Coleman Air
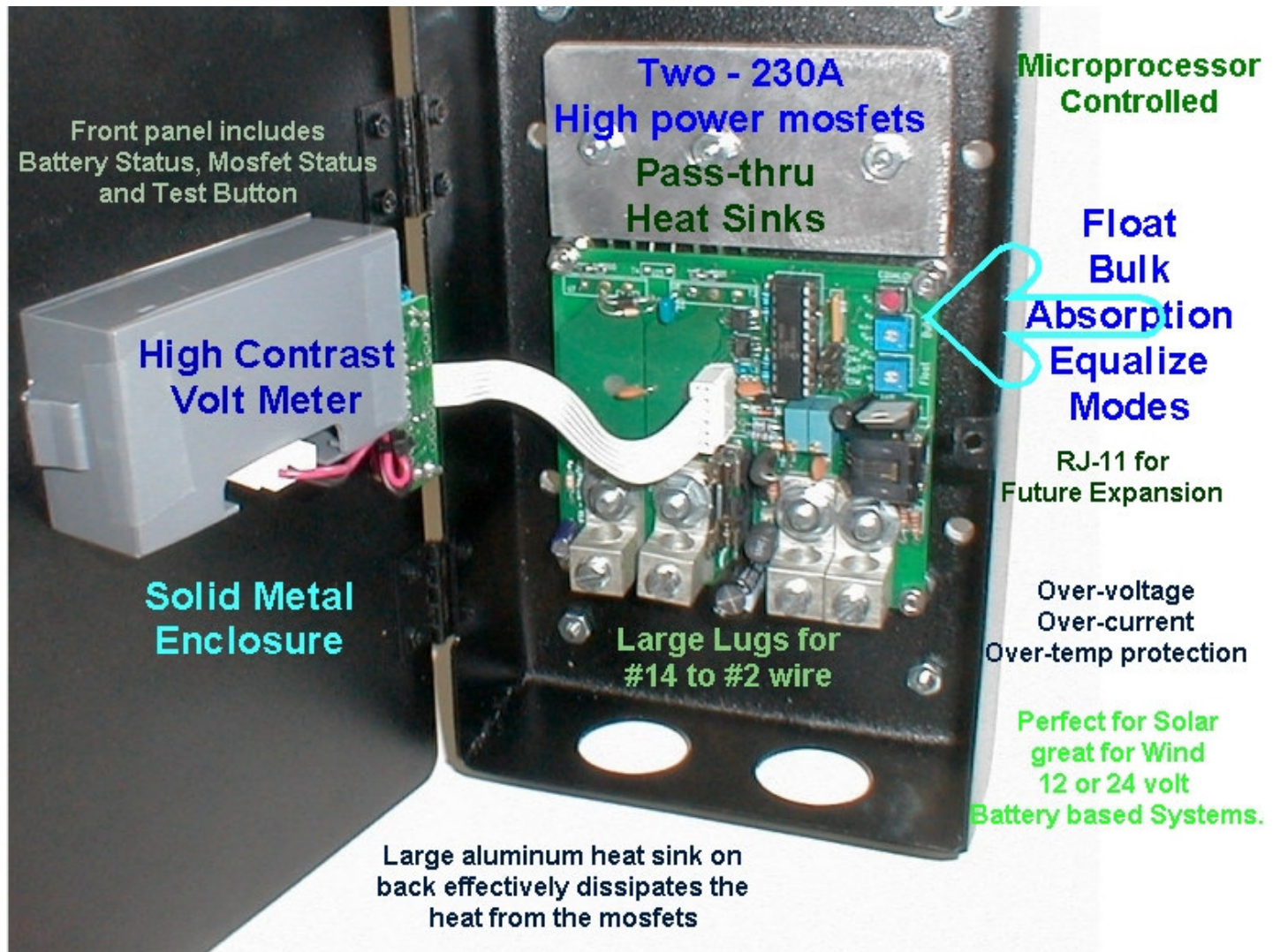
C60-PWM
60 Amp Solid State PWM Charge Controller
12 or 24 volt battery based systems
Version 2.5+

With Extended Diversion Mode and Auto Equalize

The Coleman Air C60-PWM Charge Controller

This controller is suitable for operation in a 24-volt system, which may have charge and overcharge voltages exceeding 60 volts.

60+ volts at these amperages can be LETHAL! – It only takes a micro-amp and the right (or wrong conditions) at higher voltages to kill you! Don't take chances!

