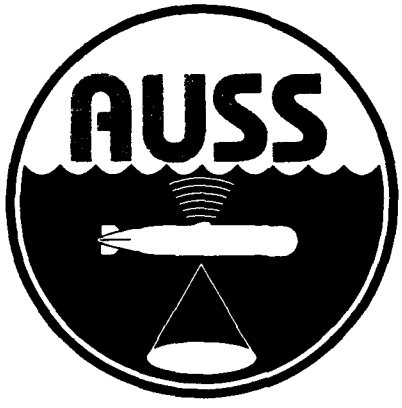

Technical Report 1539
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Advanced Unmanned Search System (AUSS) Battery Monitor/ Charging Systems

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ADMINISTRATIVE INFORMATION

The work was performed by members of the Ocean Engineering Division (Code 94), Naval Command, Control and Ocean Surveillance Center, RDT&E Division, San Diego, CA 92152-5000. The work was funded under program element 0603713N, project S0397.

Further information on this subject is available in related reports that represent NRaD efforts through FY 1992. The bibliography is found at the end of this report.

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MA

SUMMARY

This report describes the Advanced Unmanned Search System (AUSS) main battery charge/discharge monitor system and its components. Also described is the emergency processor battery charger. Charging/discharging instructions for the battery monitor, a list of schematic drawings of the battery monitor and its components, and the computer programs for the battery charges and discharges are included in this report as appendices A through E.

CONTENTS

INTRODUCTION

This report is one of a series of reports that document the integration of several components of the Acoustic Unmanned Search System (AUSS). The AUSS is the deepest, most advanced search system being developed to date. In an attempt to make the system operate for longer periods and greater stand-off, a complex technology to put higher energy into a small package becomes necessary. The high energy of a battery can be likened to a bomb. This energy component presents a need to consider the safety of the operating personnel. Several previous battery-powered systems have caused injury and the loss of life.

The main goal of the battery monitoring system is to optimize battery life while maintaining a safe operating energy system. Since the AUSS is not a single-run event, the handling of the energy system becomes a requirement for repetitive operations. The overall design goal is to monitor the battery and initiate cell isolation during charge and discharge so that the battery can be safely charged and discharged yet optimized for extended battery life. The life cycle of a battery can be as low as 20 cycles, and the operators would need to know when cell life is over.

The AUSS system has a main vehicle battery used for propulsion, on-board computers, and sensors. An emergency processor battery is also used to power the processor that monitors and controls the systems vital to vehicle recovery.

The AUSS main battery is a Yardney-manufactured battery, Model #LR140DC-1, which is a 140-Ah cell. There are 80 such cells in 4 AUSS battery packs. Twenty cells in each pack are connected in series and the four packs are then connected in series for a total battery voltage of 120 Vdc. A battery cell functions properly between two voltage plateaus, approximately 1.9 and 1.6 volts (V). These voltage plateaus are rough indicators as to the cell's charge state. The battery life can be greatly prolonged by monitoring battery voltage during charge and discharge in order to evaluate each cell's charge state condition.

The manufacturer specification recommends that the battery cell voltage remain within the high- and low-cell limits, so that cell damage can be avoided and cell life increased. The high-voltage limit is 2.05 V and the low limit is 1.1 V. The specifications recommend that each cell be charged to the high-voltage cut-off level, 2.05 V, for a complete charge. The goal of a battery charging monitor system is to continue to charge all cells to their high-voltage limit in an effort to keep the battery as balanced as possible. The monitoring system must isolate each cell that reaches the high-voltage cut-off level, so that remaining cells can continue to charge. This is achieved by shunting a 1-ohm resistor across any cell that reaches the high-voltage limit. The resistor isolates that cell by shunting the charge current and maintaining the cell voltage below 2.05 V. This cell isolation allows the rest of the battery cells to complete their charge.

A typical charge profile is one where the charge current is set at a rate close to the highest discharge rate until one cell in the battery reaches the high cut-off level. At this time the charge current is decreased to a lower rate, until a cell reaches the high-voltage limit again. Any cell that reaches the high-voltage limit at the low-charge-current rate is considered completely charged.

