



C40

CHARGE-DIVERSION
& LOAD CONTROLLER

Introducing the C40

The C40 controller is the finest large-system controller available. The C40 can be used with 12, 24, or 48-volt DC systems as a PV charge controller, a DC diversion controller, or a DC load controller (low voltage disconnect). These capabilities make the C40 the only DC controller you'll need! Numerous standard features are provided to maximize the performance of the system:

- Silent, solid-state Pulse Width Modulated (PWM) charging process with three-stage control, temperature compensation, and manual or automatic equalization. Maximizes system performance and increases battery life.
- Meets National Electrical Code (NEC) and other international controller specifications.
- Certified by ETL for the U.S. (UL Standard 1741 (draft), and Canada (CSA-C22.2 No. 14-M91 SEP 91)
- Electronic overload and short circuit protection with automatic and manual reset capability increases the reliability of unattended systems by eliminating blown fuses and tripped circuit breakers
- Field adjustment of charge setpoints is provided by rotary controls with removable knobs, reducing the potential for setpoint tampering. Calibrated scales and test points allow precise adjustments of settings
- Optional external battery temperature compensation sensor (BTS) for automatic adjustment of charge setpoints (required by UL draft standard 1741 and strongly recommended for sealed batteries)
- Over-temperature protection of the electronic circuitry (by reducing the charge rate) improves the reliability of the C40 when used in environments over 113° F / 45°C.
- Indoor-type, powder-coated enclosure for wall mounting
- Multi-color status LED with matching color label for mode/status indication
- Optional LCD meter for remote or direct mounting on the C40. May be mounted up to 1000 feet away
- 2 year limited warranty



IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS !

This manual contains important safety and operating instructions as prescribed by UL standards for charge controllers used in photovoltaic applications. This manual covers Trace Engineering model number C40 charge / load controller for use in residential and commercial photovoltaic applications. The C40 has been certified by ETL to UL Standard 1741 (draft), Power Conditioning Units for use in Residential Photovoltaic Power Systems. It is also approved to CSA standard CSA-22.2 No. 14-M91 SEP 91.

General Precautions

Before using the charge/load controller, read all instructions and cautionary markings on:

- (1) the charge/load controller
- (2) the batteries and
- (3) the photovoltaic panels

CAUTION - To reduce risk of injury, charge only deep cycle lead-acid, lead-antimony, lead-calcium, gel cell, absorbed mat, NiCad or NiFe type rechargeable batteries. Other types of batteries may burst, causing personal injury and damage.

Do not attempt to repair the C40. Take it to a qualified service center when service or repair is required. Incorrect re-assembly may result in a risk of electric shock or fire.

To reduce risk of electric shock, disconnect all wiring before attempting any maintenance or cleaning. Turning off controls will not reduce this risk. Solar modules produce power when exposed to light - cover them with opaque material before servicing.

WARNING - WORKING IN VICINITY OF A LEAD ACID BATTERY IS DANGEROUS. BATTERIES GENERATE EXPLOSIVE GASES DURING NORMAL OPERATION. Provide ventilation to outdoors from the highest point of the battery compartment.



NEVER charge a frozen battery.

No terminals or lugs are required for hook-up of the DC wiring. Wiring should be rated for 75° C and should be no less than #8 AWG / 8.367mm² gauge wire for use at 40 amps. Terminals provided accept up to #2 AWG / 33.6 mm² gauge stranded copper or aluminum wire.

Insulate tool handles with tape to reduce the chance of a short circuit occurring. Spark or short-circuits can cause an explosion.

Tools required to make DC wiring connections: Wire strippers, Phillips screwdriver #2, Slotted screw driver 5/32" (4.5 mm).

This charge/load controller is intended to be used with a battery supply of 12, 24, or 48-volts direct current nominal voltage..

For battery installation and maintenance, read the instructions provided with the batteries prior to operating.

No DC disconnect switch is provided as an integral part of this unit. DC disconnects may be required as part of the system installation. Refer to local electrical codes for requirements.

No overcurrent protection for the battery supply is provided as an integral part of this unit.

Overcurrent protection for the battery cables must be provided as part of the system installation. Refer to local electrical codes for requirements.

Although over current protection for the DC output wiring is provided as an integral part of this unit, additional over current protection of the DC output wiring may be required as part of the system installation. Refer to local electrical codes for requirements.

GROUNDING INSTRUCTIONS - This charge/load controller should be connected to a grounded, metal, permanent wiring system. Connections to the grounding system should comply with all local codes and ordinances.

Personal Precautions

Someone should be within range of your voice or close enough to come to your aid when you work near batteries.

Have plenty of fresh water and soap nearby in case battery acid contacts skin, clothing, or eyes.

Wear eye protection and protective clothing. Avoid touching eyes while working near batteries.

If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters an eye, immediately flood the eye with running cold water for at least 15 minutes and get medical attention immediately.

Baking soda neutralizes spilled lead acid electrolyte. Vinegar neutralizes spilled NiCad electrolyte. Keep a supply on hand.

NEVER smoke or allow a spark or flame in vicinity of a battery or generator.

Be extra cautious to reduce the possibility of dropping a metal tool onto batteries, it might short-circuit batteries or other electrical parts that may cause an explosion. Cover wrench handles with plastic tape or vinyl dip-coating material.



Remove personal metal items such as rings, bracelets, necklaces, and watches while installing the system. A single battery can produce a short-circuit current high enough to weld a ring to a battery terminal, causing severe burns.

Other Products from Trace Engineering:

- MicroSine miniature utility-interactive inverter fits on back of 24-volt PV solar module. Allows you to 'sell back' power to the utility grid (not for charging batteries or UPS)
- UX Series Inverters: affordable 600 to 1400 watts AC power from 12-volt DC source, available with optional standby battery charger and remote control.
- U2500 Series Inverters: 2200 to 2500 watts continuous AC power from 12, 24, 32, 36 or 48-volt DC source. Available with optional Standby charger for residential, RV, and marine applications. Can be stacked. Optional remote available.
- DR Series Inverter: 1500, 2400 or 3600 watt inverter features power-saving Search Sense, quiet operation, stacking interface, and standard three-stage battery charger.
- SW Series Inverter: True sine wave output to 230VAC from 12, 24, and 48-volt DC sources. Stackable for up to 16.5 kilowatt, three-phase power with Search Sense, Standby charger and multifunction LCD display; all standard equipment.
- Power Module System: Complete power systems enclosed in corrosion-resistant, powder-coated aluminum modules suitable for exterior installation. Modules can include inverters, batteries, charge controllers, AC and DC breakers, and all associated cabling and hardware. Factory or dealer pre-assembled.

Operating Modes

The C40 controller can operate as either a photovoltaic charge controller, a diversion controller, or a DC load controller. The C40 cannot operate as both a charge controller and a DC load controller at the same time. If both are required in a system, two C40's must be installed. Use one C40 for each mode desired.

Photovoltaic Charge Control Mode with three-stage regulation and automatic or manual battery equalization cycle. When this mode is selected, the status LED will indicate either blinking green or solid green. It will alternate red/green when in equalization mode.

Diversion Control Mode for PV, hydro-electric, wind generator, or mixed source systems with three-stage regulation and automatic or manual battery equalization cycle. When this mode is selected the status LED will indicate either blinking green or solid green.

DC Load Control Mode turns off the DC loads when battery voltage is low. When this mode is selected, the status LED will typically indicate blinking red or solid red.

Photovoltaic Charge Control Mode

The C40 can regulate up to 40-amps of continuous photovoltaic (PV) array current at 12, 24 or 48-volt DC for charging batteries. This rating includes the NEC required deratings - it is directly comparable to other controllers rated at 60 amps. When used in this mode, ensure that the operating mode jumper is on the Charge Control pins. To enable the Photovoltaic Charge Control Mode, see the *User Configuration Options* section of this booklet.



If the PV array's output increases above the 40-amp level due to reflection or "edge of cloud effect," the C40 will continue to operate until the heatsink reaches a safe operating temperature. This will take several minutes to occur depending upon the ambient temperature involved. When the heatsink reaches the maximum safe temperature, the C40 will reduce the current, cooling the transistors and the heatsink. This will occur only if the current flow exceeds the 40-amp level and the C40 is located in a very hot environment.