Use extreme caution when installing or servicing this controller. Always disconnect the energy source before servicing this unit.
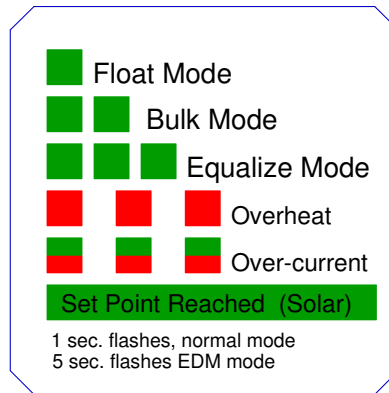
Introduction

This solid-state (no relays or solenoids) charge controller has been specifically designed for medium sized solar or turbine, battery based alternate energy systems of up to 60 amps. The Coleman Air C60-PWM uses two high-power (230 amps each), in a back-to-back configuration, allowing a significant increase in total current handling capability over competing models in this price range.

Some of the key features of this controller are:

- **Microprocessor controlled** -- This is very important for both stability and functionality.
- **Solid-State. No relays or solenoids to wear out.**
- **PWM (pulse width modulation) charging. (Charges using pulses of varying lengths)**
- **Three stage charging for better battery life.**
- **Both manual and automatic (30 day) equalize function.**
- **User changeable settings** -- Several controllers on the market set the voltage levels, and that's that!
- **High amp rating** – 60 amps solar mode or up to 60 amps diversion mode.
- **Over-current, over-voltage and overheat protection**.
- **Multiple system voltage settings** – Easy to set jumper allows use on 12 or 24 volt systems.
- **High Contrast LED battery voltage meter**.
- **On/Off switch for the meters to allow extremely low idle current.**
- **Battery and charge status LEDs** - 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 inputs.
- **Steel enclosure** - with multiple conduit openings and cooling vents
- **Large terminals** - that can actually terminate large wire, with lugs that accept up to #2 wire.
- **Extended diversion mode (EDM)**
- **Works as either a solar charge controller (series), or a diversion controller for wind/hydro systems. The controller will automatically sense the appropriate mode.**
- **Passive cooling systems uses a large aluminum plate, the entire width and height of the unit, providing continuous cooling for the entire unit allowing for proper operation at high power levels.**
- **No blocking diodes are required for solar. The back-to-back mosfets prevent reverse leakage.**
- **A PWM controller that adapts its pulse logic to perfectly accommodate wind systems.**

Note: Continuous power handling will be reduced in hot climates or installations.

The front panel decal

Float Mode

Bulk Mode

Equalize Mode

Overheat

Over-current

Set Point Reached (Solar)

1 sec. flashes, normal mode
5 sec. flashes EDM mode

Empowering Innovation

Press and hold the equalize button during power up to enable the automatic 30 day equalization.

The front panel decal describes the functionality of the two LED's (Green and Red)

Float Mode Active: Indicated by a single repeating flash of the green LED (on/off/on/off etc.)
Bulk Mode Active: Indicated by a two quick ON flashes of the green LED followed by an OFF pause.
Equalize Mode Active: Indicated by a three quick ON flashes of the green LED followed by an OFF pause.

Overheat (Cool down period active) – The Red LED will be flashing rapidly (several times a second.)
Over-current (Cool down period active) – Both Red and Green will be flashing rapidly (several times/second.)

When the controller is in the solar mode, and the currently active set point has been reached (Float/Bulk or Equalize), the Green LED will be on steady.

When the controller is in the non-EDM mode, the green LED will flash in a repeating cycle about once a second. When the EDM mode is active, the cycle of flashes will be about once every 5 seconds.

To start the equalize mode, press and hold the equalize button at any time. The equalize function will run for two hours beginning when the voltage of the battery rises to the equalize trip point.

Hold down the equalize button during power up (trip and reset the battery breaker), to enable the automatic thirty-day equalize function. Note: the 30 day function may not be exact and is likely to wander somewhat as it will not begin unless the charge source is capable of bringing the battery to the equalize voltage. A cloudy day may not allow enough solar energy to bring the batteries to the equalize voltage; therefore, the equalize charge will be delayed.

When no error is active**, the red LED will be on when the mosfets are enabled** (passing current), either allowing solar energy to flow (solar mode), or excess energy to flow to the diversion load (diversion mode).
When you click the "TEST" push-button - the mosfets are cycled. (One time unless the batteries are within the active trip point region.) Pressing the test button while in the diversion mode, with EDM active, will start a complete diversion cycle of five minutes.

Some specifics

The microprocessor is the heart of the controller. The battery level is constantly checked by the microprocessor and compared to the active mode's (Float, Bulk or Equalize) set point to determine how much (if any) current should flow into or out of the batteries. As the battery's level of charge increases, so does the voltage of the battery (the battery's level of charge can be determined by the voltage of the battery.) As the charge level increases the controller may use very short pulses of energy to "top off" or maintain the charge at the optimum level. These pulses of energy will be of varying lengths as required. This charging algorithm is referred to as pulse width modulation (or PWM), and when properly controlled, offers a very suitable method of charging deep cycle batteries to ensure good battery health and longevity.

Settings are of course user changeable! By simply turning the set point potentiometers with a **small** screwdriver, you can quickly adjust the trip point for the float or bulk mode. (Equalize mode is about 7% higher then the bulk mode).