The high-charge rate for the AUSS battery is 7 amperes (A) and the lower rate is 2 A. If the high-voltage limit is exceeded during the battery charge a cell can be permanently damaged, and could go into an internal short circuit condition. An internal short can create extreme heat, even to the point of starting a fire. The term "hot-short" has been given to this condition.

The AUSS emergency processor battery is a nickel cadmium battery. Each cell is a Sanyo Cadnica model KR-2800D with a nominal capacity of 2.8 Ah at a nominal voltage of 1.2 V. The emergency processor power requirement is approximately 2.8 A, and the KR-2800 battery provides approximately 1 hour of emergency processor operation should the main battery supply be removed due to a vehicle subsystem failure.

BACKGROUND

The main vehicle battery has its own monitoring system so that the individual cells can be monitored during a dive. These monitoring circuits are also used by the battery charge/discharge monitor system (BCDMS). The BCDMS has several purposes, however, the main purpose is to remove cells from the charge/discharge when they have reached either the upper or lower voltage limit. The BCDMS should also be able to change charge conditions as warranted, detect hot-shorts, measure charge current, and effect necessary changes, note when cells are not taking a charge along with the rest of the battery, and secure the charge/discharge when any hardware components associated with the monitor system are not functioning properly. Additionally, the monitor should keep a record, via data file, of the cell voltages and charge rate changes during the entire charge.

The emergency processor (EP) battery is composed of NiCad batteries as mentioned earlier, and they have the undesirable feature known as the "memory effect." This effect can limit the batteries' capacity since it "remembers" the previous discharged amount and will only charge back up to an amount equivalent to the discharge. This mentioned effect causes problems when the battery is only discharged a portion of its total ampere-hour capacity. The memory effect makes it desirable to completely discharge a NiCad battery before it is charged. This along with the desire to have a hands-off EP battery charger warranted an EP battery charger.

BATTERY CHARGE/DISCHARGE MONITOR SYSTEM

The BCDMS is made up of five subassemblies:

1. Battery packs and cell monitor boards
2. Sytron powers supplies
3. Computer and I/O board
4. Computer interface/isolation circuit board (CI/ICB)
5. Charger relay control and battery cell isolation relay boards

Figure 1 is the block diagram for these subassemblies. The interconnect diagram is labeled battery charging system interconnect diagram and is designated NRaD drawing 0128047. The interconnect diagram shows a seven-digit number for each subassembly that has an NRaD drawing number.

BATTERY PACKS AND CELL MONITOR BOARDS

The AUSS battery is made up of four 20-cell battery containers. The vehicle wiring harness connects the battery containers in series so that total battery voltage is the sum of 80-cell voltages. These battery containers are referred to as battery packs A, B, C, and D. Figure 1 illustrates how the battery packs are connected within the BCDMS. The cell monitor boards (CMBs) are located within each battery pack. The CMBs can sequentially step through each cell of the four battery containers and provide a cell voltage for the BCDMS. The schematic diagram numbers for the CMB and the cell monitor relay board are listed in appendix C.

SYTRON POWERS SUPPLIES

The Sytron power supplies can be computer-controlled for constant current. Battery packs A and B are connected in series and then connected to Sytron power supply #1, refer to NRaD drawing 0128047. Each power supply is rated for 150 V at 20 A. The low-voltage power supplies (+15, −15, and +5 volts) are shown in figure 1 and are located behind the Sytrons. These power supplies provide power to the computer interface/isolation circuit board (CI/ICB) and the charger relay control and relay/resistor boards.

COMPUTER AND INPUT/OUTPUT BOARD

The Computer subassembly controls the progress of the battery charge. It generates the reset and clock pulses required for the CMBs. The computer sequentially clocks through the battery and measures the individual cell voltages. After each sequential clock cycle, the computer checks to see if a hot-short is in progress by checking if the

