# Web Energy Logger: Ultra-OEM™  (WEL Ultra-OEM™)

## Design Brief:  7/1/2013



**Scope:**

This document describes the newly developed WEL Ultra-OEM™ Module (sometimes just called the "Ultra").  Much of the information in this document is preliminary, and reflects the current state of the hardware and firmware currently being field tested.

This brief should provide an own-equipment-manufacturer sufficient information to evaluate adding the WEL Ultra to their own equipment.

Just like its predecessors (see WELserver.com), the Ultra-OEM™ is designed to robustly poll a variety of sensors, perform any data scaling, calculations or long-term treatments and then post the resulting data to a central web server.  Server data-logging and charting capabilities will be still be available from WELserver.com, but the unit may also be directed to post its data to any other domain or IP address.

Unlike its predecessors, the WEL Ultra has been designed from the ground up to be compact, easy to integrate with external circuitry, and simple to deploy in volume.  The new 1.5" x 2.5" module can plug directly into a customer's controller circuit, or into a generic development carrier.  Sensors no longer need to be sequentially identified and named at each installation.  A standard configuration can be "cloned" to multiple Ultra's, and sensors will go "on-line" as soon as soon as they are connected.

The baseline Ultra-OEM™ is show below with an RCM6710 installed.

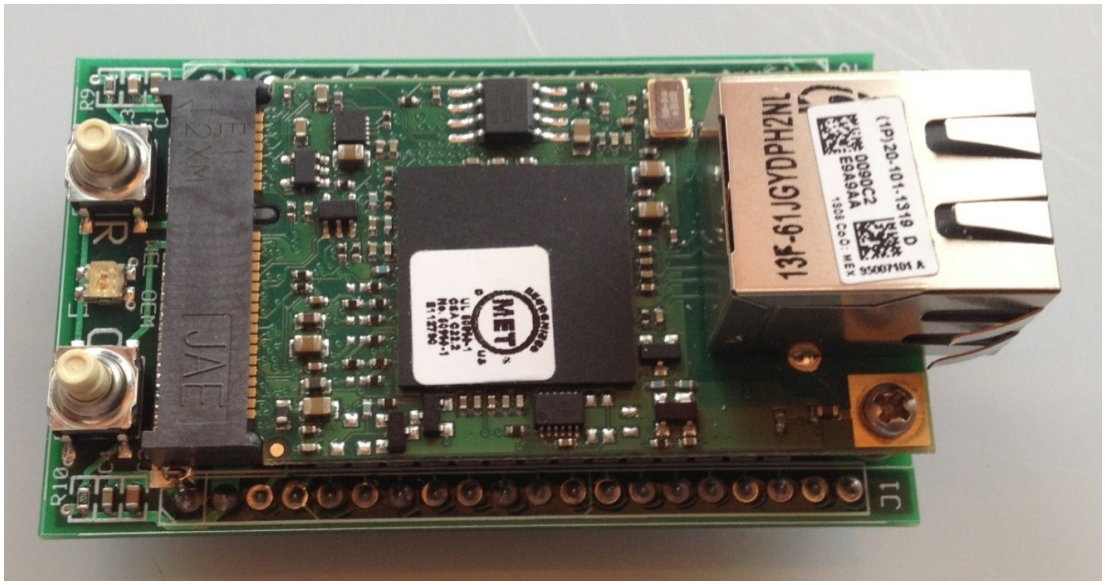



Figure 1 Ultra-OEM with RCM9710 Processor Installed

**Overview:**

The WEL Ultra was developed primarily for volume OEM applications. The focus of the new design was low cost, small footprint, easy installation and simplified maintenance. To achieve these goals, the Ultra deviates from the current WEL 4.0 product in several key ways:

Hardware differences

- The WEL Hardware and Software has been integrated onto a small **(1.5" x 2.5")** form-factor module, designed to be plugged into an OEM's controller board. The Ultra-OEM™ utilizes two rows of 0.1" header pins to obtain power and provide an enhanced set of I/O interfaces.
- The WEL 4.X's single "enhanced" 1-Wire interface has been replaced by 8 standard 1-Wire interfaces (Bus Lines). This has eliminated the need to sequentially install sensors, and identify each in turn. Now, sensors are identified by which Bus Line they are connected to, and by their specific type.
- The ability to add multiples of each sensor type to the 1-Wire bus has been eliminated. Each of the 8 Bus Lines can have only one of each sensor type attached. That is, a single Line can have several different device types attached, but NOT more than one of each type.