Two very powerful 230A mosfets ensure plenty of reserve capacity above the rated 60 amps this controller has been designed to handle. The mosfets are arranged in such a manner that they can handle currents in either direction; that is, they can perform in the capacity of a solar charge controller or a diversion mode controller. The controller automatically determines the proper mode of operation. If the controller senses that there is voltage on the "Solar/Diversion" terminal then it assumes that the controller has been wired in the solar mode. If there is no voltage present on this terminal, then the diversion mode will instead be chosen. This terminal is checked often by the microprocessor to ensure the controller selects the proper mode. If no connection has been made to the "Solar/Diversion" terminals, then the mode may be either.

The controller can handle surges in excess of 80 amps; however, sustained high amperage currents will cause the unit to heat up rapidly. It is recommended that you use the controller to control currents that will not exceed the 60 amps of solar energy under the best of charging conditions. If using the controller in the diversion mode, you should not use a diversion load (or useful load) that causes the controller to dissipate more than 60 amps. Inductive loads (like motors) can draw very large currents at startup and shut down. If you will be using a motor as a load, please do not exceed 50 amps of current to insure the mosfets are not damaged due to high turn on/off surges. We have included protection against transients on the PCB; however, it is better to properly size the load to prevent undue stresses.

1st a note about amperage and voltage – This controller has a very high amp rating! 60 Amps, this is a lot of current; please take all applicable safety precautions to ensure your safety and to prevent injury or death from electrocution or fire.

This controller is suitable for operation in a 24-volt system, which may have charge and overcharge voltages exceeding 60 volts.

60+ volts at these amperages can be LETHAL! – It only takes a micro-amp and the right (or wrong conditions) at higher voltages to kill you! Don't take chances!

Disconnects should always be available that do not require you to open a box or enclosure to activate or disengage.

About wire size -- 60 amps is a lot of current! – Ensure 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 extreme caution when installing or servicing this controller. Always disconnect the energy source before servicing this unit.

The Three Stage Charging processes in detail:

The main advantage to solid-state controllers is that they offer more advanced charging modes than single stage controllers. We will briefly discuss the three stage-charging modes used by the Coleman Air C60-PWM

- Bulk Charge
- Absorption Charge
- Float Charge

The 1st stage in a 3 stage-charging mode is the bulk charge: In this mode, most if not all of the available charge current is sent to the batteries until they reach the bulk charge voltage set point, which will generally equate to about 80% of the capacity of the battery. The bulk charge rate should be set to between 13.5 and 14.5 volts for a normal flooded lead acid battery. There is really is no perfect voltage setting here as there are many factors involved. The ambient temperature, the size of the energy sources verses battery size, the desired length of time in this mode, the cost of the energy etc. The factory setting for the Bulk Charge set point is 14 volts.

The 2nd stage of the 3 stage-charging mode is the Absorption Charge: As the batteries gets full; due to internal resistance, they accept less charge current. During the Absorption charge, the charger will hold voltage at the bulk charge for specific amount of time. During this stage, the current flowing into the batteries will begin to decline, but the voltage will be higher. Via this stage, the battery will be brought up to its maximum capacity (fully charged). During this stage, battery gassing is normal and required in order to complete the chemical reactions to obtain a fully charged battery. On the Coleman Air solid-state controllers, the Absorption Charge is held for one hour once the batteries reach the bulk voltage setting.

The 3rd and final stage is the Float Charge: This mode is the charge mode that the battery is under most of the time for a properly designed system. Once the batteries are brought to a full state of charge, the float charge mode maintains the batteries at a voltage level of about 13 to 13.5 volts (for a flooded, 12 volt lead acid battery), by applying pulses of current as required. These pulses may last less than a second or be several seconds long. By applying the required amount of charge current to offset any load the battery might be powering, as well as overcoming the batteries natural self-discharge, the batteries longevity is greatly increased. Allowing a battery to sit in a depleted state of charge for long periods of time significantly reduces battery life. A good quality battery, kept at its proper float setting, will last many years. The factory setting for the float charge of the Coleman Air solid-state controllers is 13.5 volts. When the battery drops down below the float charge for an extended period of time, a new bulk charge cycle will automatically be started.

The Equalize Charge: This mode is not a part of the normal charge cycle, but is instead initiated to help mix the electrolytes of the battery. During normal use a battery's chemical mix becomes stratified. (Separated from top to bottom). An equalize charge uses an approximately seven percent higher voltage to help mix these elements in your battery. Equalize charging also helps bring all of the batteries in a multi-battery bank to an equal state. Most people agree that an equalize charge should be run once every 10 to 40 days, for 2 to 16 hours. During this charge cycle quite a lot of gassing will occur, which causes the fluids to be mixed and the plates to be "Cleaned".

To start the equalize mode, press and hold the equalize button at any time. The equalize function will run for two hours once the voltage of the battery rises to the equalize trip point.

