SOLAR CHARGE CONTROLLER MODEL C30A

Owner's Manual

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PRODUCT DESCRIPTION

The C-30A was designed to control the charge applied to a battery bank from a solar panel array. The design goal was to produce a unit that was energy efficient, reliable, user adjustable, self-configuring and reasonably priced. The goal was accomplished using a design that incorporates a rugged battery voltage controlled relay - together with buffer and protection circuits for extended service life.

Features

* Automatic self configuration for operation in 12 or 24 VDC systems.
* Rated at 30 amps for 12 or 24 VDC applications.
* Adjustable high battery disconnect and low battery reconnect voltages.
* Automatic disconnect of solar array from the batteries during low light conditions eliminates the need for power robbing diodes.
* Design uses no semiconductors in the current path resulting in minimal voltage losses and high reliability.
* An "Equalize" switch defeats high battery disconnect allowing batteries to be charged at high voltage for periodic battery maintenance.
* An LED indicates the operating mode of the C-30A.
* Box terminals accept wire up to 4 gauge.
* Electrostatic discharge (lightning) protection.
* Conformal coated circuit board for increased environmental tolerance.

Automatic Nighttime Disconnect

At low charge currents the C-30A will periodically open its internal relay to test for solar panel activity. If the solar panel is not capable of producing battery charging current, the C-30A will go into a standby mode. In this mode, it disconnects the panels from the batteries, thus preventing feedback of current from the batteries to the panels.

Current Consumption

The C-30A consumes very little current. All relay current is taken from the panel. At low charge currents, the scan circuit will periodically open the relay to check panel status. If the panel cannot produce adequate hold current for the relay (about 70 MA) the relay will deactivate. In this state, the controller becomes dormant consuming only about 1/100th of an amp.

LED Indicator Lamp

An LED is provided to indicate the four operating modes of the C-30A.

ON/STEADY - This indicates that the C-30A is cycling from high battery disconnect to low battery re-connect and that the solar panels are active. The panels are active but disconnected from the batteries.

SLOW FLASHING - This indicates that the solar panels are active and connected to the batteries in a normal charge mode.

FAST FLASHING - A faster LED flash rate indicates solar panels delivering current to the batteries in an Equalize Charge mode.

OFF - LED out indicates that the solar panels are inactive and that the C-30A is not charging.

Equalize Switch

The Equalize switch protrudes from the top cover of the C-30A. When engaged, it bypasses the high voltage disconnect and keeps the panels connected to the batteries regardless of battery voltage. The LED will flash at a fast rate in this mode.

If the equalize switch is engaged while the panels are inactive (low light conditions) the LED will be OFF. When the panels become active, the light will begin flashing at the fast rate.

WARNING - This switch defeats the voltage protection provided by the C-30A. If left in the Equalize position indefinitely, battery damage could occur.

Protection

Over-current protection is provided by a 30 amp fuse located on the printed circuit board. Limited lightning protection is provided by a 56 volt transorb rated at 8 by 220 μs at 6800 amps and connected across the battery terminals. Protection against reverse battery connection is provided for the C-30A's electronic circuits.

INSTALLATION

General Considerations

The factory voltage setting is for temperate climates. Battery temperature has a very significant impact on the voltages that produce optimum battery charging. In warm conditions the maximum charge voltage should be reduced. For cold conditions it should be increased. The "Battery Gassing" graph on page 14 provides information on temperature versus cell voltage.

For very large control applications, more than one controller may be hooked up in parallel. In this case, the array must be divided into groups, with each group wired to its own charge controller. The maximum current for each group in the array must not exceed 30 amps.

The solar array should be grounded to protect the system (and yourself) from static voltages. This should be done both at the panel and at the controller. Use a rod to earth ground at the panels and at the batteries. In very static prone environments see your dealer for advice on further protective measures.

Mounting and Wiring Procedures

(1) Use the information in the section "Graphs and Tables" to determine the correct wire size for your installation.

(2) The controller is mounted using the two 1/4 inch holes in its back cover. Use the mounting template on page 18 to locate these holes.

(3) Remove the two phillips head screws from the front cover. (Notice that the inside of the front cover has an illustration showing the location of the module's wire terminals, trim pots and test points. This illustration is duplicated on page 17.) Fasten the controller to the mounting surface with round head screws or bolts.

(4) The model C-30A is shipped from the factory in the following configuration:

Operating voltage:	Auto 12 or 24 volts
High voltage disconnect:	14.7/29.4 VDC
Low Voltage re-connect:	13.2/26.4 VDC

Use the information in the following section "Adjusting the Voltage Settings" if your application requires voltage settings that are different than those supplied by the factory.

(5) The connections from the battery to the controller should be made first. If the wiring from the panels is connected to the C-30A before the battery is connected, the relay will cycle (open and close).

Route the battery's positive and negative leads through the appropriate romex strain relief connector on the bottom of the C-30A. The illustrations on page 15 and 16 show wiring diagrams for 12 and 24 VDC systems.

(a) The positive (plus) lead from the battery is connected to the box terminal labeled "Battery."