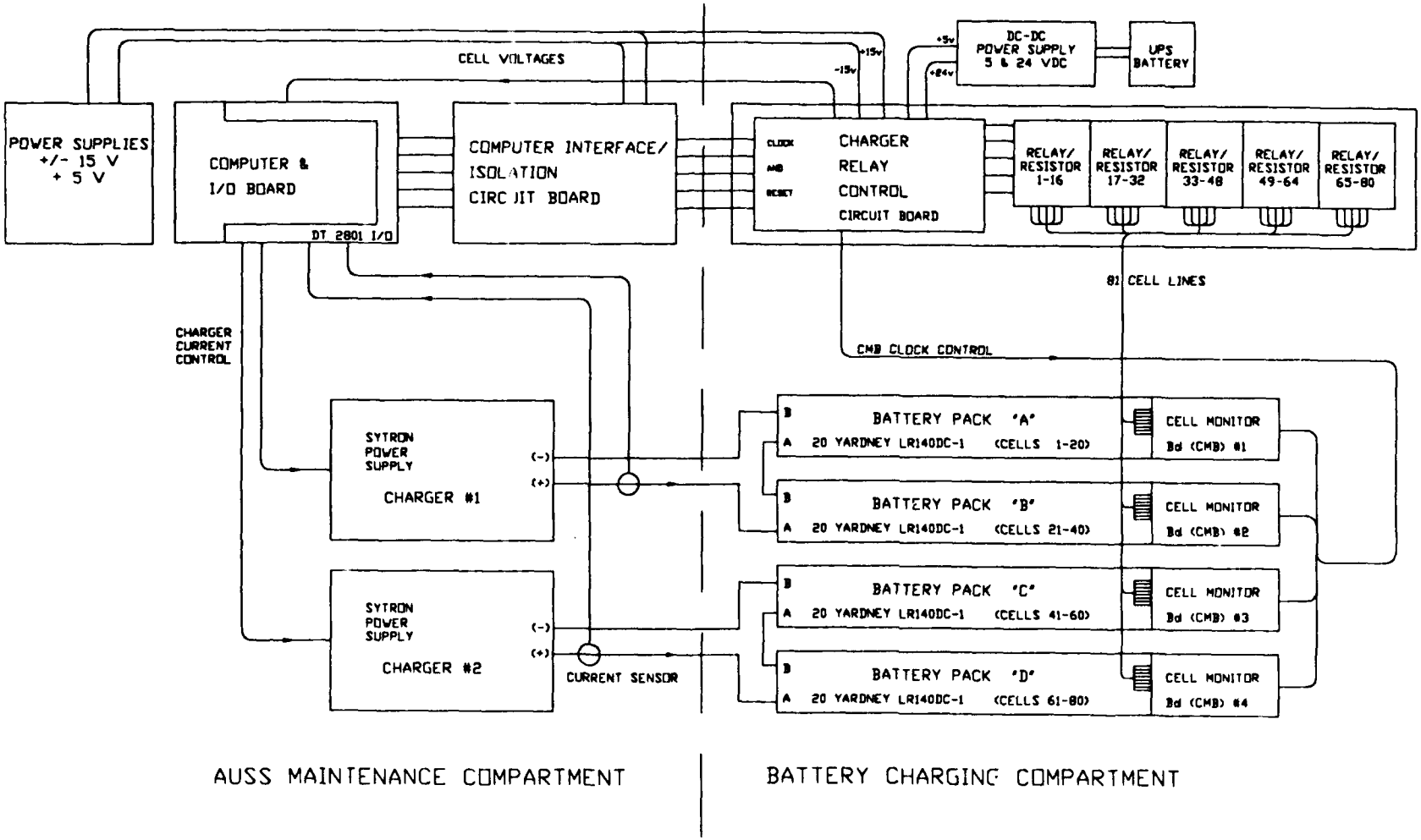

Figure 1. Battery charging system interconnect diagram.

cell voltage is less than 1.5 V. If true, the computer prints a message that the measured cell is below 1.5 V, secures that cell's charger and opens the relays affected by the current change. This condition can only exist if a cell is not taking the charge and its voltage is going in the wrong direction (down). The computer's next check is to determine if the cell has reached the high-voltage limit. When this limit is reached the program determines if that charger is at the 7-A rate or if the cell needs to be shunted with a resistor. If at the 7-A rate, the power supply affecting that cell is shifted to the 2-A rate and the relays for that bank of cells are enabled for future conditions when the cells need to be shunted by a resistor. The shunting of a cell effectively takes that cell out of the circuit. Once a cell has been shunted with a resistor its cell voltage should never exceed 2 V. If a shunted cell voltage does exceed this 2-V level, the computer secures the power supply charging that cell and opens the relays affected by that power supply's current change. The next test then determines if the measured current is the same as the commanded current. If the measured current is greater than the commanded current, the charge is secured.

