Coleman Air
Diversion Controller
Model C160M
Version 4.35

With Extended Diversion Mode
And Direct Relay Termination Lugs

Introduction

One of our most popular diversion controllers just got better. This new generation diversion controller improves on many aspects of our previous versions by beefing up the relay termination portion of the controller and eliminating the wire harnesses that were used in early models.

Some of the key features of this controller are:

- **Microprocessor controlled** -- This is very important for both stability and functionality.
- **User changeable settings** -- Several controllers on the market set the dump level, and that's that!
- **High amp rating** - 160 maximum intermittent amps diversion, 120 maximum amps solar. [1]
- **High Contrast, Auto Brightness LED battery voltage meter** (C160M)
- **On/Off switch for Meter** (C160M)
- **Battery status LED** - Several controllers do not tell you what's going on - This one does!
- **Push to test** - Ever wonder if your controller & load are working OK?
- **Steel enclosure** - with two conduit openings.
- **Large terminal blocks**, soldered directly to the relay PCB - that can handle up to # 6 wire.
- **Very efficient and cool running switching power supply.**
- **Versions 4.0 and greater now have reverse polarity protection.**
- Versions 4.2 and greater now have an extended diversion mode (EDM).
- **This controller has been designed with small to medium wind based systems in mind, but can also be used with solar only systems as well as both wind and solar (at the same time).**

Current handling capabilities are based on the mode of the controller and the battery system voltage.

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The C160/C160M can handle 160 maximum amps total current flow wired in the diversion mode when used in a 12-volt battery system and 120 amps maximum in a 24-volt system, both at a 20% duty cycle. 100 Amps continuous (50 amps/relay) design amperage is recommended for both voltages. Please see technical specs portion of the manual for more details.

Solar mode maximum current handling capability is 120 amps for a 12-volt system and 100 amps when used with a 24-volt system (50 amps/relay).

Maximum continuous solar charge wattage should never exceed 2800 watts, with a recommended maximum system design of 1200 watts for a 12-volt system (12 x 100 watt panels) and 2000 watts for 24-volt systems. (8 x 250 watt solar panels for instance), where ½ the panels are routed to one relay, and the other ½ to the second relay.

Higher amperages/and or volts will reduce the life of the relays.

Some specifics

High contrast LED meter displays battery voltage directly, allowing you to clearly see the status of your battery bank. The meter has an auto-brightness feature that automatically dims in low light conditions. An on/off switch allows you to turn the meter off when it is not needed.

Microprocessor controlled. The microprocessor is the heart of the controller. It is given the battery voltage and the user changeable trip points. This information is analyzed and acted upon by the microprocessor. The battery level is checked and based on that information the Green LED flashes or is illuminated as follows:[1]

1 - (One) Flash indicates the battery is less low -- less than 12 volts (Double for 24 volt systems.)
2 - (Two) Flashes indicates the battery is 12 to 12.3V
3 - (Three) Flashes indicates the battery is 12.4 to 12.7v (A fully charged lead acid battery at rest)
4 - (Four) Flashes indicate the battery is 12.8 to 13.1V
5 - (Five) Flashes indicates the battery is above 13.2V but less than 13.5V

Steady green means the battery is full.

Settings are adjustable. Changing the trip point will alter the flashing levels of the green Led.

The red LED is illuminated when the relays are enabled and the battery is being dumped at 14.5v or the charge source diverted. The dump remains active for a minimum of 5 seconds, at which time it is checked by the microprocessor. If battery voltage drops below the "Dump Cancel" level (about 13.4-13.6 volts), then the dump is disabled, otherwise the dump is continued and rechecked every 5 seconds. (Please see the discussion on EDM for extended diversion mode performance.)

When you click the "TEST" push-button - the 5 second cycle is started (one time, unless the batteries are within the "Dump start" and "Dump Cancel" zone.)

Settings are user changeable! By simply turning a simple potentiometer with a small screwdriver, you can quickly adjust the trip point.

High amp rating -- 160 Amps! -- This is a big controller.

About wire size -- 160 amps is a lot of current! -- The terminal blocks inside the case will handle 6 AWG wire and are better used for switching loads of 60 amps or less. Higher amperages of up to 80 amps for short periods of time (20% duty cycle) in the diversion mode are also acceptable.