(b) The negative (ground) lead form the battery is connected to box terminals labeled "Battery Ground."

(6) Route positive and negative leads from the solar panels thru a romex strain relief connector on the bottom of the C-30A.

(a) The positive (plus) lead from the panel(s) is connected to the box terminal labeled "Panel/Load Positive."

(b) The negative (ground) lead from the panel(s) is connected to the box terminals labeled "Panel/Load Ground."

(7) Grease the wire ends and connectors to prevent corrosion. Tighten securely.

(8) Tighten the romex connectors to provide strain relief.

(9) Replace the front cover.

Important - A blocking diode is not required but if one is installed, it must be located in one of the leads from the panel to the C-30A. If it is installed in a lead between the battery and the C-30A, the controller's relay will cycle and the unit will not operate.

ADJUSTING THE VOLTAGE SETTINGS

Voltage Control

The C-30A is basically a voltage controlled relay. It connects the panels to the battery when the battery voltage is low, and disconnects the panels from the battery when the battery voltage is high.

The voltages at which the relay opens and closes (connects and disconnects) are user adjustable as described below.

Cell Voltage vs Battery Voltage

The C-30A voltage settings are defined in cell voltage rather than battery voltage. A 12 volt battery has 6 cells and, therefore, has a nominal cell voltage of 2 volts. A 24 volt battery has 12 two volt cells.

The section "Tables and Graphs" on page 10 provides tables for converting battery voltages to cell voltages. There is a table for 12 volt conversions and a table for 24 volt conversions. To make a conversion, simply go to the appropriate table, locate the desired battery voltage. The corresponding cell voltage will be in the next column.

Location of Test Points and Trim Pots

The C-30A has two test points and two trim pots. The test points are 3/8" metal pins located on the left edge of the circuit board. The trim pots are 3/8" in diameter with a screw driver slot in their center. They are located 1/4" to the right of each test pin. (Refer to the illustration on page 17.)

Voltmeter

Adjusting the voltage connect and disconnect points requires a digital voltmeter with at least a 3 1/2 digit readout. Voltage adjustments are made by connecting the voltmeter's negative (black) lead to the C-30A's battery ground "Panel/Load Ground" (negative) terminals, and the voltmeter's positive lead (red) to one of the C-30A's test points. The voltmeter should be set to read DC volts on a 20 volt scale.

Note: Voltage adjustments cannot be made until the battery positive and ground are connected to the C-30A.

Setting Operating Voltages (see diagram on page 17)

The High Voltage Disconnect Must Be Set First.

Use the voltage conversion chart on page 12 to determine the desired cell voltage. To set the high voltage disconnect point, measure from the high voltage test pin to ground - "Panel/Load Negative" or "Battery Negative." Adjust the high voltage trim pot located beside the test point to the desired cell voltage.

Once the high voltage disconnect point is set, then the low voltage re-connect can be adjusted. Measure from the low voltage test point to ground. Adjust the low voltage trim pot located beside the test point to the desired voltage.

SPECIFICATIONS

Electrical

Typical voltage setting stability	0.24%/1000 Hrs.
High Battery Voltage range	3.2 to 1.6 VDC/cell
Low Battery Voltage range	95% of HB to 1.6 VDC/cell
Maximum current capacity	30 amps
Current draw - relay closed	87 ma
Current draw - relay open	10 ma
Current draw - night condition	7.5 ma typical
Typical service life of relay	100,000 cycles at 30 amps
Typical operating range	12 VDC Nominal, or 24 VDC Nominal
Maximum input voltage	56 VDC
Equalize function	Manually activated, uncontrolled charge

Environmental

Operating temperature	-20C to 60C
Storage temperature	-35C to 90C
Humidity	Non-condensing Rh Max 95%
Altitude operating	4,500 meters
Altitude storage	15,000 meters
Transportation	NSTAT procedure 1A CII

Physical

Weight	24 oz net/2 lbs.-shipping
Size	5.25"W X 6.3"L X 1.9"H
Cabinet	0.090" folded aluminum
Finish	Black anodize
Wire usage	Rated copper only

GRAPHS AND TABLES

Cell Voltage Conversion Tables (Page 12)

Since the C-30A is adjusted using battery cell voltage, two tables are provided for converting battery voltage to cell voltage -- one for 12 volt systems and one for 24 volt systems. To make a conversion simply go to the appropriate table, locate a battery voltage and to its right will be listed the corresponding cell voltage.

Wire Resistance Tables (Page 13)

The wire resistance table provides the total resistance of the ground and positive leads for various wire sizes and distances. Once resistance is known, the voltage loss for various currents can be derived from the Voltage Loss Table. You may be surprised at the size wire necessary to keep voltage losses in the panel leads at acceptable levels. For example:

A 12 volt system with ten 3.0 amp panels located 60 feet from the batteries and using 4 gauge wire will lose approximately 1 volt in the panel leads during peak charging times!

The above example is determined by first going to the "Wire Resistance Table." Select the #4 wire size row. Move across this row to the column for 60 feet. The total resistance is .030 ohms (30 milli ohms.) Go to the "Voltage Lost in Cables" table. Select the 32 amp row (it is the closest to 30 amps of our 10-3 amp panels example). Move across this row to the resistance column closest to the 30 milli ohms of our wire (32 in this case). The number given is 1.02 volts.