If the current from the PV array reaches 63 amps, the C40 will turn off to self protect. This should never occur in a properly designed system. Ten minutes after shutting off to self protect, the C40 will automatically restart.

The C40 charge controller rapidly cycles the current source on-and-off to control the charging current and voltage of the battery. This occurs in both the charge control mode and the diversion control mode. The amount of time the current source is connected to the battery is varied to control the average current flow. This is often referred to as "pulse width modulation" (PWM) and allows the current to be tapered, rather than coarsely turning the current off and on as with relay type PV array charge controllers.

Automatic PV Array Night Disconnect

Each night the PV array is automatically disconnected from the battery to prevent reverse leakage of power. This eliminates the need for a blocking diode between the battery and the PV array. If thin-film or amorphous solar modules are being used, diodes may still be required to prevent damage from partial shading conditions. Check the documentation provided with the PV modules.

Diversion Control Mode

The C40 can operate as a 40-amp diversion control to manage battery charging from alternative-energy sources such as wind or hydro-electric generators. Systems utilizing solar arrays do not have a requirement for diversion loads since a solar module can be open-circuited without damage. However, even with a solar based system it is desirable to use excess power to operate DC loads. When used in this way, the C40 controls a

diversion load to redirect the excess power generated instead of allowing it to flow into the battery. This prevents damage to the charging source from an over-speed condition which could occur if the charging source is suddenly disconnected from all loads - as series relay regulators do. Consult your dealer for load and regulator size recommendations.

When the C40 operates as a diversion regulator, it provides three-stage regulation of battery voltage, with temperature compensation and automatic or manual equalization. See the *Three-stage Battery Charging* section for more information on this process.



Diversion mode requires a separate load "dump" to regulate the battery. This load must be able to absorb more power than the charging source is able to produce at its peak output, or the DC voltage will become unregulated. The dump load must be available for the diversion of power at all times. Resistive-type heating elements are the best diversion loads. Special direct current water heating elements are available. Light bulbs and motors are not recommended as diversion loads because they are unreliable.

When used in diversion mode, ensure that the operating mode jumpers are on the charge control pins. See the *User Configuration Options* section of this booklet.

Current draw of the diversion load is very important. Problems may arise from operating with a load that is too small or too large. A diversion load that is too small will not be able to absorb all the excess power from the current source once the batteries are full.

Diversion loads in excess of 63 amps are capable of absorbing more power than the C40 is designed to handle, resulting in an over-current shut down. During this time, the unit will not regulate electrical flow in the system, and battery damage may result.

A diversion load that draws about 50 amps when connected to the battery is usually suitable for use with the C40. The load should be sized about 25% larger than the charging source's maximum output capability.

DC Load Control Mode

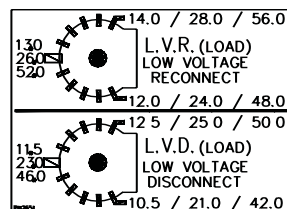
The C40 can also operate as a 40-amp load control (also called a low voltage disconnect) to manage the discharging of the battery. A load controller prevents damage to the battery from over-discharge during periods of poor weather or excessive loads.



When used in load control mode, ensure that the operating mode jumpers are on the load control pins. See *Configuring the C40* section of this booklet.

The controller delays disconnecting the DC loads for 10 minutes after the voltage drops below the low voltage disconnect (LVD) setting. Loads are either automatically or manually reconnected when battery voltage exceeds the low-voltage reconnect (LVR) setting for 10 minutes. The EQUALIZE jumper determines manual or automatic reconnect when the C40 is used as a load controller.

When used as a DC load controller, the settings of the LVR and LVD are controlled by two rotary knobs on the circuit board. The scale on the adjustment pots differ from the scale used for other functions. A decal with the corrected adjustment scale is included with the C40 and shown at right. Place this scale over the pots when using the C40 as a load controller. Do not temperature-compensate these settings. Do not install the optional battery temperature compensation sensor.



Features

The C40 features include over-temperature protection, electronic over-current protection, and automatic battery temperature compensation.

Over Temperature Protection

The temperature of the C40's transistors are continuously monitored. This protects the charge controller from damage in high temperature environments. If excessive temperatures are detected while operating in charge or diversion control mode, the C40's transistors are rapidly turned off and on to reduce the charge rate. This will reduce the transistor temperature.

As a load controller, the load is disconnected before the transistors reach an excessive temperature. Once the temperature has dropped, the loads are reconnected.

When the over temperature protection system has caused the C40 to shutdown, the status LED will be orange and will blink fast (about once a second). This is the same indication shown during an overcurrent condition.

Electronic Overcurrent Protection

During operation, the C40 continuously monitors the current flowing through it. If the current exceeds 63 amps, the transistor switches are opened, stopping the flow of electricity. This protects the loads and array wiring from short circuits and overloads. The detection circuitry is faster than breakers or fuses, and they will not trip or blow when a fault occurs.

When the overcurrent protection system is activated, the status LED will indicate orange and will blink fast (about once a second). This is the same indication as produced by an over temperature condition.

The C40 automatically resets the overcurrent protection system every 10 minutes. If an overload or short circuit is still present, the C40 will shut off and wait another 10 minutes. This will occur continuously until the problem is corrected.

The reset switch on the right side of the C40 allows the user to manually reconnect the PV array or DC loads after an overcurrent condition occurs. Hold the reset switch for 5 seconds to return to normal operation. If the C40 is unable to restart, check the wiring and reduce the loads connected. There may be a delay after manually pressing the reset switch before reconnecting the PV array.

The shunt used to measure the current flow in the C40 is located in the positive conductor of the circuit as required by UL Standard 1741 (draft). The negative terminals are all common to one another.

Battery Temperature Compensation

The optional plug-in external battery temperature sensor (BTS) automatically fine tunes the charging process of the C40. The BTS is required by UL Standard 1741(draft). ETL approval is based on its installation. However, do not install the battery temperature sensor if you are using the C40 as a DC load controller. The BTS may be extended by using a standard phone cable with RJ-11 plugs.

If the temperature sensor is installed, the regulation setpoints should be adjusted for a battery at room temperature (23 -27°C/74 -80°F). The C40 adjusts the BULK and FLOAT setpoints -5mV per degree Celsius for a 6-cell, lead-acid type battery and -2mV per degree Celsius for a 10-cell, NiCad type battery as required per UL Standard 1741. If the temperature sensor is NOT installed, the setpoints should be adjusted for the temperature of the battery during operation. Seasonal adjustment of the setpoints may be necessary to prevent battery damage and to ensure proper charging. If the battery temperature sensor is installed, no seasonal adjustments are required (see Temperature Compensation in this manual).

If the wiring to the sensor is damaged and the wires are shorted or cut, the system will return to the non-temperature compensated settings.

Install the BTS on the side of the battery below the electrolyte level. It is best to place the sensor between batteries and place the batteries in an insulated box to reduce the influence of the ambient temperature outside the battery enclosure. Ventilate the battery box at the highest point to prevent hydrogen accumulation.

LED STATUS Indicator

A multi-color LED indicator is provided to indicate the operating status of the C40. A color-coded label is included on the cover of the C40 to explain the status LED's operation. When the C40 is in Charge Control or Load Diversion mode, the LED will be green. When in Load Control mode, the LED will be red. An orange LED indicates an error condition. When battery equalization is in process, the LED will alternate between red and green.



Charge Control or Diversion Control Mode Indications

Solid Green - The battery has entered the FLOAT stage of the charging process. The status LED will remain solid unless the batteries drop below the Float voltage setting for an accumulative period of one hour. This allows the user to confirm that the system reached FLOAT during the charging process when checked at the end of the day. Reaching the FLOAT stage frequently is a good indication of proper system operation and will maximize battery life and performance.

Blinking Green - indicates that the controller is in the Charge Control or Diversion Control mode and the battery is not fully charged. As the battery voltage approaches the Bulk setting, the status LED will blink green several times (up to 5) and then pause. This indicates that the battery voltage is approaching the Bulk setting and provides an indication of the battery condition.

