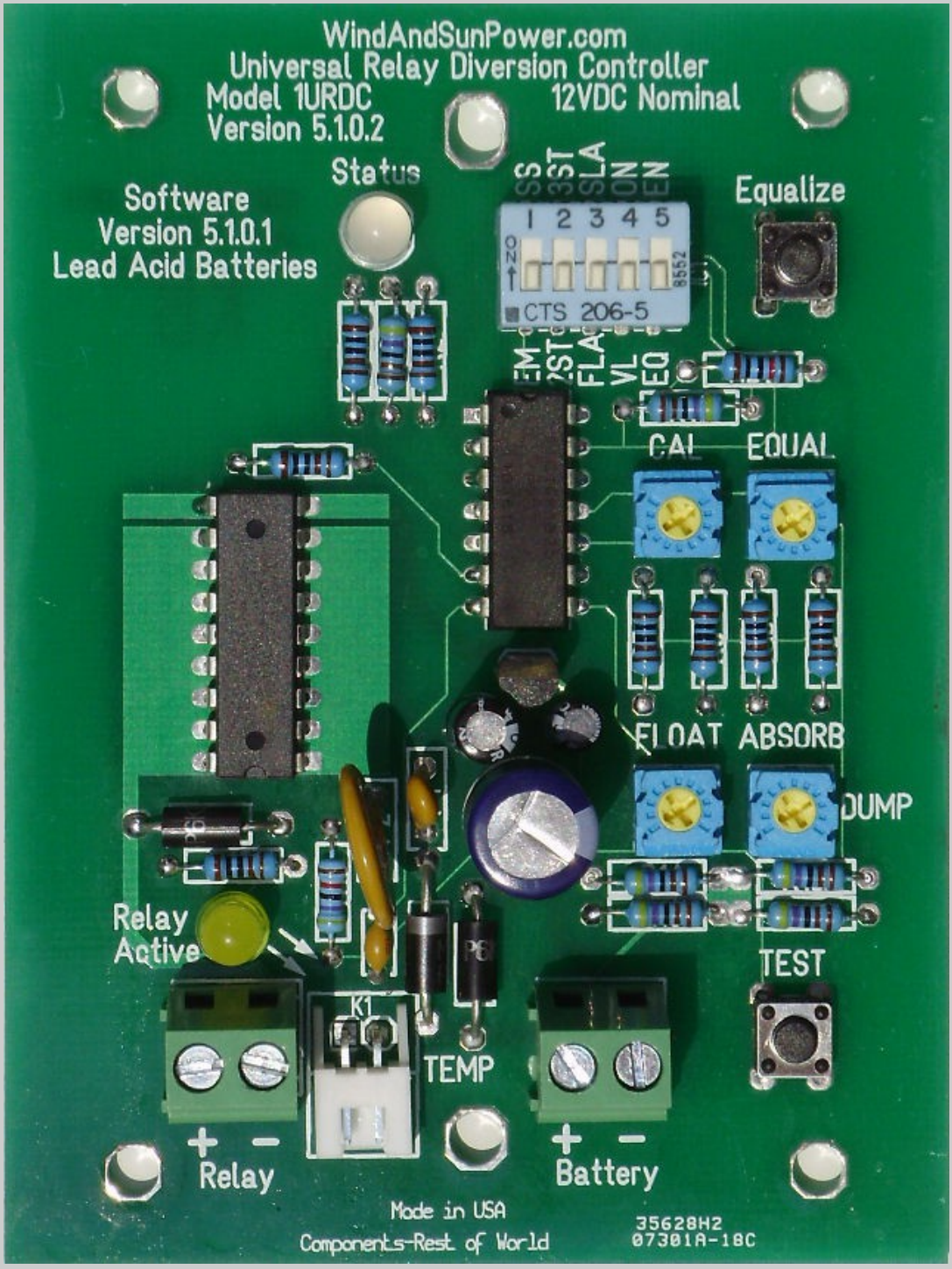
UNIVERSAL RELAY DIVERSION CHARGE CONTROLLER V5
2-STAGE or SMART/INTELLIGENT 3-STAGE using SSR'S
MODEL 1URDC 12V (Board Version 5.1.X)
For both EMR's (ElectroMechanical Relays)
and SSR's (Solid State Relays)
For Wind, Solar and Hydro
(Manual Version 1.0.3)



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READ ALL INSTRUCTIONS CAREFULLY FIRST!!

CONTROLLERS OF THIS TYPE ARE MORE COMPLEX SETTING UP THAN YOUR ALL IN ONES!! YOU MUST CALCULATE THE MAXIMUM POWER YOUR SYSTEM CAN POTENTIALLY GENERATE AND THEN CALCULATE THE SIZE OF THE LOADS AND WIRES ACCORDINGLY FOR MAXIMUM SAFETY!!! IF YOU HAVE ANY DOUBTS ABOUT YOUR ABILITIES TO PUT TOGETHER A SYSTEM OF THIS TYPE THEN DON'T DO IT!! FIND AND/OR HIRE SOMEONE QUALIFIED WHO CAN!!

ATTENTION: USE PRECAUTIONS FOR HANDLING ESD ELECTRO-STATIC SENSITIVE DEVICES.

Introduction

These diversion controllers were brought about by there being no low cost expandable diversion controllers on the market that would minimize maintenance while maximize battery charge and life.

Months of testing and research both on these and other commercially available dump controllers, had proven that the On-Off algorithm using **EMR**'s (**E**lectro**M**echanical **R**elays) in diversion/dump mode is seriously lacking. EMR's are slow (most can not be switched faster than 2 sec on, 2 sec off to prevent self destruction and contact bounce), this delay knocks the surface charge too low when switching a load on and off so that the battery cannot absorb enough energy to fully charge. This works fine however when disconnecting the charging source from the battery and letting the battery voltage drop naturally. The majority of wind and hydro generators cannot simply be disconnected from battery and allowed to free spin as this could cause them to over rev at high speeds and self destruct. Most SSR's (Solid State Relays) on the other hand can be switched at 20ms on and 20ms off **or faster** so as not to let the battery voltage drop too low. Thus allowing the batteries to absorb more energy, resulting in the batteries charging at a much faster rate and to a higher **SOC** (**S**tate **O**f **C**harge) which leads to a greatly extending battery life (**batteries are the greatest consumable cost in renewable energy systems**).

In the process of developing an effective charge algorithm for use with SSR's in which I call **ULFAPWM** (**U**ltra **L**ow **F**requency **A**daptive **P**ulse **W**idth **M**odulation) along with **CIMAA** (**C**ontinuous **I**ntelligent **M**onitoring **A**nd **A**daption) 3-Stage algorithm. I started seeing how many features and how much protection I could add and still keep them inexpensive. Also I have tried to make these as user friendly, adaptable and expandable as possible. These controllers are what **I WANTED** in a controller of this type and not the simple, barely adequate ones that were being offered on the market in this and higher price ranges.

I will try to keep this manual as simple and straight forward as possible as to not over complicate things. To keep cost down and prevent unnecessary waste this manual is available in PDF format only (just printout what you need). The latest version of this manual is **Free** for **DOWNLOAD HERE 1URDC_V5_1_Manual.pdf** from WindAndSunPower.com

The final V5 design with 3-stage mode is the result of 2 long years (untold thousands of hours) of research, designing, prototyping and testing. I also want to thank John in Canada for his help in testing, observations and suggestions which made this version possible.

Jeff

DESCRIPTION

The Universal Relay Diversion Controller/Regulator is a low cost Microprocessor controlled Diversion/Dump type controller designed for the **DIY** (**D**o **I**t **Y**ourselfer). It is designed to switch up to 6 conventional automotive style electromechanical relays (EMR) directly with up to 800ma total coil current draw with up to 240A power handling capability.

Also unlike other controllers of this type of design, it will also control DC-DC Solid State Relays (SSR) in Legacy/Conventional (Dump) diversion mode or use a **2-Stage** or **Intelligent/Smart 3-Stage** charge algorithm including a manual **Equalization mode**. It is theoretically able to directly switch up to 32 SSR's at 25ma each (untested). If using just 40 amp SSR's that adds up to a potential 1280A (2560A using 80 amp SSR's) power handling capability.

To keep cost down, this controller was designed for the DIY (Do It Yourselfer) and is the **BOARD ONLY** and does **not** include an enclosure. It can be mounted directly on a wall in an area protected from the environment or in an **Optional** or **user supplied** enclosure.