Hold down the Equalize button during power up (trip and reset the battery breaker), to enable the automatic thirty-day equalize function. Note, the 30 day function may not be exact and is likely to wander somewhat as it will not begin unless the charge source is capable of bringing the battery to the equalize voltage. A cloudy day may not allow enough solar energy to bring the batteries to the equalize voltage; therefore, the equalize charge will be delayed.

Selecting your battery system voltage (Jumper settings)

The Coleman Air C60-PWM can handle 12 or 24 volt battery based systems. To set the controller for use with a 12-volt system, place the jumper in the 1st position closest to the top; use the 2nd position for 24-volt systems.
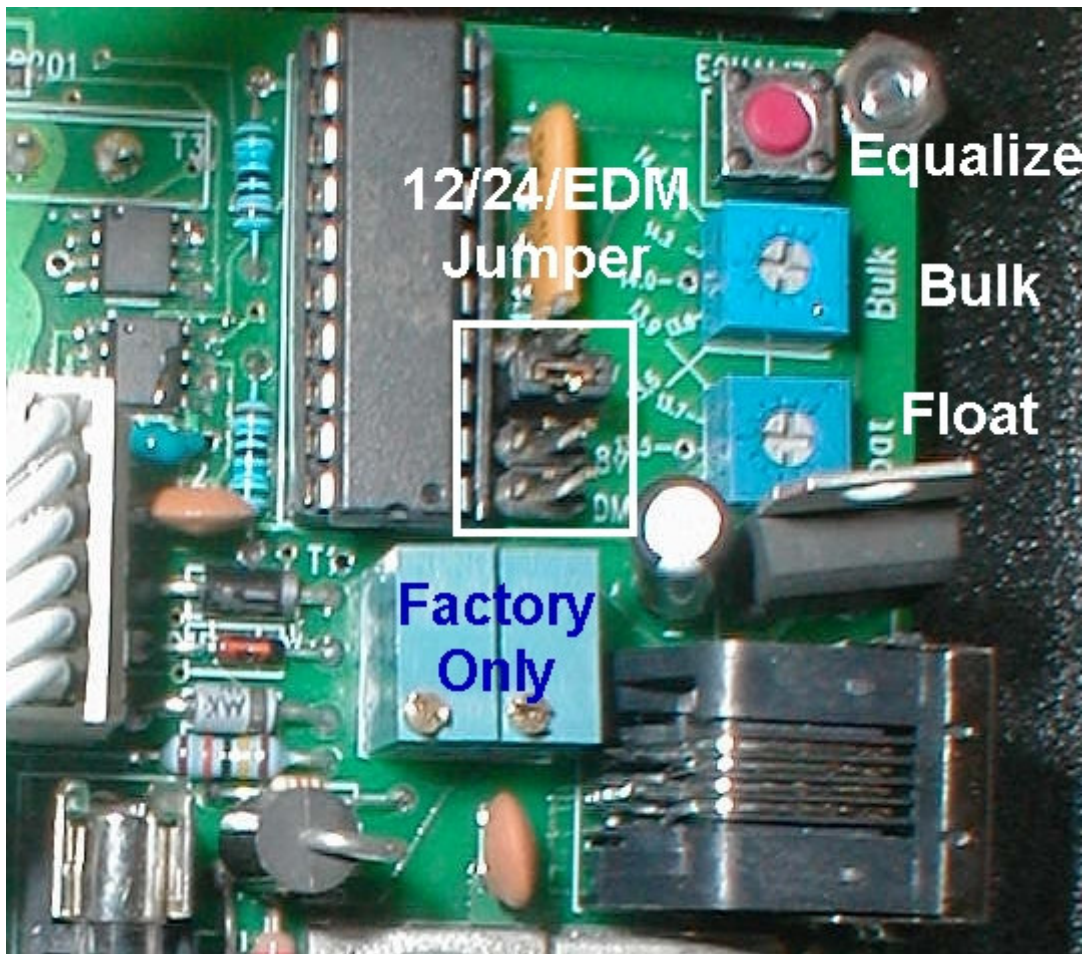
Blow up of jumper

To change the voltage selection, Remove this jumper with your fingernails or carefully using a Small pair of pliers, and place it across the desired two pins of the voltage selection. (Horizontally across the two protruding pins for that selection.)
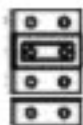
 ←This jumper position would select a 24 volt system.

      Note: Position 4 is the EDM jumper. If you elect to use EDM, install a second jumper (included) in addition to the voltage selection jumper. You will always select a particular voltage, regardless if you elect to use EDM or not. EDM is discussed in detail later in this manual. Note: The 48 volt position is not applicable to this controller model.

The controller is shipped with the voltage selection jumper set to the 24-volt position.