Temperature vs Panel Output, Gassing, Voltage Loss

Solar panels act as a current source. They will deliver the same amount of current over a range of voltages. Therefore, panels with a higher voltage output may tolerate some voltage drop in their wire leads with no appreciable loss in performance. For example: If the panels are capable of delivering full current at 16 volts, and the batteries are at 13 volts, a 2 volt loss in the wiring will still allow the panels to charge the batteries to 14 volts at full rated current. In order to select the proper wire size, the maximum voltage at which a panel can deliver its rated current is useful to know.

As temperature rises the voltage at which the panels can deliver rated current decreases. The maximum charge voltage the batteries can see without gassing is also reduced. Since the two characteristics are "going in the same direction", the panels output voltage goes down as the batteries ability to handle high charging voltages without gassing is reduced. However, the batteries could be in a cool place while the panels are heating in the sun. Under these conditions the tolerance for wire voltage loss would be less.

Battery Gassing Graph (Page 14)

The Battery Gassing Graph gives a generalized curve for battery temperature versus battery gassing for lead antimony batteries. However, we recommend that you use the specific recommendations of your battery manufacturer whenever possible.

The C-30A is factory set for temperate conditions. For unusual temperatures or other special conditions, the C-30A should be reset to appropriate voltages.

Panel Output Voltage vs Temperature Graph (Page 15)

Solar panel output voltage decreases as the temperature of the panel increases. The decrease in output voltage can be significant. This graph gives an approximation of the output voltage change with temperature for a nominal 16 volt panel.

12 VOLT BATTERY CONVERSION TABLE

Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage
10.00	1.667	11.00	1.833	12.00	2.000	13.00	2.167	14.00	2.333	15.00	2.500
10.05	1.675	11.05	1.842	12.05	2.008	13.05	2.175	14.05	2.342	15.05	2.508
10.10	1.683	11.10	1.850	12.10	2.017	13.10	2.183	14.10	2.350	15.10	2.517
10.15	1.692	11.15	1.858	12.15	2.025	13.15	2.192	14.15	2.358	15.15	2.525
10.20	1.700	11.20	1.867	12.20	2.033	13.20	2.200	14.20	2.367	15.20	2.533
10.25	1.708	11.25	1.875	12.25	2.042	13.25	2.208	14.25	2.375	15.25	2.542
10.30	1.717	11.30	1.883	12.30	2.050	13.30	2.217	14.30	2.383	15.30	2.550
10.35	1.725	11.35	1.892	12.35	2.058	13.35	2.225	14.35	2.392	15.35	2.558
10.40	1.733	11.40	1.900	12.40	2.067	13.40	2.233	14.40	2.400	15.40	2.567
10.45	1.742	11.45	1.908	12.45	2.075	13.45	2.242	14.45	2.408	15.45	2.575
10.50	1.750	11.50	1.917	12.50	2.083	13.50	2.250	14.50	2.417	15.50	2.583
10.55	1.758	11.55	1.925	12.55	2.092	13.55	2.258	14.55	2.425	15.55	2.592
10.60	1.767	11.60	1.933	12.60	2.100	13.60	2.267	14.60	2.433	15.60	2.600
10.65	1.775	11.65	1.942	12.65	2.108	13.65	2.275	14.65	2.442	15.65	2.608
10.70	1.783	11.70	1.950	12.70	2.117	13.70	2.283	14.70	2.450	15.70	2.617
10.75	1.792	11.75	1.958	12.75	2.125	13.75	2.292	14.75	2.458	15.75	2.625
10.80	1.800	11.80	1.967	12.80	2.133	13.80	2.300	14.80	2.467	15.80	2.633
10.85	1.808	11.85	1.975	12.85	2.142	13.85	2.308	14.85	2.475	15.85	2.642
10.90	1.817	11.90	1.983	12.90	2.150	13.90	2.317	14.90	2.483	15.90	2.650
10.95	1.825	11.95	1.992	12.95	2.158	13.95	2.325	14.95	2.492	15.95	2.658
11.00	1.833	12.00	2.000	13.00	2.167	14.00	2.333	15.00	2.500	16.00	2.667