These checks are made, on each subsequent cell until the entire battery has been checked. Once all 80 cells have been monitored, the high- and low-cell voltages are determined and total ampere-hours are calculated. The computer then displays the last 80-cell voltages, the high and low cells, the measured current for each charger, the total number of cells latched to a resistor, the commanded current and the actual measured current, the total ampere-hours for each charger, the sum of the cell voltages (battery voltage), and the overall average cell voltage. After 10 cycles through 80 cells, the most recent data previously displayed are recorded to the TEMP1 file on the hard disc. Other information is available to the operator as explained in the Charging and Discharging Instructions for Battery Monitor, appendices A and B respectively.

The file name of the GWBASIC program that executes these instructions is CHG.BAS. A temporary file called "TEMP1" is created during the charge and contains all pertinent charge information. After the charge is complete TEMP1 should be save through the use of PKZIP and then deleted. The next battery charge information will be appended to the previous charge if the file is not deleted.

COMPUTER INTERFACE/ISOLATION CIRCUIT BOARD (CI/ICB)

The CI/ICB circuit, refer to NRaD drawing 0127973, is used to change the control and clock signals from the computer to an RS/232 format, isolate the computer digital-to-analog (D/A) outputs from the "floating" control boards on the Sytron power supplies, and shut down the charger current and relay control current in the event computer power or low-voltage power supplies are removed.

CHARGER RELAY CONTROL AND BATTERY CELL ISOLATION RELAY CIRCUIT BOARDS

The main function of the charger relay control board (CRCB), NRaD drawing 0127970, is to energize the isolation relays located on the battery cell isolation relay printed circuit board (PCB) (NRaD drawing 0122772). The CRCB accomplishes this by converting the RS/232 signals from the computer interface circuit board to transistor-transistor logic (TTL) levels, and sequentially stepping through the cell monitor PCB (0122510), so that each cell is sampled. The CRCB provides a buffered-cell voltage to the computer for computer sampling for charge-state and cell-isolation requirements. The cell voltage is also provided to an analog-to-digital (A/D) converter on the CRCB for noncomputer-controlled charges. The CRCB can be configured for operation without a computer so that the relay latch conditions are completely controlled by the A/D and logic circuits. The CRCB has always been configured for computer control, TP2 shorted to TP3. Refer to NRaD drawing 0127970.

The CRCB energizes the appropriate relay when the charge conditions so dictate, shunting a 1-ohm resistor across an individual cell. The five battery cell isolation relay (BCIR) PCBs are interconnected as per the NRaD drawing 0127973. The BCIR PCB has 16 identical circuits, except for the relay energize control lines. The control lines are configured on each board for its location within the charger rack, refer to NRaD drawing 0122772. Five of these boards accommodate the 80 cells in the battery. The relay pins on the BCIR boards are wired to connectors ABC&D, NRaD drawing 0122772, and are connected to the individual cell lines on J2 of the cell monitor relay board, thus providing the necessary individual cell connections for relay/resistor isolation. Reset commands from the computer can open relays 1 through 40 inclusively, and/or 41 through 80 inclusively.

EMERGENCY PROCESSOR BATTERY CHARGER

The function of the EP battery charger is to completely discharge the NiCad batteries used in the EP battery packs and then automatically switch to a charge configuration. The charger should then maintain a "trickle" charge on the battery until it is reinstalled on the vehicle. The charger has three identical circuits to accommodate continuous vehicle use of EP batteries.

A partially discharged EP battery requires approximately 16 hours to be completely discharged and recharged. This means that two more EP battery packs must be available for continuous vehicle use on AUSS. See figure 2 for emergency processor battery charge/discharge time.

