OWNER'S MANUAL
Model C-30

TRACE ENGINEERING

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Part #818

<<< PRODUCT OVERVIEW >>>

The C-30 is a battery voltage controlled relay. It is designed to be operated from either 12 or 24 volt battery systems. It can be configured to operate as either a charge controller or load controller. User adjustable high voltage cut off and low voltage return points allow optimum settings for differing system requirements.

Input protection is provided by a 56 volt transorb and a 30 amp slow blow fuse. Reverse battery polarity protection is provided for on board electronics. Large box type terminals accept #14-#4 wire allowing easy large wire hook up. The positive from the solar panels connect to the incoming box terminal. This line is protected by a 30 amp slow blow fuse and connects to the normally open contact of the 30 amp dust covered relay. The common relay contact connects to the positive battery box terminal. The negative is common for panel, battery and module, two box terminals are provided.

For very large control applications more than one controller may be hooked up in parallel as long as separate positive wires are run from each solar array. Large loads may be controlled by separating circuits to 30 amps maximum with separate positive wires.

Ground your panels to protect them and yourself from static voltages. This should be done at the panel and at the controller if long wires are used. Static protection is provided by a transorb rated at 8 by 20 us at 500 amps. In very static prone environments see your dealer for extra protection devices, and information on what works best in your area.

<<< INSTALLATION >>>

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

(2) The module is mounted using the two 1/4 inch holes in its back cover. A mounting template is supplied on page 13 which references the hole locations and the units outline.

(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 also shown on page 15. Fasten the module to the mounting surface with round head screws or bolts.

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

Operating voltage -	12 Volts
Mode -	Charge Controller
High voltage disconnect -	14.2 VDC
Low voltage reconnect -	13.0 VDC

Using the information in the following section "Configuring the Model C-30" to check that the factory operating voltage and mode are correct. If your application requires different settings use this information to adjust the unit to your requirements.

(5) The connections from the battery should be made first. If the wiring from the panels is connected to the C-30 without the battery being connected, the relay will cycle (open and close) until the battery connections are completed.

> Important - If the C-30 is used in a 24 VDC system while configured for operation at 12 VDC, the C-30's relay will be damaged.

Route the battery's positive and negative leads thru a romex strain relief connector on the bottom of the C-30. The illustrations on page 13 and 14 show wiring diagrams for 12 and 24 VDC systems in which the C-30 is used as a charge controller.

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

(b) The negative (ground) lead from the battery is connected to either of the box terminals labeled "Ground".

(6) If the C-30 is being used as a charge controller (as with solar panels), route the panel's positive and negative leads thru a romex strain relief connector on the bottom of the C-30.

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

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

(6a) If the C-30 is being used as a DC load controller, route the load's positive and negative leads thru a romex strain relief connector on the bottom of the C-30.

(a) The positive lead from the DC loads is connected to the box terminal labeled "P/L".

(b) The negative lead from the DC loads is connected to the box terminal labeled "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.

> <u>Important</u> - If a blocking diode is used, it must be installed in one of the leads from the panel to the C-30. If it is installed in a lead between the battery and the C-30, the C-30 will not operate and the C-30's relay will cycle.

<<< <u>CONFIGURING THE MODEL C-30</u> >>>

<u>Switch Settings</u>

Two slide switches are use to configure the C-30. One is used to tell the C-30 whether it is being used in a 12VDC or 24VDC system. The other is used to tell the C-30 whether to operate as a charge controller (to control solar panel charging) or as a load controller (to turn off DC loads if the battery voltage is low). Refer to the illustrations on page 12, 13 and 14. The inside cover of the C-30 also has a parts placement illustration.

To operate as a charge controller: Use the switch labeled "C" to the left and "L" to the right. Set the switch to the left.

To operate as a load controller: Use the switch labeled "C" to the left and "L" to the right. Set the switch to the right.

To operate at 12VDC: Use the switch labeled "24" to the left and "12" to the right. Set the switch to the right.