24 VOLT BATTERY CONVERSION TABLE

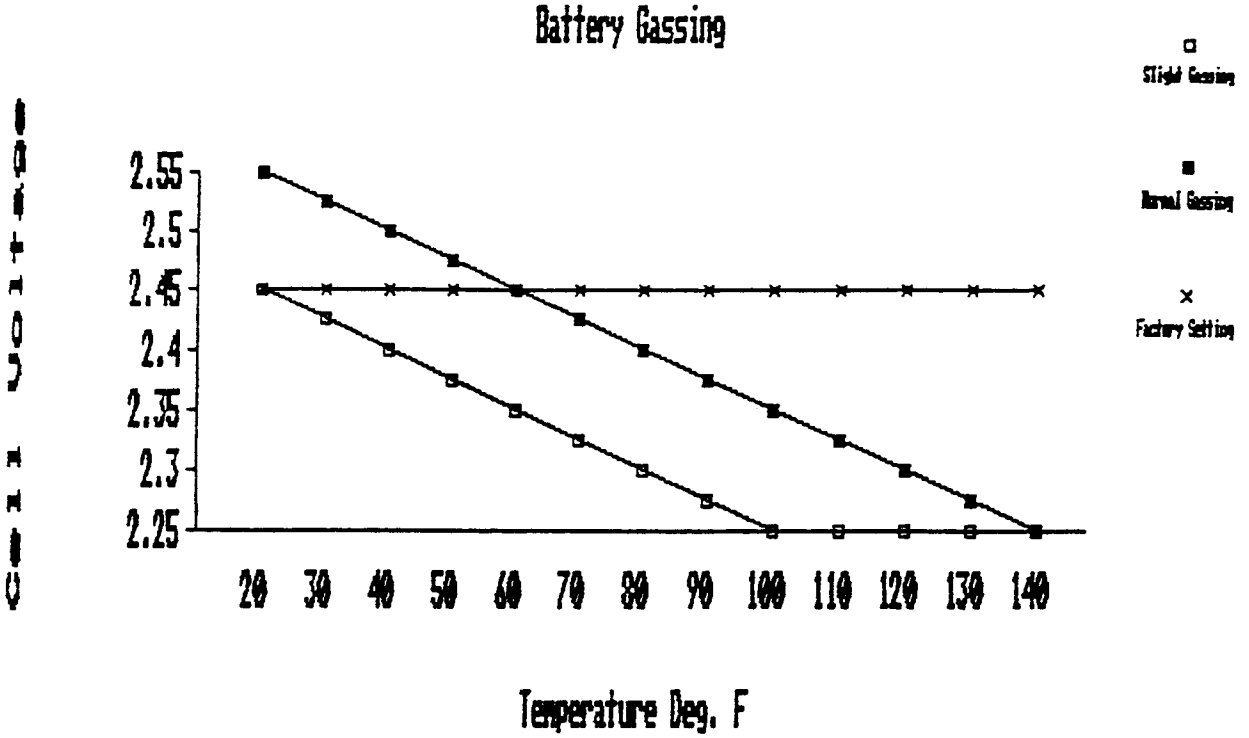
Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage
20.00	1.667	22.00	1.833	24.00	2.000	26.00	2.167	28.00	2.333	30.00	2.500
20.10	1.675	22.10	1.842	24.10	2.008	26.10	2.175	28.10	2.342	30.10	2.508
20.20	1.683	22.20	1.850	24.20	2.017	26.20	2.183	28.20	2.350	30.20	2.517
20.30	1.692	22.30	1.858	24.30	2.025	26.30	2.192	28.30	2.358	30.30	2.525
20.40	1.700	22.40	1.867	24.40	2.033	26.40	2.200	28.40	2.367	30.40	2.533
20.50	1.708	22.50	1.875	24.50	2.042	26.50	2.208	28.50	2.375	30.50	2.542
20.60	1.717	22.60	1.883	24.60	2.050	26.60	2.217	28.60	2.383	30.60	2.550
20.70	1.725	22.70	1.892	24.70	2.058	26.70	2.225	28.70	2.392	30.70	2.558
20.80	1.733	22.80	1.900	24.80	2.067	26.80	2.233	28.80	2.400	30.80	2.567
20.90	1.742	22.90	1.908	24.90	2.075	26.90	2.242	28.90	2.408	30.90	2.575
21.00	1.750	23.00	1.917	25.00	2.083	27.00	2.250	29.00	2.417	31.00	2.583
21.10	1.758	23.10	1.925	25.10	2.092	27.10	2.258	29.10	2.425	31.10	2.592
21.20	1.767	23.20	1.933	25.20	2.100	27.20	2.267	29.20	2.433	31.20	2.600
21.30	1.775	23.30	1.942	25.30	2.108	27.30	2.275	29.30	2.442	31.30	2.608
21.40	1.783	23.40	1.950	25.40	2.117	27.40	2.283	29.40	2.450	31.40	2.617
21.50	1.792	23.50	1.958	25.50	2.125	27.50	2.292	29.50	2.458	31.50	2.625
21.60	1.800	23.60	1.967	25.60	2.133	27.60	2.300	29.60	2.467	31.60	2.633
21.70	1.808	23.70	1.975	25.70	2.142	27.70	2.308	29.70	2.475	31.70	2.642
21.80	1.817	23.80	1.983	25.80	2.150	27.80	2.317	29.80	2.483	31.80	2.650
21.90	1.825	23.90	1.992	25.90	2.158	27.90	2.325	29.90	2.492	31.90	2.658
22.00	1.833	24.00	2.000	26.00	2.167	28.00	2.333	30.00	2.500	32.00	2.667

