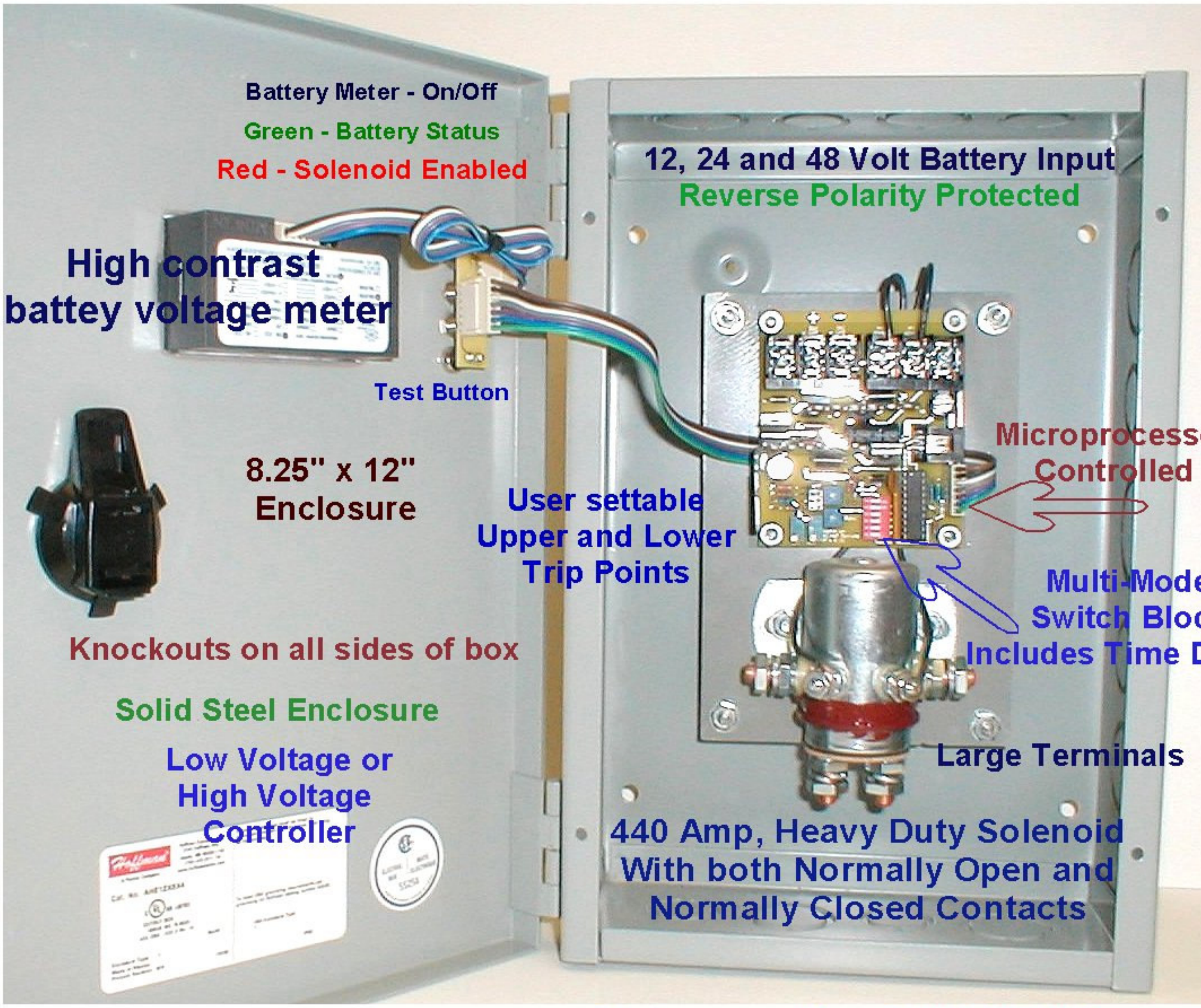
Coleman Air

C440-MMC
440 Amp Multi-Mode
Diversion/Load Controller
Version 1.0



Coleman Air - C440 MMC
440 Amp Multi-Mode Controller

Introduction

The Coleman Air MMC (Multi-Mode Controller) is an extremely capable, highly flexible multi-mode, multi-set point controller, specifically designed as a load controller for alternate energy systems. It can perform both as a high voltage or low voltage cut-in/cut-out controller with user settable trip points and time delays.

Although this controller can function as a standard charge controller, the additional functionality built into this controller allows it to be used for much more specialized applications where a standard charge controller simply would not provide the proper level of control.

If you need only battery overcharge protection, please consider one of our standard diversion controllers, as they are more specifically designed for such an application.

One of the most common uses of this controller is to turn on (or off), a load once a voltage level has been reached (either a high or low voltage) and keep it on (or off), until the 2nd voltage level is reached and/or until a certain amount of time has passed. More detail on this subject is provided later in this manual.

Some of the key features of this controller are:

- **Microprocessor controlled** -- This is very important for both stability and functionality.
- **User changeable settings –** Both the low voltage and high voltage trip points can be user adjusted.
- **Works with 12, 24 or 48 volt systems–** Easy to set jumper allows use on 12, 24 or 48 volt battery based systems.
- **Can engage or disengage the solenoid on either a low or high voltage trip**.
- **Time delays from 1 minute to 76 minutes**
- **Can be forced to stay engaged (or disengaged) until both the voltage set point is reached and (or) the time delay has been reached.**
- **High amp rating** - 440 amps, 10,000 watts.
- **Solenoid has fully isolated normally open and normally closed contacts**.
- **High Contrast LED battery voltage meter**.
- **On/Off switch for Meter**.
- **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?
- **Reverse polarity protected –** This unit will not be damaged if you inadvertently reverse the battery sense lines.
- **Steel enclosure** - with multiple conduit openings.
- **Large terminals** - that can actually terminate large wire
- **Ability to divert the source** from the batteries to the load, or dump both the batteries along with the source. – Perfect for use with wind systems.
- **Ability to be used as a disconnect controller. –** Perfect for use with both wind and solar systems, including both at the same time.
- **Ability to control large loads including induction motors, pumps, grid-tie inverters etc.**

General Information:

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 and based on this input information the Green LED flashes or is illuminated as follows:

> One flash indicates the battery is less than the lower trip point.
> Two flashes indicate the battery is equal to or slightly higher than the lower trip point.
> Three and four flashes indicate the battery is in a mid-state between the lower and upper trip points.
> Five flashes indicate the battery is very close to the upper trip point.
> A steady green LED means the battery is at or above the upper trip point.
>
> **Voltage settings are adjustable.**

The red LED is illuminated (and the solenoid engaged) when the battery reaches the primary trip point. The relay remains active until the opposite trip point has been reached and/or the time delay has expired. (See discussion on switches 5 and 6.) If switch 5 is turned on, then the red LED and the solenoid will be OFF when the battery reaches the primary trip point.