Firmware differences

- A "Raw Sensor" page shows what sensor types are currently connected to each Bus Line, and what data is being read from each sensor. No "names" or functions are assigned on this page. Color coding is used to display Bus status and sensor utilization.
- A "Devices" page is used to define a list of system "Data-Source Devices". Each Device is named, and then associated with one source of data from the "Raw Sensor" page. That is, each Device is tied to a specific Bus-Line, Sensor Type and Channel. Each Device also has a calibration Scale and Offset, Filter Time Constant, and possible Treatment.
- An "Expressions" page is used to define mathematical or logical operation to be performed on Data Items. Data Items can be Device Values or Expression Values. Expressions can also be assigned additional Treatment operations. The concept of "Constant Expressions" has been eliminated since constants can now be entered directly into any expression in place of a Data Item Name.
- Treatments can be applied to Devices and Expressions to generate three (not two) derived values. For example, an accumulator would generate Daily, Monthly and Yearly values. Treatment names have new, more generic suffixes, of _T1, _T2 and _T3.
- The Ultra can synchronize its Real Time clock to world-time whenever it powers up. Periodic synching options are also planned.
- The Ultra maintains a FAT16 file system on its flash. Static and dynamic system data is stored in several small files. The Ultra can be commanded to upload and download these files to an FTP side. This enables remote setup for any WEL Ultra, as well as remote backup.
- The Ultra has a fail-safe program update capability which enables code updates to be pushed out to units in the field. This can be initiated by the unit, or by the central web server. A failed update will revert back to the prior code version.

Status Display Differences

The Ultra utilizes a Dual-Color LED to display system status. Three different status types are supported:

- Boot:
  - From the time the Ultra powers on (or is reset), to the time the main program starts running, the LED will rapidly alternate between red and green (approximately 1 Hz).
- Operation:
  - Once booting is complete, the LED will pulse GREEN during periods of normal activity. This may include any of the following:
    - Scanning the 1-wire bus lines for devices.
    - Polling any active 1-wire bus line
    - Receiving Analog and pulse data from on-board inputs.
    - Accessing the Local Area Network (LAN) to post data to the WEB, download or upload configuration files.
    - Accessing the WEB for a software update.
- Error:
  - If the WEL detects an error condition, the LED will switch to displaying the Error code in RED. The Error code is a number from 1 to 99. The LED will pulse in a series of long and short flashes. Each Long flash will represent a 10'a digit, and each short flash will represent a 1's digit.
    Eg: Error code 23 would be Long, Long, Short, Short, Short.
    Once the error condition goes away, the LED will revert to normal "Operation" state.