Using the C60-PWM as a Solar Charge Controller

When the batteries reach the trip point, the mosfets are deactivated which opens the circuit from the solar panels to the batteries.
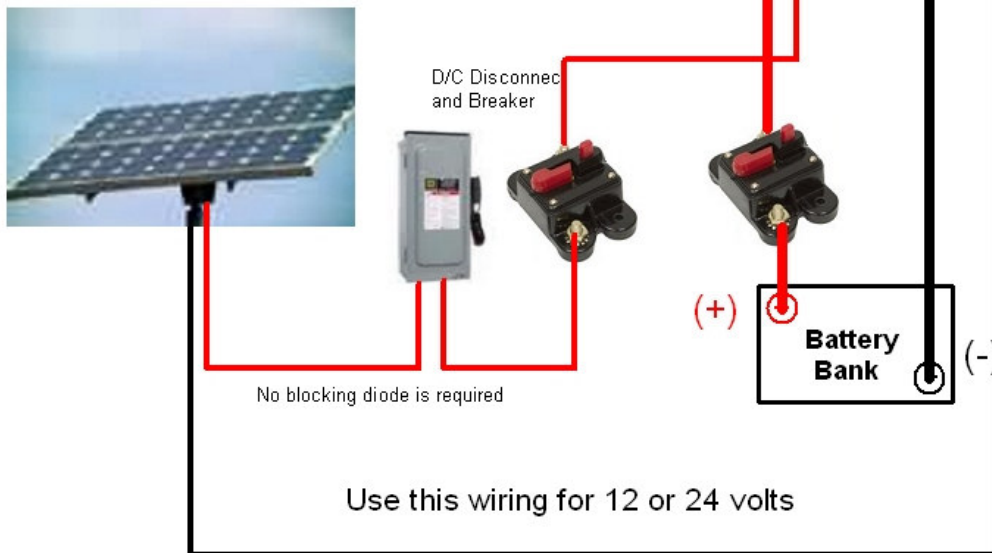
12 or 24 Volts Solar Wiring Diagram

Caution:
Disconnect solar Input, before disconnecting the controller from the batteries.

Disconnect the controller from the batteries before servicing.
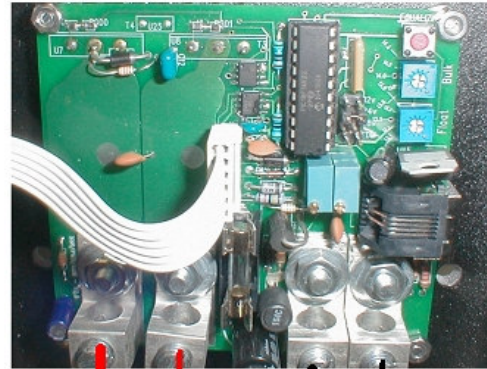
Solar Array - Open collector voltage should not exceed double your battery system nominal voltage.

D/C Disconnect and Breaker

No blocking diode is required

(+)

Battery Bank

(-)

Use this wiring for 12 or 24 volts

Wires shown that cross each other are not connected together.

Series disconnect charge controllers are used with solar systems and other energy sources where the charge source does not require a constant load. In this mode, the charge source is simply disconnected from the batteries once the active trip point is reached. It is then reconnected as soon as the battery voltage drops a little. This on/off cycle may happen many times per second, or last for several hours depending on the current available from the charge source and the charge state and size of the battery bank. This controller excels in the solar mode and can handle up to 60 amps of solar charge current on a continuous basis providing there is adequate cool air entering the enclosure. In warmer installations, the mosfets may be disconnected by the microprocessor as required (if handling high currents) to allow for a 30 second cool down period.

Using the C60-PWM as a Diversion Charge Controller

12 or 24 volt
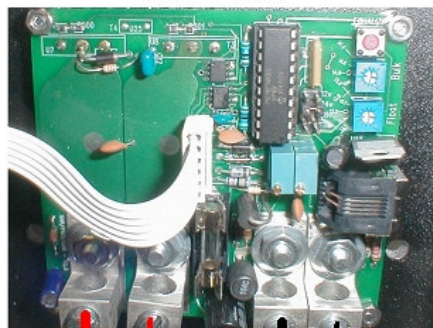**Diversion Control for Wind**
Wiring Diagram

Turbine
Disconnect/Brake

Wind or Hydro Energy Source

C60-PWM

LOAD

3 Phase Rectifier

3 Phase
Input

DC (-)
Ground

DC (+)
Positive

(+)

(+)