FEATURES

- The ability to Directly Switch up to 6 Electromechanical or 32+ DC-DC Solid State Relays
- Legacy Dump/Diversion/On-Off – Electromechanical or Solid State Relays
- 2-Stage - Dump/Diversion (using 20ms on – 20ms off or faster SSR's Only)
- 3-Stage - Dump/Diversion (using 10ms on – 10ms off or faster SSR's Only)
- Manual Equalization Mode (using 20ms on – 20ms off or faster SSR's Only)
- Extremely Low Power Consumption (≤ 10ma) in Standby/Monitoring
- Accurate Battery Voltage Tracking
- Switching Speeds Up To 50 On-Off Cycles Per Second When Using SSR's (≤50Hz)
- User Settable Dump/Diversion/On-Off/Absorb Voltage Set-point (13.1 to 15.1 Volts)
- User Settable Float Voltage Set-point (12.5 to 14.5 Volts 3-Stage using SSR's Only)
- User Settable Equalization Voltage Set-point (14.5 to 16.5 Volts using SSR's Only)
- **Optional** FLA Temperature Compensation -40°F(-40°C) to 140°F(60°C) 0.0168V per 1°F
- **Optional** SLA Temperature Compensation -15°F(-26°C) to 140°F(60°C) 0.012V per 1°F
- The Ability to Divert/Dump 800ma Directly for Very Small Systems
- Self Resetting Fuses (Separate Power and Microcontroller Section Fuses)
- Multicolored LED Status Indicator
- LED Relay Power/Active Indicator
- Test Button
- Voltage Limiter (limits Maximum voltages to Approx 14.8V Except Equalization mode)
- Reverse Polarity Protection
- Over Voltage Protection
- Over Current Protection
- Transient/Lightning/Surge Protection

OPERATION

Basic operation principle is quite simple. The Microcontroller constantly monitors the battery voltage and temperature (if optional probe is connected). When battery voltage meets the specific criteria, the Microcontroller activates or deactivates the LED's and external relays. The temperature probe automatically raises or lowers the Absorb/Dump/Float voltage setting dependent upon battery temperature.

3-Stage Operation

Bulk/Standby Mode: Monitors battery voltage and the time it takes to reach absorption voltage (up to 1Hr 20Min).

Absorption Mode: Once the battery voltage reaches the Absorb set-point it enters into absorption mode where it multiplies the accumulated time by 1.5 to give up to 2Hrs of absorption time. This time counts down for as long as the voltage remains at the Absorb setting to -0.25V of the Absorb setting.
Or Else:

1. The voltage drops to -0.25V to -0.5V of the Absorb setting it then counts down half as fast giving up to 3Hrs total absorption time.
2. From -0.5V to -1.0V of the Absorb setting no time is added or subtracted and if it remains there until approximately 1Hr continuous time accumulates it returns to Bulk/standby mode where it resumes monitoring and adding time again.
3. Below -1V of the Absorb set-point no time is added or subtracted . If it remains there until approximately 15Min continuous time accumulates it returns to Bulk/standby mode where it resumes monitoring and adding time again.

Float Mode: Once the Absorption or Equalization (3-Stage Only) requirements are met it enters Float mode where it can remain for up to approximately 24 hours as long as the voltage remains within -0.25V of the Float setting then a new bulk cycle will be initiated.
Or Else:

1. The voltage drops below -0.25V of the Float setting for approximately 1 hour of continuous time accumulates a new bulk cycle will be initiated.
2. The voltage drops below approximately 12.65 volts for approximately 2 minutes of continuous time accumulates a new bulk cycle will be initiated.

MOUNTING

To keep cost down, this controller was designed for the **DIY** (**D**o **I**t **Y**ourselfer) and is the board only and does not include an enclosure. It can be mounted directly on a wall in an area protected from the environment or in an **optional** or **user** supplied enclosure.
This Board has been designed to fit in the following inexpensive **BUD Industries** NEMA Enclosures:
NBF-32002 ABS Solid Door
NBF-32102 ABS/PC Indoor Version Solid Door
NBF-32202 ABS/PC Indoor Version Clear Door
NBF-32302 PC/PBT Outdoor Version Solid Door
NBF-32402 PC/PBT Outdoor Version Clear Door

The board does not generate much heat but it does generate some and the more relays, the more heat. Because heat sinking is incorporated into the board design and to prevent shorting, the board should be mounted at least ¼ inch off the surface using some sort of standoffs.

With EMR's the controller and the relays can usually be mounted in the same enclosure if there is adequate room because under normal operating conditions the EMR's usually generate little heat. However if you are using SSR's they can generate a lot of heat and the SSR heat-sink assembly should be mounted in a well ventilated area on a metal surface in free air preferably or in a well ventilated metal inclosure. The same goes for power resistors.

RELAYS

This was designed to use up to 6 Automotive style EMR's (the ones you can find in auto parts stores for 3 to 5 dollars each) or up to 32 DC-DC SSR's. Multiple relays need to be wired in parallel. This can be used with other types of NON-LATCHING EMR's with nominal **coil ratings of 12VDC 800ma max and the contacts MUST be rated above your battery bank voltage**. You will need to test them out to see if they will perform suitably. Dependent on the load, batteries and generator output, this controller can regulate the battery voltage to within ± .5% + 0.03V on the average with SSR's. Whereas using EMR's with On/Off type Diversion controllers, battery voltage can fluctuate up to a volt or even more. This was designed for use with **DC-DC** SSR's Only! SSR's need adequate heat-sinking as they can get **HOT**!

Diagrams 1. and 2. below are some examples of SSR Heat Sinks.

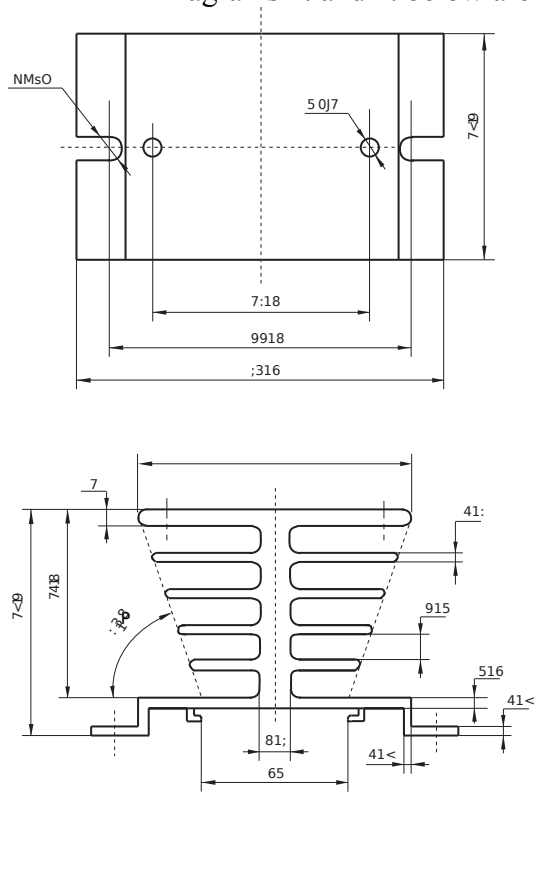


Diagram 1.
15A SSR Heatsink Example
Approximately 2”L x 2.5”W x 2”H

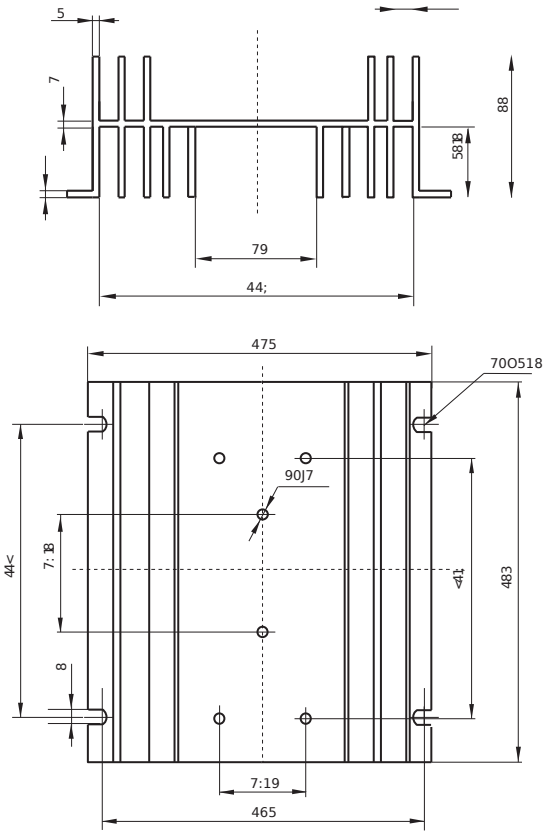


Diagram 2.
40A-80A SSR Heatsink Example
Approximately 6”L x 5.5”W x 2”H

Note: SSR's used for 2-Stage and Equalization modes MUST be able to switch 20ms On & 20ms Off or FASTER!! 3-Stage REQUIRES 10ms On & 10ms Off SSR's or FASTER!!
Also some SSR Manufactures suggest using their SSR's at less than 70% of it's rated power (40A=28A Max).