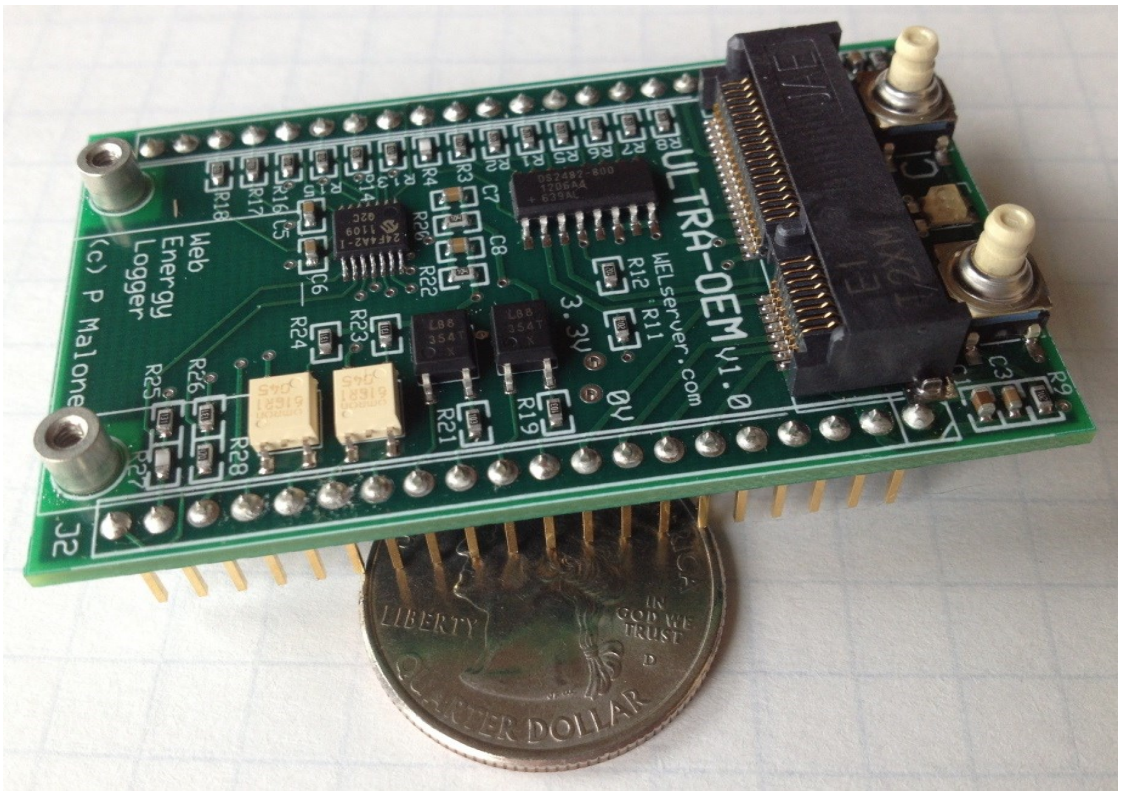



Figure 2 Ultra-OEM without processor installed.

**Sensor Allocation Chart**

Due to the new strategy of eliminating the need to individually identify 1-Wire sensors, there are now only a finite number of sensors that can be attached to the Ultra. To ensure that the needs of a particular installation can be met by an Ultra, it's important to plan out the sensor connection strategy (ie: which sensors to connect to which lines).

A Sensor Allocation spreadsheet has been created to simplify this process. Each planned installation can be documented in advance using this form, to enable rapid deployment and WEL configuration. The name of a sensed function can be placed in each box on the chart…

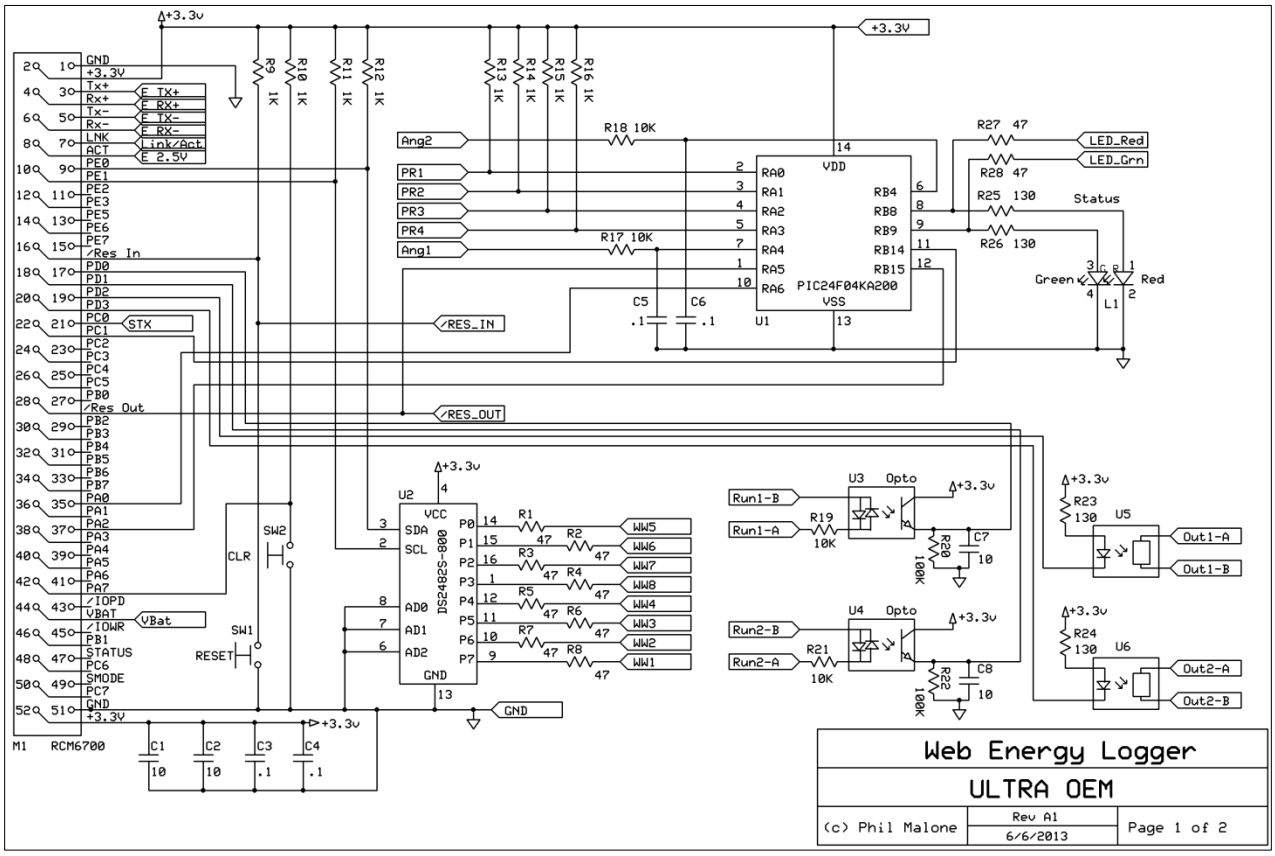
| Sensor Map: | | | | | Color Key: | Temperature | On/Off | Counter | Voltage |
|---|---|---|---|---|---|---|---|---|---|
| 1-Wire Sensors | | | | | | | | | |
| | Chan | Line 1 | Line 2 | Line 3 | Line 4 | Line 5 | Line 6 | Line 7 | Line 8 |
| 18B20 | Ch1 | | | | | | | | |
| 18S20 | Ch1 | | | | | | | | |
| 2406 | Ch1 | | | | | | | | |
| 2408 | Ch1 | | | | | | | | |
| | Ch2 | | | | | | | | |
| | Ch3 | | | | | | | | |
| | Ch4 | | | | | | | | |
| | Ch5 | | | | | | | | |
| | Ch6 | | | | | | | | |
| | Ch7 | | | | | | | | |
| | Ch8 | | | | | | | | |
| 2423 | Ch1 | | | | | | | | |
| | Ch2 | | | | | | | | |
| 2438 | Ch1 | | | | | | | | |
| | Ch2 | | | | | | | | |
| | Ch3 | | | | | | | | |
| 2450 | Ch1 | | | | | | | | |
| | Ch2 | | | | | | | | |
| | Ch3 | | | | | | | | |
| | Ch4 | | | | | | | | |
| On-Board Sensors | | | | | | | | | |
| | Chan | Line 1 | Line 2 | Line 3 | Line 4 | Line 5 | Line 6 | | |
| Voltage | Ch1 | | | | | | | | |
| Counter | Ch1 | | | | | | | | |
| Run | Ch1 | | | | | | | | |