When you click the test push-button - the full relay cycle is initiated. If you have set a 16 minute time delay, then the relay will be engaged for a full 16 minutes.

Functions as either **a high voltage controller** or a **low voltage controller**.

High amp rating -- 440 Amps, 10,000 Watts -- This is a big controller.

> **About wire size -- 440 amps is a lot of current! – Insure you have selected an adequate size wire for the amperage you will be controlling. Undersized wire can result in high heat build up in the wire and connections possibly leading to a fire.**
>
> **Use a fuse or DC disconnect! Hooking up an alternate energy source or a load without a fuse or disconnect can result in serious injury or death!**
>
> **Use extreme caution when installing or servicing this controller. High amperages can KILL you. – Always disconnect the energy source before servicing this unit.**

If you need battery overcharge protection only, please consider one of our standard diversion controllers, as they are more specifically designed for such an application.

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 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.

Primary Modes:

The Coleman Air MMC controller can function as either **a high voltage controller** or a **low voltage controller**. In either mode, both the upper and lower voltage trip points can be adjusted, yet the two modes are distinctly different:

Before explaining these primary modes of operation, it is necessary to discuss a few terms.

Primary set point: The primary set point is the upper voltage set point if the controller is configured as a high voltage controller, and the low voltage trip point if the controller is configured as a low voltage controller. The primary set point is adjusted via the top potentiometer as shown in the image on page 7 labeled “Set Point”.

Switch position 5. In both modes, once the primary trip point has been reached, the solenoid is engaged until the opposite set point is reached and/or the specified time delay has expired. If you turn switch position 5 on, then the relay will be disengaged (not engaged). Basically, switch position 5 causes the operation of the solenoid to be opposite of normal. Switch position 5 does not cause the controller to be a low voltage controller verses a high voltage controller, it simply determines if the relay will be engaged or disengaged when the battery voltage is the “normal” range. For clarity in this manual, we will assume switch position 5 is off, and that the relay will be engaged once the primary trip point is reached.

Switch position 6: You may have noticed that we said “and/or” in the paragraph above, when discussing the time delay. Switch position 6 controls the “And/Or” functionality of the time delay.

> Switch 6 off: The relay will remain engaged until the opposite set point is reached **OR** the time delay is achieved (Either condition may be met.)
>
> Switch 6 on: The relay will remain engaged until the opposite set point is reached **AND** the time delay is achieved (Both conditions must be met.)

Configured as a high voltage controller (HVC)

A standard diversion controller (charge controller) is generally used for battery-based systems having a wind (or hydro) turbine or wind/solar combination to prevent battery overcharge. In this mode, the controller monitors the battery voltage, and if it should rise to (or above) a certain voltage, the relay is engaged, either diverting or disconnecting the incoming energy to prevent a further rise in battery voltage. This is the mode of operation for all of our other diversion controllers. For many if not most alternate energy systems, this functionally is all that is required for proper battery protection.

When the Coleman Air MMC controller is configured as a high voltage controller, it basically functions as a standard diversion controller with the following additional functionality.

1) The lower trip point can be adjusted as required to match your exact requirements.
2) The amount of time the relay stays engaged (or disengaged) can be specified.

When configured as a high voltage controller the following principles of operation are applied.

The battery voltage is monitored and should the voltage rise to the upper trip point, then the relay is engaged (or disengaged depending on switch position 5), until the battery voltage drops to the lower voltage trip point and/or (Switch 6) the time delay expires.

As a high voltage controller, when the battery voltage rises to the upper trip point, the timer is started.

As a low voltage controller (LVC)

When configured as a low voltage controller the following principles of operation are applied.

The battery voltage is monitored and should the voltage drop to (or below) the lower trip point, the relay will be engaged (or disengaged depending on switch position 5), until the upper voltage trip point is reached and/or (Switch 6) the time delay expires.

A low voltage controller is generally used to engage (or disengage) a device or load until the time delay expires and/or the higher voltage trip point is reached.

A common use for a low voltage controller is to engage a battery charger for a specific amount of time, and/or until the batteries reached a settable high voltage point. We will discuss more uses for this mode later in this document.

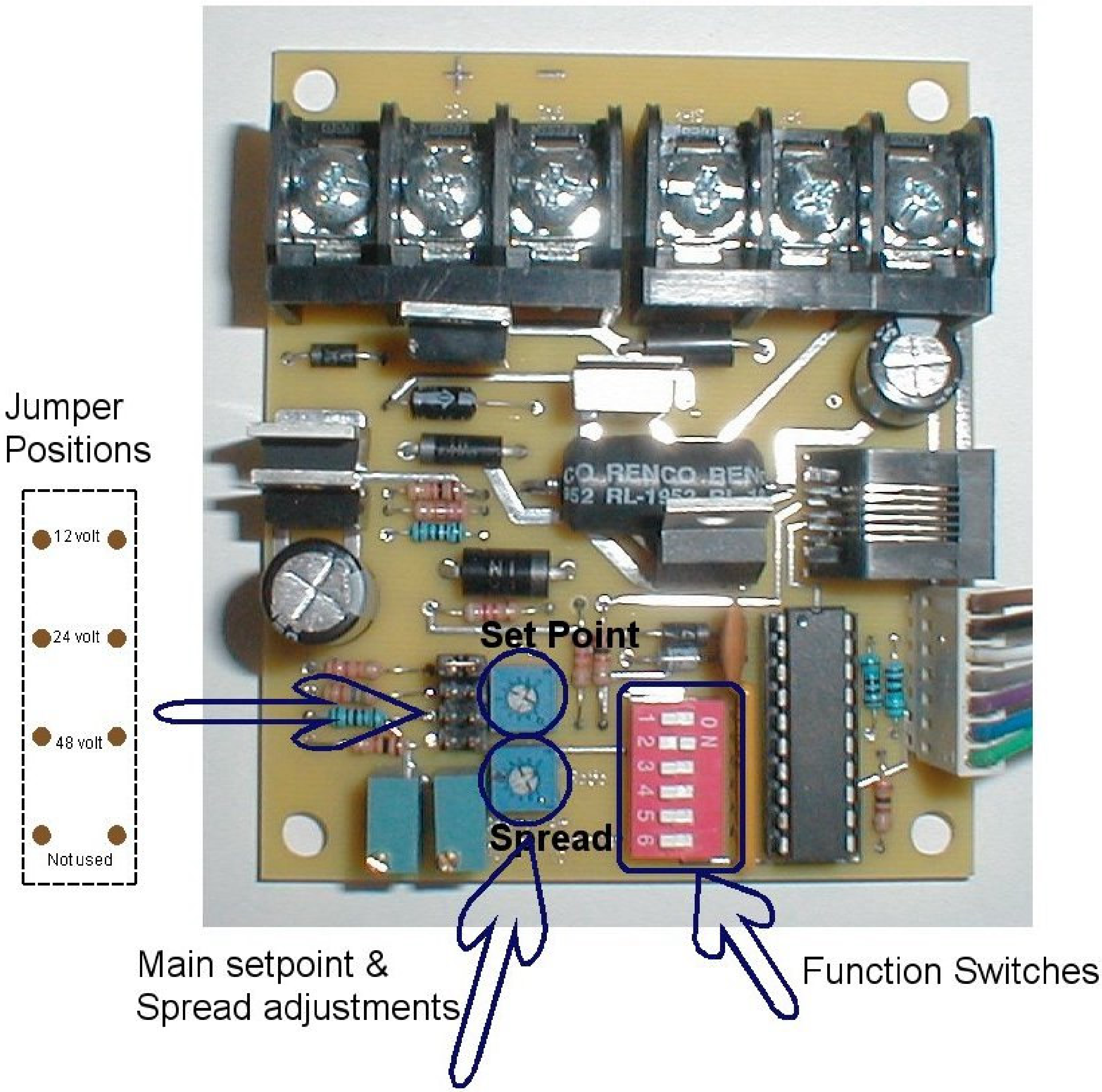
As a low voltage controller, when the battery voltage drops to the lower trip point, the timer is started.