A diversion load is
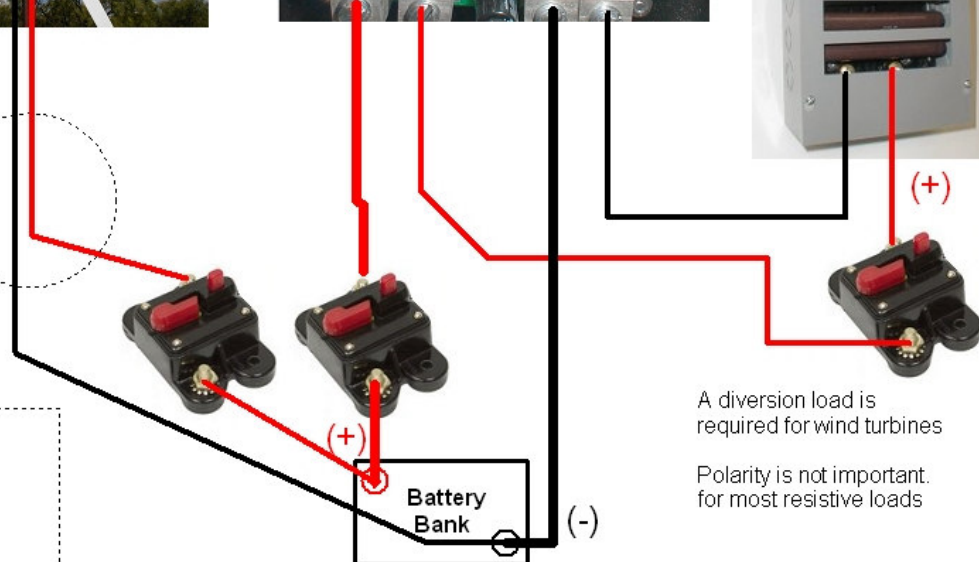required for wind turbines

Polarity is not important.
for most resistive loads

Output of turbine shown to be DC
(after the rectifier if required) for clarity
of diversion control.

Add a 3 phase rectifier if applicable
(Your turbine is 3 phase)

A disconnect switch and breaker
are recommended

Battery
Bank

(-)

Use this wiring for 12 or 24 volts

Wires shown that cross each other are not connected together

When the batteries reach the trip point, the mosfets are activated which
sends current to the diversion load allowing the turbine to remain running
without overcharging the batteries

Diversion controllers are generally used with turbine-based systems and other energy sources where the charge source requires a constant load. In this mode, the charge source is <u>not</u> disconnected from the batteries; but instead once the active trip point is reached; the excess energy is routed to a diversion load (or useful load). Once the battery voltage drops a little, the load is disconnected. This on/off cycle may happen many times per second (if the EDM mode is not active), or last for several hours depending on the current available from the charge source and the charge state and size of the battery bank. The Coleman Air C60 controllers can handle up to 60 amps of <u>diversion</u> current on a continuous basis providing there is adequate cool air entering the enclosure. In warmer installations, the mosfets may be disconnected by the microprocessor as required (if handling high currents) to allow for a 30 second cool down period. It is important that you do not attempt to use to an excessively large load since if the controller requires repeated cool down periods, the batteries may be allowed to overcharge.