Version 4.0 now offers reverse polarity protection: This unit is protected against accidental reverse polarity battery sense connections. (The + and – input leads on the top of the controller); however, please use caution when hooking up your wires to insure you do not contact any of the components on the circuit board with a “Live” wire. **Damage is very likely should a wire contact a component.**

There should be no power on any lead when hooking up your controller. All positive leads coming from any energy source should be protected by a fuse or breaker, and should be disabled and locked out while you are terminating or servicing your unit.

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[1] This information is for a 12 volt system. It will be double for a 24 volt system, etc.

About load diversion (For wind/hydro turbines)

The basic operating philosophy of a diversion controller is quite simple. Monitor the battery voltage, and if it should rise to a predetermined level, connect a diversion load or "Dummy Load", of sufficient size, to the battery or energy source to prevent the battery voltage from increasing any further. This is a very simple, yet very effective way of preventing battery overcharging. All alternate energy systems should have some form of battery overcharge protection.

Several schools of thought on the subject.

1. The source of power (wind turbine, solar panels etc.) -- should remain connected to the batteries while the dump load controller is actively dumping the excess voltage.
2. The source should be diverted to the load directly and disconnected from the batteries.

   We happen to believe that is far better to leave the wind turbine connected to the batteries at all times. Why? When you remove the battery level voltage from a wind turbine and send it's power directly to a load, and then it sees for all practical purposes a short circuit (depending on the resistance of the load and lead wires.) This may cause the turbine blades to slow dramatically and in some cases bring it to a halt. This braking action can cause heat build up in the stator if it is repeated every few seconds or so (if the battery is just a little over the top). **When you allow the turbine to see the batteries, along with the load, the turbine remains more within its design realm** -- always a good thing.

   This controller is designed to allow the turbine to be hooked up directly to the batteries, the turbine is not disconnected when the batteries become charged.

Diversion Load Types

A diversion load needs to be larger (by at least 10-20%), than the sum total of all your solar/wind/hydro charge sources combined that will be routed through the diversion load. When the diversion load is too small, battery voltage may continue to rise even when the diversion is active. It is also important to use a load that is not likely to fail. Light bulbs and similar such loads are <u>not</u> good diversion (dummy) loads, since they <u>will</u> fail and you may be left with no method to dump the excess energy going into your batteries.

It is commonly thought that a standard 120vac, 2000 watt heating element (readily available from your local hardware store), would make a good load; however, in reality, they are not well suited, as it takes several of these elements to actually be effective in lower voltage systems. <u>A 2000 watt, 120VAC element will not dissipate 2000 watts at lower voltages</u>. You will need to install multiple elements in parallel to achieve the desired load specifications.

Please use the following chart as a quick guide in using a 2000-watt, 120 VAC heating elements.

60Vdc dump (48Vdc system) -- 500 Watts -- 8.3 amps
30Vdc dump (24Vdc system) -- 125 Watts -- 4.2 amps
15Vdc dump (12Vdc system) -- 35 Watts – 2.1 amps
120Vac -- 2000 Watts, at 16.7 amps

Basically, a standard 2000-watt, 120 VAC element, in a 12-volt system will only dissipate 35 watts.

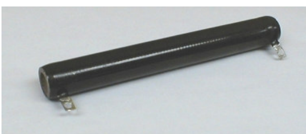
Water heating elements designed specifically for 12, 24 and 48-volt systems are by far a better choice.

A very acceptable diversion load is a power resistor. These can be obtained via the www.ColemanAir.us website. Various wattages are available as either completed load centers or individual power resistors.

Product Code: L675W12V


45A/12V 675 Watt Diversion Dummy Load Resistor Heater -- For 12 volt systems

Product Code: 2R100W


2 Ohm, 100 Watt power resistor for 12v systems.

Place multiple resistors or load centers in parallel for a higher wattage load. When you place the same value resistors in parallel, you double the wattage rating, and ½ the resistance. This is a safe method of doubling the wattage/amperage handling capability of your diversion load.