Here are some inexpensive Chinese DC-DC SSR's tested:
SMUNGLE SG D2240D BAD – Tested to 35.75A@14.3V, <50HZ (eBay) Latched closed
FOTEK SSR – 40 DD WORKED – But doesn't seem to fully turn on (eBay)
Mager MGR-1 DD220D40 GOOD – Tested to 38.75A@15.5V, <=50HZ (eBay) (Still working)
FOTEK HPR-40 DD BAD – Tested to 35.75A@14.3V, <50HZ (eBay) Short to ground
FOTEK SSR-80 DD BAD – Tested to 71.5A@14.3V, <50HZ (Aliexpress) Latched closed

Needless to say, I don't recommend, nor am I going to test any more FOTEK's.

LOADS

This controller was designed for use with **Resistive** loads such as P**ower Resistors** and **DC Water Heating Elements** and such. This was **NOT** designed to use Grid Tie Inverters and other electronic devices as loads, the switching speeds could damage or destroy your electronics! What you would be looking for is a **Load Controller** that turns something on when the batteries reached a set voltage and then turn it off when the voltage drops to a set voltage.

You can buy resistive loads such as power resistors and DC water heating elements on many RE websites with the volts, amps and watts listed for them. Or to save money you can do the calculations yourself and purchase at a lower cost from electronic suppliers and/or surplus sellers. Also if your real handy you can build your own from junkyard parts.

Your Loads need to be **MORE** (1.3 to 1 or 130% or higher recommended) than the Maximum power that your system could potentially generate For Proper Operation. To calculate your systems maximum watts simply multiply the maximum amperage your system can generate by your batteries maximum charge voltage V x I =W. If you are going to switch the source generator, you should use the maximum voltage and amperage that it can generate to calculate the size of your loads.

1. The Hard Way to Calculate Loads:

The power dissipated by a linear resistor may be calculated from its resistance, and voltage or current. The formula is a combination of Ohm's law and Joule's laws:

Where **P** is the power in watts, **R** the resistance in ohms, **V** the voltage across the resistor, and **I** the current through it. This formula is applicable to devices whose resistance varies with current.

$$P = V \cdot I = \frac{V^2}{R} = I^2 \cdot R$$

2. The Easy Way to Calculate Loads:

Here's an online Voltage-Current-Resistance-Power calculator

WindAndSunPower.com Ohm's Law Power Calculator

Here's some links on homemade/DIY Resistors/Loads **(I Accept No Responsibility For Any Information in any of these Documents, Use AT YOUR OWN RISK!)**

www.thebackshed.com/Windmill/articles/200wDumpLoad

www.thebackshed.com/Windmill/articles/BuildingEncapsulatedResistors

Resistive loads can get extremely **HOT,** hot enough to start a fire or cause severe burns so be sure to follow proper safety precautions, such as:

1. **Do Not** mount Power resistors directly to flammable materials.
2. **Do Not** put flammable materials on or in close proximity to Power resistors.
3. **Do** mount Power resistors to a metal surface/plate, preferable with stand offs between wall and resistor mounting plate for cooling.
4. **Do** mount Power resistors in a location where children, pets or yourself will not come into physical contact with them as they can get hot enough to cause severe burns. If necessary purchase or build a protective cage around them.
5. Lastly **Do Use Common Sense!**

WIRING

If you look at the diagrams you can see the wiring is pretty straight forward. You should use pairs of 22 to 16 gauge AWG wire between the controller and batteries, also from the controller to the relays. Keeping distances between components close as possible for maximum efficiency and accuracy. But **NOT** in the same enclosure with the Batteries as arcing from the relays can ignite the Hydrogen gasses produced by the batteries and explode! Also the corrosive gasses can damage the electronics. The loads, fuses and wires from the relays to the loads and power sources to the batteries will need to be calculated for your systems maximum potential output.

Min. Copper Gauge	Max. Amperage	Min. Copper Gauge	Max. Amperage
18AWG	7.5A	**8AWG**	45A
16AWG	10A	**6AWG**	60A
14AWG	15A	**4AWG**	80A
12AWG	20A	**2AWG**	100A
10AWG	30A	**1AWG**	125A

Function Selection Switch

1. **SS/EM** = **Relay type switch –** Top position = **SS** 2/3-Stage Modes **(Use With SSR's Only!!)**, Bottom position = **EM** Legacy On/Off Mode (EMR's or SSR's)
2. **2ST/3ST = Charge Algorithm Selection –** Activated Only when **SS** is selected **(Use With SSR's Only!!)** - Top position = 3 Stage, Bottom position = 2 Stage
3. **FLA/SLA = Temperature Compensation Selection –** Top position = **S**ealed/Gel **L**ead **A**cid, Bottom position = **F**looded **L**ead **A**cid
4. **VL = Voltage Limiter** – limits the maximum voltages to approx 14.8V for low cost inverters and other electronics that can't tolerate voltages ≥15V (Except Equalization Mode).Top position is **ON/Enabled,** Bottom position is **OFF/Disabled**
5. **EQ** = **Equalization Button (Use With SSR's Only!!)** - Top position button is **Enabled,** Bottom position button is **Disabled**

TEMPERATURE COMPENSATION (With Optional Probe)

If your batteries are in a controlled environment with temperatures remaining between 70 and 90 degrees Fahrenheit temperature compensation is usually not necessary. Otherwise **temperature compensation extends battery life and enables a higher SOC**.

To connect your temperature compensation probe you simply plug the connector into the socket marked **TEMP** on the PCB and slip the other end between two batteries or tape it to the side of one. Set the **FLA/SLA** switch to FLA for Flooded Lead Acid batteries (-40°F(-40°C)140°F(60°C) .0168V per 1°F) or to SLA for Sealed/Gel Lead Acid batteries (-15°F(-26°C)140°F(60°C) .012V per 1°F). You may also select the SLA setting for Flooded Lead Acid batteries if you need/prefer less aggressive temperature compensation.

WARNING! DO NOT use the FLA setting for SLA/GEL cell batteries ! The battery voltage can rise high enough to damage and/or destroy your batteries!

VOLTAGE LIMITER

The **V**oltage **L**imiter is a feature to limit the temperature compensation voltages below the 15V Max that most low cost inverters have. To activate put the DIP switch labeled **VL** in the up/on position. This will limit the dump voltage to approximately 14.8 volts (It Does Not work in equalization mode). **Additionally I recommend setting the VL to On when using SLA/Gel cells as an extra precaution.**

TEST BUTTON

Pressing the test button simulates an high battery voltage condition, activating red status LED and the dump relay/'s. If equalization is in progress it cancels it out. If in Absorption or Float modes it exits returning to Bulk/standby mode.

Also when set to 3-Stage mode

1. Pressing down the test button for approximately 2 seconds until it flashes Green once, sets the Absorption timer to 2Hrs.
2. Continuing to hold it down for approximately 4 seconds until it flashes Green twice, sets the Absorption timer to 0.
3. Continuing to hold it down for approximately 6 seconds until it starts flashing Green three times and releasing before it finishes, forces it into Float mode.