Figure 3 Sensor Allocation Chart / Spreadsheet

Each colored box represents a possible sensor channel. Vertical columns represent physical lines coming off the Ultra-OEM. Horizontal rows represent different sensor types/channels. The color of a box indicates the function that this particular sensor performs. In a sensor-rich application ALL of the boxes may be utilized, illustrating that the limits introduced by the Ultra-OEM are not particularly onerous.

**Electrical Schematic.**

The following schematic shows the WEL Ultra-OEM™ logic and interfaces. The specific schematic functions are discussed on the following pages.



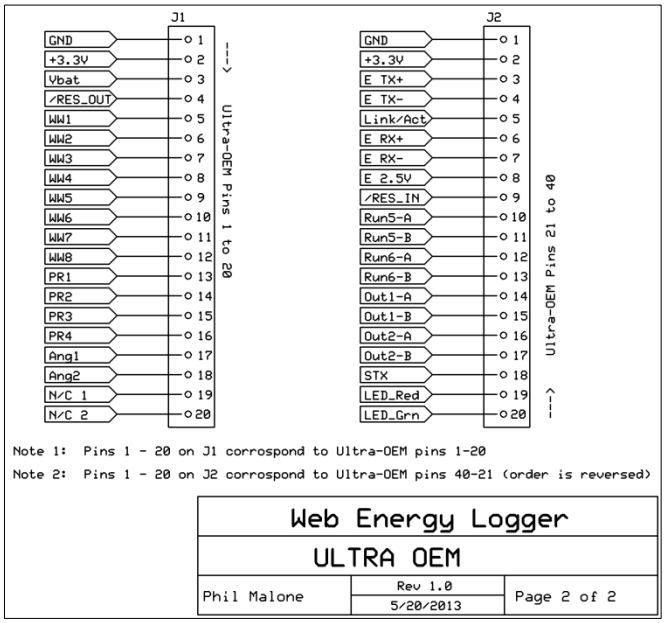




Figure 4 Ultra-OEM Schematic

Power.