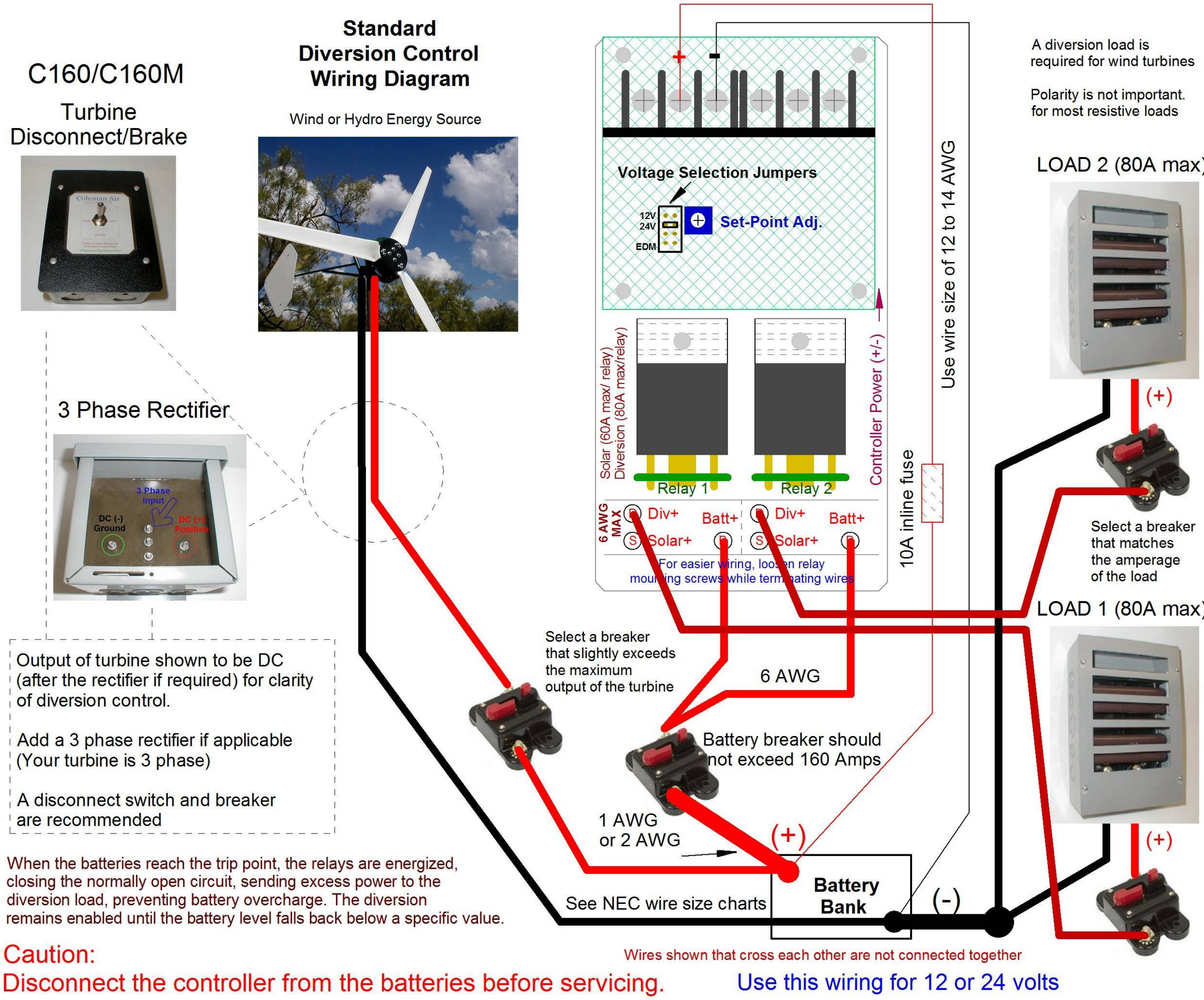
Note: you cannot simply use a lower value resistance without also increasing the wattage rating of your resistor. For instance, attempting to use a single 100 watt power resistor of 1 ohm on a 24 volt battery system (30v dump), will result in the dissipation of 900 watts, however the resistor is only rated at 100 watts and will be destroyed. Please refer to Ohms law for more information on resistance verses amps.

A diversion load is not required for solar only systems.

Please visit our online store for a selection of diversion loads, diodes and rectifiers. Please note: this controller does not include a blocking diode nor an A/C to D/C rectifier as these are specific to your application. If you are using the controller with a DC turbine or solar panels, you may need to purchase a blocking diode. A/C turbines require rectification from A/C to D/C.