To operate at 24VDC: Use the switch labeled "24" to the left and "12" to the right. Set the switch to the left.

Voltage Control

The C-30 is basically a voltage controlled relay. It either connects or disconnects whatever it is used with from the battery. If it is being used as a charge controller, 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. If it is being used as a DC load controller, it connects the DC loads to the battery when the battery voltage is high and disconnects the DC loads from the battery when the battery voltage is low.

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

Cell Voltage

The C-30 is set using cell voltage rather than battery voltage. A 12 volt battery has 6 cells and, therefore, a nominal cell voltage of 2 volts. A 24 volt battery has 12 two volt cells.

The section "Tables and Graphs" provides tables for converting battery voltages to cell voltages. There is a table for 12 volt conversions and a table for 24 volt conversions on page 9. 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.

Location of Test Points and Trim Pots

The C-30 has two test pins and two trim pots. The test points are 3/8" metal pins located in the upper right hand area 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" below the test pins. Refer to the illustration on page 12 or the inside cover of the C-30.

Voltmeter

Adjusting the voltage connect and disconnect points is done with either an analog or a digital voltmeter. Voltage adjustments are made by connecting the voltmeter's negative (black) lead to either of the C-30's ground (negative) terminals and the voltmeter's positive lead (red) to one of the C-30's test points. The voltmeter should be set to read DC volts and set for the 5 volt scale.

> NOTE: Voltage adjustments cannot be made until the battery positive and ground are connected to the unit.

<u>Setting Voltages when used as a Charge Controller</u>:

THE HIGH VOLTAGE DISCONNECT MUST BE SET FIRST.

Use the voltage conversion chart to determine the desired cell voltage. To set the high voltage disconnect point, measure from the high voltage test pin to ground (battery negative). Adjust the high voltage trim pot located beneath the test point to the desired voltage.

Once the high voltage disconnect point is set, measure from the low voltage test point to ground. To set the low voltage reconnect, adjust the low voltage trim pot located beneath the test point to the desired voltage.

<u>Setting Voltages when used as a Load Controller</u>:

THE HIGH VOLTAGE RECONNECT MUST BE SET FIRST.

Use the voltage conversion chart to determine the desired cell voltage. To set the high voltage reconnect, measure from the high voltage test point to ground (battery negative). Adjust the high voltage trim pot located beneath the test point to the desired voltage.

Once the high voltage reconnect point is set, measure from the low voltage test point to ground. To set the low voltage disconnect, adjust the low voltage trim pot located beneath the test point to the desired voltage.

<<< SPECIFICATIONS >>>

TECHNICAL:

Reference stability	0.24%/1000 Hrs. Typical
Reference voltage ranges HB .	3.2 to 1.6 VDC/Cell
Reference voltage ranges LB .	Setting of HB to 1.6 VDC/cell
Maximum switched current . .	30 A
Relay closed	87 ma
Relay open	10 ma
Typical switching	100,000 times at 30 A
Typical operating range . . .	12 VDC Nominal
	24 VDC Nominal
Maximum input voltage	56 VDC @ 24VDC setting
Maximum input voltage	47 VDC @ 12VDC setting

ENVIRONMENTAL:

Operating temperature	-20C to 60C
Storage temperature	-35C to 90C
Humidity	Non-condensing Rh max 95%

PHYSICAL:

Weight	Net 24 Oz Gross 2 Lbs
Size	5.25"W 6.3"L 1.9"H
Cabinet	0.090 Aluminum
Finish	Black Anodize

Cell Voltage Conversion Tables

Since the C-30 is adjusted using battery cell voltage two conversion tables are provided 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 a battery voltage and to its right will be listed the corresponding cell voltage.

