PF2100 MODBUS LOGGER CARD

SYSTEM SPECIFICATION

v1.0 DRAFT
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Last Revised by Alex Messner

PROFIRE ENERGY INC

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1 Overview

The Profire Data Logging Card allows a Profire system to log process data to a standard USB key as well as communicate with other devices using Modbus. The expansion card periodically logs the state of the BMS to the USB key in a spreadsheet, recording information such as temperature readings, solenoid valve status and temperature setpoints along with corresponding timestamp information. The Data Logging Card also has two additional inputs for a 0-20mA and 0-30V signal which are logged along with the system data. The Data Logging Card also supports communication with Modbus over an RS 485 link, allowing it to log status data to a USB key and a remote device such as a PLC simultaneously.

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2 User Interface

The user interface will consist of a 4 digit, 7 segment clock display along with 14 LEDs and 4 buttons. The display will be off by default, the user can toggle between time and date with the Up/Down buttons the associated Time/Date LED will be lit to indicate what is being shown on the display. The low battery LED will light up when the battery voltage is low.

2.1 LEDs

- Low Battery LED: Turns on when battery voltage is below the threshold
- Time LED: Turns on when the clock display is showing the time
- Day LED: Turns on when the clock display is showing the day
- Month LED: Turns on when the clock display is showing the month
- Year LED: Turns on when the clock display is showing the year
- USB Logging LED: Turns on when a new log entry is written to the USB Storage device
- mA LED: Turns on when setting the 4-20mA input to mA
- V LED: Turns on when setting the 4-20mA input to V
- TX LED: Device is sending Modbus data
- RX LED: Device is receiving Modbus data
- Error LEDs: The Data Logging Card has four error LEDs.

A description of these LEDs is given below:

Error LED	Description
A	Unused
B	Unused
C	Unused
D	Any USB key error. These include ▪ Corrupted USB key ▪ Full USB key ▪ Incorrectly formatted USB key

Currently all LEDs light up if there is no USB media installed. The A – C error LEDs will be utilized in future hardware revisions to provide a more detailed diagnosis of the error.

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2.2 Buttons

The system has 4 buttons to configure the system and to eject the USB key:

- USB Eject
  - Push the button to eject the USB key and flush the write buffer
- Mode/Set
  - Push and hold to enter set mode
  - When in set mode push to step through settings: Time, Day, Month, Year
- Up
  - Push to toggle through modes: Time, Day, Month, Year, Voltage, Current
  - When in set mode increase the displayed value. Push and hold will auto increment.
- Down
  - Push to toggle through modes: Time, Day, Month, Year, Voltage, Current
  - When in set mode decrease the displayed value. Push and hold will auto decrement.

There is still a reset button present on the board, although it is not working anymore. The button can't trigger the watchdog reset anymore since the watchdog got removed.

When the Data Logging Card is initially powered up, it displays the current Time, Day, Month and Year on its LED display. To view these values again, press and release the Mode button repeatedly to cycle through the currently set time and date.

If the displayed date and time is not correct, it can be modified using the buttons on the Data Logging Card. The procedure to set the date and time is given below:

1. Press and hold the Mode/Set button for three seconds
2. Press the Up and Down buttons to modify the value flashing on the display.
3. Press the Mode/Set button to confirm the change and switch to the next value
4. Repeat the previous steps until all of the values have been confirmed

After the year has been set by pressing the Mode/Set button, the display will show "4 – 20". This setting is not related to the time or date used by the Data Logging Card. Refer to Section 2.5 for information on this setting. The following procedure can be used to switch between the two modes of the 4-20mA input:

1. Follow the time and date configuration procedure until the display shows "4 – 20"
2. Press the Up and Down buttons to switch between the two modes. The two LEDs (V and mA) to the right of the display are used to determine the selected mode, according to the table below:

LED	Mode	Logging Type
mA	Current Input	Analog
V	Voltage Input	Digital

3. Press the Mode/Set button to confirm the selected mode.

The Data Logging Card will immediately begin logging data in the configured mode.

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2.3 Display

The display is a 4 digit, 7 segment clock display.