Relay Termination Blocks (2 relays, with 3 terminals each)

Standard wiring for 12v and 24v battery banks



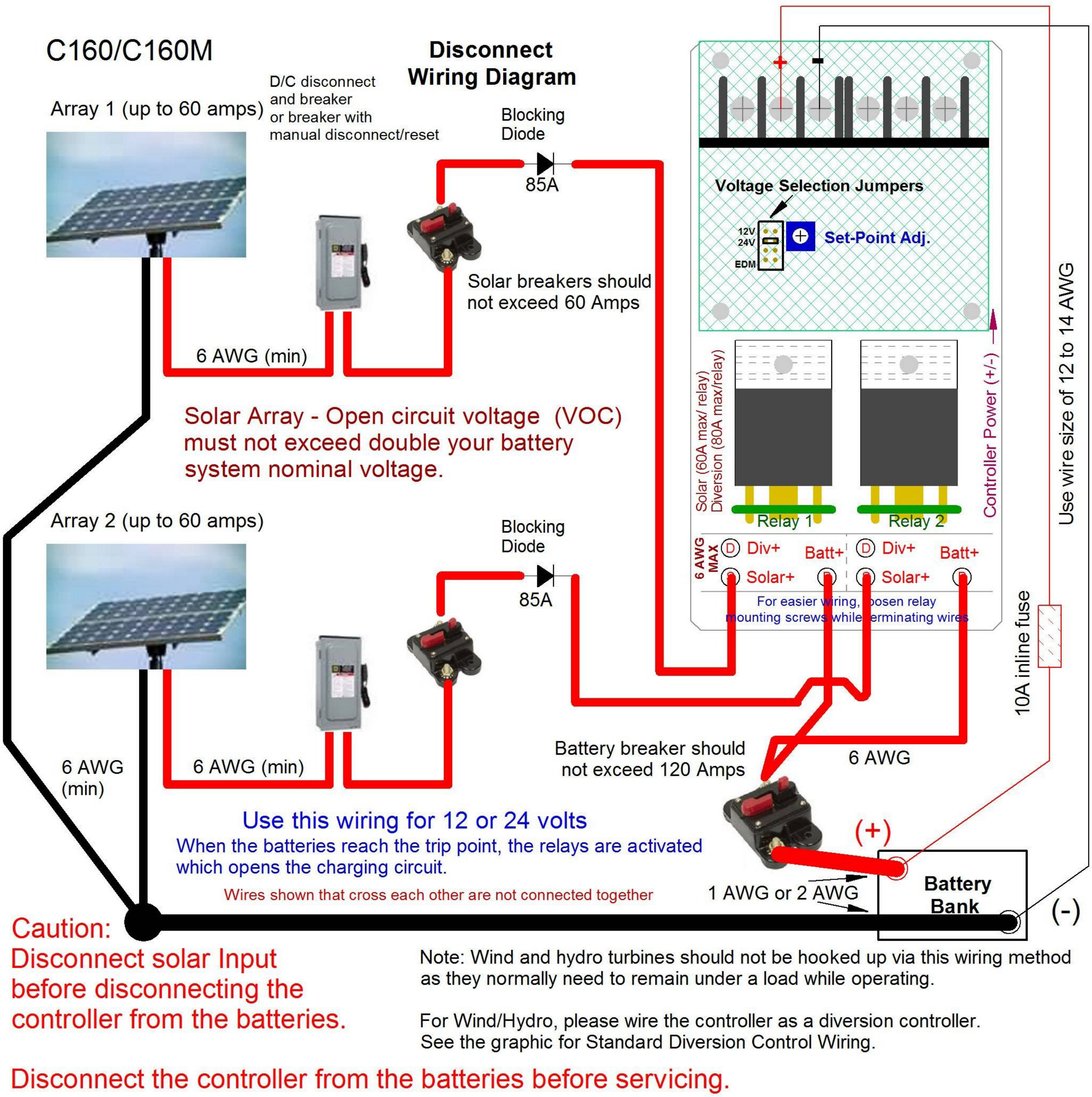
This wiring is for turbines, and is the most common setup for the C160/C160M controller. To use this wiring:

1. Hookup your diversion loads to the relays as shown. Since each relay can handle a maximum of 80 amps (20% duty cycle) or 60 amps continuous, it is important that you split larger diversion loads between the two relays as shown. Hookup the positive side of your load (most loads are not polarity sensitive) via a fuse, to the top leftmost terminal of either relay (marked "Diversion"). Duplicate this for a 2nd load.
2. Hookup the negative side of your load(s) to the negative post of your battery bank. Having a negative buss-bar is helpful.
3. Run a wire from the positive post of your battery breaker to the Batt+ terminal of each relay that is being used. (Bottom right of relay board.) Note: It is not necessary to run a wire to the Batt+ lug of a relay you will not be using.
4. Run a pair of 12 AWG (gauge) or 14 AWG black and red wires to the upper terminals of the controller. It is important that the red positive wire be fused or has a small breaker. A 5 to 10 amp inline fuse is recommended.
5. Finally, hookup your turbine directly to your batteries via a breaker (or fuse), disconnect switch and blocking diode or rectifier as applicable.

Hint: Loosen the nuts that hold the two relays in-place to allow easier access to the relay termination lugs. Tighten these back when you have completed the hookup and before powering up your controller.

Please note: this controller does not include a blocking diode or an A/C to D/C rectifier, as these are specific to your application. If you are using this controller with a DC turbine or solar panels, you may need to purchase a blocking diode. A/C turbines require rectification from A/C to D/C.

Standard Disconnect Wiring for 12 and 24 volt systems.



To use this wiring:

1 Hookup the positive wires of one or more solar panels (which are in tied parallel) to the relays as shown. Each solar array must go through a disconnect switch and a fuse or breaker. (Many breakers/switches offer both features.) Since each relay can handle a maximum of 60 amps continuous, it is important that you split your arrays between the two relays as shown such that no array exceeds 60 amps.

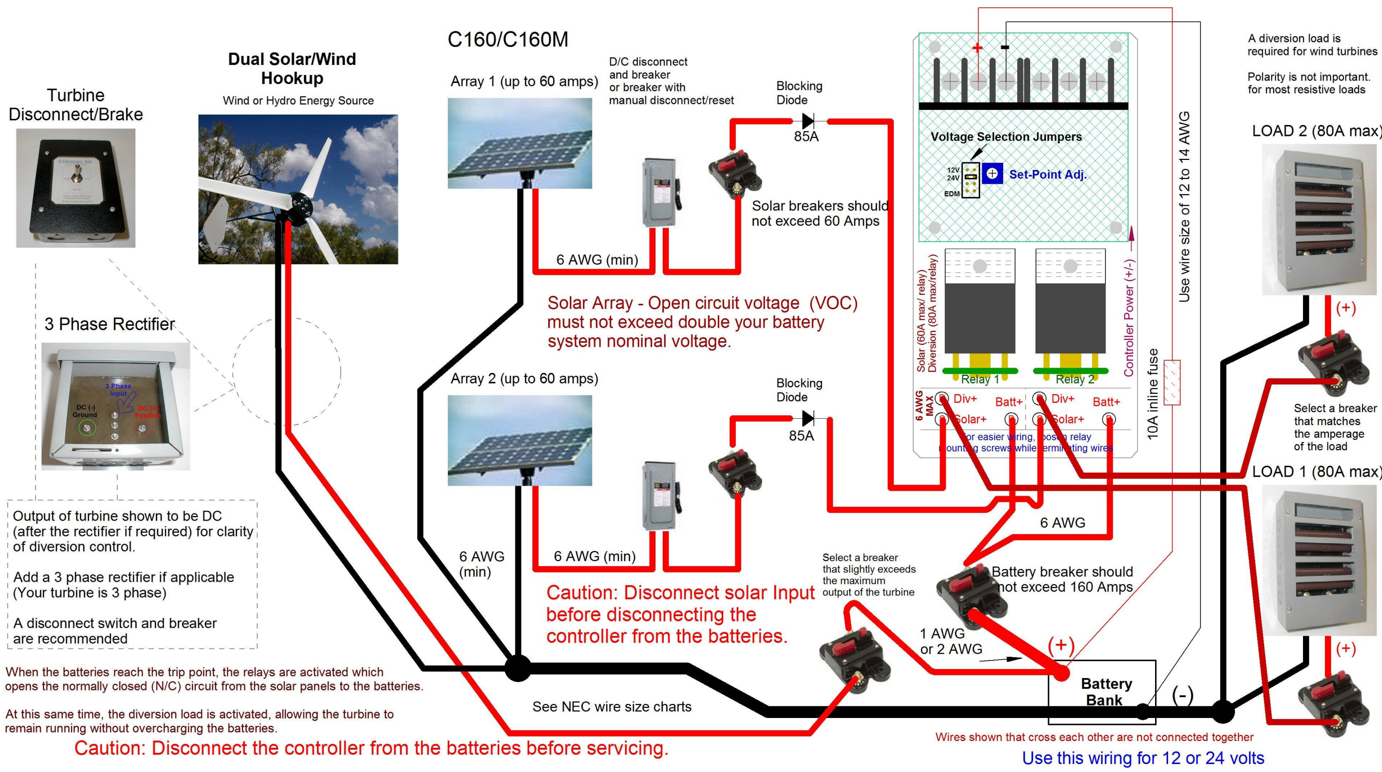
2 Hookup the negative side of your panel(s) to the negative post of your battery bank. Having a negative buss-bar is helpful.