Selecting the Primary mode of operation is discussed later in this manual.

More about switch 5:

An important consideration in determining whether to use the normally open or normally closed contacts, verses using switch 5 to reverse the way the solenoid is engaged is 1st to consider this primary factor. What would happen if the voltage were to drop to a point that the controller could no longer engage the solenoid? It takes a voltage of at least 10 volts (11 is recommended) to pull in the solenoid, and at least 7.5 volts to keep it pulled in. So when you decide on your hookup scenario, keep in mind that you should allow for a failsafe condition. That is, if the battery voltage should drop quite low – which contacts on the solenoid offer the safest condition should the solenoid be disengaged due to lack of power to pull it in or keep it pulled in. If you feel it is very unlikely that the voltage would continue to drop to a point the solenoid cannot be engaged, or that there is no major adverse affects should it not be pulled in, then use the mode that is easiest to understand and/or demands the least amount of power in your total system. The controller uses only a few milliamps if the solenoid is not pulled in. Once the solenoid is engaged, it will draw between 12 and 15 watts of power.

Switch and Jumper settings:



The voltage jumper block allows you to configure the controller for a 12, 24 or 48 volt battery bank. Please move the jumper as necessary, to match your battery bank.

The two potentiometers in the middle of the circuit board (shown with blue circles around them), allow you to set both the upper and lower trip points. This will be explained in detail below.

The function switch block (Red bank of slide switches numbered 1-6), control the time delay and other specific functionality of the solenoid.

The two small rectangular potentiometers on the bottom left are for factory use only.
The RJ-11 connector is for future expansion only.

Switch Positions 1-4 control the time delay.

Position 1: - Adds 5 minutes to the time delay
Position 2: - Adds 10 minutes to the time delay
Position 3: - Adds 20 minutes to the time delay
Position 4: - Adds 40 minutes to the time delay

<u>If all switches are off, the time delay will be 1 minute.</u>
If you turn on all switches, you have set a time delay of 76 minutes. (1 + 5 + 10 + 20 + 40)

You many turn on or off any combination of switches to achieve a time delay that best matches your requirements. For instance, turning on switch 1 and 3 will yield a 26-minute delay. (1 + 5 + 20)

Please note: Time delays are approximate, and may very by +/- 5%

Switch position 5. In both modes (low voltage controller or high voltage controller), once the primary trip point has been reached, the solenoid will be <u>engaged</u> until the opposite set point is reached and/or the specified time delay has expired. If you turn switch position 5 on, then the relay will be <u>disengaged</u> (not engaged). Basically, switch position 5 causes the operation of the solenoid to be opposite of normal. Switch position 5 does not configure the controller to be a low voltage controller verses a high voltage controller, it simply determines if the relay will be engaged or disengaged when the battery voltage is the "normal" range. For clarity in this manual, we will generally assume switch position 5 is off, and that the relay will be <u>engaged</u> once the primary trip point is reached.

Switch position 6: You may have noticed that we said "and/or" in the paragraph above, when discussing the time delay. Switch position 6 controls the "And/Or" functionality of the time delay.

Switch 6 off: The relay will remain engaged until the opposite set point is reached **OR** the time delay is achieved (Either condition may be met.)