Green = Charge Control Mode or
Diversion Control Mode

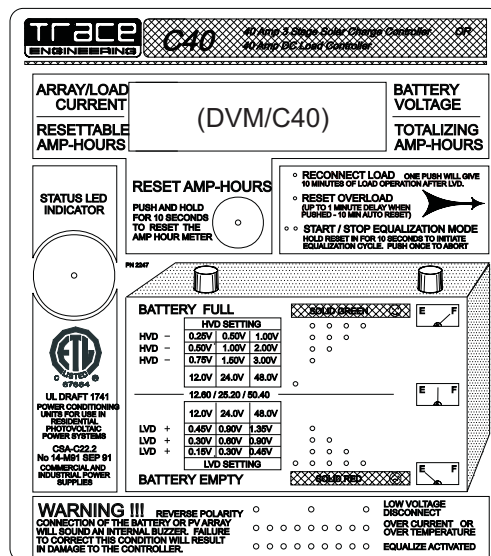
When flashing, battery voltage =
HVD(bulk) setting minus value
shown.

Single green flash = voltage below
lowest HVD setting. See table.

Red = Load Control Mode
When flashing, battery
voltage = LVD setting plus value
shown on table.
Single Red flash = low voltage

Orange = Slow Flash = Low
Voltage
Fast Flash = Error Condition

Red/Green Alternating =
Equalization in Process



Load Control Indications

Solid Red - indicates that the controller is in the DC Load Control mode and the battery voltage has reached the Low Voltage Disconnect (LVD) setting. After a 10 minute delay, DC loads will be disconnected unless the user reduces the loads to a point that the battery voltage exceeds the LVD setting.

Blinking Red - As battery voltage approaches the LVD setting, the LED will blink red several times (up to 5) and then pause. This provides an indication of battery condition.

Slow Blinking Orange - indicates that the C40 is in the DC Load Control mode and has disconnected the loads due to reaching the LVD setting. The user can press the reset switch for a maximum 10 minute "grace" period, or can wait until the voltage rises above the Low Voltage Reconnect (LVR) setting to allow an automatic reset to occur.

Equalization Mode Indication

Alternating Red and Green - indicates that the C40 is in equalize mode. It will automatically stop the equalization process after accumulating two hours of operation at a voltage above the BULK setting. The user can stop the equalization process at any time by pressing the reset switch until the status LED stops alternating red and green.

Error Mode Indication

Fast Blinking Orange - indicates that the C40 has detected a short circuit or an over-temperature condition and has disconnected the loads. The C40 will try to automatically restart the loads after a 10 minute delay. If the C40 will not restart, turn off all loads and press the reset switch. If the C40 then restarts, the loads may be too large. A delay up to five seconds may occur before the C40 attempts to restart after pressing the reset switch.

Installation

The C40 controller is a state-of-the-art precision electronic instrument. Installation, environment, mounting, and wiring must be accomplished in accordance with applicable local and national electrical codes. The instructions that follow are applicable to the typical installation. For special applications, consult a qualified electrician or your Trace dealer. Installation procedures will vary according to your specific application.

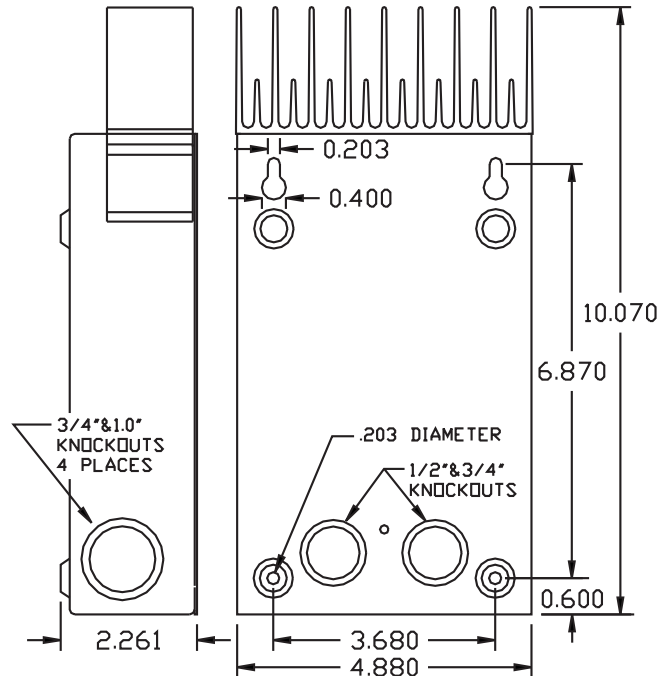
Mounting

The C40 is designed for indoor mounting. Care should be taken in selecting a location and when mounting the enclosure. Avoid mounting the C40 in direct sunlight in order to reduce heating of the enclosure and subsequent high operating temperatures. The enclosure should be mounted vertically on a wall.

Mounting and enclosure dimensions are shown in the adjacent diagram. Remove the faceplate on the C40 and locate the upper two screw locations on the wall. The back of the enclosure is provided with key-holes for mounting. Leave the screw heads backed out approximately 1/4 inch (6 mm). Place the C40 onto the screws and pull it down into the keyhole slots. Then insert the two lower screws to lock the enclosure onto the wall. Provide either strain-relief clamps or conduit to prevent damage to the circuit board and terminal block from pulling on the wires. The cover should be replaced and retained with the screws provided (#10-32 x 3/8" SMS).

In severe environments, additional consideration should be taken to minimize exposure to wet environments. The use of conformal-coated circuit boards, plated terminals, powder coated metal components, and stainless steel fasteners improves tolerance to hostile environments.

Caution: It is in your best interests to install the C40 in a dry, protected location away from sources of high temperature, moisture, and vibration. Exposure to saltwater is particularly destructive. Corrosion of the circuit board is not covered by the warranty. If you wouldn't put your television there, don't put the C40 there.



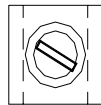
Do not locate the C40 in a sealed compartment with the batteries. Batteries can generate hydrogen sulfide gas which is very corrosive to electronic equipment and everything else. They also generate hydrogen and oxygen. If accumulated, this mixture could be ignited by an arc caused by the connection of battery cables, a loose terminal, etc. Installation within a ventilated enclosure with sealed batteries only is acceptable.

Wiring

Be sure to set the voltage selector jumper to the appropriate setting before energizing the system (see *User Configuration Options* for instructions). Incorrect settings may result in damage to the system as the charging regulation will not occur. Torque the terminals to 25 inch-pounds once the wires have been installed. Replace the cover after wiring.

NOTE: Regardless of configuration, only the positive conductor from a PV array or a DC load may be connected to the terminal marked "PV POS/LOAD."

The minimum recommended wire gauge is 8 AWG (13.3 mm²) with a 75° C insulation rating. The terminals on the C40 will accept up to #2 AWG (33.6mm²) copper or aluminum wire. No crimp-on terminals or lugs are required. The following table gives the maximum permissible length allowed for each wire size at 40 amps with 3% voltage drop. Find your



PV+/WIND+/LOAD+

Warning: Due to a printing error (what were we thinking?), the input terminal on the C40 Rev. #2230D printed circuit board is incorrectly labeled 'PV+/WIND+/LOAD+.' Never connect a wind generator to this terminal. Rev.#2230D is not designed to accept the very large current fluctuations typical of wind generators. Damage to the C40 will result.

Maximum One-Way Wire Distance in Feet/Meters (40 Amps with 3% Voltage Drop)

C40 VOLTAGE	8 AWG	6 AWG	4 AWG	3 AWG	2 AWG
12vdc	5.6/1.7m	8.8/2.68m	14/4.26m	17.7/5.38m	22.4/6.83m
24vdc	11.1/3.38m	17.6/5.36m	28/8.53m	35.4/10.79m	44.8/13.66m
48vdc	22.2/6.77m	35.2/10.72m	56/17.06m	70.8/21.58m	89.6/27.31m

system voltage in the left column, and the distance from your power source (feet/meters) to the C40 (or the distance from the C40 to your load) on the same line, then read the wire size required at the top of the column. Don't use wire smaller than #8 gauge.

The wiring, overcurrent protection devices (fuses and circuit breakers) and installation methods used must conform to all local electrical codes requirements.

Wiring should be protected from physical damage with conduit or a strain relief clamp. You should pull the temperature sensor cable through the conduit first as the connector may not fit if other wires have been pulled first.