3 Run a wire from the positive post of your battery breaker to the Battery+ terminal of each relay. (Bottom right). Note: It is not necessary to run to the Batt+ wire of a relay if you will not be using that relay.

4 Run a pair of 12 AWG (gauge) or 14 AWG black and red wires to the upper terminals of the controller. It is important that the red positive wire be fused or has a small breaker. A 5 to 10 amp inline fuse is recommended.

Hint: Loosen the nuts that hold the two relays in-place to allow easier access to the relay termination lugs. Tighten these back when you have completed the hookup and before powering up your controller.

Dual Control for wind (or hydro) and solar.



Simply combine the hookup instructions of the two earlier diagrams to complete the terminations for the dual solar/wind hookup.

*1: Blocking diodes are required for solar panels to prevent discharge at night. They are often installed on the back of the panels.

Please review the installation instructions for your solar panels. The drawing above shows a larger blocking diode inline with the wire going to the controller; you may also install the blocking diode in this manner as well. A fuse or breaker is required for safety. Please use a fuse of no more than 60 amps, per array a 12v system, and 50 amps per array for 24v.

Please note: this controller does not include a blocking diode nor any A/C to D/C rectifier, as these are specific to your application. If you are using the controller with a DC turbine or solar panels, you may need to purchase a blocking diode. A/C turbines require rectification from A/C to D/C.

*2 Important: If your solar panels charge current will exceed 60 amps, then you must you split the current flow through the relays by hooking up ½ of your panels to one relay and ½ of the panels to the other relay. This will ensure that no single relay is forced to carry more than its rated load should one relay engage or disengage prior to the other.

Do not use solar panels that have a VOC (Voltage, open circuit) that exceeds double your battery nominal voltage. For instance, a 12 volt system requires 12 volt panels with a preferred VOC of around 18 volts, and does not exceed 24 volts. A 24 volt system should use 24 volt panels which have a preferred VOC of around 36 volts, and does not exceed 48 volts.

A 24 volt system may use 12 volt panels if each two 12 volt panels are tied in series to make a “24 volt pair”. These pairs are then tied in parallel as necessary to complete the array hookup.

Parallel means Red (+) to Red (+) and Black (-) to Black (-) for all panels in the array.

Series is Red (+) to Black (-)

Extended Diversion Mode – EDM

Applicable for the diversion mode only (Wind/Hydro)

The basic operating philosophy of a diversion controller is quite simple. Monitor the battery voltage, and if it should rise to a predetermined level, connect a diversion load, of sufficient size, to the battery or energy source to prevent the battery voltage from increasing any further. The amount of time the diversion load is connected is generally only 10 to 30 seconds. In this amount of time, the battery voltage will have dropped enough to be back in the normal region. The controller will continue to engage and disengage the relays as often as necessary to prevent battery overcharge. This is the normal mode of operation. The microprocessor uses several advanced algorithms to prevent rapid relay cycle, yet it is common for the relays to be engaged and disengaged a few times a minute. This constant attention keeps the batteries very close to (or just below) the trip point you have set.