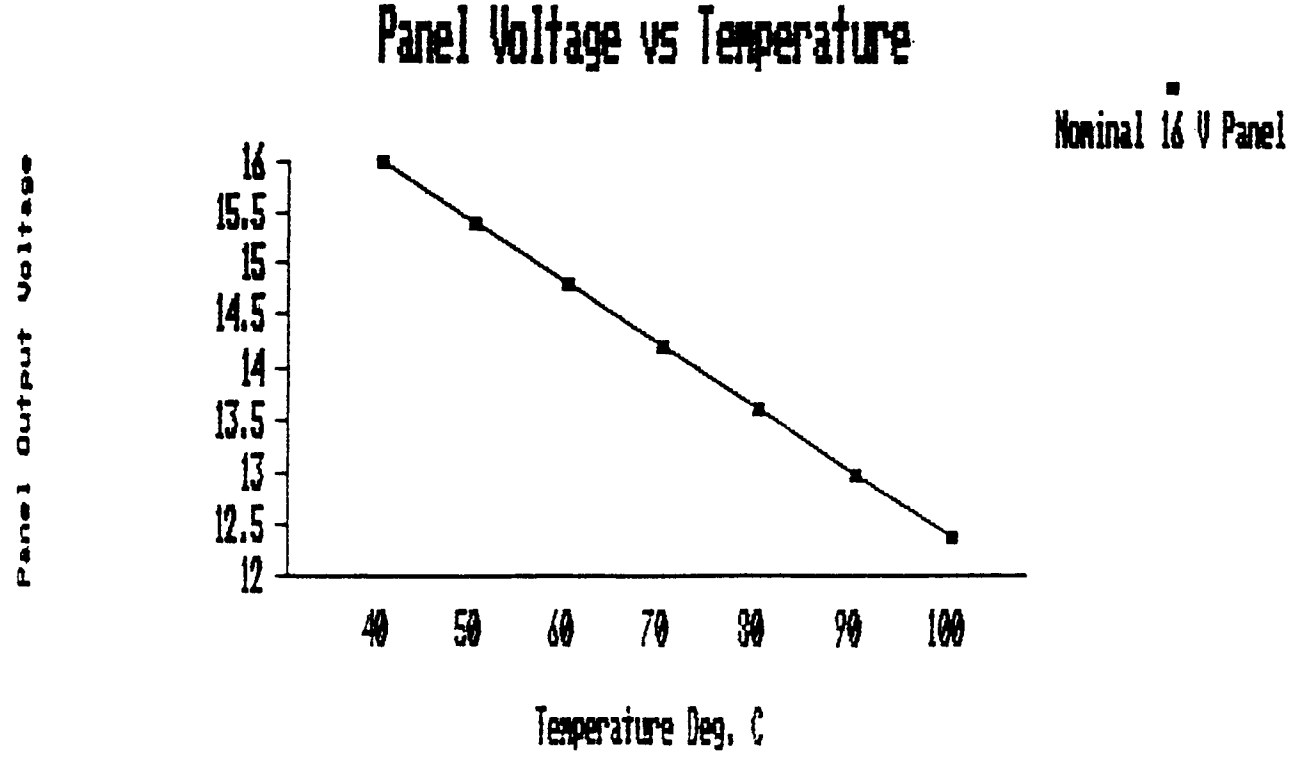
WIRE RESISTANCE TABLE in ohms/1000 - milli ohms

Wire Size	Distance from Panels to Battery in Feet									
	20	40	60	80	100	150	200	250	300	400
#14	101	202	302	403	504	756	1008	1260	1512	2016
#12	64	127	191	254	318	477	636	795	954	1272
#10	40	80	120	160	200	300	400	499	599	799
#8	25	50	75	100	126	188	251	314	377	502
#6	16	32	47	63	79	119	158	198	237	316
#4	10	20	30	40	50	75	99	124	149	199
#2	6	13	19	25	31	47	63	78	94	125
#0	4	8	12	16	20	30	39	49	59	79