As a minimum, a 60-amp DC rated current limiting fuse in an appropriate fuse holder or disconnect switch should be provided near the battery for protection from short circuits. Local electrical codes should be consulted for wire sizing and any additional installation requirements. The use of breakers or fuses above 60 amps is not recommended. Use Trace part number CD60DC available from your Trace dealer.

PV Charge Control Mode Cabling

Photovoltaic arrays generate current whenever light strikes the surface of the array. Before connecting the C40, cover the array to prevent any current from being generated. Remove one or more of the knockout plugs on the C40's case and feed the connecting wires through it. Connect the PV array's positive output to the terminal marked PV POS/LOAD at the bottom of C40's circuit board. Connect the negative output to the terminal marked PV NEG. Tighten the lugs to 12 ft/lbs (17.86 Kg/m).

Connect the battery positive cable to the terminal marked BAT POS on the bottom of the C40's circuit board. Connect the negative battery cable to the terminal marked BAT NEG on the C40's circuit board. Secure the cabling with strain reliefs after allowing a little slack inside the case to prevent damage to the C40's circuit board.

Diversion Control Mode Cabling

When using the C40 as a diversion or DC load controller, the DC load needs to be connected to the terminals marked as PV POS/LOAD and PV NEG on the C40. The two negative terminals are common and can be reversed or wired with a single conductor to a more convenient location such as a DC load center negative bus.

Connect your DC current source (PV, wind, hydro, etc.) directly to a battery, then connect an appropriately-sized cable from the positive battery terminal to the C40 terminal marked BAT POS. Connect a cable from the negative battery terminal to the terminal marked BAT NEG on the C40's circuit board. Connect a cable from the C40's terminal marked PV POS/LOAD to the positive terminal of your DC Diversion load. Connect a cable from the terminal marked PV NEG on the C40 to the negative terminal of your DC Diversion load. Tighten the terminal lugs to 12 ft/lbs (17.86 Kg/m). Allow a little slack on the cables within the C40 and secure the wiring with strain reliefs.

DC Load Control Mode Cabling

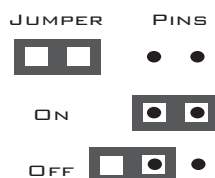
Connect the positive battery cable to the terminal marked BAT POS on the C40 PCB, and the negative battery cable to the terminal marked BAT NEG when using the C40 as a load controller. Connect a cable between the PV POS/LOAD terminal on the C40 and the positive terminal on the DC load. Connect a cable between the PV/NEG terminal on the C40 to the negative terminal of the load.

Grounding

The C40 is designed to work with both negative ground and ungrounded electrical systems. The metal chassis of this charge/load controller must be grounded for either system by connecting it with a copper wire to a grounding electrode such as a ground rod driven into the earth. If a negative ground system is desired, connect the negative current carrying conductor to the grounding system at one point in the system. Consult local electrical codes for more information and any additional requirements.

Configuring the C40

Located on the right side of the C40's circuit board are three jumpers. It is mandatory that these jumpers be set correctly for the unit to operate to its maximum potential.



A jumper is a small, rectangular piece of plastic with two square holes in it that fits over two pins as shown in the illustration at left. A jumper contains an internal conductor that joins the two pins, completing a circuit. When the jumper is removed, the circuit is interrupted. Jumpers are often used for changing configuration parameters. When a jumper is not connecting two pins, it can be stored by slipping it over just one of the pins instead of both. This will have no effect upon the configuration, but will keep the jumper handy for future use.

The C40 is equipped with several of these jumpers. They control equalization, low voltage reconnect, battery voltage, and operating modes. Each of these are discussed in the appropriate section of this manual. The factory default settings are shown below:

BATTERY VOLTAGE:	48 VOLTS DC
EQUALIZE/LVR:	MANUAL EQUALIZATION
OPERATING MODE:	CHARGE CONTROL

Automatic/Manual Battery Equalization (EQ) and Low Voltage Reconnect (LVR)

Enables automatic or manual battery equalization in Charge Control mode, and automatic or manual reconnect in the event of low voltage at the BAT POS terminal in Load Control mode. When AUTO is enabled in Load Control mode, the unit will reconnect automatically when voltage at the BAT POS terminal exceeds the LVR setting. Factory setting is manual equalization and manual reconnect.

Operating Mode - This jumper determines the operating mode: PV Charge Control and Diversion Control mode, or Load Control model. Factory setting is Charge Control mode.

Reset Switch - Press and hold to manually initiate or suspend battery equalization in Charge Control mode. Press and release to reset following an error condition. Press and release to reconnect following a low-voltage disconnect event. If voltage remains below the LVD setting, the unit will disconnect after a 10-minute 'grace' period.

Voltage - This jumper determines the voltage of the system that the C40 will be working with. Connect the two pins adjacent to the legend for the voltage of your system: 12, 24, 48. Factory setting is 48-volts. The maximum DC voltage allowed is 90VDC for a 48-volt system, 50VDC for a 24-volt system, and 25VDC for a 12-volt system.

If the optional digital volt meter (DVM/C40 or C40R) is attached to the C40, be sure to set the jumper on the back of it for the appropriate system voltage. The jumper for limiting power consumption and dimming the DVM display is also located on the back of the DVM.

Adjusting the C40

The charge voltage and 0reconnect/disconnect voltage setting of the C40 are adjustable via two rotary potentiometer controls. The knobs are removable to reduce the likeliness of tampering with the settings. Calibrated scales are provided to allow setting of the control without requiring the use of a digital voltmeter. Visual adjustment allows an accuracy of +/- 0.1 volts.

Setting Voltage Parameters

In Charge Control mode or Diversion Control mode, you can adjust the Bulk and Float charging voltage by adjusting the potentiometers (pots) located in the bottom center of the C40 circuit board (for more information regarding Bulk and Float settings, see the Three Stage Battery Charging Process section of this manual).

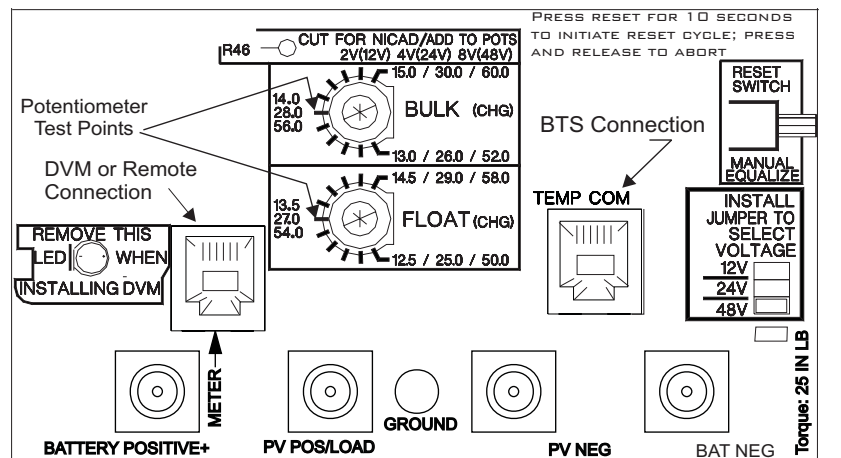
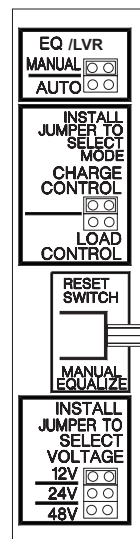
The pot scale for Bulk charge voltage is calibrated from 13.0 to 15.0 volts (when the voltage jumper is set for a 12-volt system) in increments of 0.2 volts, from 26.0 to 30.0 volts (24-volt system) in increments of 0.4 volts, or from 52.0 to 60.0 volts (48-volt system) in increments of 0.8 volts. For Float charge voltage, the pot scale is calibrated from 12.5 to 14.5 volts (12-volt system), 25.0 to 29.0 volts (24-volt system), and from 50.0 to 58.0 volts (48-volt system) with the same increments as above.