There are however, situations where you would really like the controller to engage the relays for a longer period of time once the batteries get to a "Full" state. This is what we call Extended Diversion Mode. When you enable this mode (see jumper settings below), and the batteries reach the trip point you have set (the same trip point as the normal mode), the control will engage the relays for approximately five minutes or until our batteries are depleted by 15%, which ever comes first.

The EDM mode is very useful for running such items as water pumps or small grid tie inverters that you do not want turning on and off every few seconds. When you enable the EDM mode, the wiring remains the same; the difference is that the load you connect will be engaged for a longer period of time.

It is very important that the load you choose is 100% dependable if this controller is being used to prevent battery overcharge. If the load is not present, then your batteries will overcharge. Grid-tie inverters are not a load if the grid fails (power outage due to thunderstorm etc.). Such a loss of load can also cause damage to your wind turbine if it depends on this load.

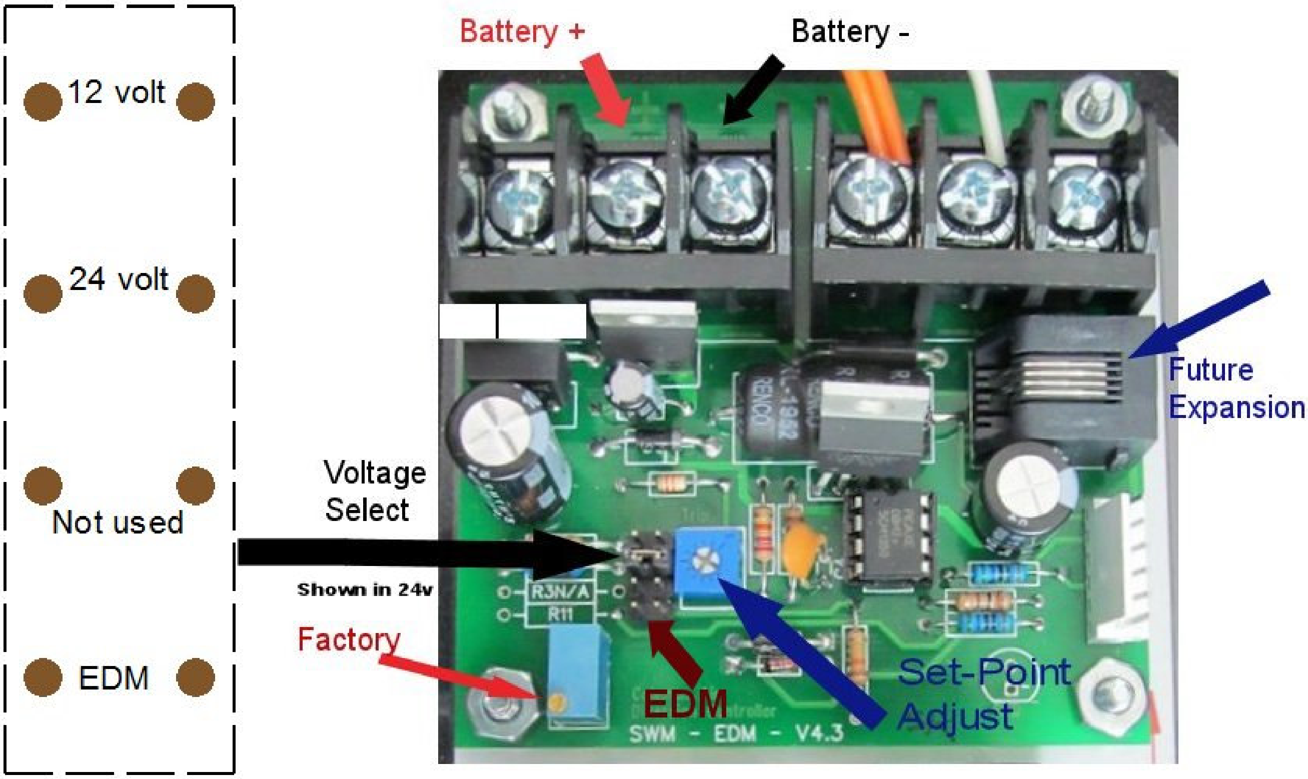
If you will be using the EDM mode with a load that may not be present at all times, then it is important that you have another controller in parallel that is also monitoring the system with a slightly higher trip point. This second, failsafe controller will then divert the excess energy to a diversion load that is 100% dependable should the 1st controllers load not be present or capable of disbursing all of the excess energy.