The Ultra-OEM™ requires a regulated 3.3V power supply. This supply must be provided by the OEM's carrier board via two 3.3V Pins and two 0V (GND) pins. By moving the 3.3V Regulator off-board, the Ultra-OEM™ enables the most energy efficient design to used, based on the available input voltage range. Final current requirements will depend on the specific CPU module used, but it will typically be in the 300-500 mA range.

Processor/Network.

The Ultra-OEM™ uses a Digi.com RCM6XXX series processor as its main CPU and network interface element. This processor family is significantly smaller and faster than the RCM3700 which is used on the current WEL. Several flavors of this device are available with differing network and memory options. The base Ultra-OEM™ unit will use the RCM6710. This CPU module plugs into an Express PCI connector, and is bolted rigidly in place. A compatible Wi-Fi equipped RCM6600 processor model is also available, which will eventually be offered as a WEL-Ultra option.

1-Wire interface.

Instead of the "LINK-OEM" module used by the standard WEL, the Ultra-OEM™ uses the 8 channel DS2482S-800 chip. This device provides 8 addressable 1-wire bus lines. This feature makes the "ID-less setup" feature of the Ultra possible. All external 1-wire lines are protected by inline 47 Ohm resistors. Compatible sensors are: DS18S20, DS18B20, DS2408, DS2423, DS2438, DS2406, DS2408 & DS2450

Standard inputs.

Two 0-3.3V analog inputs (Ang1,2)and four pulse/run (PR1-4) inputs are provided by a custom programmed PIC processor. These are in addition to any external 1-wire devices. The analog inputs may be used to interface to devices that generate a varying voltage, like pressure sensors or pyrometers. The pulse/run inputs will typically be used to interface to devices such as flow meters, watt-meters, current switches and contact closures. Note that all of these inputs MUST adhere to the general 0-3.3V input voltage limits. If levels to be sensed are outside this range then additional conditioning circuity MUST be added to the carrier board.

New interfaces.

The Ultra-OEM™ provides two new on-board interfaces. The first of these is a pair of optically isolated 24VAC input lines (Run5&6) which can be interfaced to "read" existing low-voltage control lines. These inputs are designated Run 5 and Run 6, since they augment the 4 counter/run inputs.

The second new interface is a pair of solid-state relay outputs (Out1,2), suitable for switching low-voltage (< 40V) control signals at low current (< 400mA). These outputs will not be initially supported by the Ultra-OEM™ firmware, but they will be available for future use.

LED Status Indicator.

A single dual-color LED is used to display WEL Ultra status. This LED is controlled by the RCM6XXX processor, via the PIC processor, so that the LED can display the Boot status prior to the main software running. LED signals are also provided on the connector to enable a simmilar LED to be provided on the carrier board for end-user use.

Battery.

A 3V coin cell, or alternate battery backup, can be provided off-board to keep the Real Time Clock running when power is not available. Program code, device configurations and accumulated data do not require battery backup.

**Mechanical layout**

The Ultra-OEM™ has a 1.5" x 2.5" footprint. Two 20-pin, 0.1" pitch, headers are provided for electrical interfacing. These headers extend out the bottom of the board and are spaced 1.3" apart. The physical layout of the board and its connectors is shown in the diagrams below.