Testpoints for Voltage Settings

At midrange on these scales, a test point is provided for use with a volt meter for assuring more accurate adjustment. The pots are equipped with removable knobs, to prevent accidental adjustments by the curious or uninformed. If the knobs are missing, a 5/64" hex-head driver can be used to adjust the settings. A digital volt meter can be connected from the BAT NEG terminal on the circuit board and the small testpoint located to the left of each adjustment pot at the 9 o'clock position. The testpoint provides a reading from zero to two volts - this value must be added to the lower value of the adjustment range (Bulk=13.0, Float=12.5, LVR=12.0, LVD=10.5). Multiply this value by 2 for 24 V and by 4 for 48 V.

For example, to set the BULK (HVD) voltage to 14.4 volts, adjust the pot until the testpoint reads 1.4 volts ($13.0 \text{ V} + 1.4 \text{ V} = 14.4 \text{ V}$) or to set to 28.2, adjust the pot until the testpoint reads 1.10 volts [$1.10 \times 2 (24 \text{ V}) = 22 + 26.0 = 28.2$].

Remember to add two volts to the settings when using NiCad type batteries.



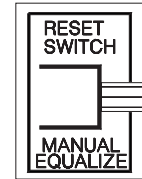
If you are using the C40 as a DC load controller, be sure to set the pots as shown in the *DC Load Control* section of this manual. The upper knobs settings are reduced by one volt, resulting in a range of 14.0 to 12.0 VDC (for a 12 volt system). The lower knobs settings are reduced by two volts, resulting a range of 12.5 to 10.5 VDC (for a 12 volt system).

Equalization

The C40 offers either manual or automatic triggering of the equalization process (the default setting is manual). Automatic equalization is enabled by moving the jumper located on right side of the circuit board above the reset switch. When automatic has been selected, an equalization charge (holding the voltage one volt (for 12 volt systems) above the BULK setting for 2 hours) will occur every 30 days. During the equalization process the status LED will indicate equalization by alternately blinking green and red. (Equalization is not recommended for NiCad batteries and is disabled when the R46 resistor is cut - see the drawing for location.)

Manual Equalization

Manual equalization of the battery can be enabled by pressing the reset switch on the right side of the C40 for 10 seconds. The status LED indicator will begin to alternate between red and green once equalization is enabled. The equalization process will continue until the batteries have been held at or above the BULK setting for two hours of accumulated time. During the equalization process, the battery voltage will be limited to one volt above the BULK setting for 12 volt systems (for 24V systems, 2 volts and 48V systems, 4 volts above BULK). Once the battery voltage has been at or above the BULK setting for a cumulative period of two hours, the C40 will return to the FLOAT stage of the charging process.

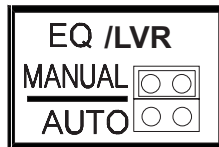


To stop the equalization process, press the reset switch. The status LED will stop alternating between red and green. If the equalization process was shorter than one hour, the C40 will continue with a BULK charge cycle and then hold the battery at the BULK setting for one hour (the absorption stage) before returning to the FLOAT setting.

During the equalization process the status LED will alternate between red and green and will not provide any other mode/status indication. Large battery banks may need several equalization cycles to fully stir the electrolyte and charge the cells. These cycles should follow one another until the battery voltage reaches the upper limit for the full two hours.

Automatic Equalization

The C40 can automatically trigger an equalization charge every 30 days. The status LED will indicate that the equalization process is occurring. The equalization process will continue until the voltage has been held above the BULK setting for a cumulative period of two hours. This might take several days on larger systems with big batteries and small PV arrays. The battery voltage only needs to exceed the BULK setting for the timer to start counting - the voltage may not reach the equalization voltage limiting setting of one volt above the BULK setting (for a 12 volt system).



To enable automatic equalization, the jumper located on the right side of the circuit board must be moved to the AUTO setting. The default setting of the C40 is for manual equalization. To permanently disable the automatic equalization system, remove the equalize jumper.

To manually stop the equalization process, press the reset switch at the right side of the C40 until the status LED stops alternating between red and green. If the equalization process was shorter than one hour, the C40 will continue with a BULK charge cycle and then hold the battery at the BULK setting for one hour (the absorption stage) before returning to the FLOAT setting.

Once a manual equalization has been triggered, the 30-day period to the next automatic equalization will be restarted. To prevent automatic equalization, move the equalize jumper to the manual position.

Temperature Compensation

If a temperature compensation sensor is installed, the charge or diversion control process will be automatically adjusted for the battery temperature. Set BULK and FLOAT voltage for a battery at normal room temperature (23 -27°C/74 -80°F). Actual voltage may vary above or below these settings due to adjustment for battery temperature.

If no temperature compensation sensor is installed and the batteries will be operating in very hot or very cold conditions, adjust the BULK and FLOAT settings to allow for the battery temperature. The recommended adjustments can be found in the table below. The setting should be lowered for ambient temperatures above 80°F/27°C and raised for ambient temperature below 75°F/23°C. If significant seasonal variations are common, you will have to change the settings several times a year to prevent battery damage and ensure proper operation.

Do not compensate the settings when using the C40 as a DC Load Controller.

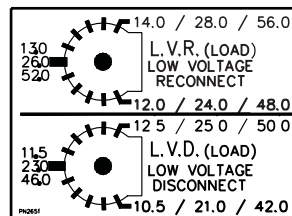
Charger Setpoint Temperature Compensation Chart

Battery Type	System Voltage		
	12 VOLT	24 VOLT	48 VOLT
Lead Acid (6 cells)	.030 Volts/°C	.060 Volts/°C	.120Volts/°C
Nicad (10 cells)	.020 Volts/°C	.040 Volts/°C	.080 Volts/°C

Setting LVR and LVD (Load Control Mode)

You can change the low voltage disconnect (LVD) and low voltage reconnect (LVR) settings using the same potentiometers described above. When the C40 is in DC Load Control mode, the pots scale calibration is altered. For 12-volt application subtract two volts from the scale shown on the circuit board for the LVR setting (Bulk setting when in Charge Control mode) and subtract two volts from the scale shown for the LVD setting (Float setting in Charge Control mode). Subtract four volts for a 24-volt application, and eight volts for a 48-volt application. The C40 comes with a two-part decal that can be placed over the pots (after removing the knobs) that shows the correct scales for DC Load Control mode. The decal can be found inside the C40 chassis at the bottom.

MANUAL reconnect of the loads is allowed if voltage has not exceeded the LVR setting. To reconnect the loads, press the reset button on the right side of the C40. If the voltage is below the LVR level, the DC load can be reconnected for an approximately 10 minute "grace" period. Multiple "grace" periods are allowed, but the duration of the 'grace' period will vary with battery voltage. The EQUALIZE jumper allows the C40 to be set for AUTO reconnect of the DC load when the voltage exceeds the LVR setting.



Note: The LED will light red *only* in Load Control mode; never in Charge or Diversion mode.

Setting HVD (Diversion Control Mode)

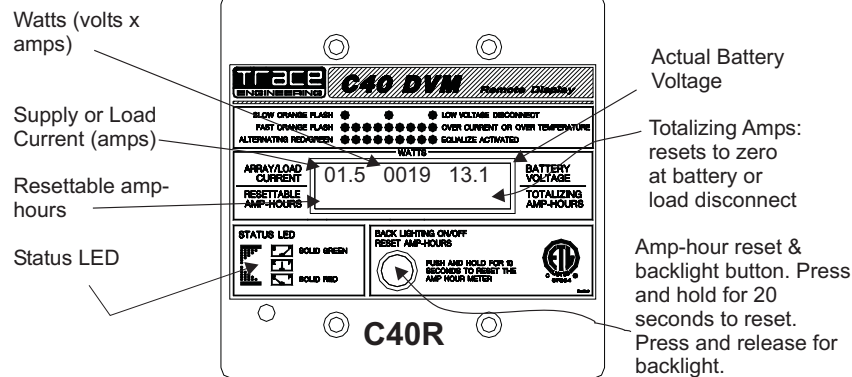
When the C40 is configured for Diversion Control mode, you can set the voltage at which the unit begins diverting current (high voltage diversion). The unit will continue diverting excess current to the diversion load until the source voltage falls to the HVD (Bulk) setting.