Wire Resistance Tables

The wire resistance table gives the resistance sum in milli ohms of the ground and positive leads. Once the resistance is known the voltage loss can be derived from the Voltage Loss Table for varying currents. 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 eight 3.0 amp panels located 60 feet from the batteries and using 4 gauge wire will lose nearly 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 ft. The number given is 30. This is the .030 ohms (30 milli ohms) resistance for the wire. Go to the "Voltage Lost in Cables" table. Select the 32 amp row (it is the closest to 30 amps of our 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.

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 delivery 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 this condition the tolerance for wire voltage loss would be less.

Battery Gassing Graph

The Battery Gassing Graph graph gives a generalized curve for battery temperature verses battery gassing. The graph is for lead antimony batteries. If possible use your battery manufacture's recommendations.

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

Panel Output Voltage vs Temperature Graph

Solar panel output voltage decreases as the temperature of the panel increases. The decrease in output voltage is significant. This graph gives an approximation of the output voltage change with temperature of 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

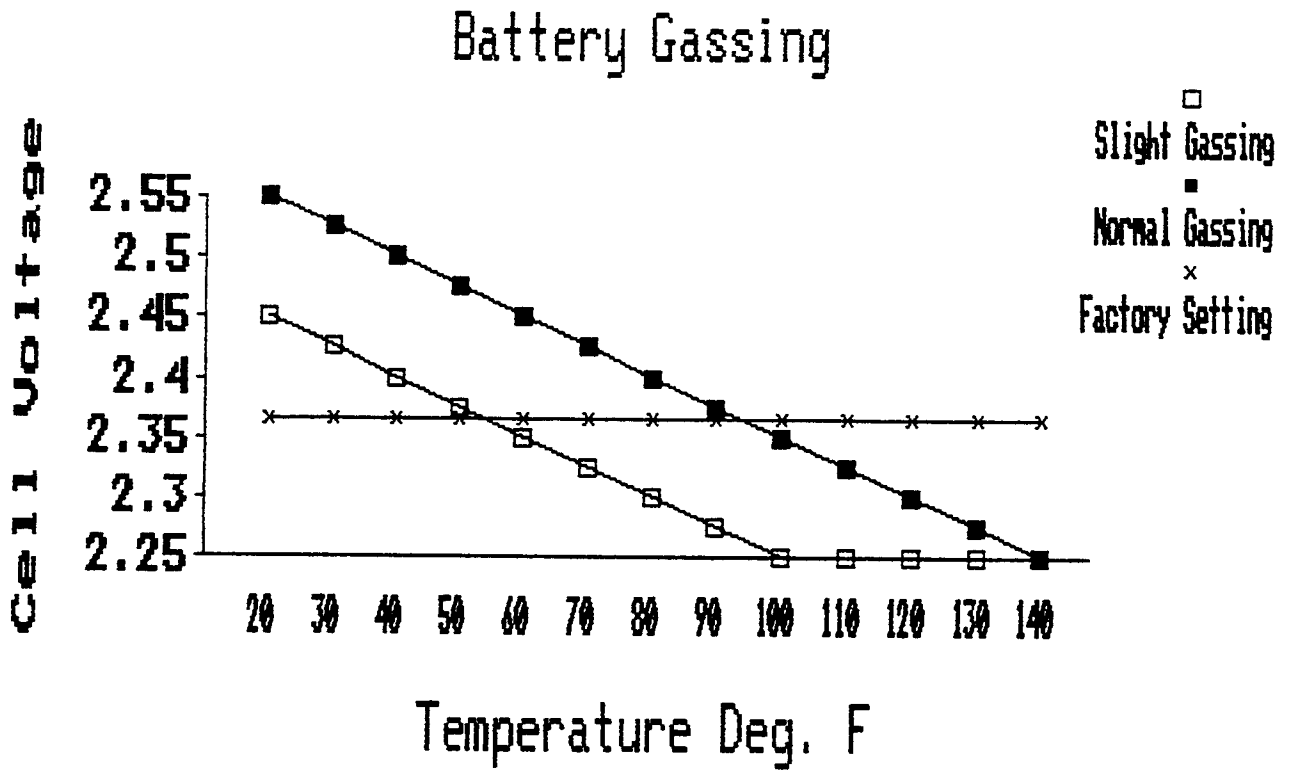
Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage	Battery Voltage	Cell Voltage
20.00	1.667	22.00	1.833	24.00	2.000	26.00	2.167	28.00	2.333	30.00	2.500
20.10	1.675	22.10	1.842	24.10	2.008	26.10	2.175	28.10	2.342	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