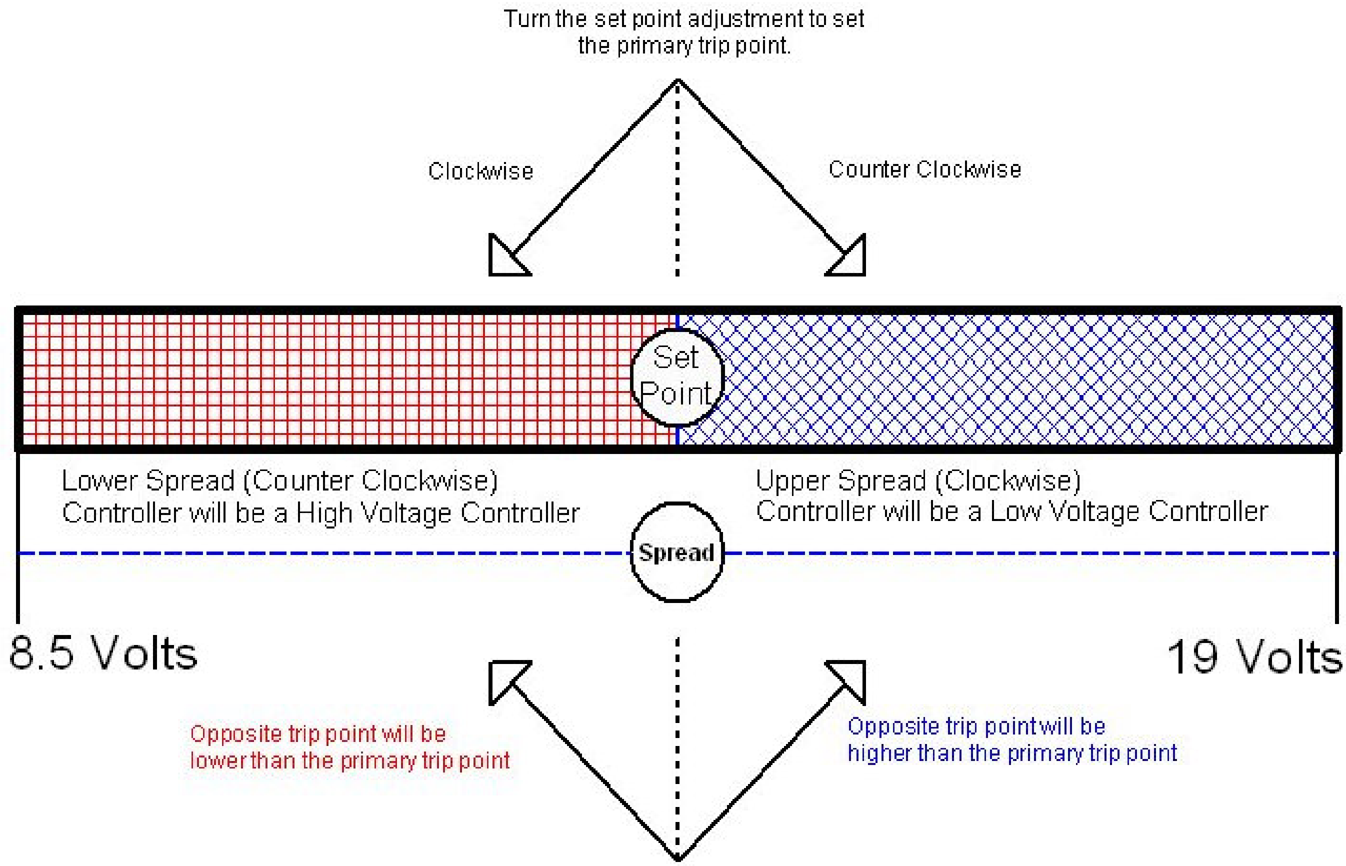
Switch 6 on: The relay will remain engaged until the opposite set point is reached **AND** the time delay is achieved (Both conditions must be met.)

We have calibrated the controller as a high voltage controller (HVC), using the following voltage settings.

Upper Trip Point (On)	Lower Trip Pont (Off)	
14.4	12.5	(With jumper set to 12 volts)
28.8	25.0	(With jumper set to 24 volts)
57.6	50.0	(With jumper set to 48 volts)

Primary Set Point (Set Point potentiometer) and the Spread potentiometer:

The set point and spread adjustment potentiometers allow you to set both the upper and lower trip points. The position of the spread potentiometer also determines if the controller will function as a low voltage controller or high voltage controller. Please refer to the image below as well as the image on page 7.



Voltages reflect a 12-volt system; double this for 24-volt systems, quadruple for 48-volt systems.

If the spread adjustment is turned clockwise from center, the controller will function as a low voltage controller. In this mode, you will set the lower trip point via the set point adjustment (Primary set-point), and adjust the upper voltage trip point using the spread potentiometer.

If the spread adjustment is turned counter-clockwise from center, the controller will function as a high voltage controller. In this mode, you will set the upper trip point via the set point adjustment (Primary set-point), and adjust the lower voltage trip point using the spread potentiometer.

Turning the primary set point adjustment moves both trip points. Moving the spread adjustment causes the opposing trip point to move away from (or come closer to) the primary trip point. The greater one direction or the other you turn the spread adjustment, the further the opposing trip point will be from the primary trip point. The primary trip point is unaffected by a change in the spread adjustment. If the spread adjustment is set to exactly midway, then both trip points will be set to the same voltage level.

About load diversion (High voltage controller)

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, 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.

   The wiring diagrams in this document demonstrate how to dump the batteries along with the source. Should you desire to disconnect the source from the batteries and send it to the load directly, simply utilize the N/C contacts of the relays as well. We'll be happy to send you a diagram -- this is a very simple change.

On our standard diversion controllers, the relay will stay engaged until the batteries drop by about five percent, or basically until the batteries are no longer in an over voltage condition. The lower trip point is not adjustable, but simply follows the upper trip point. This is all that is required (and generally more desirable) for battery overcharge protection.

When the Coleman Air MMC controller is configured as a high voltage controller, it basically functions as a standard diversion controller with the following additional functionality.

1) The lower trip point can be specifically adjusted as required to match your exact requirements.
2) The amount of time the relay stays engaged (or disengaged) can be specified.

This allows the Coleman Air MMC controller to provide both overcharge protection as well as timed load control. A common use of this controller in this mode is to turn on a pump or perhaps grid tie inverter for say ½ hour once the batteries reach a fully charged condition.

Note: If your grid-tie inverter has the capability to send the power to the grid when the battery voltage is within a certain range, then you do not need this controller to provide such functionality. In that case your grid-tie inverter should be hooked up directly to your batteries. Most modern, advanced grid-tie inverters allow you to select the voltage your batteries must be at before sending energy back to the grid.

Diversion Load Types (High voltage controller)

A diversion load needs to be larger (by at least 20%), than the sum total of all your solar/wind/hydro charge sources combined. When the diversion load is too small, battery voltage may continue to rise, even when the dump is active. It is also important to use a load that is not likely to fail. Light bulbs and similar such loads are not good diversion (dummy) loads, since they will fail and you may be left with no method to dump the excess energy from your batteries. A common dummy load is a standard 120vac, 2000 watt heating element readily available from your local hardware store. Please note, a 2000 watt element will not dissipate 2000 watts at lower voltages, therefore you may need to install multiple elements in parallel to achieve the desired load specifications.

Please use the following chart as a quick guide in using 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

Another acceptable diversion load are power resistors. These can be obtained at most electronics resellers and are often available via online auction sites.

Use the following chart values of power resistors to obtain a 500-watt diversion load.

60Vdc dump (48Vdc system) -- (1) 500 watt, 8 ohm resistor (450 watts)
30Vdc dump (24Vdc system) -- (1) 500 watt, 2 ohm resistor (450 watts)
15Vdc dump (12Vdc system) -- (1) 500 watt, .5 (1/2) ohm resistor (450 watts)

The 500 wattage rated resistors in the chart above are an example only, it is perfectly acceptable to use higher wattage power resistors if they can be obtained economically.