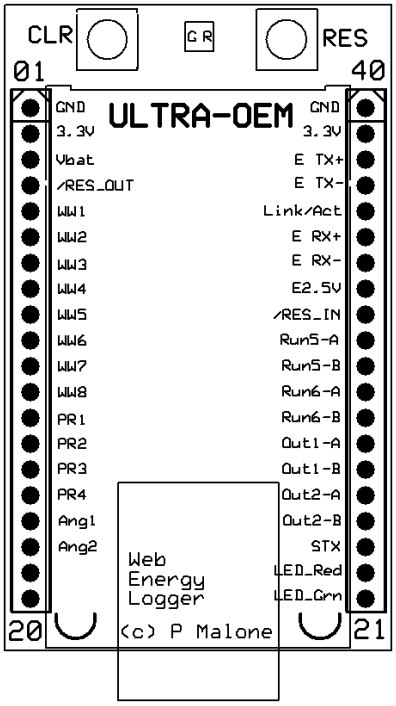



Figure 5 Ultra-OEM Top View

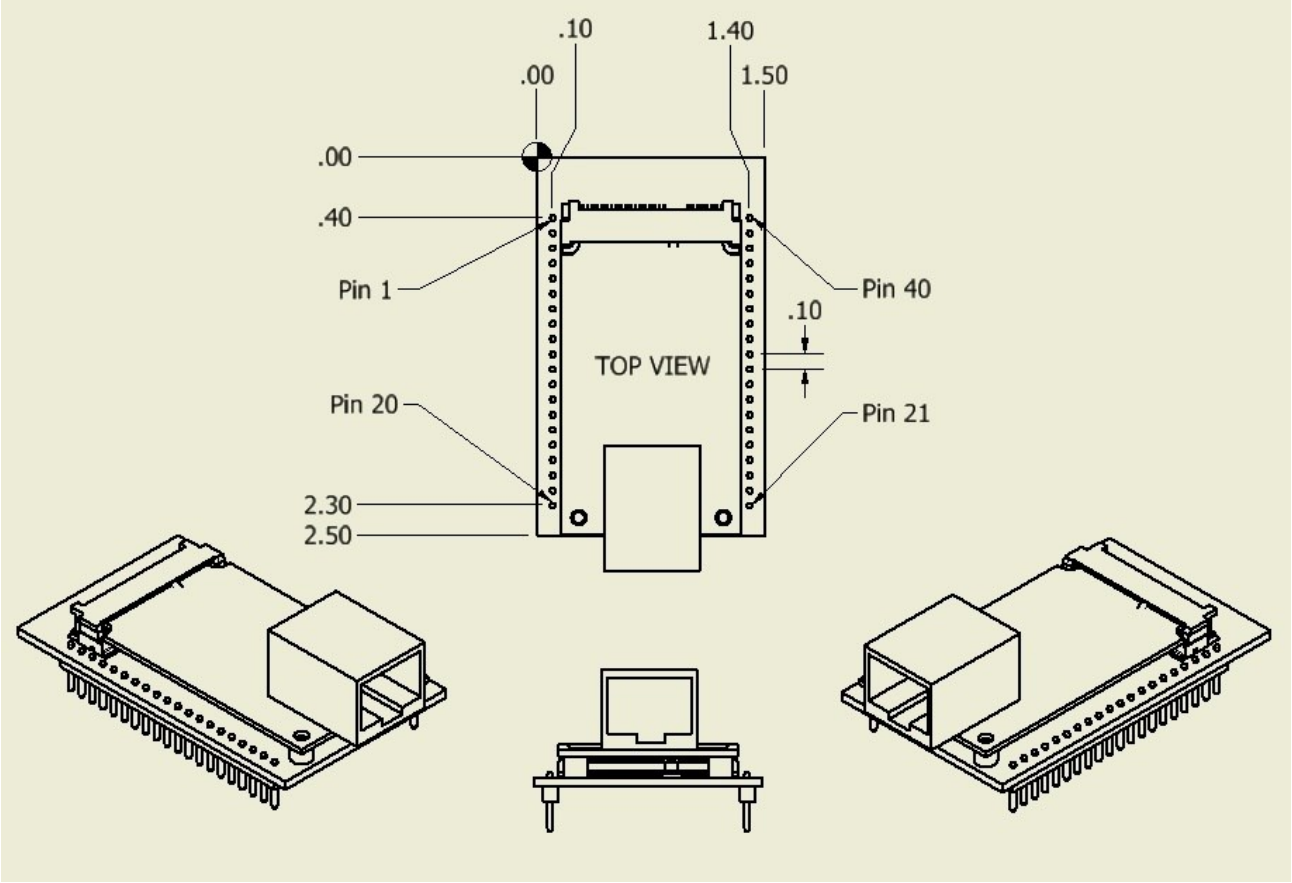



Figure 6 Ultra-OEM: Mechanical layout

**Software**

The initial program for the RCM6X00 processor is provided as a binary image which must be loaded onto the RCM6X00 processor prior to mounting on the carrier board. Once the initial program is loaded and running, subsequent versions can be manually or automatically downloaded to the unit via the internet.

Software is provided as a per-unit license. License fees will depend on quantity considerations.

The Ultra will post its data to the designated HTTP server using a simple HTML protocol. Posts may occur at intervals of 1 minute or greater. Additional communications can be used to implement upload and download of program and configuration files. An Application Programmers Interface (API) document will be available to licensees.

Remote access to the Ultra is not required for data posting or backup/restore operation, but port forwarding may be used to enable remote access to the Ultra's local configuration screens if desired.

**Ultra-OEM™ Development**

To enable equipment manufacturers to evaluate the Ultra-OEM™ design, a basic carrier board has been developed. This board (called the Ultra-DEV) simply provides power and connectivity to the Ultra. Screw terminals are provided to allow the easy connection of 1-Wire sensors, pulse and analog inputs. The on-board switching voltage regulator permits a broad range of input voltages (9-24V DC).


