:*

* The **Operating Mode** should be **Automatic** (this is default)
* Fuel Connectors are **M60** **cartridges** (the 60L tanks of methanol) and should be set accordingly. Pay attention to the two separate connectors. When a new tank is connected, make sure that the fuel gauge is reset to 100%.

*From the Expert menu:*

The Expert menu can be accessed by pressing and holding OK and Menu buttons at the same time for 2 seconds.

* The battery type should be set to **AGM**, though the set points should be identical is Lead Acid is chosen instead (Chris Wollen, email “ProEnergy system batteries”, July 30, 2019). We have used both settings at various times during testing.
* The **Communication** should be set to **MODBUS RTU**
* The **MODBUS Address** should be set to **4**
* The **MODBUS Config** should be set to **9600,8,E,1**

**Communications:**

A CAT5 cable runs from the EFOY “Data Interface” RJ45 port on the front panel of the device through an RS232 to RS485 converter to the RS485 terminal block that is connected to the data logger. Refer to the wiring diagram for details.

The EFOY is an RS232 MODBUS device. The conversion to RS485 allows us to communicate with it using the same bus as the other RS485 devices on the ASFS. The communications settings are as follows:

Baud: 9600

Parity: Even

Stop bits: 1

Data bits: 8

These setting differ in baud rate from the other RS485 devices, which are 19200. Thus, the serial port configuration is changed temporarily in the CR1000X code during each scan to contact the EFOY. The ModbusMaster function is used and is called four separate times to accommodate the different data types of the variables stored in the desired registers. All scale factors are applied in the code and the final data is stored as IEEE4.

**Variables:**

The variables retrieved from the EFOY each scan (5 s) are listed in the table below. The values are accumulated for 1 minute (n = 12), aggregated as listed under 1 min Calc in the table, and reported in the “slow” data table file using as the Data file var name in the table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Register #** | **Register Name** | **Long Name** | **Data file var name** | **1 min Calc** | **Units** | **Expected Value** |
| 30001 | Tst | Stack temperature | efoy\_Tst | Average | DegC | 0 to ~70 |
| 30003 | Tint | Internal temperature | efoy\_Tint | Average | DegC | 0 - ~50 |
| 30005 | Twt | Heat Exchanger temp | efoy\_Twt | Average | DegC | 0 to ~70 |
| 30015 | Ubat | Battery voltage | efoy\_Ubat | Average | V | 24.6-28.4 |
| 30028 | laus | Output current | efoy\_Laus | Average | A | 0 (not charging) or ~4.5 (charging) |
| 30035 | FuellSt | Reservoir Fluid Level | efoy\_FuellSt | Average | % | 0-100 |
| 30037 | Error | Error | efoy\_Error | Max | code | 0 (manual sec 7.2) |

**Daily Data Checks:**

* The battery voltage (efoy\_Ubat) should not fall below about 24.6 V. If it does, there is a problem with the charging or the battery.
* efoy\_Error should read 0. Else, consult the manual and proceed accordingly.
* efoy\_FuellSt can, in principle, be used to monitor the level of the tanks. However, it is listed as the reservoir level, which may be the internal reservoir in the EFOY and not the tank. Even if it is the tank level, it is a calculation and does not appear to be very reliable.
* The temperatures (Tst, Tint, Twt) should not fall below 0 C. If they do, the system will likely fail and a replacement will be needed. Note that temperatures in other areas of the box (e.g., CR1000X panel temperature, Ptemp) are expected to be below 0.

**ASFS Visit Checks:**

* Be careful not to cold-soak the EFOY for too long. The manufacturer suggests leaving the box open for no more than 30 minutes during winter.
* Check the condition of the tanks and inspect the fuel lines
* Check that snow is not infiltrating the Hardigg box through the fuel line inlet
* Check for corrosion on the battery leads
* Note the status information on the LCD panel
* Check for and remove ice blocking the exhaust
* Replace fuel cartridges as needed and reset the cartridge settings using the LCD screen.
* Before you leave ensure that data is being properly collected by the logger using the Public output of the LoggerNet Connect Screen.