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, and 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 not 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.

```
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 and 24 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.
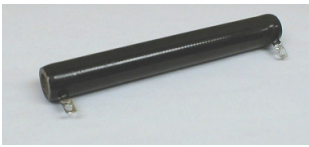
Product Code: L675W12V

 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 ohms on a 24 volt battery system (30v dump), will result in the dissipation of 300 watts, however the resistor is only rated at 100 watts, and will probably be destroyed.

A diversion load is not required for solar only systems.

If you wish to use the controller for both wind and solar at the same time, then you will wire the controller using the diversion mode (page 9), and all excess energy from both the wind and solar sources will be sent to the diversion load. Both the wind turbine and solar panels are wired directly to the batteries. You will then need a blocking diode for the solar panels if you wish to prevent the small reverse battery leakage at night. If you have a solar only system, then no blocking diode is required and the solar panel positive is terminated to the solar/diversion terminal of the controller.

Please visit our online store for a selection of diversion loads, diodes and rectifiers.

Extended Diversion Mode -- EDM

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 a few seconds (or less). In this amount of time, the battery voltage will have dropped enough to be back in the normal region. The controller will continue to open and close the circuit as often as necessary to prevent battery overcharge. This is the normal mode of operation. The microprocessor uses several advanced algorithms to determine the proper width of the energy pulses being sent to the diversion load.

There are; however, situations where you would really like the controller to engage the load 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), and the batteries reach the trip point you have set (the same trip point as the normal mode), the controller will engage the load 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 (or fractions of 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-tied inverters are no longer 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 controller's 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 controller. Do not attempt to hookup highly inductive, high amperage loads (large motors or pumps), as the controller may be damaged due to high currents during the motor start or stop.

Important, pressing the test button with the EDM jumper set, may at times engage the load 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.

As shipped, the EDM (Extended Diversion Mode) jumper will be **hanging on one stud 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 bottom pins as shown in the voltage selection image.

The EDM is only available in the diversion mode (not the solar charge mode.) The EDM jumper is simply ignored if you are using the controller in the solar mode.

Calibrating the Controller
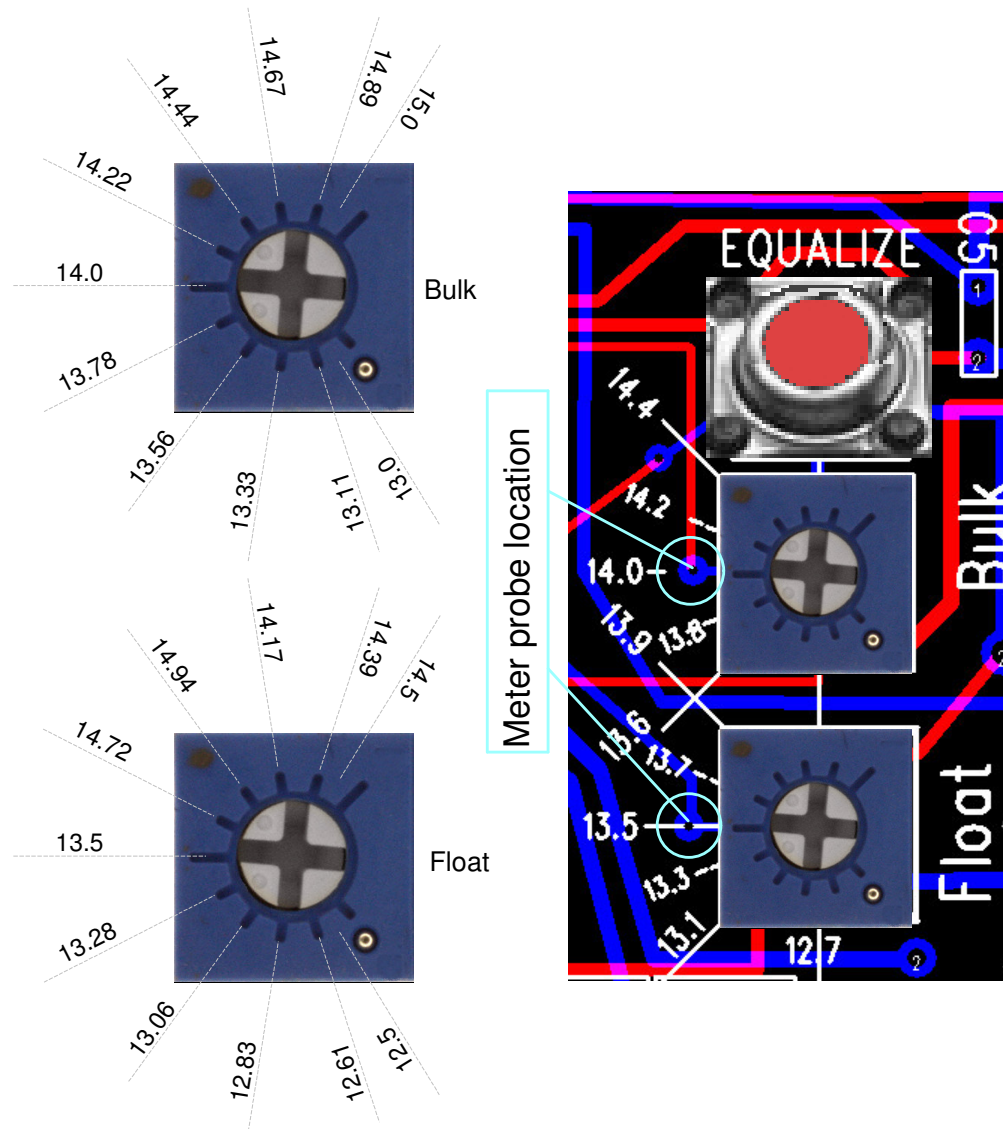
PCB set point adjustments

The controller has already been calibrated by the factory using the following settings, and does not require calibration unless the factory set points are not satisfactory for your installation.

Factory Defaults: Float Set Point: 13.50 volts
Bulk Set Point: 14.00 volts
Equalize Set Point 15.00 volts

Note: Double the above numbers for a 24-volt system. Be sure to set the proper voltage for your system using the voltage selection jumper (page 7).

The float and bulk settings are independent of each other. Adjusting the float potentiometer does not alter the bulk setting and visa-versa. The equalize setting is always about 7 to 8 percent higher than the bulk setting.

If you would like to change either set point, please use one of the following procedures.

Use a <u>Small</u> screwdriver; an oversized tool may damage the potentiometers!

Method 1: If you own a variable voltage power supply and would like to calibrate the unit on the bench or while it is disconnected from the main system, then the following procedure is recommended.

Connect the positive lead from your power supply to both the Battery + and Solar/Diversion terminals of the charge controller (You will need a small jumper to go from the battery+ to the Solar/Diversion terminals).

Connect the ground lead from your power supply to one of the ground terminals of the controller.

1) Turn the float or bulk level potentiometer fully counter clockwise (calibrate one at time)
2) Set the voltage of the power supply to the desired trip point (for instance 14.2 volts)
3) Slowly turn the potentiometer <u>clockwise</u> until the red LED is illuminated
4) Increase the voltage of the power supply slightly and the red LED should go off
5) Slowly turn the voltage of the power supply up and down near your set point, checking to see if you achieved your desired setting