After two hours at the HVD setting, the unit will reduce the battery charging voltage to the Float voltage setting. This will usually result in more current being diverted to the diversion load. The Status LED indicator will flash from one to five times followed by a five-second pause to indicate battery voltage. Depending upon system voltage and the number of flashes between pauses, subtract the value shown on the faceplate of the unit from the HVD (Bulk) setting. When the LED flashes only once between pauses, the battery voltage is less than the lowest HVD value at the bottom of the chart. For a unit configured for 24 volts, for example, with the HVD (bulk) set at 26 volts and the LED flashing only once between pauses, the battery voltage will be less than 24.5 volts (26 minus 1.5 = 24.5). This means that the battery could be seriously discharged. When the LED stops flashing and lights steadily, the battery voltage is equal to the float charging voltage.

Note: The LED will light green *only* in Diversion and Charge Control mode, never in Load Control mode.

C40 Digital Volt Meter Displays

Two optional LCD digital volt meter (DVM) displays are available for the C40; the DVM/C40 replaces the standard faceplate on the C40 and the C40R/50 or C40R/100 mounts remotely in a standard double-gang switch box. The remote version is available with either 50 foot or 100 foot cables. Longer runs maybe possible because the communication is a serial-data type link.



These displays include a two-line, 32 character LCD and a status LED indicator.

The DVM display provides the following information:

- PV Array or DC load pass-through current: 0 to 63 amps DC
- Battery voltage: 4 to 100 volts DC
- Watts: 0 to 3600 watts DC (volts times amps)
- Amp-hours: 0 to 65536 ah; can be reset to 0
- Totalizing amp-hours: 0 to 65536 ah; resets to zero when power is disconnected
- Status LED: green, red, or orange

If the C40 is disconnected from the battery or the DVM cable, the DVM will be reset when it is powered up. You can press and hold the pushbutton on the front of the DVM to manually reset the amp-hour meter. Press and release this button to turn the backlight on or off. An adjustable potentiometer on the back of the DVM enables you to adjust the contrast of the LCD display. When installing the DVM, be sure to set the jumper on the printed circuit board over the pin set for the system voltage, either 12, 24, or 48 volts.

Installing the DVM/C40

To install the faceplate LCD, first remove the factory-installed faceplate by removing the four Phillips-head screws, and then pull out the LED indicator near the bottom left corner of the C40 printed circuit board (PCB). Plug the yellow cable on the DVM/C40 display into the six-conductor modular RJ15 connector adjacent to the LED that you just removed. Align the face plate and reinstall the screws. If the LED later needs to be replaced, note that it will operate in either orientation, except that if replaced incorrectly the color of the status LED will be reversed. The connecting cable for the display is a six-conductor telephone cable with modular type connectors (RJ15). Although any telephone-type cable will work, the cables provided with the displays use stranded and tin plated wire for better performance and longer life.

Mounting the C40R

The C40R is the remotely-mounted digital LCD voltmeter that mounts in a standard double gang outlet box, which can be permanently installed in a wall or cabinet. The unit can also be surface mounted with relief behind it, and it can be located up to 1000 feet from the C40 itself. If the DVM meters appear inaccurate or unusual on runs over 100 feet from the C40, remove the jumper located below the voltage configuration pins on the back of the C40R. This dims the LCD backlight, reduces power consumption and improves meter accuracy.

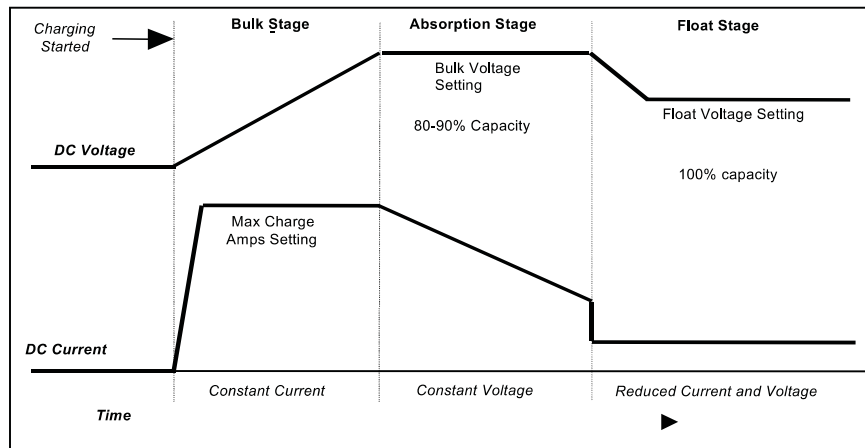
Three Stage Battery Charging

Battery voltage and current vary during the three-stage charging process as follows:

BULK - During this stage the batteries are charged at the Bulk voltage setting and maximum current output of the DC source up to 40 amps. When battery voltage reaches the BULK voltage setting, the controller goes to the next stage. During the bulk charging process the status LED may blink from one to five times before pausing. The more times it blinks consecutively, the closer the battery voltage is to the BULK voltage setting.

ABSORPTION - During this stage the voltage of the battery is held at the BULK voltage setting until an internal timer has accumulated one hour. Current gradually declines as the battery capacity is reached. During the ABSORPTION stage, the status LED blinks five times, then pauses and repeats.

FLOAT - During this stage the voltage of the battery is held at the FLOAT voltage setting. Full current can be provided to the loads connected to the battery during the float stage from the PV array. When the C40 has reached the FLOAT stage, the status LED will be solid green.



Typical BULK and FLOAT Setpoints for Batteries				
Battery Type and Materials	12 VDC System	24 VDC System	48 VDC System	Equalization ?
Default Settings (Knobs at 9 O'clock Position)	14.0 VDC BULK 13.5 VDC FLOAT	28.0 VDC BULK 27.0 VDC FLOAT	56.0 VDC BULK 54.0 VDC FLOAT	Disable
Sealed Gel or A.G.M. Lead Acid battery	14.1 VDC BULK 13.5 VDC FLOAT	28.2 VDC BULK 27.0 VDC FLOAT	56.4 VDC BULK 54.0 VDC FLOAT	Not advised
Maintenance-Free RV/ Marine Lead Calcium Battery	14.3 VDC BULK 13.2 VDC FLOAT	28.6 VDC BULK 26.4 VDC FLOAT	57.2 VDC BULK 52.8 VDC FLOAT	Limited appropriateness if water level can be checked
Deep-Cycle, Liquid Electrolyte Lead Antimony Battery	14.6 VDC BULK 13.4 VDC FLOAT	29.2 VDC BULK 26.8 VDC FLOAT	58.4 VDC BULK 53.6 VDC FLOAT	Recommended
NiCad or NiFe Alkaline Battery* (using 10 cells in series)	16.0 VDC BULK 14.5 VDC FLOAT	32.0 VDC BULK 29.0 VDC FLOAT	64.0 VDC BULK 58.0 VDC FLOAT	Check with manufacturer
* For NiCad and NiFe battery you must clip R46 and add 2V to the values for BULK and FLOAT shown on the circuit board. For example, to set the BULK for 16.0V, adjust the BULK knob to 14.0V after clipping R46 . Values above are for batteries at room temperature. For applications with significant temperature variations or systems with sealed batteries, install a cycled often or temperature sensor.				

When battery voltage drops below the FLOAT setting for a cumulative period of one hour, a new BULK cycle will be triggered. This typically occurs each night. If the battery is full at the start of the day, it will receive an ABSORPTION charge for one hour and then be held at the FLOAT setting for the remaining period of the day. Should the battery voltage drop below the FLOAT setting for a cumulative period of one hour, another BULK and ABSORPTION cycle will be initiated.

This three stage charging process results in faster charging compared to on-off relay type or constant voltage solid state regulators. Faster recharging increases the performance of the system by storing more of the PV array's limited output. The final FLOAT voltage setting reduces battery gassing, minimizes watering requirements and ensures complete battery recharging.

Equalization (Non-Sealed Batteries Only)

Approximately every month, some batteries may need to be "equalized" (a fancy term for overcharged). Since the individual cells of the battery are not identical, some cells may not be fully charged when the charging process is completed. If the batteries have been left in a discharged condition for long periods of time, the plates will have sulfates on them from the electrolyte. If the sulfate remains on the plates for an extended period of time, it will harden and seal off a percentage of the plate area, reducing the capacity of the battery. By equalizing the batteries before the sulfate hardens, the sulfate is removed from the plates.