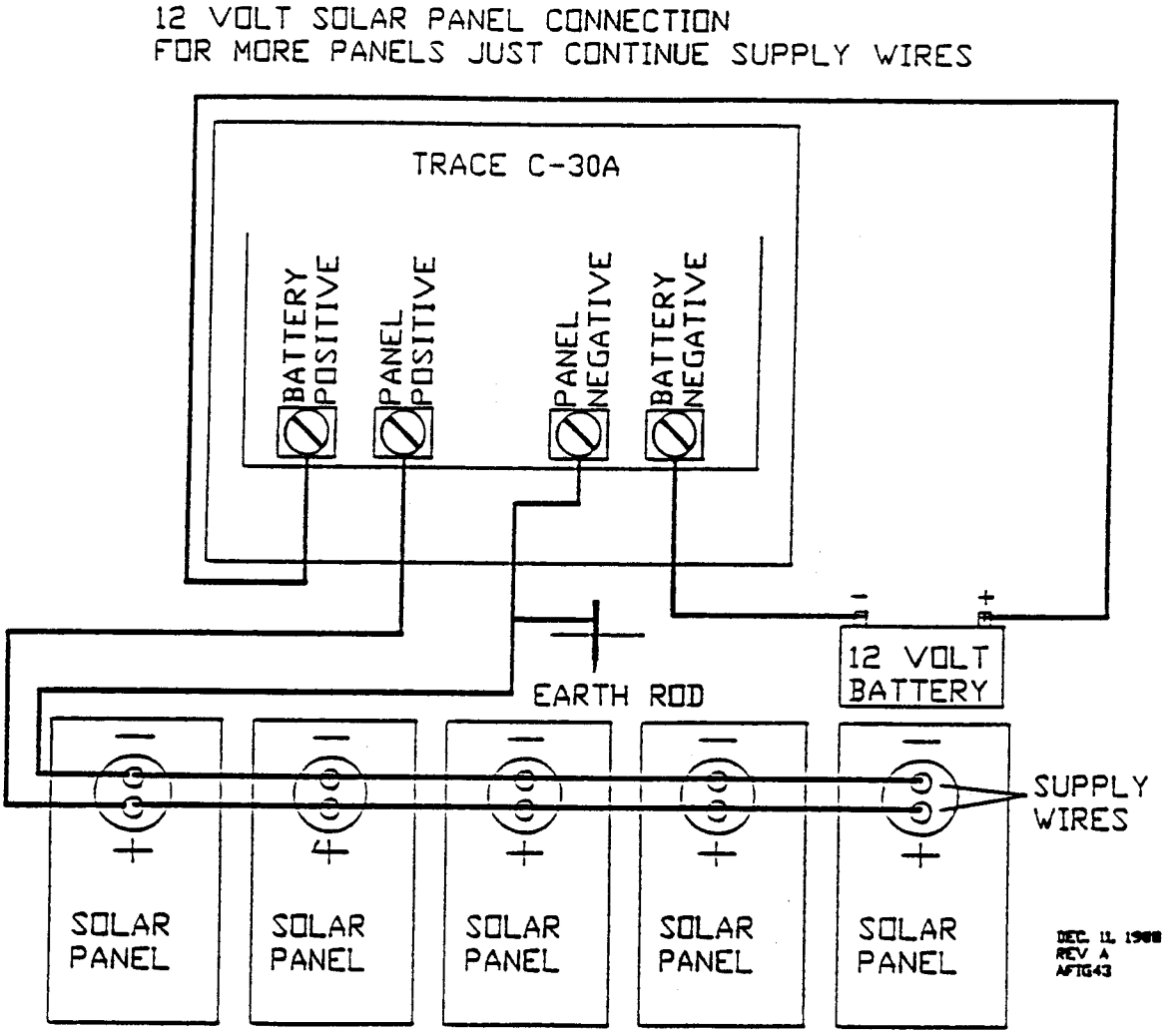
VOLTAGE LOST IN CABLES

Current in Amps	Resistance in Ohms/1000 - M ohms									
	1	2	4	8	16	32	64	128	256	512
1	.00	.00	.00	.01	.02	.03	.06	.13	.26	.51
2	.00	.00	.01	.02	.03	.06	.13	.26	.51	1.02
4	.00	.01	.02	.03	.06	.13	.26	.51	1.02	2.05
8	.01	.02	.03	.06	.13	.26	.51	1.02	2.05	4.10
16	.02	.03	.06	.13	.26	.51	1.02	2.05	4.10	8.19
32	.03	.06	.13	.26	.51	1.02	2.05	4.10	8.19	16.38
64	.06	.13	.26	.51	1.02	2.05	4.10	8.19	16.38	32.77
128	.13	.26	.51	1.02	2.05	4.10	8.19	16.38	32.77	65.54
256	.26	.51	1.02	2.05	4.10	8.19	16.38	32.77	65.54	
512	.51	1.02	2.05	4.10	8.19	16.38	32.77	65.54		