Charge Algorithm Selection

Legacy Electromechanical Relay *On/Off Mode*:

1. Wiring diagram 1: Dumping the battery. Good if your on a tight budget. Not good for batteries because of the slow switching speeds used to keep the EMR's from self-destructing and to prevent contact bounce. The deeper discharge during this delay prevents the batteries reaching a high SOC resulting high sulfation rates. (“14.7/13.7 volts (2.45/2.28 vpc) for on/off charging with a minimum array amp-hour to load amp-hour ratio of about 1.3.” Sandia National Laboratories)
2. Wiring diagram 3: Dumping the charging source. This works good with sources such as solar panels. This is **NOT** recommended for wind or hydro, because by fully loading the generator down, you could cause it to over heat and possibly result in damage to it.
3. Wiring diagram 4: Disconnecting charging source from batteries. This works good with sources such as solar panels. This is **NOT** good for wind or hydro, because if you unload the generator it could over rev and self destruct.

2-Stage-*Bulk and Float Stages with SSR's:*

Wiring diagram 2: Dumping the battery. Good for Float Service systems (I recommend setting up to 0.2 to 0.3 volts above manufactures recommended Float voltage) and systems that are subject to daily cycling with average to heavy loads (For FLA batteries, I recommend setting up to 0.2 to 0.3 volts above manufactures recommended Daily Charge voltage. For SLA/Gel and other sealed batteries, do not exceed manufactures Daily Charge voltage).

3-Stage-*Bulk, Absorption and Float Stages with SSR's:*

Wiring diagram 2: Dumping the battery. Good for all types of systems **except** for those used in Float Service.

Float setting: I recommend setting up to 0.2 to 0.3 volts above manufactures recommended Float voltage.

Absorption setting: For FLA batteries, I recommend setting up to 0.2 to 0.3 volts above manufactures recommended Daily Charge voltage. For SLA/Gel and other sealed batteries, do not exceed manufactures Daily Charge voltage

EQUALIZATION
(Solid State Relays in 2-Stage Mode Only)

Equalization mode is Not temperature compensated if you have the optional probe connected.

A lot of small systems may not generate enough power to fully equalize the batteries. To equalize your FLA batteries (Follow Manufactures Recommendations! Check/Fill Battery water level Before and After!):

1. Disconnect/Turn Off (dependent upon device) any and all devices that cannot handle equalization voltages (usually 15.5 volts and higher).
2. Make sure the EQ switch is set to **EN (**enabled).
3. Push and hold the Equalize button until the Status LED flashes alternating Red and Green

Equalization mode will continue until 1 of 3 conditions are met:

1. The total time accumulated that the batteries are at between the set equalization voltage and -0.3 volts of the set equalization voltage equals approximately 2 hours.
2. It times out after approximately 48 hours if the batteries do not accumulate 2 hours at equalization voltages.
3. The test button is pushed canceling equalization.

WARNING! If using this controller with Sealed, Gel Cell or other like batteries, Disable and DO NOT use the equalization option unless the manufacture says it is safe to do so! If needed, Recalibrate the Equalization set-point at or below the battery manufactures specifications! Not following these precautions can cause the battery voltage to rise high enough to damage and/or destroy your batteries!

DUMP/DIVERT VOLTAGE and other SET-POINT ADJUSTMENTS

First off, **DO NOT adjust the calibration potentiometer (Marked CAL on the PCB)** as this is used to calibrate the Status LED and Internal set-points.

The controller is preset at 14.3 volts. This is a safe point for most batteries, it is low gassing and will charge most batteries to approximately 90 to 95 percent of their rated capacity. However this setting will **not** charge most FLA (Flooded Lead Acid) deep cycle batteries fully and the batteries maximum capacity will, little by little, drop lower with each subsequent charge (due to sulfation). Check the battery manufactures recommended charge voltage which you can usually find on their website. Most FLA deep cycle batteries have a high daily charge voltage (currently TROJAN recommends 14.8 V daily charge and 15.5 V equalization charge). Both of which causes higher water loss (adding distilled water more frequently), and **VERY HIGH GASSING** which unless you have a proper ventilation system in place and follow proper safety practices can be **DANGEROUS!** If you can't meet these requirements leave the setting at 14.3V or lower (Set to 14.1V when using SSR's in 2-Stage).

(Note: When using the legacy EM mode to dump Lead Acid batteries scientific studies have shown that a high SOC is not reached and sulfation builds up quickly at dump settings below 14.7-14.8V.)

The 14.3V was settled on because most smaller systems are not generating all the time and it was the voltage that gave the highest charge capacity with low gassing. There are so many variations in systems and batteries it's imposable to have a "**perfect universal**" default Dump/Absorption setting. It is up to you, to decide on the best Dump/Absorption voltage for your system. This is why all good controllers have adjustable set points.

This could take some time. The potentiometers are very sensitive, you barely need to turn one to change a setting. You will be adjusting the potentiometer marked **ABSORB DUMP** on the PCB.

1. If you have the optional temperature compensation probe, unplug it from the PCB.
2. Hook an accurate volt meter directly to your batteries.
3. Let the batteries fully charge to the current set-point and stabilize.
4. If lowering the set-point slowly turn counterclockwise until the battery voltage reaches the desired setting, let it stabilize and repeat up or down if necessary until your satisfied with the setting. If raising the set-point slowly turn clockwise until the yellow dump led goes out. Wait for the voltage to rise to the new set-point and stabilize, Check your volt meter to see if it dumps at the desired voltage. Repeat adjusting the pot up or down if necessary until your satisfied with the setting.
5. If you have the optional temperature compensation probe, plug it back in to the PCB.
6. Disconnect volt meter if you wish.

Note: If your using SSR's with the 2 stage setting and your constantly generating power with your batteries staying fully charged most of the time. You might want to set the dump voltage down closer to the manufactures recommended float voltage and equalize the batteries more often or switch to 3-Stage operation.

FLOAT SET-POINT ADJUSTMENT

First off, **DO NOT adjust the calibration potentiometer (Marked CAL on the PCB)** as this is used to calibrate the Status LED and Internal set-points.

The same procedures above apply for setting the Float set-point except you must enter Float mode to do so.

The controller is preset at 13.5 volts. 13.4 to 13.8 volts are good set-points for most LA batteries of all types. I see the best results when **Dumping** the batteries at 13.8 volts with this controller.

This could take some time. The potentiometers are very sensitive, you barely need to turn one to change a setting. You will be adjusting the potentiometer marked FLOAT on the PCB.

1. If you have the optional temperature compensation probe, unplug it from the PCB.

2. Hook an accurate volt meter directly to your batteries.
3. Let the batteries fully charge, enter Float mode and stabilize. Alternately, if the battery voltage is above the current Float set-point, you can use the test button to force it into Float mode and let it stabilize.
4. If lowering the set-point slowly turn counterclockwise until the battery voltage reaches the desired setting, let it stabilize and repeat up or down if necessary until your satisfied with the setting. If raising the set-point slowly turn clockwise until the yellow dump led goes out. Wait for the voltage to rise to the new set-point and stabilize, Check your volt meter to see if it dumps at the desired voltage. Repeat adjusting the pot up or down if necessary until your satisfied with the setting.
5. If you have the optional temperature compensation probe, plug it back in to the PCB.
6. Disconnect volt meter if you wish.

EQUALIZATION SET-POINT ADJUSTMENT

First off, **DO NOT adjust the calibration potentiometer (Marked CAL on the PCB)** as this is used to calibrate the Status LED and Internal set-points.

The same procedures above apply for setting the Equalization set-point except you must enter Equalization mode to do so. The system must be able to bring the battery voltage up to the desired set-point and then you can turn the Equal adjustment down until the relays activate.

The controller is preset at 15.5 volts.

This could take some time. The potentiometers are very sensitive, you barely need to turn one to change a setting. You will be adjusting the potentiometer marked EQUAL on the PCB.

1. Hook an accurate volt meter directly to your batteries.
2. Let the batteries fully charge to the current set-point and stabilize.
3. If lowering the set-point slowly turn counterclockwise until the battery voltage reaches the desired setting, let it stabilize and repeat up or down if necessary until your satisfied with the setting. If raising the set-point slowly turn clockwise until the yellow dump led goes out. Wait for the voltage to rise to the new set-point and stabilize, Check your volt meter to see if it dumps at the desired voltage. Repeat adjusting the pot up or down if necessary until your satisfied with the setting.
4. Disconnect volt meter if you wish.

CAL SET-POINT ADJUSTMENT

This is Preset! Do this only in-case of need for recalibration!