- By pressing the Up/Down button the device toggles through the following data:
  - Time - 24 hour clock, no time zone support
  - Day of the month
  - Month
  - Year
- When in set mode the digit to be set flashes

2.4 DIP Switches

The Data Logging Card uses eight DIP switches to change the behaviour of data logging and Modbus communications.

#	Setting	Description
1	**Logging Interval**	These switches determine how often the Data Logging Card writes data to the USB key. The value configured by these switches can represent either seconds or minutes, depending on the position of the Min/Sec switch. The encoding is as follows: OFF OFF = 5 OFF ON = 10 ON OFF = 30 ON ON = 60
2		
3	**Minute/Second Time Base**	This determines the units for the Logging Interval set using the previous two switches: OFF = Minutes ON = Seconds
4	**Unused**	Unused
5	**RS-485 Baud Rate**	Baud rate used for Modbus communications OFF = 9600 bps ON = 19200 bps
6	**Rx-to-Tx Delay**	Delay between receiving/transmitting Modbus messages OFF = 2ms ON = 25ms
7	**Temperature Units**	Temperature units for USB key logging and Modbus communication OFF = Celsius ON = Fahrenheit
8	**RS-485 Termination**	Internal termination for RS-485 OFF = 120Ω termination ON = No termination

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3 Terminal Descriptions

The Data Logging Card has nine terminal block connections. A description of each is provided below:

Label	Description
RS485 Bus +	Non-inverting RS-485 input. This pin should have a positive voltage relative to “RS485 Bus -“when idle.
RS485 Bus -	Inverting RS-485 input. This pin should have a negative voltage relative to “RS485 Bus +” when idle.
RS485 Isolated GND	Common ground for RS-485. Although RS-485 is differential and uses two wires for its signal, it is critical that a common ground exists between all devices on the bus. This ground is **not** connected to the Profire system’s ground.
12/24V Output	12V or 24V output, depending on the Profire system’s voltage. This can be used to power an external transmitter.
4-20mA	Current input which is measured and logged to the USB key.
0-30V	Voltage input which is measured relative to GND and logged to the USB key.
GND	Ground for 4-20mA and 0-30V inputs.

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4 Data Logging

The Data Logging Card works with any USB key which has to be formatted using FAT16 or FAT32. If a USB key meeting these requirements is inserted, the Data Logging Card will immediately begin to log data onto it. The “USB Logging” LED will momentarily blink every time that the Data Logging Card writes data to the USB key.

1.1 Logging

When a USB key is removed from the Data Logging Card and connected to a computer, two files are present on the USB key:

- **PF2100.CSV –** This comma-separated value file contains the logged data.
- **VERSION.TXT –** This text file contains the firmware version of the Data Logging Card.

The log file is saved in the CSV file format, which stands for Comma-Separated Value. This is a simple file format which can be read with a variety of software tools, although spreadsheet software such as Microsoft Excel is recommended.

1.2 Log File Format

The table below shows an example of the structure of the CSV log file, as it would be displayed in spreadsheet software such as Microsoft Excel:

Log Date	Log Time	Restart Flag	Run
24-Jun-14	11:16:20	1	0
24-Jun-14	11:17:20	0	0

The first row of the CSV file contains headers describing the meaning of each column’s data. Every subsequent row corresponds to a single sample of data from the Data Logging Card.

The CSV log file system status information as well as specific information related to the Data Logging Card itself. The data available in the CSV log file is described below:

Log Date: Date of the log entry

Log Time: Time of the log entry

Restart Flag: This field will equal ‘1’ on the first log entry after a restart. Either of the following events are considered a restart:

- Power is removed and reapplied to the Profire system
- The USB key is removed and reinserted into the Data Logging Card.

This field will not equal ‘1’ if the system shuts down and enters a waiting state, such as waiting for a low voltage event to clear.

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Run: The Run bit is set when the PF2100 is running in Auto Mode in any state other than Ready, Alarm, and Shutdown. This indicates that the system is actively firing, is attempting to relight, or is waiting for an enabled wait condition to clear before relighting. The Run bit will never be set if the system is in Manual Mode.

Pilot: The Pilot bit is set whenever the controller is attempting to drive the Pilot Solenoid to an open position. This is not a proof of position.