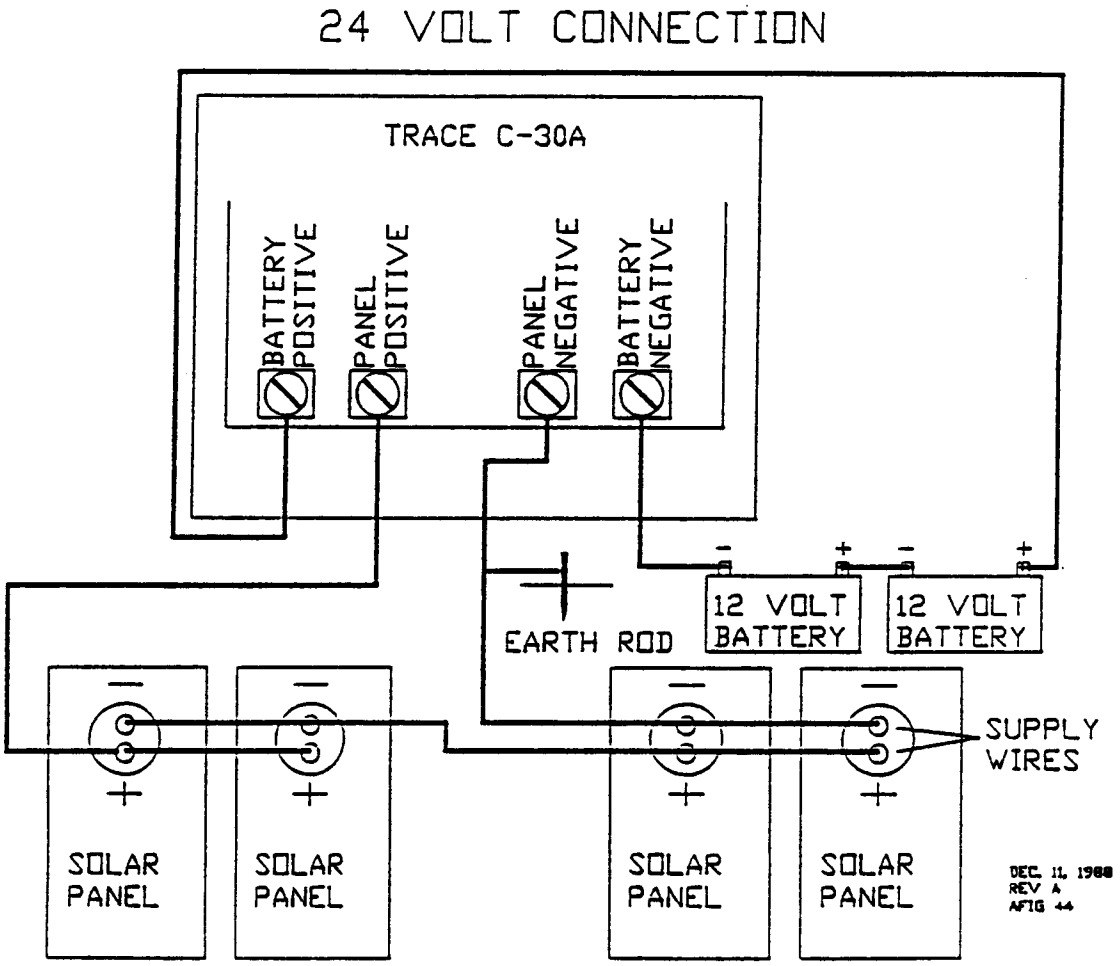

Battery Gassing
Slight Gassing
Normal Gassing
Factory Setting
Cell Voltage
2.55
2.5
2.45
2.4
2.35
2.3
2.25
20 30 40 50 60 70 80 90 100 110 120 130 140
Temperature Deg. F


Panel Voltage vs Temperature
Nominal 16 V Panel
Panel Output Voltage
16
15.5
15
14.5
14
13.5
13
12.5
12
40 50 60 70 80 90 100
Temperature Deg. C

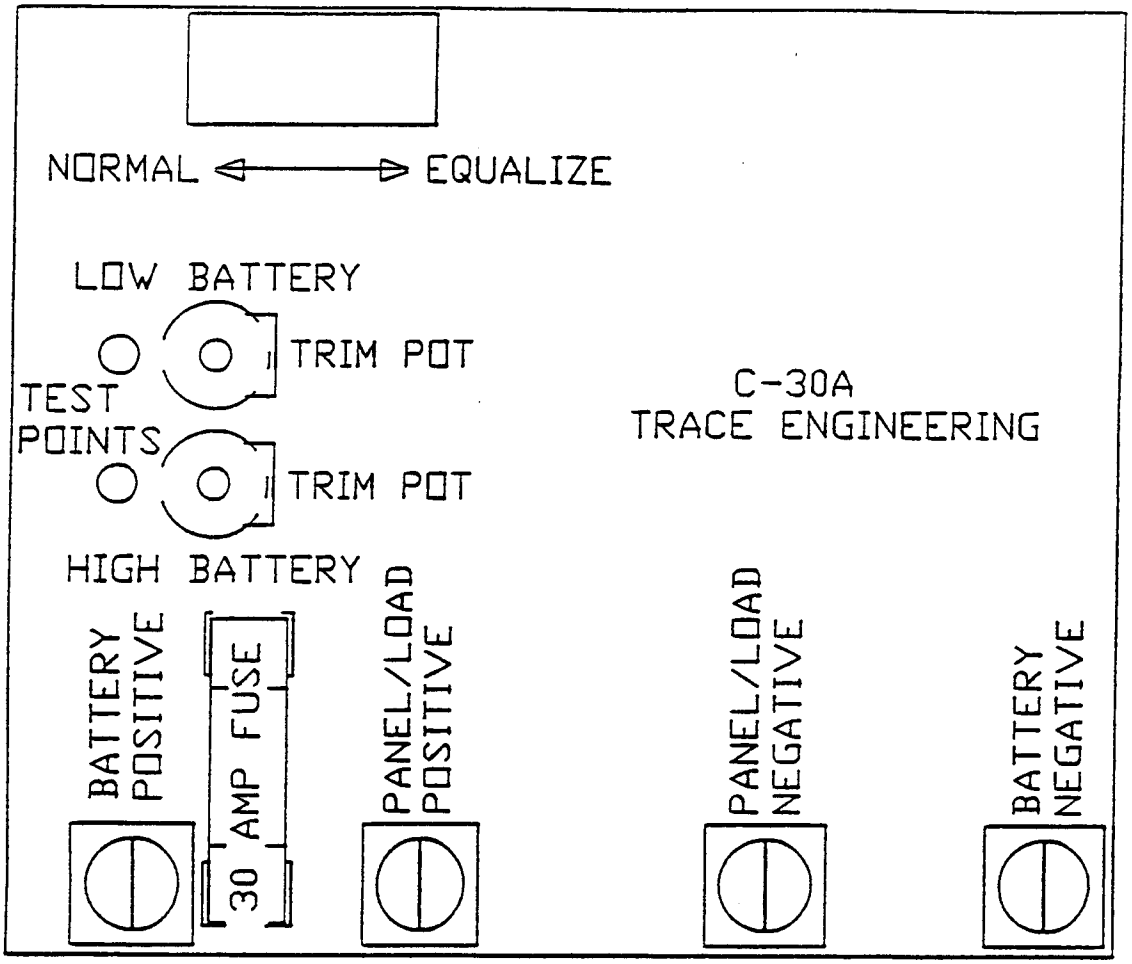
Sample Installation Diagram - 12 VDC Charge Controller