Make sure dump voltage is set above 14.1 volts and the temperature probe is disconnected. Connect a bench supply and an accurate volt meter to the boards battery connectors. Adjust the Bench supply to 14.00 volts, the Status LED should light a constant Green. Adjust the Bench supply to 13.99 volts, the Status LED should start rapidly flashing Green. If not, adjust the pot marked CAL up or down until you get these results.

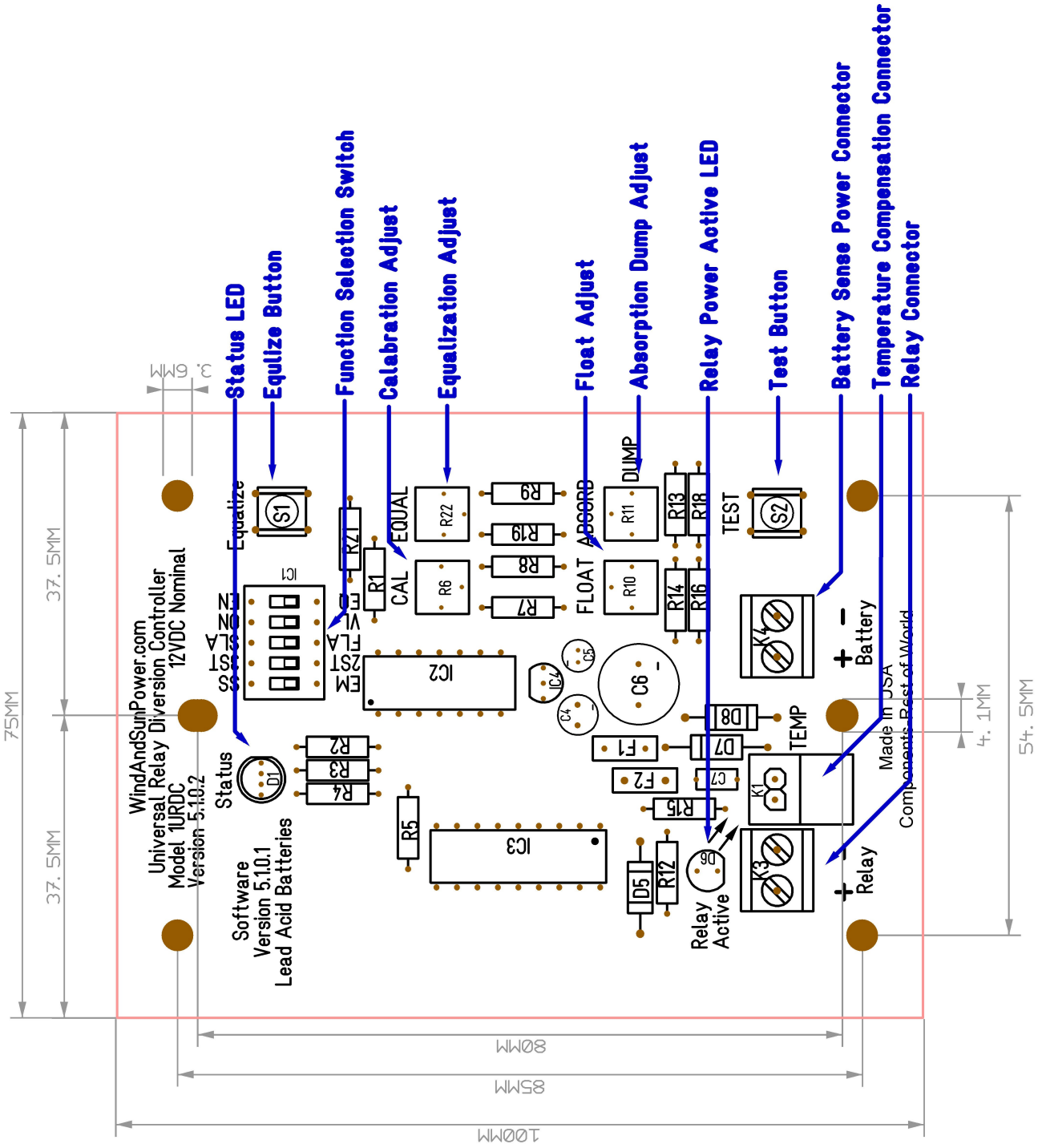
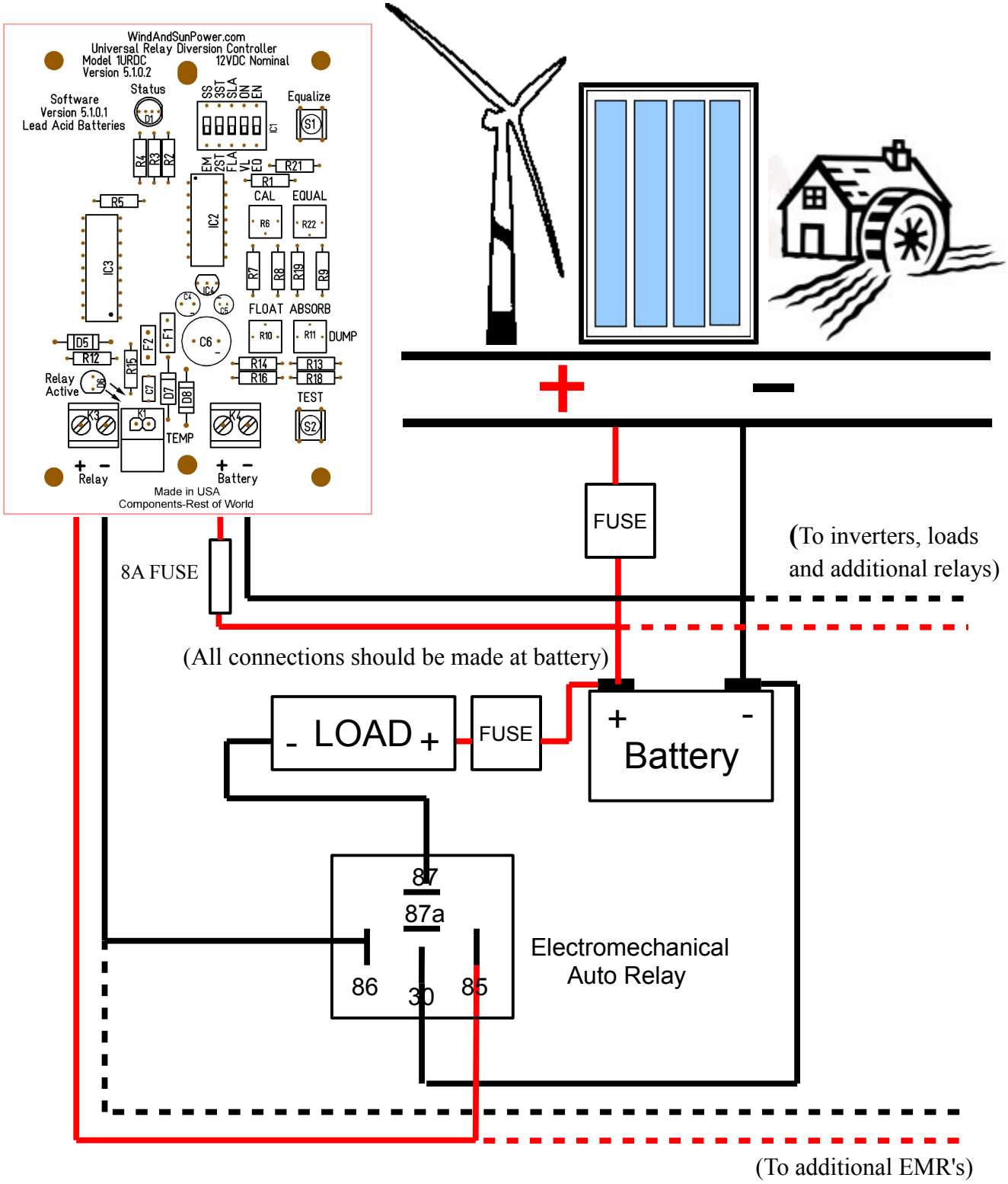

Status LED
Equlize Button
Function Selection Switch
Calabration Adjust
Equalization Adjust
Float Adjust
Absorption Dump Adjust
Relay Power Active LED
Test Button
Battery Sense Power Connector
Temperature Compensation Connector
Relay Connector
WindAndSunPower.com
Universal Relay Diversion Controller
12VDC Nominal
Model 1URDC
Version 5.1.0.2
Software
Version 5.1.0.1
Lead Acid Batteries
Made in USA
Components Rest of World
Battery
Relay
Status
Equalize
EQUAL
CAL
FLOAT
ABSORB
DUMP
TEST
TEMP
Relay
Active
75MM
37.5MM
37.5MM
54.5MM
4.1MM
100MM
85MM
80MM

Diagram 3.