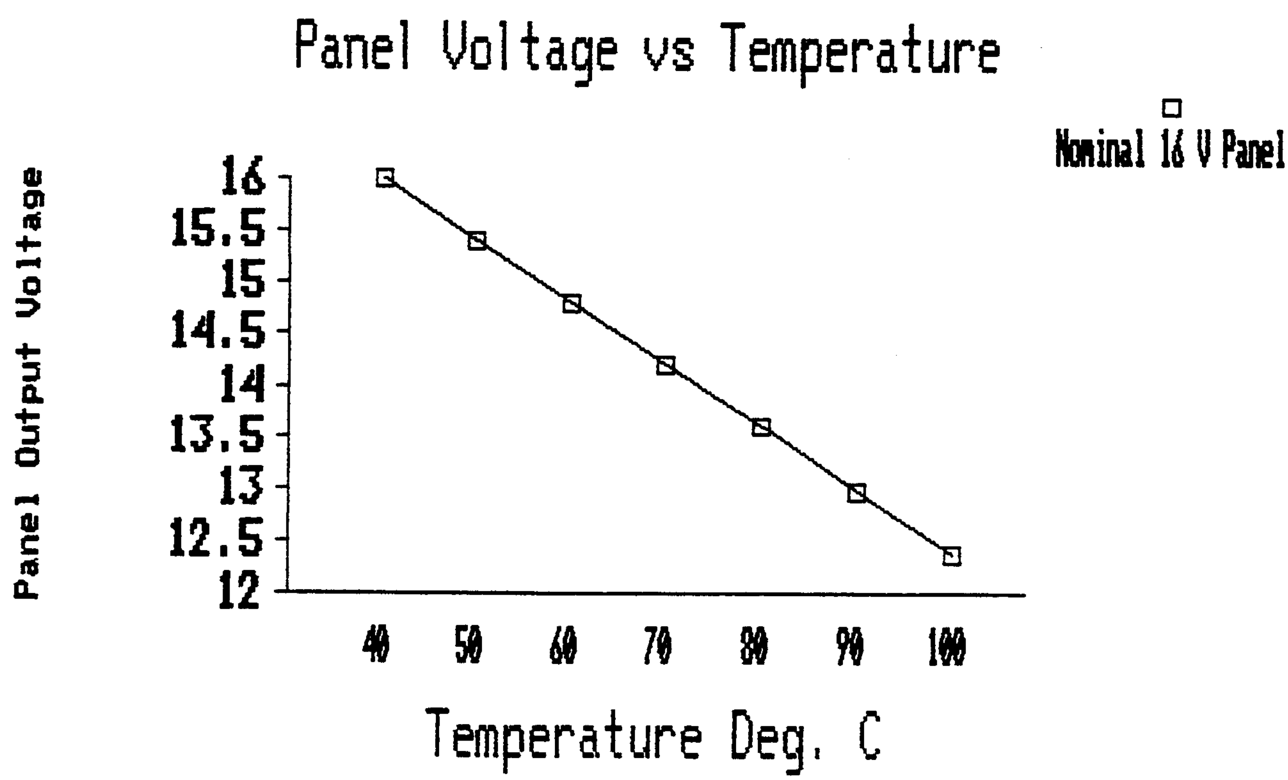
WIRE RESISTANCE TABLE in ohms/1000 - milli ohms

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	400	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