Sample Installation Diagram - 24 VDC Charge Controller

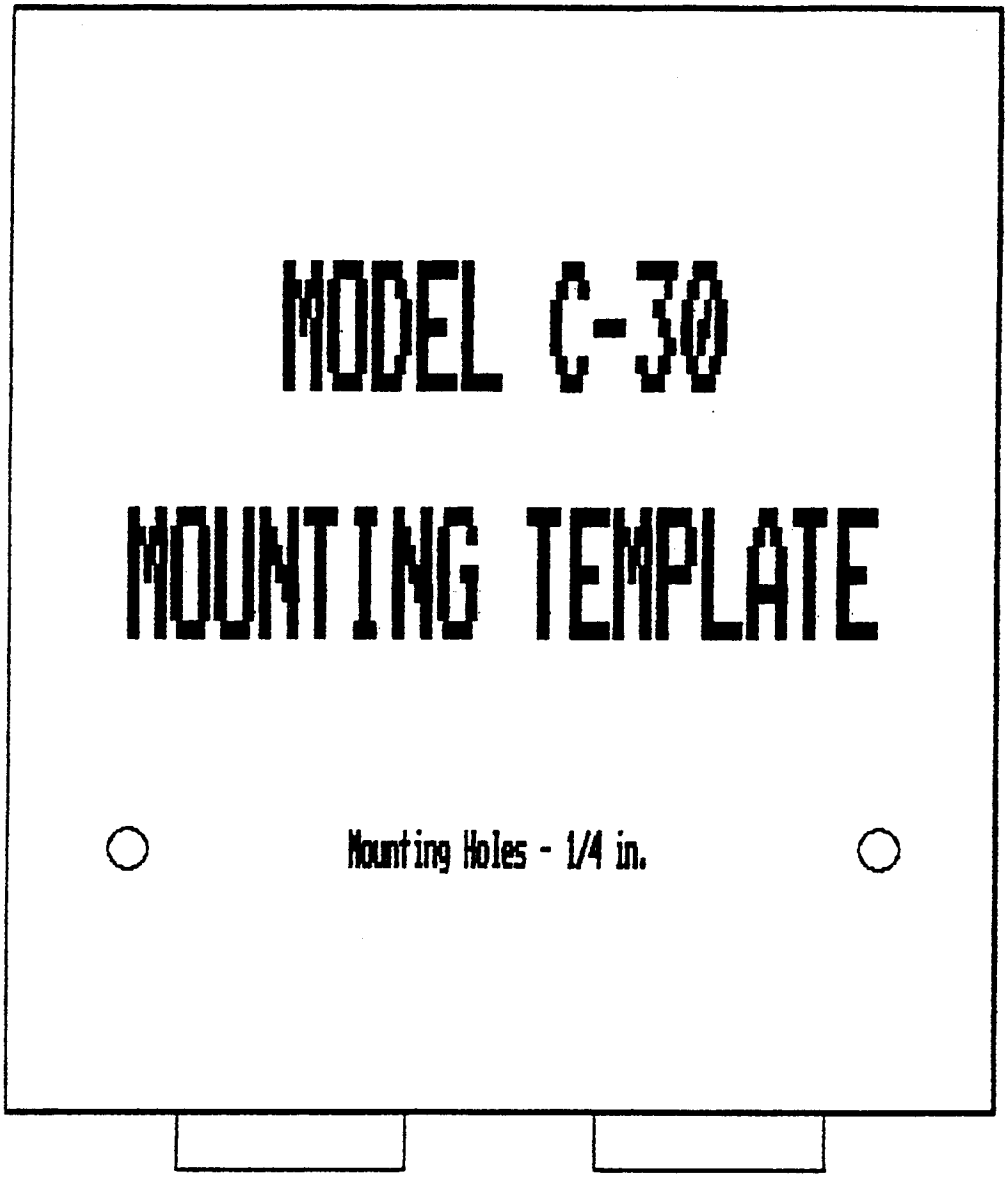


Location Diagram Model C-30A



MODEL C-30

MOUNTING TEMPLATE



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