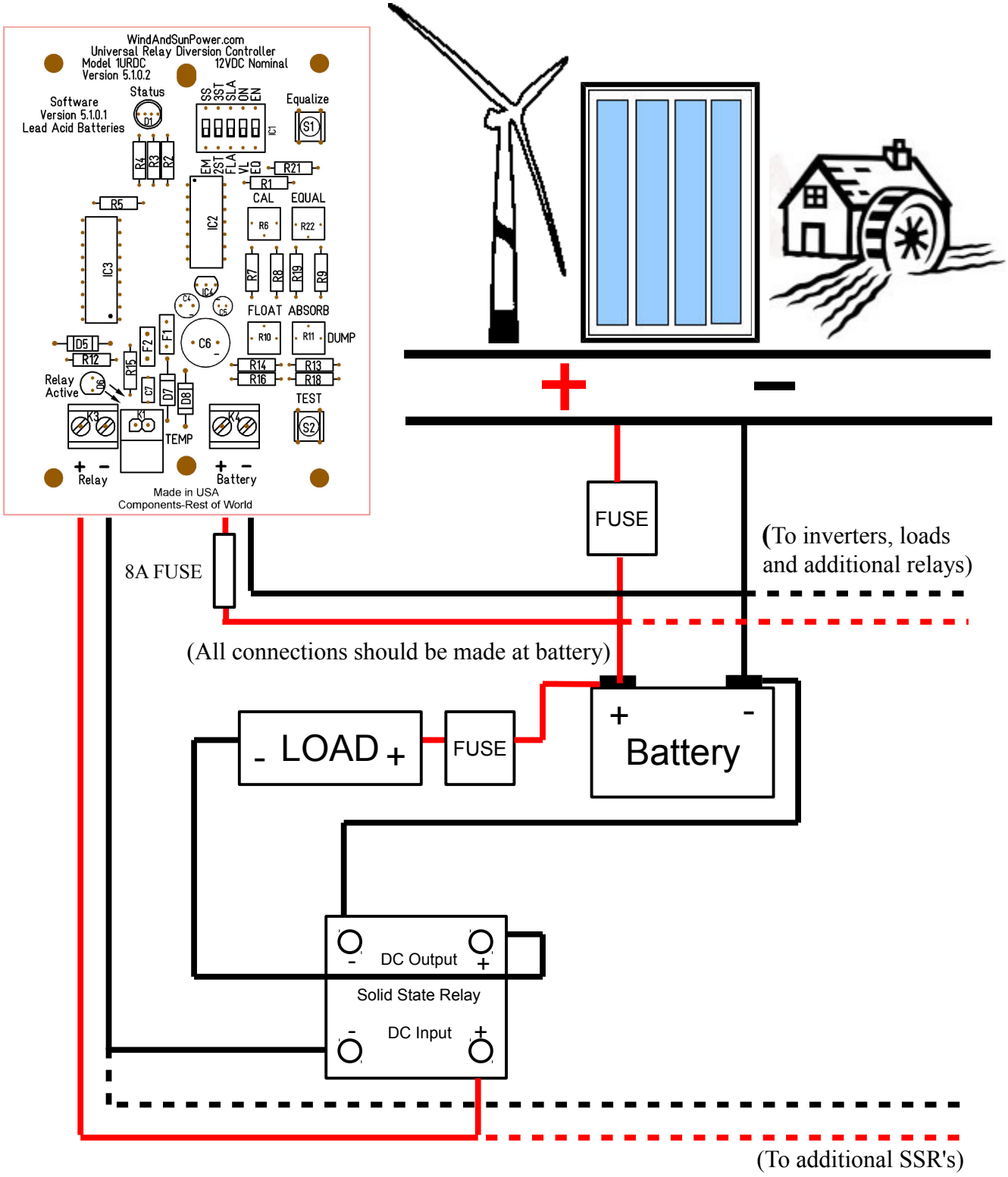
Wiring Diagram 1. ELECTROMECHANICAL RELAY (EMR) DIVERSION/DUMP MODE

SOLAR YES (You can have all 3 sources connected to/charging)
WIND YES (the batteries at the same time in this configuration)
HYDRO YES



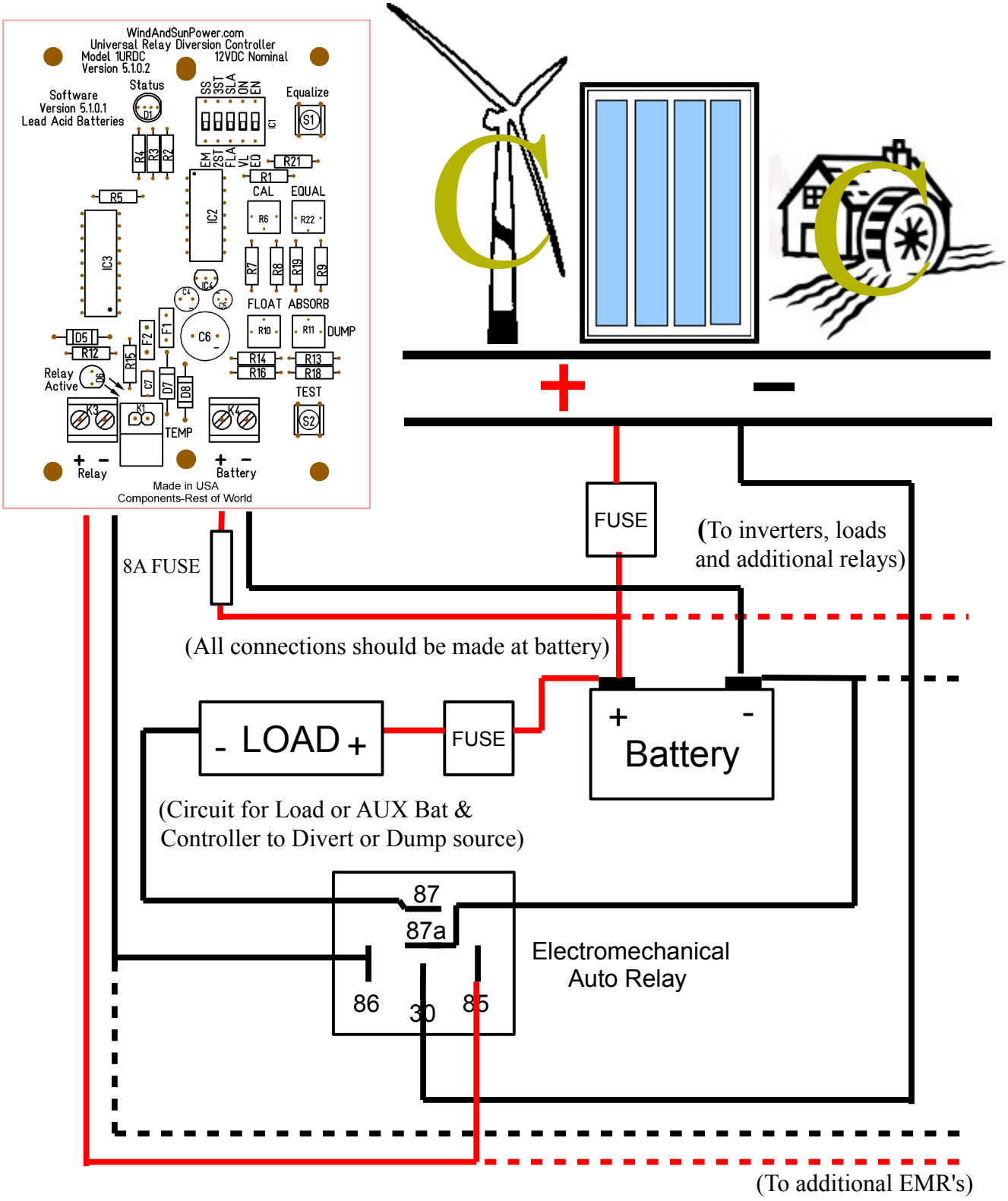
Wiring Diagram 2. SOLID STATE RELAY (SSR) DIVERSION/DUMP MODE