To operate the EP charger, connect a partially discharged EP battery to one of the three connectors on the EP charger and press the reset button nearest that connector. The EP charger then shunts the battery with a high-wattage resistor and discharges the

cell until it reaches the low-voltage cut-off level. During this time a red light-emitting diode (LED) is illuminated to indicate the discharge cycle. The EP charger then changes to a charge configuration and charges at a constant current rate (280 mA) for 15 hours. During this interval there is a yellow LED illuminated to indicate the charge is in progress. After a 15-hour timeout, the EP charger switches to a trickle rate (20 mA) to maintain a charged battery until the next vehicle installation.

The schematic diagram for the EP battery charger is NRaD drawing 0128050, emergency processor battery charger.

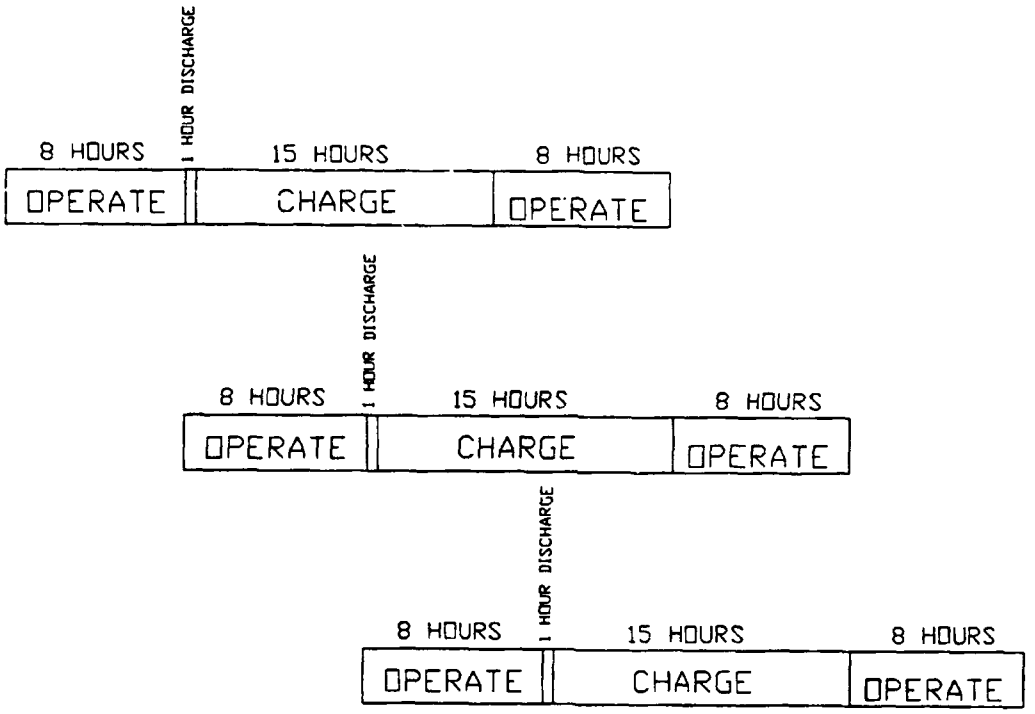

Figure 2. Emergency processor battery charge/discharge time.

LESSONS LEARNED

A new battery cell has a fixed number of cycles. A discharge followed by a charge represents one cycle. Also, once a cell has been charged by the initial "wetting" with the electrolyte, it has a limited shelf-life. It has been observed that the shelf-life of the battery is approximately 12 months, but can last longer when the battery is cycled regularly. The battery cell can withstand more cycles by avoiding exposure to voltages above or below the high- and low-cell voltage plateaus as advertised by the manufacturer. However, in a series battery cell configuration, one cell can limit the charge or discharge of the entire battery if that cell reaches the voltage limits too soon. This constitutes an unbalanced battery since all of the cells do not have the same charge state.

As mentioned in the introduction, the goal of the BCDMS is to maintain a safe operating energy system and to keep the battery balanced so as to optimize charge and discharge cycles to extend the battery life. The BCDMS is designed to isolate cells that have reached the high- or low-voltage cut-off points so that the remainder of the cells can be brought to the same charge state as the cell that had been isolated and avoid hot-shorts, which can cause fires and explosions. Due to the imperfections in cell construction the battery can still become unbalanced even after ten or more cycles where it becomes necessary to conduct an equalizer discharge and equalizer charge.