Low Fire: The Low Fire bit is set whenever the controller is attempting to drive the Low Fire Solenoid to an open position. This is not a proof of position.

High Fire: The High Fire bit is set whenever the controller is attempting to drive the High Fire Solenoid to an open position. This is not a proof of position.

Level: The Level Input bit shows the state of the Level Input. When the Level Input is closed (normal condition), the Level Input bit is off. When the Level Input is open (alarm condition), the bit is on.

Main Solenoid: The Main Solenoid Feedback bit can be used to verify the proper operation of the circuitry and wiring that powers the Main Solenoids (both Low Fire and High Fire). This bit will be set if either output has voltage present on it, regardless of the source of the voltage.

Pilot Solenoid: The Pilot Solenoid Feedback bit can be used to verify the proper operation of the circuitry and wiring that powers the Pilot Solenoid. This bit will be set if the output has voltage present on it, regardless of the source of the voltage.

High Press: The High Pressure Input bit shows the state of the High Pressure Input. When the High Pressure Input is closed (normal condition), the High Pressure Input bit is clear. When the High Pressure Input is open (alarm condition), the bit is set.

PoC: The Proof of Closure Input bit shows the state of the Proof of Closure Input. When the Proof of Closure Input is closed (normal condition), the Proof of Closure Input bit is clear. When the Proof of Closure Input is open (unit not safe to start condition), the bit is set.

ESD: The ESD Input bit shows the state of the ESD Input. When the ESD Input is closed (normal condition), the ESD Input bit is clear. When the ESD Input is open (alarm condition), the bit is set.

Start Input: The Start Input bit shows the state of the Start Input. When the Start Input is closed (normal condition), the Start Input bit is clear. When the Start Input is open, (unit off), the bit is set.

Low Pressure: The Low Pressure Input bit shows the state of the Low Pressure Input. When the Low Pressure Input is closed (normal condition), the Low Pressure Input bit is clear. When the Low Pressure Input is open (alarm condition), the bit is set.

Flame Detected: The Flame Detected bit shows the state of the flame detection circuitry. When there is no flame or the flame does not meet minimum requirements, the bit is clear. When the flame meets or exceeds the minimum flame detection requirements, the bit is set.

Flame Test Fail: The Flame Test Fail bit shows the state of the flame test system. The flame detection circuitry is does a self test every 1.2 seconds, if the flame test is OK the Flame Test Fail bit is off. If the flame test fails, the Flame Test Fail bit will be on.

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Unit Fail: The Unit Failure bit shows the state of the unit self tests. During operation the unit does many self tests and verifications of the internal operation of the unit. If the unit is passing these tests, the Unit Failure bit is clear. If any of the tests fail, the Unit Failure bit will be set.

Volt Alarm: The Low or High Voltage bit shows whether the voltage applied to the controller is within acceptable limits. If the voltage is within limits, the Low or High Voltage bit is clear. If the voltage is out of limits, the bit is set.

High Temp: The HiTemp Alarm shows the state of the High Temperature Shutdown. If the process temperature is below the High Temperature Shutdown limit, the bit is clear. If the High Temperature Shutdown limit is exceeded, the bit will be set.

4-20 Alarm: The 4-20 Alarm bit shows the current state of the 4-20 Input. The Alarm bit is set if: The level or pressure inputs are below their respective low setpoints, above their respective high setpoints, disconnected, or there is a hardware failure on the 4-20 card.

High Temp: This is the current reading of the High Temp Thermocouple encoded as a 16-bit signed integer in °C.

Proc Temp: This is the current reading of the Process Thermocouple encoded as a 16-bit signed integer in °C.

Aux Temp: This is the current reading of the Aux Thermocouple encoded as a 16-bit signed integer in °C.

Flame Signal: This number represents the quality of the pilot flame. The higher the number the better the flame.

Pilot Off Set: This is the current Pilot Off Setpoint. Valve has no meaning if Pilot Off is disabled.

Low Fire Set: This is the current Low Fire Setpoint. Valve has no meaning if Low Fire is disabled.

High Fire Set: This is the current Process Setpoint.

4-20 Exp Level: This is encoded as a 16-bit unsigned integer in the units specified in the PF2100 settings.