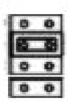
As in the case with the normal mode, the load you connect cannot exceed the capacity of the relays. Do not attempt to hookup highly inductive loads (motors larger than 10 amps per relay), as the relays will be damaged due to high currents during the motor start.

Important. Pressing the test button with the EDM jumper set, may at times engage the relays for a full 5 minutes. This is especially true if you have pressed the test button for a very short time or have pressed it repeatedly.

Jumper Settings: Changing from 24 volt to 12 volt operation.

To set the controller for use with a 12 volt system, place the jumper in the 1st position, closest to the large terminal block.




←This jumper position would select a 24 volt system.

For a 24 volt battery bank, set the jumper in the 2nd position. (As shown in the image above.)

Position 3 is not used.

Position 4 enables the EDM mode. This mode can be used with both 12 and 24 volt modes. As shipped, this jumper will be hanging one terminal only. We have shipped it in this manner so the jumper is available to you but not actually being used. To enable EDM, place the jumper across both of the pins on the end of the jumper. (Farthest from the larger terminal block)

Calibrating the Diversion Controller.

The factory using the following settings has already calibrated the controller.

The green led indicates the voltage level of the battery.

1 - (One) Flash indicates the battery is less low -- less than 12 volts (Double for 24 volt systems.)
2 - (Two) Flashes indicates the battery is 12 to 12.3V
3 - (Three) Flashes indicates the battery is 12.4 to 12.7v (A fully charged lead acid battery at rest)
4 - (Four) Flashes indicate the battery is 12.8 to 13.1V
5 - (Five) Flashes indicates the battery is above 13.2V but less than 13.5V

Steady green means the battery is full

The Red LED is illuminated when the battery has reached a voltage level of 14.5v or higher

Please note: A battery at rest will have a lesser voltage than a battery that is receiving a charge current. A fully charged lead acid battery that is not receiving any charge current, and not running any loads **(the battery is at rest) will show 3 flashes.** This same fully charged battery receiving a charge current (of at least 13.5 volts) would show a steady green light.

If you would like to change the dump level trip point, please use the following procedure.

If you own a variable voltage power supply**,** then the following procedure is recommended.

Note: Disable the EDM Jumper, while calibrating.

1) Turn the dump level potentiometer fully counter clockwise.
2) Set the voltage of the power supply to the desired dump level trip point (for instance 14.2 volts)
3) Slowly turn the dump level potentiometer clockwise until the green LED is illuminated steady.
4) Pause for at least 5 seconds, then slowly continue to turn the dump level potentiometer clockwise until the red LED is illuminated.
5) Lower the voltage of the power supply by at least one volt.
6) Slowly turn the voltage of the power supply up until the red LED is illuminated, checking to see if you achieved your desired setting. Please note; the input level is only checked once every 5 seconds while the green LED is flashing, and only once every second while the green LED is steady, so you must make very slow adjustments during this procedure. If you feel you have passed your set point, then restart the procedure. Turning off the power supply to force all voltages to be dissipated, can be very helpful.

Please note: Changing your dump level set point will also change the voltage levels for which the green LED flashes.

If you do not own a variable voltage power supply, or would rather set the controller while it is installed, then if you have an inverter that is able to set the float or bulk charge voltage of the battery bank to a particular level, use the inverter as your variable voltage supply.

If you do not have an inverter that is capable of this, then you will need to cause your batteries to be brought to desired dump level trip point via your wind/solar/hydro energy source. Then once they have achieved this set point, turn the dump level set point potentiometer fully counter clockwise. Wait 15 seconds, or until the green LED is flashing no more than 3 times. Then slowly turn the same potentiometer clockwise until the green LED is illuminated steady. Wait 5 seconds, then, slowly turn the same potentiometer until the RED is illuminated.

Note: The 24 volt trim potentiometer is set by the factory to insure both the 12v and 24v settings are the same. This pot does not need to be adjusted by the user due to the fact you are only concerned with the trip point on your specific battery bank, and will not be concerned if it remains correct for other size battery banks.

www.ColemanAir.us

Coleman Air, Inc
Made in the U.S.A.

Some electronic components have been imported.

Technical specifications and further information is available at www.ColemanAir.us