Place multiple resistors in parallel for a higher wattage load. When you place 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 500 watt power resistor of 2 ohms on a 48 volt battery system (60v dump), will result in the dissipation of 1800 watts, however the resistor is only rated at 500 watts, and will be destroyed.

Please visit our online store for a selection of diversion loads, diodes and rectifiers.
http://www.ColemanAir.us

Using the Coleman Air LVHC controller as a low voltage controller.

The battery voltage is monitored and should the voltage drop to (or below) the lower trip point, the relay will be engaged (or disengaged depending on switch position 5), until the upper voltage trip point is reached and/or (Switch 6) the time delay expires.

<u>As a low voltage controller, when the battery voltage drops to the lower trip point, the relay is engaged and the timer is started.</u>

One of the reasons we built this controller was to provide a solution for customers who own inverters that incorporate an A/C bypass. These inverters basically power all devices from the grid if the grid is present. They also constantly charge the batteries keeping the batteries topped off at all times. This functionality is great for battery maintenance and longevity; yet a great deal of energy created from your alternate energy sources may be wasted since the inverter will often have charged the batteries during the times the alternate energy sources are unavailable. For instance, these inverters will often have fully charged the batteries overnight, then when the sun shines the next day, there may be nowhere to go with the solar energy as the batteries are already full.

A manual solution for such circumstances is often to disconnect the A/C input (via a disconnect switch) going into the inverter, preventing it from charging the batteries and or powering the devices, which are hooked up to the inverter's output. Then when the battery voltage drops, the A/C disconnect is again closed (manually), to allow the inverter to see the grid. This solution often leads to fully discharged batteries since if not constantly monitored, the inverters load may exceed the solar/wind input to the inverter and deplete the batteries. Every time you deplete the batteries (deep cycle), you take a little life from them. In general, this simply is not a good long-term solution.

The Coleman Air MMC controller solves this problem perfectly.

By configuring the controller as a low voltage controller, with a primary set point around 12 to 12.3 volts, and an upper set point at around 13.8 volts, and then wiring the inverters A/C input through the solenoid contacts, the controller will provide the exact functionality needed for this application.

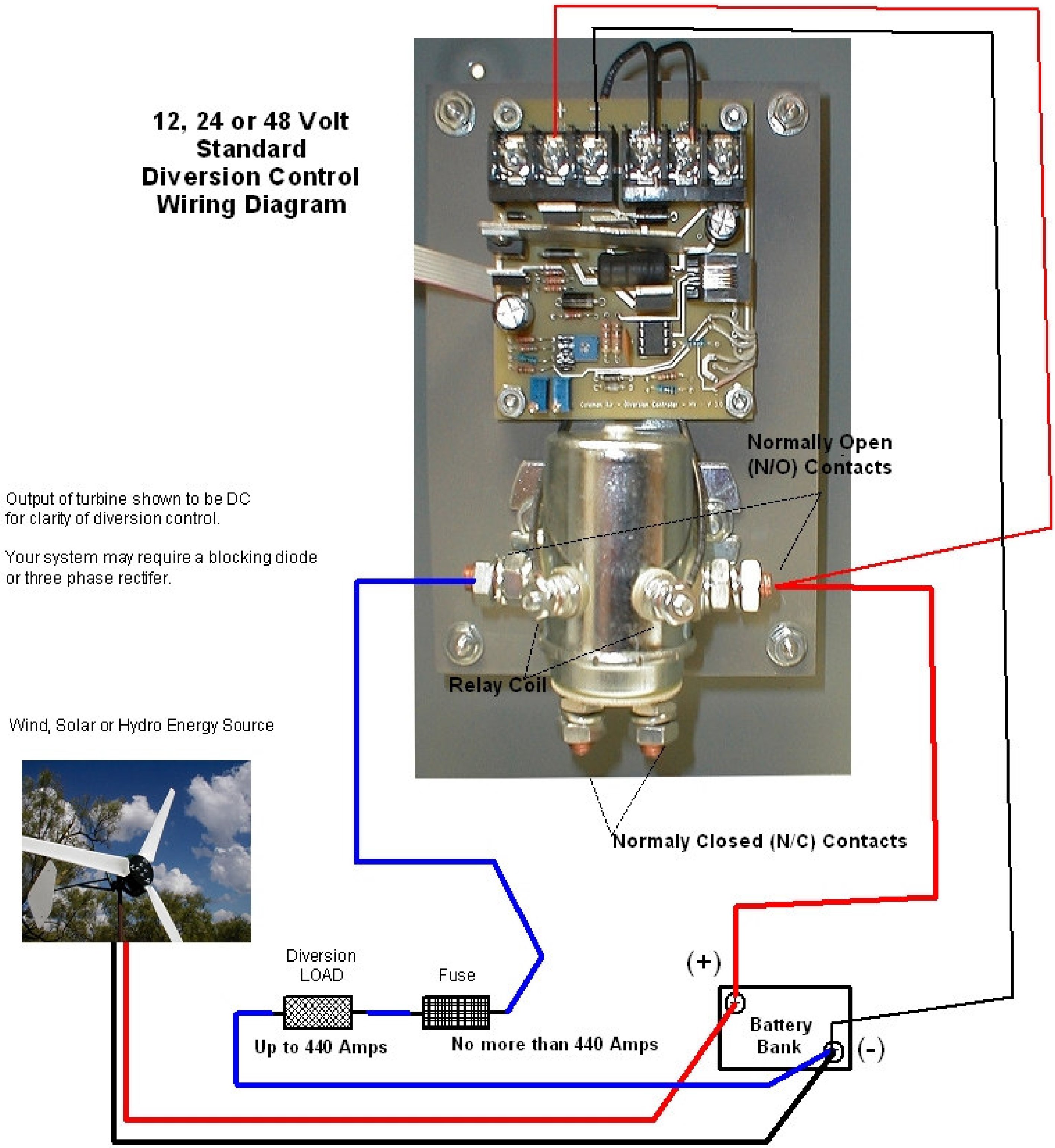
Here is how it would work in greater detail. When the controller is 1st turned on, and the batteries are between 12 and 13.8 volts (or whatever set points you configure), then the solenoid will be in the normal disengaged[1] state. If you have wired the inverters A/C input though the normally open contacts of the solenoid, then the inverter will not see the A/C input (The solenoid will have shut if off.). All loads will be powered via the inverter and battery power along with any incoming alternate energy that is available.