4-20 Exp Press: This is encoded as a 16-bit unsigned integer in units specified in the PF2100 settings, but the value is encoded x10 (ie. 30psi would be encoded as 300).

4-20 Exp Shut Code:

Log Board Temp: This field represents the temperature of the Profire system itself. This is measured using an internal temperature sensor. This is logged as an integer value with no decimal precision.

Log Volt Input: This field equals the voltage measured on the 0 – 30V input on the Data Logging Card itself. This value is logged with one decimal point of precision.

Log 4-20 Input: This field equals the measurement of the 4 – 20 input on the Data Logging Card itself. The meaning of this data depends on the configuration of the 4-20mA input:

- *Current Input (Analog)*

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The field stores 0 – 100, which corresponds to the percentage of the 0-20mA range measured at the input. This value is logged with one decimal point of precision.

- *Voltage Input (Digital)*
  This field will equal '1' when a voltage is detected at the input.

Run Time Sec: This field stores the number of seconds during the last logging interval where the Profire system was running. This value can range from zero to the logging interval of the Data Logging Card, measured in seconds (e.g. 3600 if a 60 minute logging interval is used). A Profire system is considered "running" when the Run bit is set. Generally speaking, this bit is set and the Run Time Sec value increases when the Profire system is performing automatic process control. As an example, if the Profire system is purging or waiting to restart from a recoverable alarm condition , the Data Logging Card considers the system "running" even though all attached valves are closed and no fuel is being consumed.

The order of the data in the CSV file follows the order of registers in the *Modbus Expansion Card Register Map (*available at www.profireenergy.com), the header from each column can be used to confirm which columns correspond to each register. In addition, the encoding of the values stored in each column of the CSV file match the descriptions in the *Modbus Expansion Card Register Map* (e.g. ON = 1, OFF = 0).

It should be noted that **the headers used to describe each column in the CSV file assume that the Data Logging Card is connected to a PF2100.** If the Data Logging Card is connected to a PF2100F, the logged data is still valid, but certain columns may have meaningless data or misleading descriptions (e.g. Low Fire status/setpoint). The manual for PF2100F systems supporting the Data Logging Card cover the differences in Modbus registers between the PF2100 and PF2100F, so that document should be consulted if assistance is required in understanding the CSV file's format.

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5 Modbus

The Data Logging Card supports Modbus communication over an RS 485 link with the Profire system acting as a Modbus slave. This functionality is identical to that of the Profire Modbus Expansion Card, and this document does not cover these features. Once the Data Logging Card is mounted in a Profire system, the system will treat it like a Modbus Expansion Card. For detailed information about setting up and configuring the Data Logging Card for Modbus communications, refer to the Modbus Expansion Card Manual, available at www.profireenergy.com

The Data Logging Card stores system status information that is accessible externally using the Modbus Expansion Card. The *Modbus Expansion Card Register Map,* available at www.profireenergy.com, provides descriptions of the logged data.

The Modbus can be configured with 3 DIP switches on the Data Logger Card:

- Termination DIP: The termination switch enables/disables the internal termination for RS-485. If the switch is set to off the internal termination is set to 120Ω.
- Baud rate DIP: This switch sets the baud rate of the Modbus. If the switch is set to off the system uses the baud rate 9600 bps. If the switch is enabled the baud rate is set to 19200 bps.
- Rx/Tx Delay DIP: The Rx/Tx Delay switch enables a delay between receiving a command and sending the response.

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6 Clock

A real time clock is integrated in the board. It runs off of a 32.768kHz crystal with 20ppm accuracy (no temperature stability mentioned). During the manufacturing test the 1024Hz output will be measured and a calibration will be applied to the clock to account for crystal tolerance.

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7 Battery

A BR2032 lithium coin battery will be mounted in a holder on the board. When the voltage drops below 2.6V the low battery light turns on. This event should be logged. When the main power is removed the battery will power the RTC and the protected RAM. The draw on the battery when the main supply is removed is 0.75uA, assuming a worst case battery capacity of 100mAh that gives around 15 years of standby time.

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8 Document Revision History

Version Number	Date	Who	Description of Changes
v1.0	2014-10-10	Alex Messner	Initial Release

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