Figure 8 Ultra-DEV

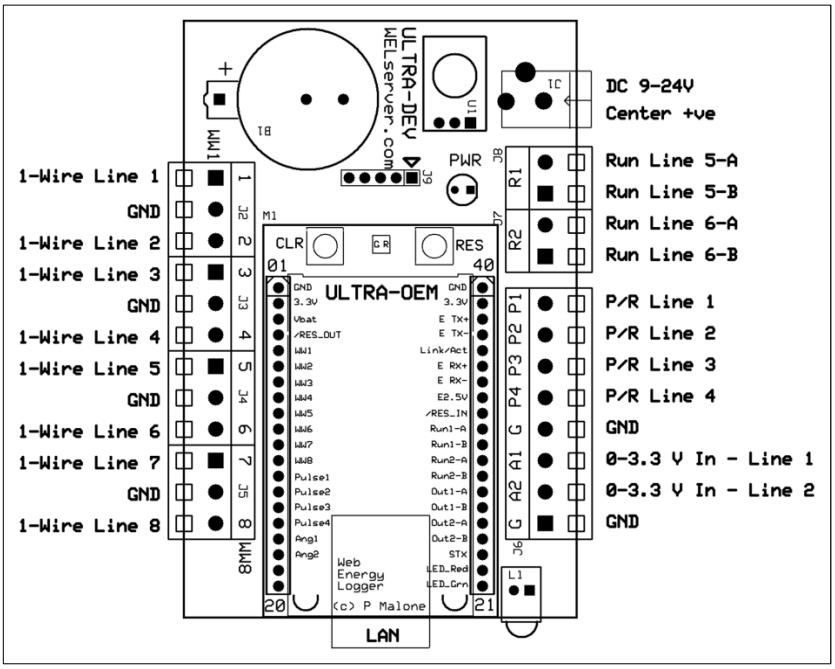



Figure 7 Ultra-DEV Terminal designations

This design shows how simply the Ultra-OEM can be utilized, requiring only power to operate.

Although not intended for this purpose, the Ultra-DEV could also be used to host the Ultra-OEM™ in the field as a stand-alone item, so, it has been designed to be compatible with a plastic enclosure sold by Polycase.com. The standard LP-51F case (http://www.polycase.com/lp-51f) would need some holes manually drilled for cabling, or it could be customized by Polycase to suit a particular installation.

The schematic for the Ultra-DEV is shown in the following figure.