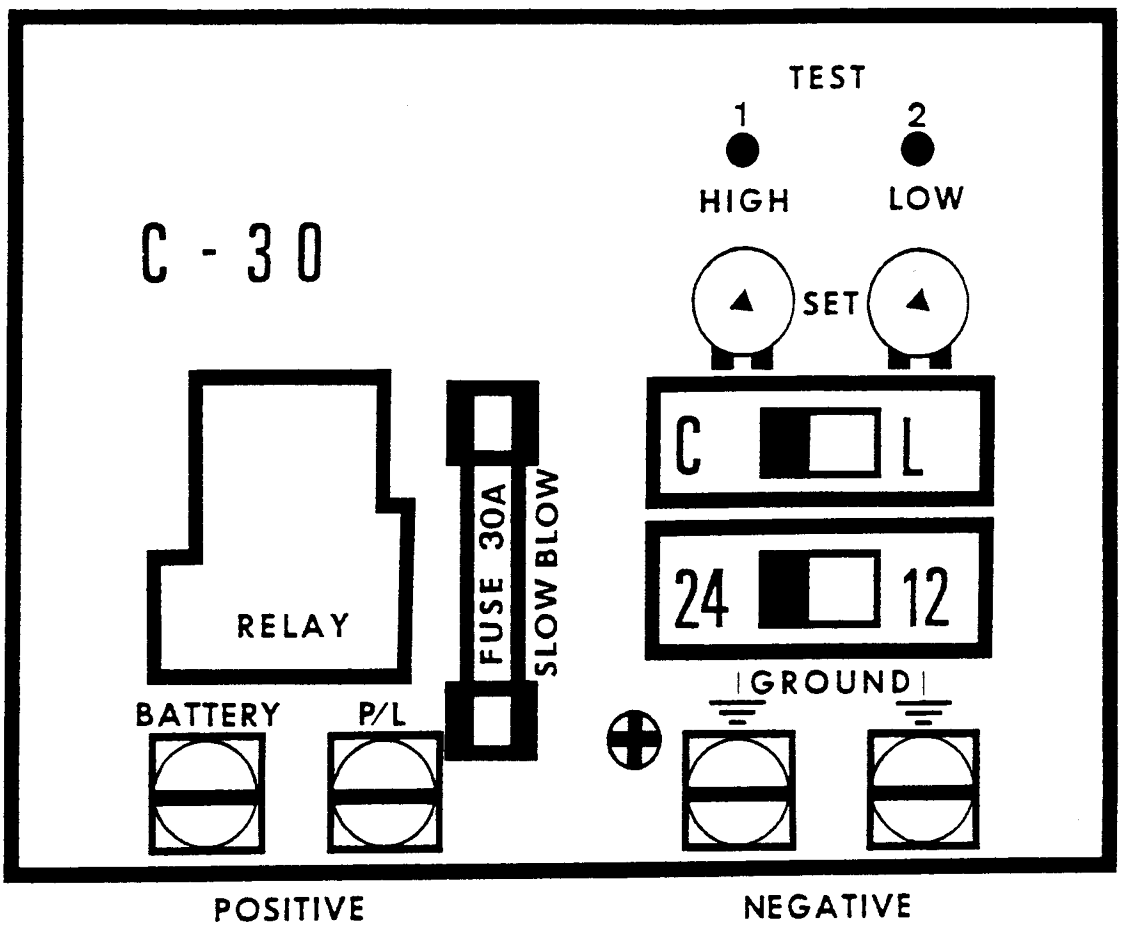
VOLTAGE LOST IN CABLES

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		

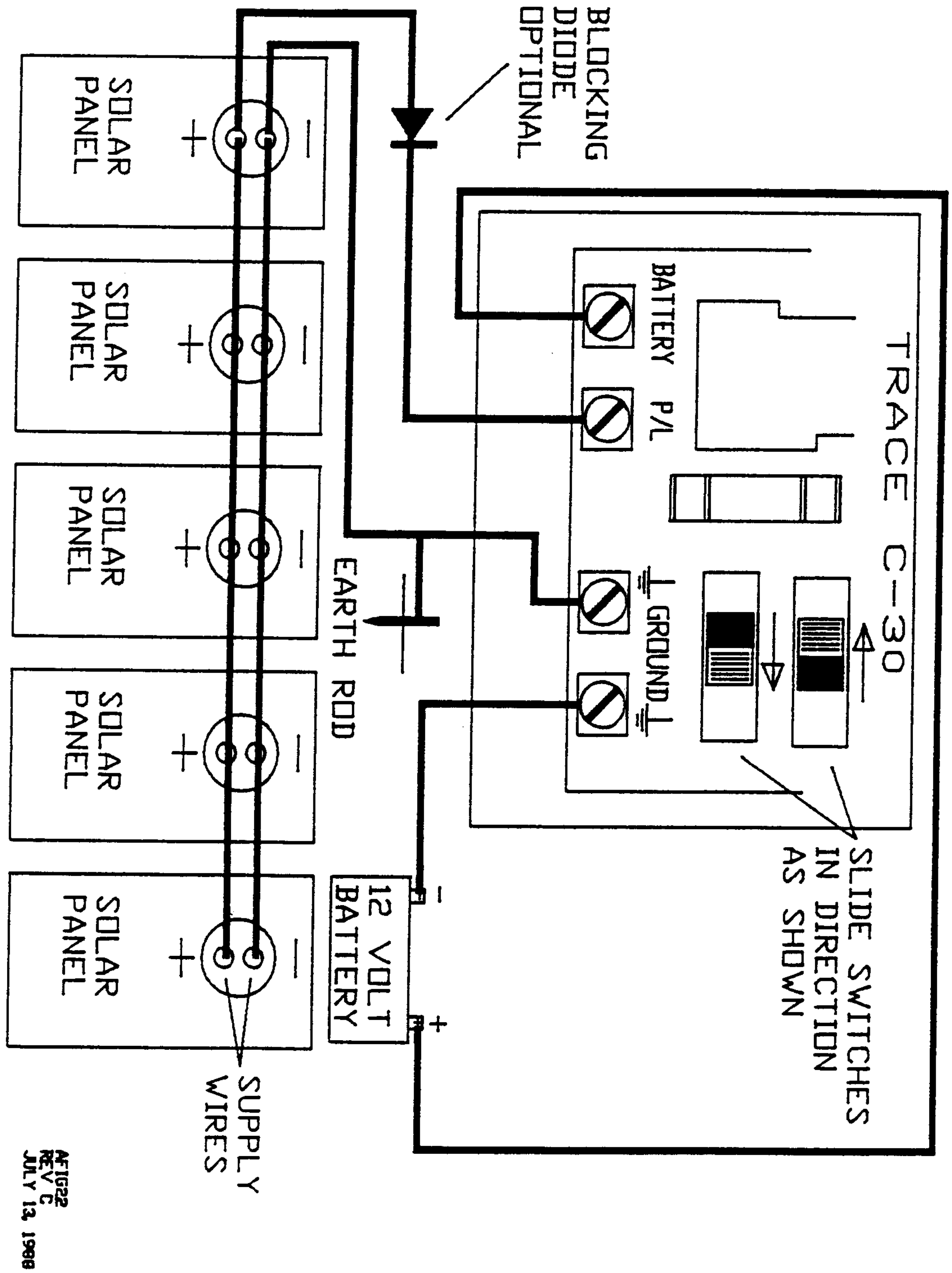

Battery Gassing
Slight Gassing
Normal Gassing
Factory Setting
Cell Voltage
2.55
2.5
2.45
2.4
2.35
2.3
2.25
20
30
40
50
60
70
80
90
100
110
120
130
140
Temperature Deg. F