Should the battery voltage drop to 12 volts, the relay will be engaged (by the controller) for the time period you have specified and/or until the batteries reach 13.8 volts (voltages are user settable.). During this time, the inverter will be provided with A/C input and begin to charge the batteries and power the inverters loads.

Once the upper trip point is reached, the solenoid will be disengaged and remain disengaged unless the voltage drops again to 12 volts, at which time the cycle will be repeated.

[1] Remember, you can use switch 5 to cause the relay to be engaged or disengaged while the batteries are in the normal range (between set points). Because the solenoid has both normally open and normally closed contacts, it is really a matter of choice, not necessity on how you set switch 5. Often it better to configure switch 5 so that the relay is off more than it is on. This provides for a more efficient system. You do need to consider however, that a certain voltage level is required to keep the relays engaged. This is discussed elsewhere in the manual.

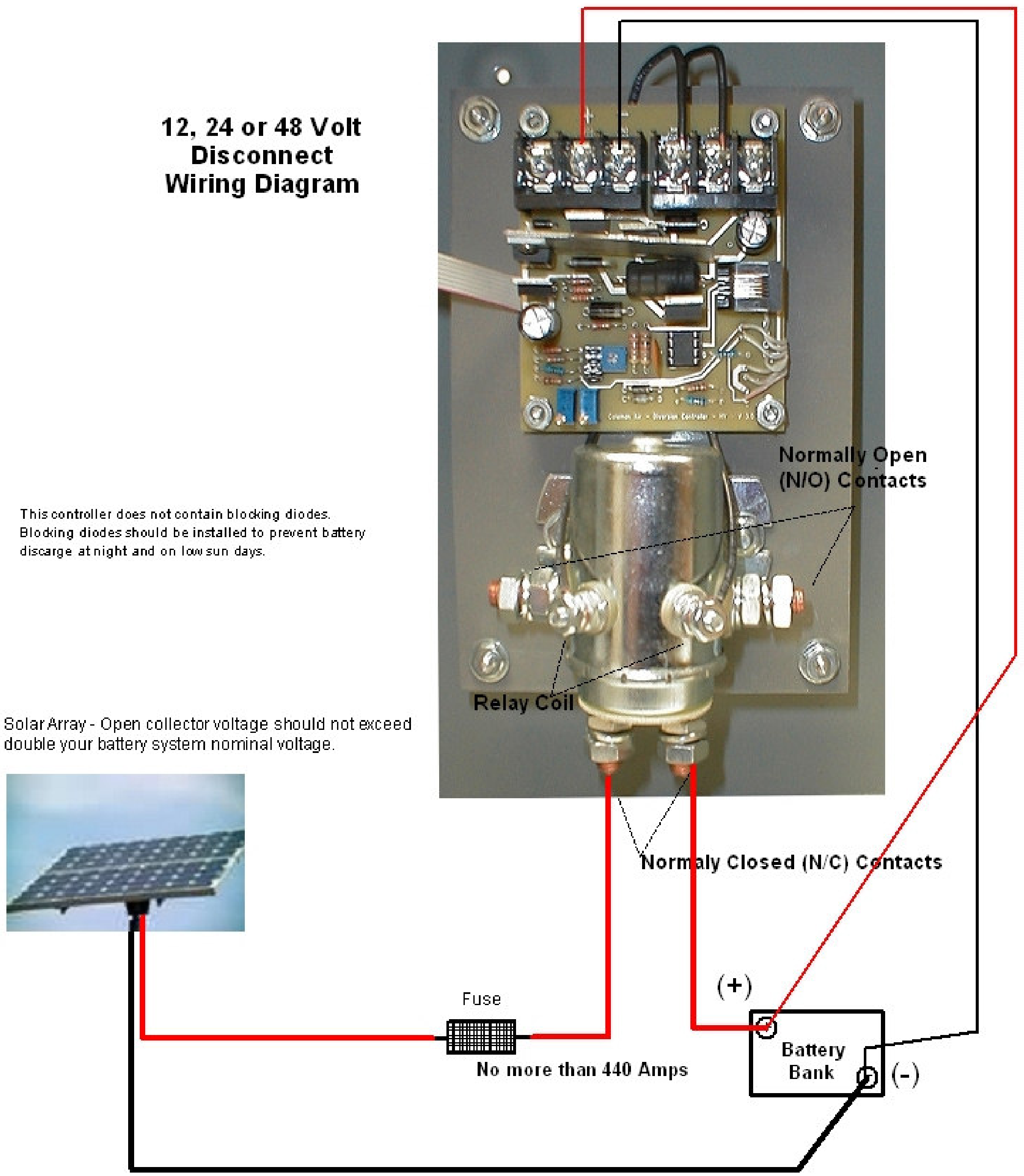
Standard wiring for 12, 24 and 48 volt battery banks