We observed through several equalizer charges that the battery appeared to balance better when the equalizer charge was preceded with an equalizer discharge. An equalizer discharge is a discharge where each cell is brought to the low-voltage cut-off by discharging the cells through the shunt resistors. Once a cell reaches its cut-off voltage, the resistor shunt circuit is opened so the remainder of the battery cells could be uniformly discharged. The equalizer discharges are followed by an equalizer charge, and the individual cells reach their respective high cut-off voltages at very nearly the same point in time, achieving a more balanced battery.

The discharge ampere-hours for three types of batteries used from March 1985 to June 1992 are shown in figures 3 through 6. The third battery was of different manufacture from the Yardney LR type. The first three batteries were 230-ampere-hour batteries. As can be seen from the plots, the 230-Ah batteries had a higher mean discharge level, but never really used the full potential rating of the battery. The fourth plot shows the history of the 140 Ah battery, which was monitored during charge and discharge by the BCDMS. The mean discharge cycle of the fourth battery was within 91 percent of the rated ampere-hour capacity for the LR 140 battery cell. The mean discharge cycles on batteries one, two and three were 37 percent, 59 percent, and 57 percent respectively. These data indicate that keeping better control on the voltage-limit levels of the cells can improve battery performance. Since the batteries have all had several cell failures at approximately 12 months, the BCDMS did not increase the life of a battery.

The manufacturer recommends when the battery is not being used for any length of time greater than 2 weeks, it was better for the battery to be in the discharged state. In the discharged state, the cells have less stress on the plates since the voltage potential is lower.

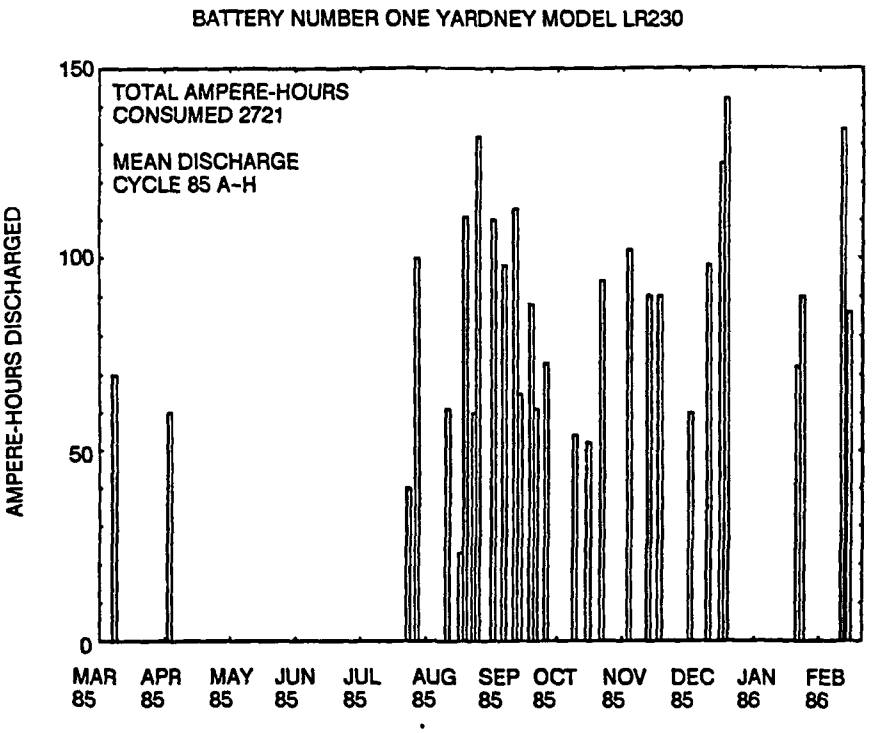

Figure 3. Battery number one Model LR230.