SOLAR YES (You can have all 3 sources connected to/charging)
WIND YES (the batteries at the same time in this configuration)
HYDRO YES



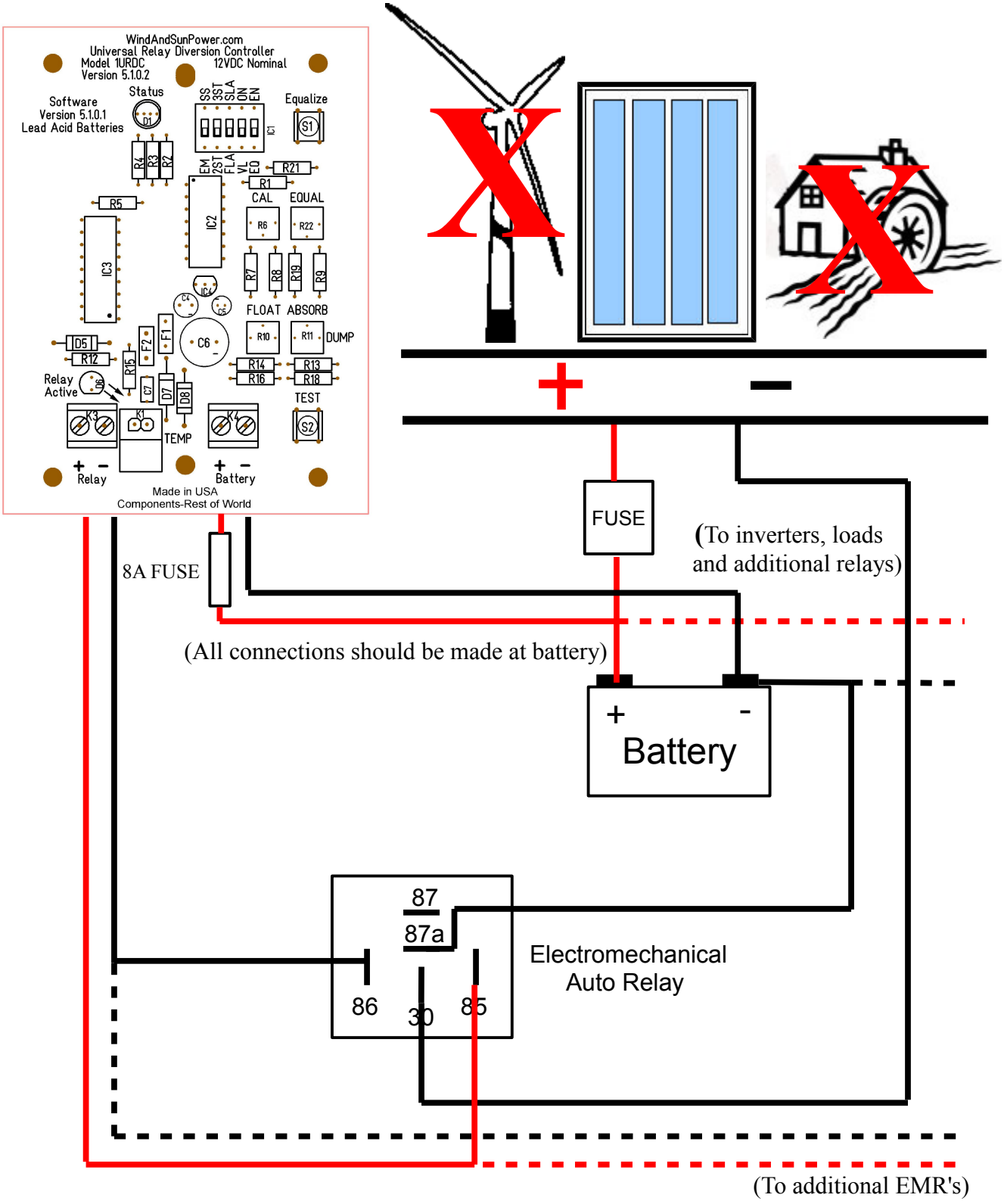
Wiring Diagram 3. ELECTROMECHANICAL RELAY (EMR) ON-OFF DIVERSION/DUMP SOURCE MODE

SOLAR YES
WIND CAUTION (You can use this circuit but understand that by fully loading the generator)
HYDRO CAUTION (down, you could cause it to over heat and possibly result in damage to it)



Wiring Diagram 4. ELECTROMECHANICAL RELAY (EMR)
DISCONNECT or ON-OFF MODE

SOLAR YES
WIND NO! (You can NOT use this circuit for wind or hydro, because if-)
HYDRO NO! (you unload the generator it could over rev and self destruct)

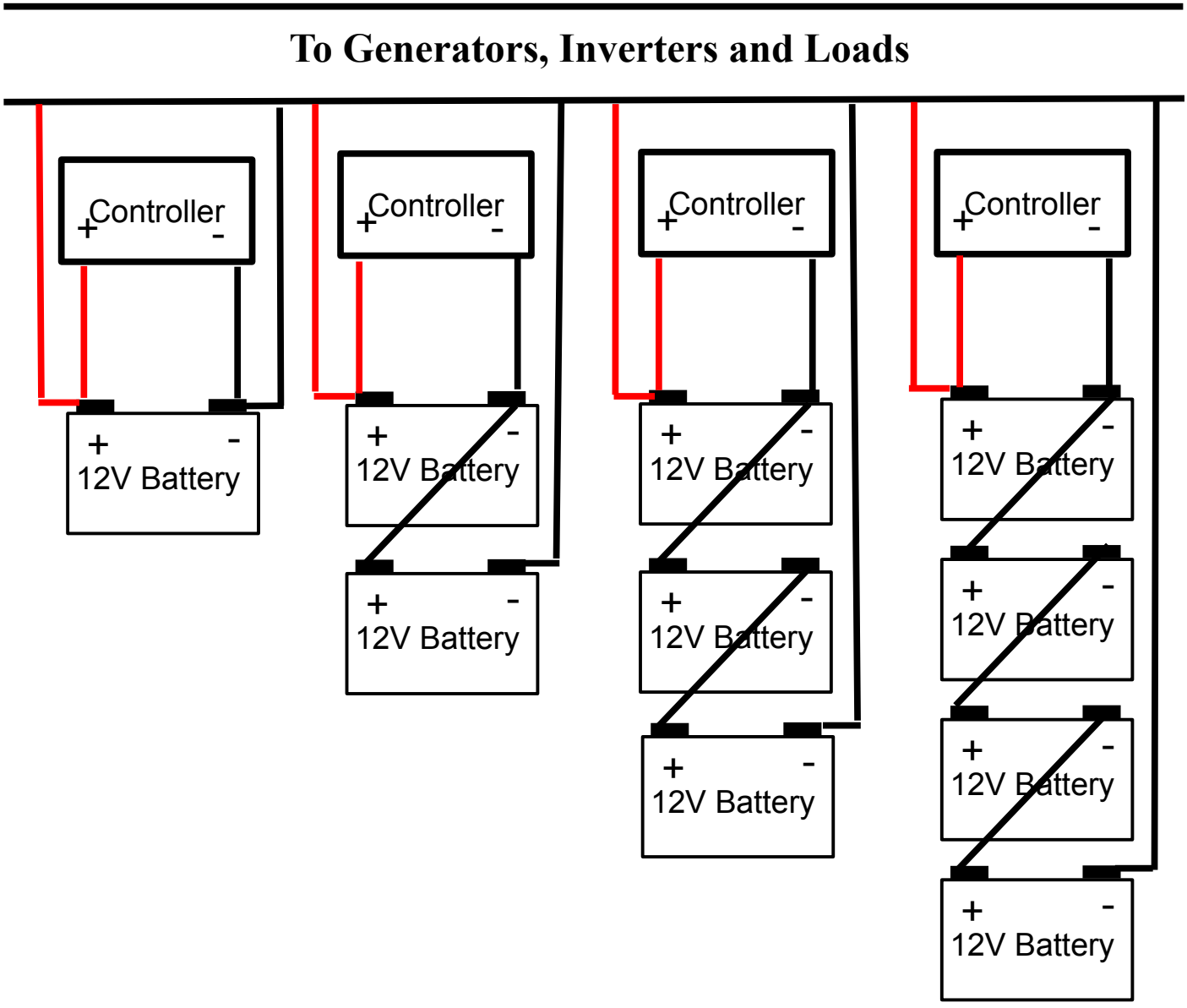


Wiring Diagram 5. Battery Wiring Diagrams for 12, 24, 36 and 48 Volt Systems

You simply hook the controller's "**Battery**" leads to a **12V cell** in your 24, 36, 48, 60, etc. volt battery bank and you connect your properly configured loads, inverters and generators across the full voltage of your battery bank. **The relay's Coil/Input needs to be 12V nominal, the Contacts/Output Needs to exceed the battery banks maximum voltage.** If your batteries are in good shape, all set points, temperature compensation, and LED indicator voltages are proportionally compensated. You just take the nominal system voltage and divide by 12, you the take the resulting answer and use it to multiply the set points and LED voltages.