Using the controller as a disconnect controller

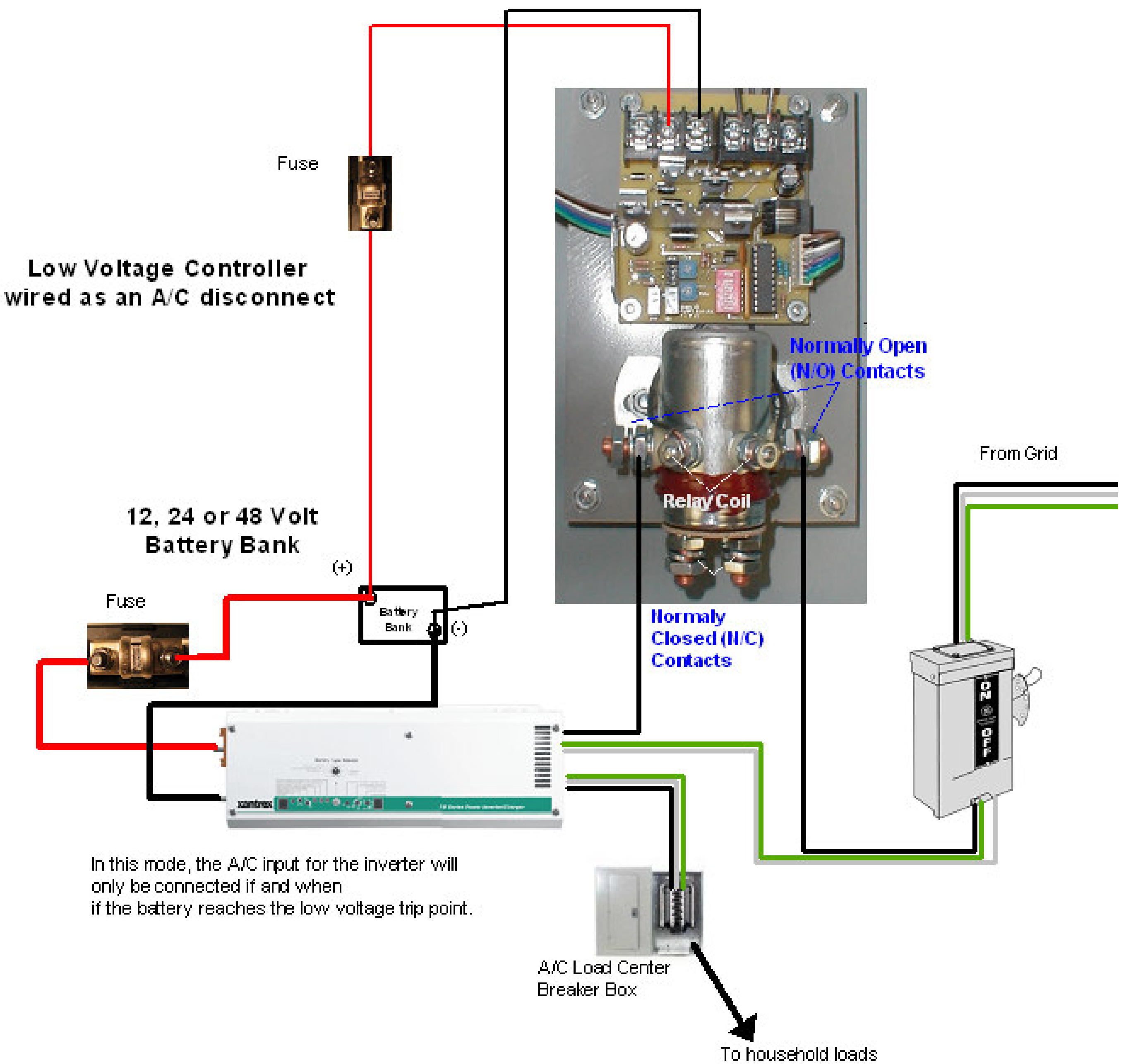
(Shown as a high voltage controller with solar panels)

Disconnect controllers are used with solar systems and other energy sources where the source does not require a constant load (Solar). Using the Coleman Air 440 Amp controller in this fashion is just a mater of using the normally closed contacts of the relay instead of the normally open contacts. See the images below.



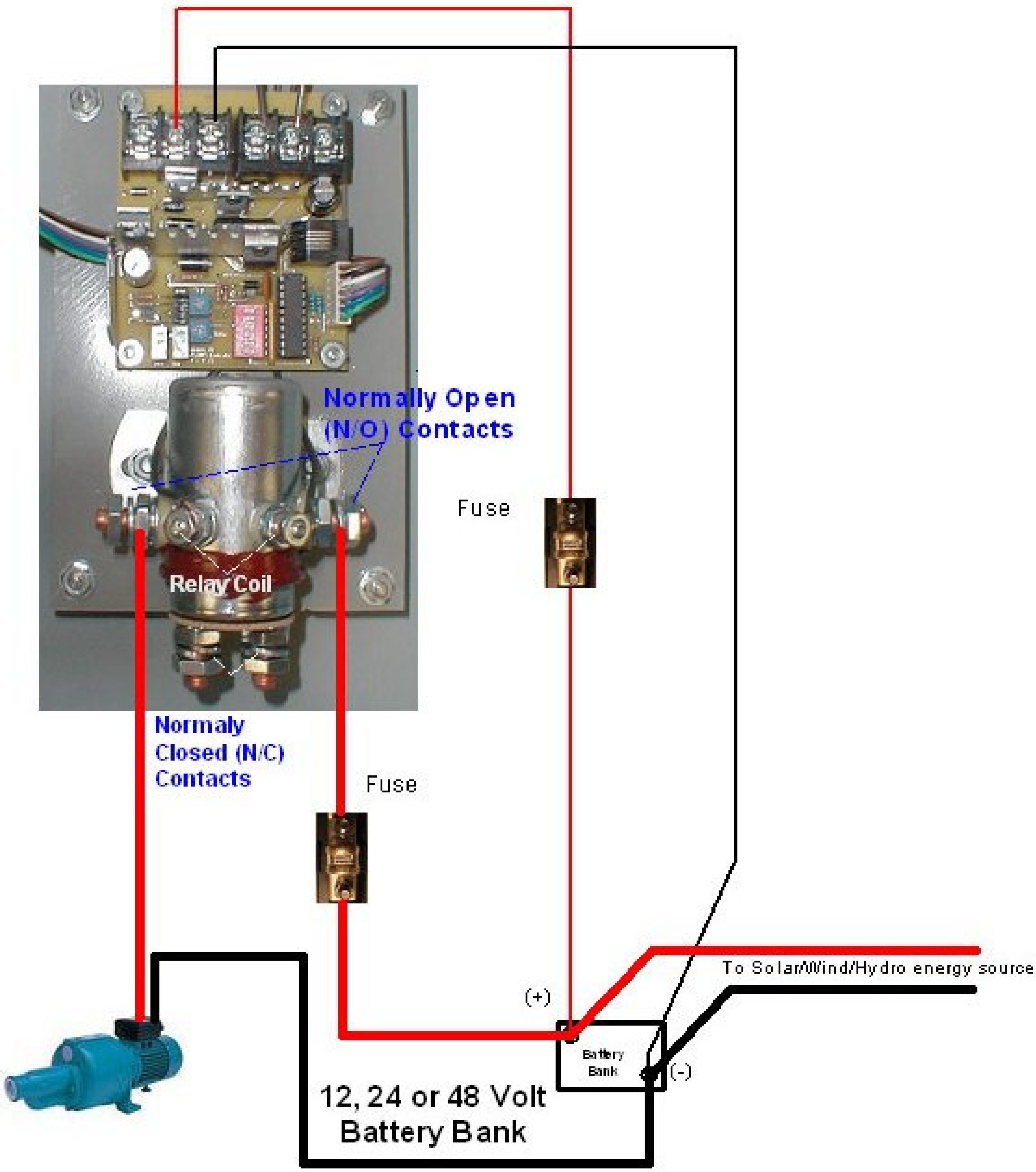
Note: Both wind and Solar can be used together by combining the two wiring diagrams.