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

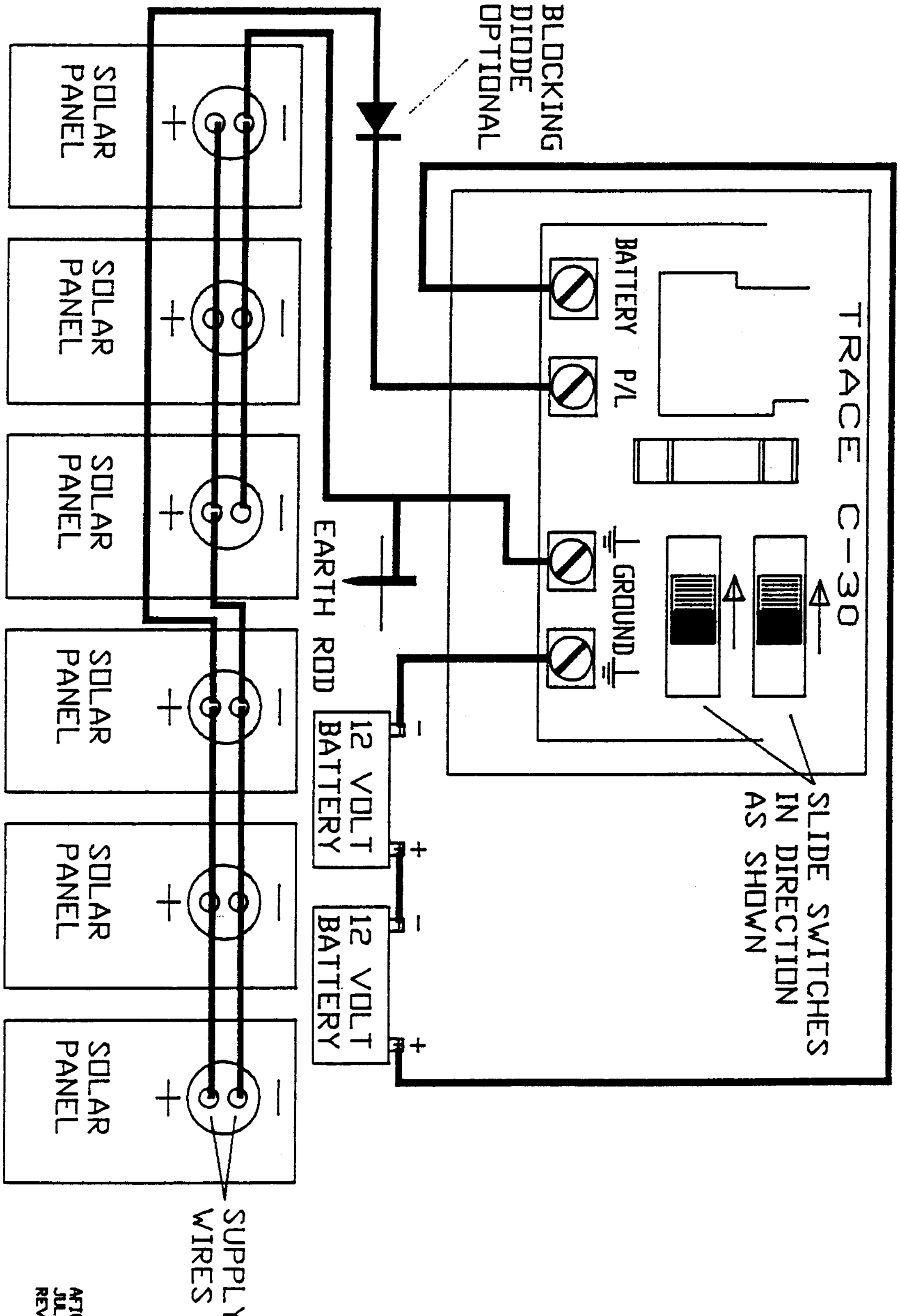
Parts Placement Illustration



Sample Installation Diagram - 12 VDC Charge Controller



Sample Installation Diagram - 24 VDC Charge Controller