Examples 24v / 12v = 2 then 2 x 14.3v = 28.6v
48v / 12v = 4 then 4 x 14.3v = 57.2v

(Tested)	(Tested)	(UnTested)	(UnTested)
12 Volt System	**24 Volt System**	**36 Volt System**	**48 Volt System**
	Set Point & LED Voltages		
X1	**X 2**	**X 3**	**X 4**



LED FLASH LEGEND

Approximate State of charge at 80ºF (26.6ºC) and at rest for 6 hours or more.

(No Charging or Discharging) (LED SOC Generalized for FLA Deep-Cycle Batteries)

If more precise Voltage monitoring is necessary connect an accurate voltmeter directly to the batteries.

🔴	**RED** LED **1** flash every 10 sec	11.35 volts or lower	0% state of charge
🟢	**GREEN** LED **1** flash every 5 sec	11.36-11.65 volts	1 to 20% state of charge
🟢🟢	**GREEN** LED **2** flashes every 5 sec	11.66-11.95 volts	21 to 40% state of charge
🟢🟢🟢	**GREEN** LED **3** flashes every 5 sec	11.96-12.25 volts	41 to 60% state of charge
🟢🟢🟢🟢	**GREEN** LED **4** flashes every 5 sec	12.26-12.5 volts	61 to 80% state of charge
🟢🟢🟢🟢🟢	**GREEN** LED **5** flashes every 5 sec	12.51-12.7 volts	81 to 99% state of charge
🟢○	**GREEN** LED **2** flashes every sec	12.71-13 volts	100% state of charge
🟢○	**GREEN** LED **4** flashes per sec	13.01-13.5 volts	
🟢○	**GREEN** LED **10** flashes per sec	13.51-14.0 volts	
🟢	**GREEN** LED Steady/Constantly on	14.01 volts or higher	

🔴 **RED** Constant – Absorption Mode
At Absorption Voltages, Timer Counting Down (3-Stage)

🔴 **RED** Flashing On/Off – Below Absorption Voltages, Absorption Timer Is NOT Counting Down, 1Hr Absorption Mode Exit Timer Is Counting Down (3-Stage)

🟣 **Light VIOLET** Constant –Absorption Mode Exit Timer Is Counting Down (1V Below Absorb Setting for 15 Min) (3-Stage)

🟣 **VIOLET** Constant – Float Voltage (3-Stage)

🔵 **BLUE** Constant – Below Float Voltage – 1Hr Exit Timer Counting Down (3-Stage)

🩵 **Turquoise** Constant – Below Float Re-bulk Voltage (<13.65V for 2 Minutes) – 2Min Exit Timer Counting Down (3-Stage)

🔴🟢 **RED** and **GREEN** LED Alternating – Equalization Mode.

🟣🩵 **Violet** and **Turquoise** LED Alternating – Equalization Voltages Reached Timer counting Down – Ends if it Accumulates 2 hours time with battery at Equalization Voltages, until 48 hr timer runs out or the test button is pushed canceling Equalization Mode.

🟠🟠 **ORANGE** and **YELLOW** Flash Simultaneously (Status LED looks like it's Flickering in SS mode) Relay Active – EMR and SSR all modes

TROUBLESHOOTING

Symptom	Probable Causes	Possible Solutions
Status LED Flashes Random Combinations	Bad or corroded wiring connection.	Check, clean and/or tighten all connections.
Both Status LED is ORANGE and YELLOW "Relay Active" is Constantly ON	1. Relay malfunction. Bad or corroded wiring connection. 2.Dump load too small.	1. Check for bad relay. Check, clean and/or tighten all connections. 2. Increase load size.
Status LED is ORANGE and YELLOW "Relay Active" LED is OFF	1. Power section fuse tripped. Too high relay load or short in power section, relays and/or wires. 2. FET array damaged or destroyed	1. Reduce number of relays, check for bad/shorted relays, check wires from controller to relays for shorts. 2. Contact WindAndSunPower.com for repair or replacement.

SPECIFICATIONS

Min. Operating Volts	7 VDC	**Max. Operating Volts**	30 VDC
Nominal Operation Voltage	12VDC	**FLA Temperature Compensation (W/Optional Probe)**	-40°F(-40°C)140°F(60°C) .0168V per 1°F ± 5% (Flooded Lead Acid)
SLA Temperature Compensation (W/Optional Probe)	-15°F(-26°C)140°F(60°C) .012V per 1°F ± 5% (GEL/SLA)	**Dump/Absorption Adjustment Range**	13.5 to 15.5 Volts
Float Voltage Adjustment Range	12.5 to 14.5 Volts	**Equalization Voltage Adjustment Range**	14.5 to 16.5 Volts
Battery Voltage Regulation (High/Low Volts Using EMRs)	± 6% ± 0.93V **(This specification can fluctuate due to system variables and design)**	**Battery Voltage Regulation (High/Low Volts Using SSRs)**	± .5% + 0.03V **(This specification can fluctuate due to system variables and design)**
Status LED Accuracy	± .5% + 0.03V	**Voltage Limiter**	14.8V ± 0.1V
Standby Power	≤ 10ma		
Power Max.	≤ 35ma	**Power Sunk Max.**	-800ma
Automotive style ElectroMechanical Relays	1 up to 6 30 to 40 Amp with 12VDC coil	**Solid State Relays** **2-Stage & Equal** **3-Stage**	DC-DC 1 to 32? ≤20ms On/Off ≤10ms On/Off
EMR Operating Frequency	Dump Volt Setting -0.3V + 4 Sec.	**SSR Operating Freq.** **2-Stage & Equal** **3-Stage**	 ≤25Hz(On+Off 25 x Sec.) ≤50Hz(On+Off 50 x Sec.)
Operating Temp. **Storage Temp.**	-20°C to 50°C -50°C to 150°C	**Dimensions**	75 mm x 100 mm (2.95 in. x 3.93 in.)

Specifications subject to change without notice.

Made in USA-Components Made in Rest of World

WARRANTY:

WindAndSunPower.com. Model 1URDC is warranted to be free of defects in material and workmanship for three years from the date of purchase. Failure to provide correct installation, operation or care for this product, in accordance with the instruction manual, will void the warranty. Product liability shall be limited to repair or replacement, at the discretion of the manufacturer. The manufacturer is not responsible for the labor or other charges necessitated by the removal, transportation, or reinstallation of any defective product. Warranty does not cover damage due to, mishandling, abusive conditions, lightning, or exposure to weather. No specific claim of merchantability shall be assumed or implied beyond what is printed in this manual. No liability shall exist from circumstances arising from the inability to use this product, or it's inappropriateness for any specific purpose. In all cases, it shall be the responsibility of the customer to insure a safe installation in compliance with local, state and national electrical codes.

RETURN PROCEDURE:

To return a model 1URDC for warranty service please contact WindAndSunPower.com for return authorization and shipping instructions. Provide the following information shipped with the controller. Name/Company name, return address, daytime phone number, description of failure, copy of sales receipt. Include $4.00 for return shipping

Tip's n Tricks

1. You can use 1 relay to activate more relays.

Amendments

1. Due to a few user accidents showing the potential for a 30V+ and high current supply being connected. I now recommend putting an 8 amp “Catastrophe” fuse between the battery positive connector and the battery.

11/15/12

2. Revised Manual Version 1.0.1 to 1.0.2
   Revised “**LED FLASH LEGEND”** in manual. Was for Version 4.x, Now for Version 5.1.x

11/18/13