If you do not own a variable voltage power supply, or would rather set the controller while it is installed, then there are three additional calibration options:

Method 2: If you have an inverter that is able to set the exact float or bulk charge voltage of the battery bank to a particular level, use the inverter as your variable voltage supply and follow the instructions in method 1 to calibrate your set points.

Method 3: Using a volt/ohm meter to measure the exact position of the float or bulk potentiometers.

Please take a look at the figure on the preceding page, <u>PCB set point adjustments</u>. If you look just to the left of either of the two blue potentiometers (pots), you will see there is a small blue circle and hole on the PCB itself. These are meter test probe points (The drawing above has indicated them using a light blue circles drawn around the test probe test points). If you measure the voltage at either of these trip points, you will see a reading between 0 and 5 volts, with 2.5 volts being exactly midway. These voltages are what the microprocessor itself uses to determine the set points you have chosen. The math used is quite simple.

The float setting of the controller can range from 12.5 to 14.5 volts (a 2 volt span). The float potentiometer output can range from 0-5 volts (a 5 volt span).

0 volts on the float pot (0%), equals 12.5 volts float setting (0%), and 5V (100%) on the pot, equals 14.5 volts (100%). 2.5 volts on the pot (50%) equals 13.5v (50%).

The exact formula is:
(Desired set point – Lowest set point) / 2 * 5

To set your float to say 14 volts:

(14 – 12.5) / 2 * 5 = 3.75 volts – You would set the float potentiometer to 3.75 volts (as read with the volt/ohm meter at the test probe location) – This will result in the float setting for the controller to be at exactly 14 volts.

The bulk setting voltage range is 13 to 15 volts, also a 2-volt span.

To set the bulk setting to say 14.4 volts:

(14.4 – 13) / 2 * 5 = 3.5 volts – You would set the bulk potentiometer to 3.5 volts (as read with the volt/ohm meter at the test probe location) – This will result in the bulk setting for the controller to be at exactly 14.4 volts.

Method 4:

If you are unable to use any of the above methods, then you will need to cause your batteries to be brought to desired trip point via your wind/solar/hydro energy source. Then once they have achieved this set point, turn the desired set point potentiometer fully counter clockwise. Wait a few seconds, and then slowly turn the same potentiometer clockwise until the red LED changes state. You will want to check this setting as the battery voltage is brought up and down around your set point.

You may choose to simply use the markings on the potentiometers themselves to determine the approximate set point within +/- .075 volts. Please refer to the image on page 13 in this manual for more precise voltage reference locations over that which may be printed on the circuit board.

Remember, the red LED is illuminated when the mosfets are conducting current, regardless of whether it is in the solar or diversion mode. If the red LED is illuminated in the solar mode, then solar energy is being allowed to charge the batteries. If the red LED is illuminated in the diversion mode, then battery and excess energy is being diverted to the diversion load.

General Operating Specifications

	12V	24V
Minimum operating voltage	8.5v	8.5v
Maximum allowable intermittent/surge voltage (1)	45v	45v
Maximum input from solar panels (VOC)	24v	48v
Preferred maximum input from solar panels	18v	36v
Maximum continuous solar charge amperage (2)	60A	60A
Maximum continuous diversion amperage (2)	60A	60A
Maximum surge solar charge amperage	80A	80A
Maximum surge diversion amperage (resistive)	80A	80A
Energy consumed by the electronics (meters off)	< .1W	< .15W
Energy consumed by the electronics (meters on)	1.2W	1.0W
On state resistance of the mosfets at 77F -- (Ohms)	0.002	0.002
Voltage drop across mosfets during charge at 60 Amps	.12V	.12V
Minimum float setting (volts)	12.5	25
Maximum float setting (volts)	14.5	29
Factory default float setting (volts)	13.5	27
Minimum bulk setting (volts)	13	26
Maximum bulk setting (volts)	15	30
Factory default bulk setting (volts)	14	28
Time in absorption charge once bulk set point has been reached	1 hour	1 hour
Time in equalize charge once equalize set point has been reached	2 hours	2 hours

(2) -- May require automatic 30 second cool down periods if air flow though the enclosure is not sufficient

For indoor use only. Install in a non-corrosive, dry environment only.

External dimensions of the enclosure (Inches) 8.5 x 12.5 x 4.5

Minimum ambient air temperature	-20F
Maximum ambient air temperature (60 Amps)	72F
Maximum ambient air temperature (40 Amps)	90F
Maximum ambient air temperature (30Amps)	120F

Designed for battery-based systems only.

These specifications and measurements are subject to periodic change without notice.

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