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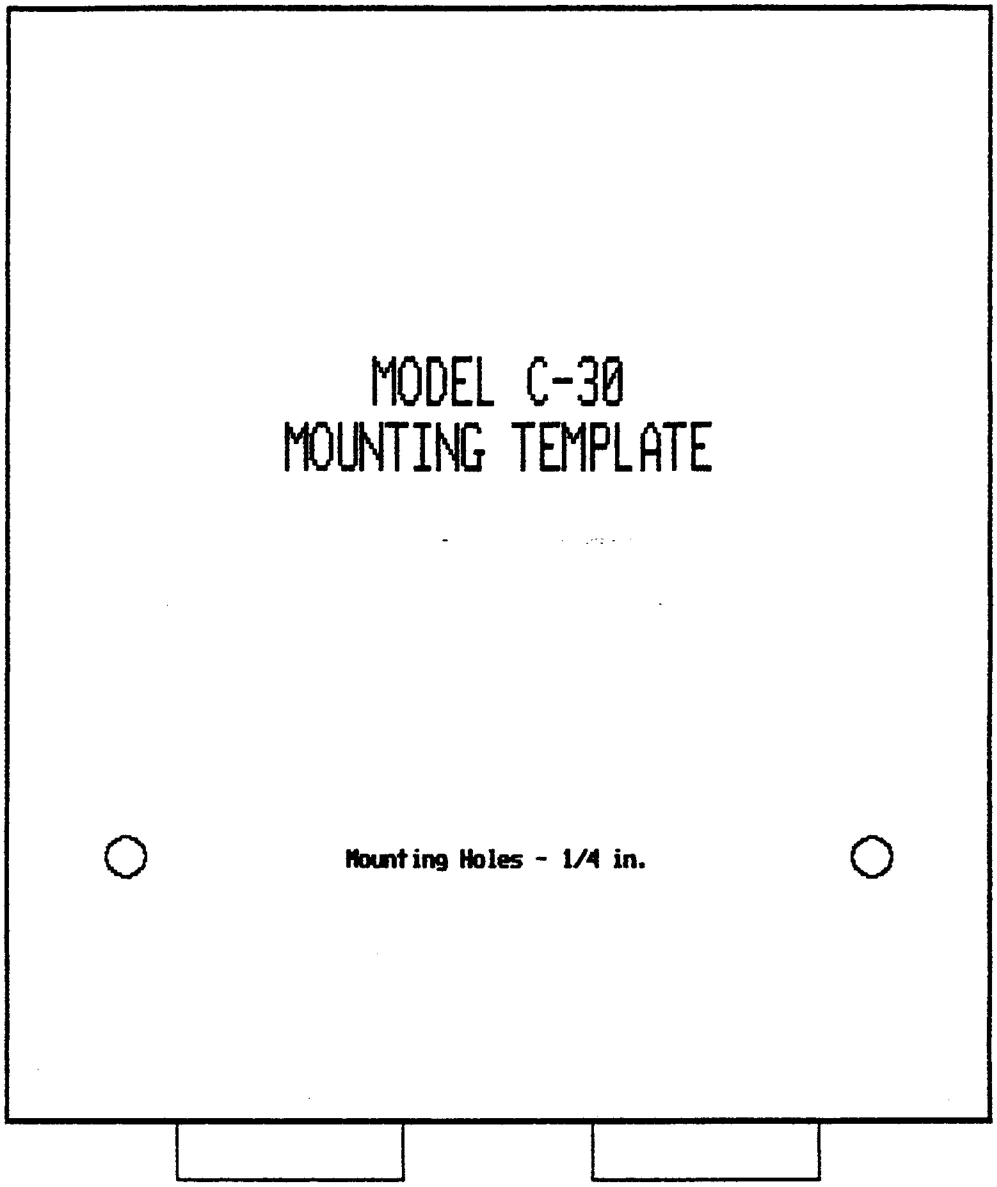
MODEL C-30
MOUNTING TEMPLATE
Mounting Holes - 1/4 in.

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