Batteries with liquid electrolyte may become stratified. Stratification concentrates the sulfuric acid into the bottom of the cell while the top becomes diluted. This corrodes the lower portion of the plates, reducing battery life. Mixing of the electrolyte by the formation of gas bubbles during the equalization process reduces stratification.

Two methods can be used to determine if a battery needs to be equalized. If possible, measure the voltage of each individual cell while the battery is at rest (not being charged or discharged), a variation of 0.05 volts between cells indicates an imbalance exists. If the battery construction prevents measurement of the individual cell voltages, use a hydrometer. A variation of 0.020 in the specific gravity between cells is considered significant. Both conditions can be corrected by an equalization charge.

A proper equalization charge will not damage a vented, liquid electrolyte type battery. It may, however, cause significant electrolyte usage and require that the battery be refilled with distilled water to the correct level. This may be a problem with unattended systems in remote areas which do not receive regular maintenance. Consult the battery manufacturer for their recommendations.

CAUTION: Equalization should be done only on vented (not sealed or maintenance free) lead-acid, liquid-electrolyte batteries. The battery manufacturer should be consulted before attempting to equalize any other battery type. Add clean, distilled water to the battery following the equalization process.

DC loads may need to be disconnected by turning off circuit breakers or removing fuses before equalization to prevent damage by the required higher voltages.

WARNING: If the batteries are equipped with HYDROCAPS (catalytic gas recombiner caps), they should be removed during the equalization process. If hydrocaps are used, you should disable automatic equalization to prevent possible damage.

Batteries

Batteries come in different sizes, types, amp hour capacity, voltages and chemistries. Here are a few guidelines that will help in battery selection, and ensure that the batteries are properly maintained. The best source of the most appropriate settings for the C40 will be from the manufacturer or supplier of the batteries.

Automotive Batteries

Automotive and truck batteries are designed for high cranking power - not deep cycling. Don't use them unless no other battery type is available. They simply will not last long in a cycling application.

Maintenance-Free Batteries

This type of battery is often sold as a RV or marine battery, but is rarely appropriate for use with a PV system. They typically have an additional reserve of electrolyte, but are vented. This is not the same as a sealed battery.

Deep Cycle Batteries

Best suited for use with PV systems, this type of battery is designed to be more deeply discharged before being recharged. Deep-cycle batteries are available in many sizes and types. The most common is the vented liquid electrolyte battery.

Vented batteries usually have battery caps. The caps may appear to be sealed, but are not. The caps should be removed periodically to check the level of electrolyte. When a cell is low, distilled water should be added after the battery is fully charged. If the level is extremely low, add only enough distilled water to cover the plates before recharging. The electrolyte volume increases during the charging process and the battery will overflow if it is filled all of the way up before recharging. Use only distilled water because impurities will reduce battery performance.



A popular and inexpensive deep-cycle battery is the "golf cart" battery. It is a six-volt design typically rated at 220 amp-hours. RV and marine deep-cycle batteries are also popular for small systems. They are usually referred to as Group 24 or Group 27 batteries and are rated at 80 to 100 amp-hours at 12-volts. Many larger systems use L16 batteries, which are usually rated at 350 amp-hours at six-volts each. They are 17 inches high and weigh about 130 pounds. 8D batteries are available with either cranking or deep cycle construction. Purchase only the deep cycle version. The 8D is typically rated at 220 amp-hours at 12 volts.

Sealed Batteries

Another type of battery construction is the sealed gel cell. They don't use battery caps. The electrolyte is in the form of a gel rather than a liquid, which allows the batteries to be mounted in any position. The advantages are no maintenance, long life (800 cycles claimed) and low self discharge. Absorbed glass mat electrolyte (AGM) batteries are also acceptable. Their electrolyte is contained in mats between the battery plates. Sealed

batteries reduce the maintenance requirements for the system and are good for remote applications. They are much more sensitive to the charging process and can be ruined in as little as a day of overcharging.

NiCad and NiFe Batteries

The Trace C40 is compatible with (NiCad (nickel-cadmium) and (NiFe)(nickel-iron or alkaline) type batteries, which must be charged to a higher voltage level to achieve a full charge. To use the C40 with NiCad batteries, remove the resistor labeled "R46" in the middle of the C40 circuit board by cutting it. This adds two volts to the printed scale on the circuit board around the BULK and FLOAT potentiometers. When NiCad mode is selected, the equalization process is disabled.

Adjust the BULK Charge Voltage to the setting recommended by the battery manufacturer. Add 2 volts to the scale shown when making the adjustment. FLOAT voltage settings for NiCad/NiFe batteries should also be set to the battery manufacturer's recommendations. Add 2 volts to the scale when making the adjustment.

In all applications the BULK voltage setting should be adjusted to a level below the maximum operating voltage of the DC loads. This may be as low as 15 volts for some types of electronic loads. Under-charging may occur in this instance, but DC equipment will be protected. Check with the manufacturers of the DC equipment being powered for its maximum DC input voltage tolerance. If equalization is expected to occur, then the DC equipment being used must tolerate the voltages which will occur during the equalization process.

Battery Sizing

Batteries are the fuel tank of the system. The larger the batteries, the longer the system can operate before recharging is necessary. An undersized battery bank results in short battery life and disappointing system performance. To determine the proper battery bank size, compute the number of amp-hours that will be used between charging cycles. Once the required amp-hours are known, size the batteries at approximately twice this amount. Doubling the expected amp-hour usage ensures that the batteries will not be overly discharged and will extend battery life. The critical formula is Watts = Volts X Amps. Divide the wattage of the load by the battery voltage to determine the amperage the load will draw from the batteries. Multiply the amperage times the hours of operation and the result is, reasonably enough, amp-hours.

Diversion Loads

Anyone dealing with solar, wind, or hydro power generation systems knows that a critical component in these systems is the charge/load controller(s). The job of the charge controller is to see that a battery bank is charged in a controlled manner. Also, protection against over discharge and overcharging is provided by disconnecting the charging source(s) from the battery should one of these conditions occur.

A load controller is generally designed to remove a load or loads from the system when an over discharge or overload situation occurs.

A diversion load controller is designed to monitor battery state, and when the battery is full, divert the power coming out of the source (Solar, wind, or hydro generator) to a load which will utilize the excess power. Usually a water heater or some other type of heating element is present for this purpose.

Systems utilizing solar arrays do not have a requirement for diversion loads since a solar module can be open circuited without damage. However, even with a solar based system it is desirable to use excess power to operate DC loads. On the other side of the equation, when a wind or hydro generator is operating, the diversion load prevents over speeding and self destruction. Unload the system by suddenly removing the load and the generator will over speed and potentially fail. The only way to safely deal with this situation is to either stop the generator, or allow its power output to continue, but divert it away from the batteries to prevent overcharging. This is the duty of a diversion load controller.

What Should I Use for a Diversion Load?

Several different types of diversion loads are available to the alternative energy market. These loads are designed to operate with the power output levels common to most diversion load controllers. The following are several available diversion loads which may be used successfully for heating water or air.

A 120VAC, 2000 watt water heater element available at most any hardware store, may be used with a 12, 24, or 48 volt DC system, however do not expect a 2000 watt power dissipation. The power draw is determined by the heater element's DC resistance, the output voltage of the controller, as well as the output current capability of the charging source(s). These heater elements were designed to operate at 120 Volts AC. A 48 volt 40-amp charge controller will operate just fine with this type of a system providing about 500 watts of power dissipation. A 12 or 24 volt diversion load controller will work but doesn't put out enough power to effectively heat water with only one element. The remedy to this type of problem is to parallel several of these heater elements to increase the power output. The chart below shows power dissipation of a 120VAC, 2000 watt heater element operated at different voltages. Note that the voltages given are roughly the bulk charge stage voltages for a given system. Remember that if you parallel heater elements the diversion load can handle more current.

System Voltage	Power	Amperage
60 VDC (48 VDC SYSTEM)	500W	8.6 AMPS
30 VDC (24 VDC SYSTEM)	25W	4.3 AMPS
15 VDC (12 VDC SYSTEM)	30W	2.1 AMPS
120 VAC	2000W	16.7 AMPS

A couple of other excellent diversion loads which may be utilized effectively are available from Alternative Energy Engineering of Redway California.