Using the controller as an A/C disconnect
Low Voltage Controller



The image above depicts the controller as an automatic A/C disconnect for a common line of inverters, which have built in battery chargers. As depicted, the Coleman Air MMC controller has been configured as a low voltage controller with a time delay in the one-hour range. Switch 5 would be off, switch 6 on. In this mode, if the battery voltage drops to the low voltage trip point (say 12.3 volts for a 12 volt system), the solenoid will be engaged, allowing A/C power from the grid to power the inverter. This will start the inverters battery charger and will also cause the household loads to be powered by the grid. The relay will stay engaged until the batteries are charged (reach the high voltage trip point) and at least one hour has passed. At that time the solenoid will be disengaged and will remain disengaged unless the voltage drops again to the low voltage trip point. It is assumed (but not shown) that there is some sort of solar or wind energy etc. also adding energy to the battery bank, requiring that you have a 2nd controller to prevent battery overcharge.

As a D/C Load Controller



In this mode, the D/C input to the pump will only be connected if and when the battery reaches the user settable upper trip point.

This wiring is very similar to the standard diversion control wiring diagram a shown for wind. The difference is that the primary purpose of this wiring is to run the pump as long as there is sufficient battery power (not specifically to charge the batteries until they are full), so all of the available energy sources are tied directly into the batteries (via rectifiers and blocking diodes as required by your energy source.). The pump will begin to run as soon as the battery reaches the upper trip point, which in this case will be set quite a bit lower than you would for a battery overcharge protection system, perhaps in the 13 volt range. The pump will then run until the voltage drops to the lower trip point and/or the time delay expires. In this mode, the controller will be configured as a high voltage controller with switch 5 off. It is very important that the pump is very reliable or battery overcharge is a possibility. The pumps potential energy consumption must also exceed the input energy.

Calibrating the Diversion Controller

Before using your controller, you will need to calibrate it (set the trip points), as required for your system.

The 1st decision you will need to make is whether you need a low voltage or high voltage controller. Please read the discussions at the beginning of the manual for help in making this decision. Once this decision is made, simply follow the applicable procedure below.

In both modes, the green LED is used to help in the calibration process.

One flash indicates the battery is less than the lower trip point.
Two flashes indicate the battery is equal to or slightly higher than the lower trip point.
Three and four flashes indicate the battery is in a mid-state between the lower and upper trip points.
Five flashes indicate the battery is very close to the upper trip point.
A steady green LED means the battery is at or above the upper trip point.

The Red LED is illuminated when the battery has reached (or surpassed) the primary trip point. The primary trip point is the lower trip point for a low voltage controller, and the upper trip point for a high voltage controller.

If you own a variable voltage power supply**,** then calibration is relatively simple. If you do not own such a supply, but instead 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 own neither a variable voltage power supply or an inverter that is capable of setting a particular charge voltage, then you will need to cause your batteries to be brought to the desired trip points via your wind/solar/hydro or other charge source and appropriate loads. Then once the batteries have achieved each of the desired voltage points (both upper and lower, one at a time of course) set the corresponding trip points (upper or lower) using the procedures below.

During the calibration procedure, it is recommended that you have switches 1 – 4 on (full time delay) and switches 5 and 6 off. By having a large time delay with switch 6 off, the timer will not affect our calibration procedure. By setting switch 5 off, the relay will be in the normal engagement mode.

Calibrating a high voltage controller:

1) Turn both the primary set point and spread potentiometers fully counter clockwise.
2) Bring the batteries to the upper trip point voltage.
3) Slowly turn the primary set point potentiometer clockwise until the green LED is flashing 5 times.
4) Pause for at least 5 seconds, then slowly continue to turn this same adjustment clockwise until the red LED is illuminated.
5) To double-check this setting, lower the voltage of batteries by at least two volts. Disconnect or turn off the supply to the controller for 5 at least seconds, then reconnect the supply and slowly bring the voltage back 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 or lowering it substantially to force all voltages to be dissipated, can be very helpful.

6) Once you are satisfied with the upper set point, then lower the battery voltage to desired lower trip point.

7) Slowly turn the spread potentiometer clockwise until the red LED is turned off. – Important note: Please turn the potentiometer, only after counting the flashes of the green LED. As you get closer to the lower trip point the green LED will flash fewer times. When the green LED flashes only two times, you are very close.

8) You can recheck the lower trip point by bringing the battery voltage a little higher until the green LED flashes twice. Then slowly lower the battery voltage to see where the green LED begins to flash once only. The green LED will flash once only just below the lower trip point.

9) If it is not overly difficult, check both your upper and lower trip points once by bringing your battery voltage up to the upper trip point, then letting it fall to the lower trip point and verify that your settings are as you require.

10) Set the six-position switch block as required for your installation.

Calibrating a low voltage controller:

1) Turn both the primary set point and spread potentiometers fully clockwise.
2) Lower the batteries to the lower trip point voltage. If the red LED is illuminated, temporarily disconnect power and reconnect it. At this point the green LED should be illuminated steady and the red LED off.
3) Slowly turn the primary set point potentiometer counter clockwise until the green LED is flashing 2 times. Hint: Once the LED is flashing, pause and count the number of flashes before continuing.
4) Pause for at least 5 seconds, then slowly continue to turn this same adjustment counter clockwise until the red LED is illuminated.
5) To double-check this setting, raise the supply voltage by at least two volts. Disconnect or turn off the supply to the controller for 5 at least seconds, then reconnect the supply and slowly bring the voltage back down, until the red LED is illuminated. Please note; the input level is only checked once every 5 seconds while the green LED is flashing, 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.
6) Once you are satisfied with the lower set point, then raise the battery voltage to desired upper trip point.

7) Slowly turn the spread potentiometer counter clockwise until the red LED is turned off. Again, turn the potentiometer only after counting the number of flashes. Once you get to 5 flashes, you are very close and should make very small adjustments. Continue to turn very slowly and the green LED will become steady. Once the green LED is steady, the red LED will turn off.

8) You can recheck the upper trip point by lowering the battery voltage somewhat until the green LED flashes 5 times. Then slowly raise the battery voltage to see where the green LED is on steady. The green LED will be on steady when the upper trip point has been reached. Note: The red LED will not be illuminated again unless you lower the supply voltage to the lower trip point.

9) If it is not overly difficult, check both your upper and lower trip points once by bringing your battery voltage down to the lower trip point, then letting it raise back up to the upper trip point and verify that your settings are as you require.

10) Set the six-position switch block as required for your installation.