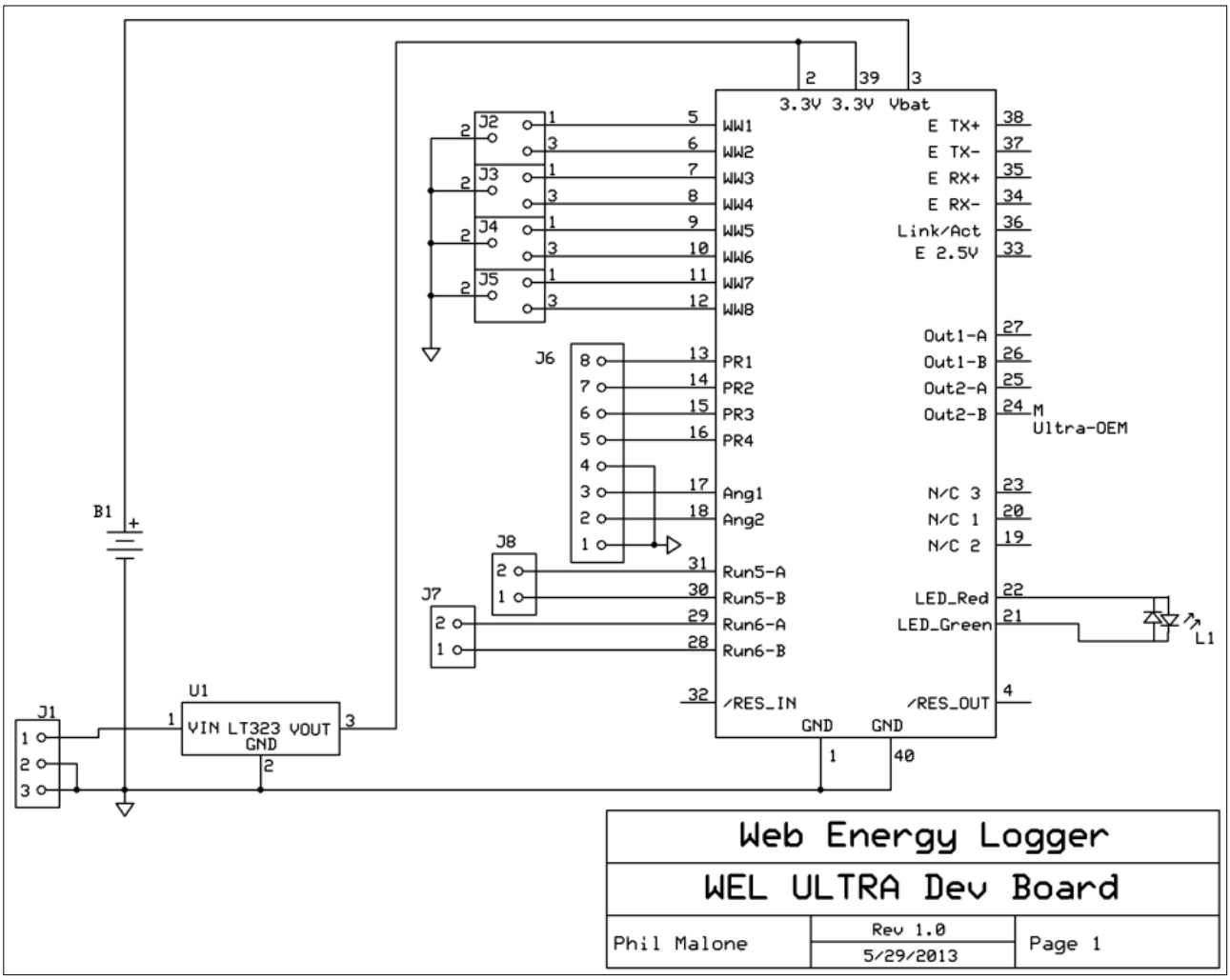



Figure 9 Ultra-DEV: Reference Schematic

**Ultra-OEM™ design integration**

Since the schematic of the Ultra-OEM™ is public, it may also be fully integrated into an OEM's controller board at the underlying circuit/component level. This would enable the lowest size/cost solution for a volume manufacturer, since any unnecessary interfaces could be eliminated. A current parts list with Mouser.com Part numbers is shown below.

The key technology component for this solution would be the pre-programmed devices (RCM6X00 and PIC) which implement the WEL functionality. These will be available under license from Phil Malone (WELserver.com).

| Ident | Type | Description | Mouser Part Number | Quant | Notes |
|---|---|---|---|---|---|
| C1,2,7,8 | Cap | 10 uF | 810-C1608X5R0J106M | 4 | |
| C3-6 | Cap | 0.1 uF | 81-GRM188R70J104KA1D | 4 | |
| J1-2 | Header | 20 Pin | 649-68000-120HLF | 2 | |
| L1 | LED | Dual LED Red/Grn | 604-APBL3025ESGCF01 | 1 | |
| M1 | Socket | Express PCI 52 pin | 656-MM60-52B1-E1-R | 1 | |
| R1-8,27,28 | Resistor | 47 Ohm | 652-CR0603-JW-470GLF | 10 | |
| R23-26 | Resistor | 130 Ohm | 652-CR0603-JW-104GLF | 4 | |
| R9-16 | Resistor | 1K Ohm | 652-CR0603-JW-102GLF | 8 | |
| R17,18,19,21 | Resistor | 10K Ohm | 652-CR0603-JW-103GLF | 4 | |
| R20,22 | Resistor | 100K Ohm | 652-CR0603-JW-104GLF | 2 | |
| SW1,2 | Switch | Tactile | 611-KSC931JLFS | 2 | |
| U1 | IC | PIC24F04KA200 | 579-PIC24F04KA200IST | 1 | |
| **U2** | **IC** | **8-Channel 1-Wire Master** | **DS2482S-800+** | **1** | ***1** |
| U3,4 | IC | Opto-Isolator | 859-LTV-354T | 2 | |
| **U5,6** | **IC** | **Solid State Relay (opt)** | **653-G3VM61GR1** | **2** | ***2** |
| M2 | H/W | Express PCI Nut (SMD) | 656-NT4R1600 | 2 | |
| **M3** | **H/W** | **Bolt M2 x 4mm** | **#90116A008** | **2** | ***3** |

**Notes:**

- ***1 Not available from Mouser. Order from www.MaximIntegrated.com**
- ***2 This item is optional. May be supported in future, for control purposes.**
- ***3 Not available from Mouser. Order from www.McMaster.com**