1. A 12/24 volt DC or 24/48 volt DC water heater element (AEE Part #20909 or #20919 (24/48V))
2. Open air heater with a fan (AEE Part #2091312 (12V, 720W), #2091324 (24V,720W), #2091412 (12V,1440W), #2091524 (24V, 1440W), and #2091648 (48V,1440W)).

For more information call 1(800) 800-0624, or 1(800) 777-6609, or FAX 1(800) 777-6648.

Regardless of the type of diversion load you decide to utilize, make sure that the diversion load can handle all the power the charging system is capable of putting out. Paralleling heater elements (whether open air or water heater) will allow more power dissipation. A good rule of thumb is to not have a combined charging source greater than 80% of the diversion load controller's current handling ability. For example, if a Trace C40, 40 amp diversion load controller is being used, do not place a combination of charging sources which are capable of putting out more than 32 amps (80% of 40 amps) on the load controller's circuit. Sizing a diversion system this way allows a safety margin for unusual conditions (High winds, high water flow, etc.). It is not recommended that light bulbs be used as diversion loads for a couple of reasons.

- 1) An incandescent light bulb has a substantially lower cold filament resistance than when it is on. This means it draws more power (up to five times) to start the light when it is cold than once the filament has warmed up. Even a forty watt lightbulb may have an inrush amperage at turn-on of 200 amps. This would cause the load controller to shut down.
- 2) In the event a light bulb load burns out, a smaller-than-necessary load will be present and the excess energy will have no where to go. When the controller switches to diversion mode, the other bulbs will probably burn out in succession since they can't handle the excess current, and very quickly you will have a no load situation.

WarrantyProcedure

Complete the warranty card and mailed it to Trace Engineering within ten (10) days from the date of purchase. Keep your bill of sale as proof of purchase, should any difficulties arise concerning the registration of the warranty card.

Warranty registration is tracked by model and serial numbers only, not by owner's name. Therefore, any correspondence or inquiries made to Trace Engineering must include the model and serial number of the product in question. Be sure to fill in the model and serial numbers in the space provided below. Keep this portion of the warranty card in a safe place for future reference.

Warranty service must be performed only at an authorized Trace Service Center, or at the Trace Engineering factory. Notify the repair facility before shipping to avoid the possibility of needless shipment.

UNAUTHORIZED SERVICE PERFORMED ON ANY TRACE PRODUCT WILL VOID THE EXISTING FACTORY WARRANTY ON THAT PRODUCT.

FACTORY SERVICE: If you wish your Trace Engineering product to be serviced at the factory, it must be shipped fully insured in the original packaging or equivalent; this warranty will not cover repairs on products damaged through improper packaging. If possible, avoid sending products through the mail.

Note: Before returning any equipment to Trace Engineering, call our Warranty Coordinator and request an Return Merchandise Authorization (RMA) number. Be sure to have the serial number of the equipment handy.

Ship To:

**Trace Engineering Company, Inc.
Attn: Service Department. RMA#
5916 195th NE
Arlington, WA 98223
Phone: (360) 435-8826
(Warranty Coordinator)**

Be sure to include in the package:

- ☐ Complete return shipping address (PO Box numbers are not acceptable) and telephone number where you can be reached during work hours.
- ☐ A detailed description of any problems experienced, including the make and model numbers of any other equipment in the system, types and sizes of loads, operating environment, time of unit operation and temperature.
- ☐ A copy of your proof of purchase (purchase receipt).

Repaired products will be returned freight C.O.D. unless sufficient return shipment funds are included with the unit. Products sent to the factory from outside the U.S. MUST include return freight funds, and sender is fully responsible for all customs documents, duties, tariffs, and deposits.

Record the model and serial numbers on page one and retain for your files.

Limited 2 Year Warranty

Trace Engineering Company warrants its power products against defects in materials and workmanship for a period of two (2) years from the date of purchase and extends this warranty to all purchasers or owners of the product during the warranty period. Trace does not warrant its products from any and all defects: (1) arising out of material or workmanship not provided by Trace Engineering, or (2) resulting from abnormal use of the product or use in violation of the instructions, or (3) in products repaired or serviced by other than Trace Engineering repair facilities, or (4) in components, parts, or products expressly warranted by another manufacturer. Trace Engineering agrees to supply all parts and labor or repair or replace defects covered by this warranty with parts or products of original or improved design, at its option, if the defective product is returned to any Trace Engineering authorized warranty repair facility or to the Trace Engineering factory in the original packaging, with all transportation costs and full insurance paid by the purchaser or owner.

All remedies and the measure of damages are limited to the above. Trace engineering shall in no event be liable for consequential, incidental, contingent or special damages, even if trace engineering has been advised of the possibility of such damages. Any and all other warranties expressed or implied arising by law, course of dealing, course of performance, usage of trade, or otherwise, including but not limited to implied warranties of merchantability and fitness for a particular purpose, are limited in duration to a period of two (2) years from the date of purchase. Some states do not allow limitations on how long an implied warranty lasts, or the exclusion of incidental or consequential damage. So the above limitations may not apply to you. This warranty gives you specific legal rights. You may also have other rights which vary from state to state.

C40 Specifications and Features

Voltage Configurations:	12VDC	24VDC	48VDC
General Specifications			
Nominal battery voltage	12 vdc	24 vdc	48 vdc
Maximum PV array open circuit voltage	25 vdc	50 vdc	90 vdc
Maximum voltage drop @ 40 amps	0.30 volts - Charge control mode		
Typical current consumption (tare loss)	15ma (typical), at idle – 3 ma (tare)		
Maximum charging/load current	45 amps DC continuous, 60 amps intermittently		
Charger regulation method	solid state, 3 stage (Bulk, Absorption and Float) Pulse Width Modulation		
Regulation settings - Charge Control mode	Float 12.5 – 14.5 vdc	Float 25.0 – 29.0 vdc	Float 50.0 – 58.0 vdc
Lead Acid type battery –	Bulk 13.0 – 15.0 vdc	Bulk 26.0 – 30.0 vdc	Bulk 52.0 – 60.0 vdc
NiCad type battery - add 2V (12V), 4V (24V), 8V (48V)	EQ +2 vdc above Bulk	EQ +4 vdc above Bulk	EQ +8 vdc above Bulk
Regulation settings – Load Control mode	LVR - subtract 1 vdc from Float setting, or use decal provided LVD - subtract 2 volts from Bulk setting or use decal provided		
Standard Features			
Status indicator	Multi-color LED indicates the operating/battery voltage status		
Low voltage disconnect - Load Control mode	User selectable manual or automatic reconnection – includes warning flash before disconnect and 10 minute “grace” period		
Equalization charge - Charge Control mode	User selectable manual or automatic equalization (every 30 days)		
Short circuit protection	Fully electronically protected with auto-reset		
Field adjustable control setpoints (test points provided for high accuracy)	Two user adjustable voltage setpoints for control of loads or charging sources (settings retained if battery is disconnected)		
Options			
LCD meter panel - (DVM/C40, C40R/50, C40R/100)	Back-lit, 2 line, 32 character, alphanumeric liquid crystal display panel for remote (C40R) or direct mounting (DVM/C40) on the C40		
External Battery Temperature Sensor - (BTS/15, BTS/35)	Provides automatic adjustment of the charge control setpoints to the battery temperature (may be extended)		
Environmental Limitations			
Enclosure type	Indoor, ventilated, powder-coated steel, with ¾" and 1" knockouts		
Specified temperature range	32°F to 104°F (0°C to +40°C) (output will meet specified tolerances)		
Allowed temperature range	-40°F to 140°F (-40°C to +60°C) (output may not meet specified tolerances)		
Non-operating temperature	-67°F to 284°F (-55°C to +75°C)		
Altitude limit operating	15,000 feet (5000 meters)		
Altitude limit non-operating	50,000 feet (16,000 meters)		
Dimensions – controller only	10" (25.4 cm) high, 5" (12.7 cm) wide, 2.5" (6.35 cm) deep		
Mounting	Vertical wall mount		
Weight	Controller only - 4 lbs (1.8 kg), Shipping - 4.5 lbs (2 kg)		

Note: All specifications are subject to change without notice.