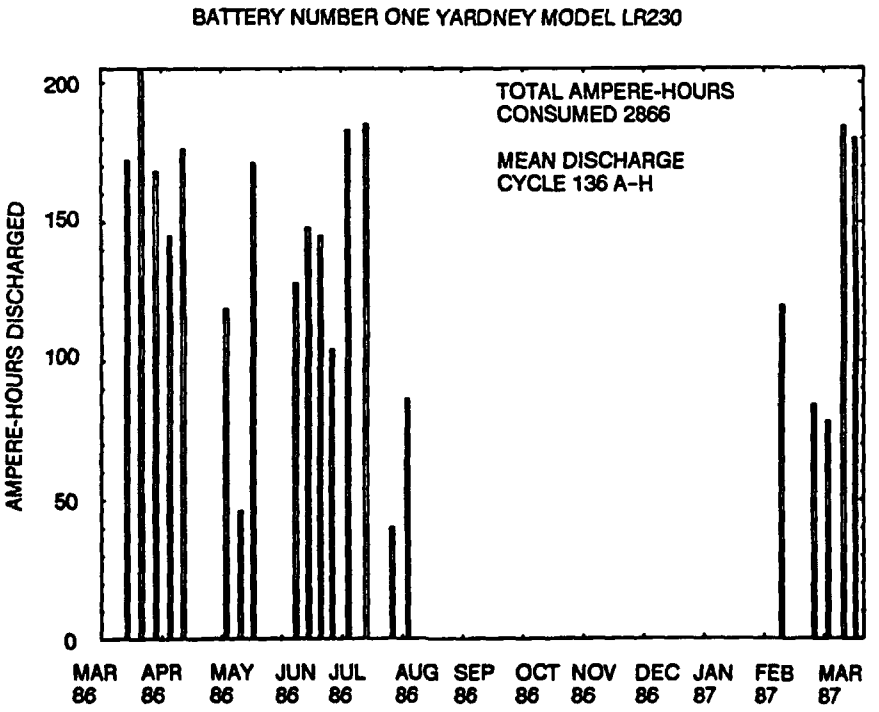

Figure 4. Battery number two Model LR230.

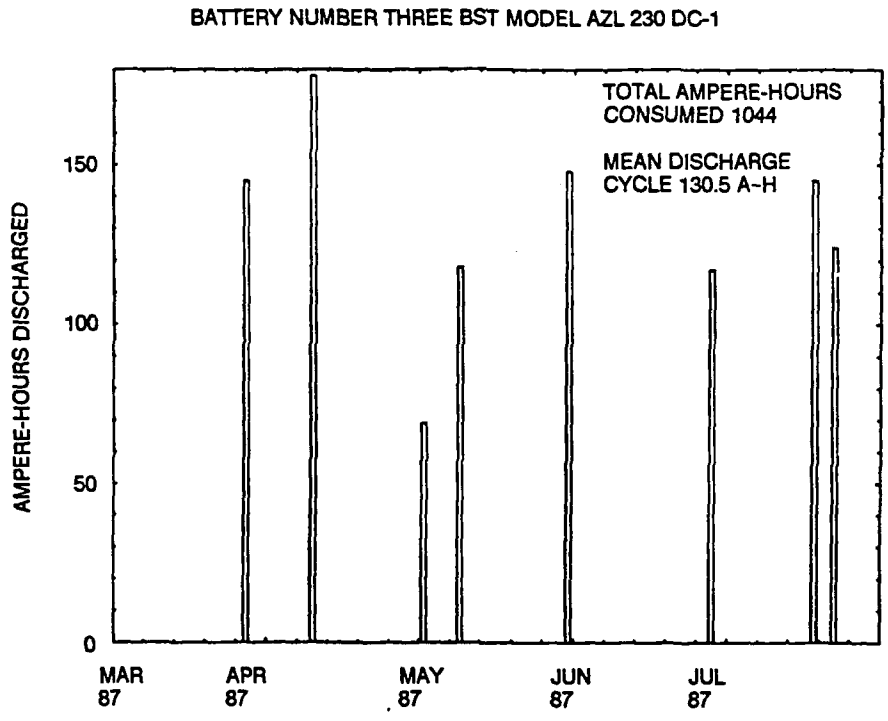

Figure 5. Battery number three Model BST230.

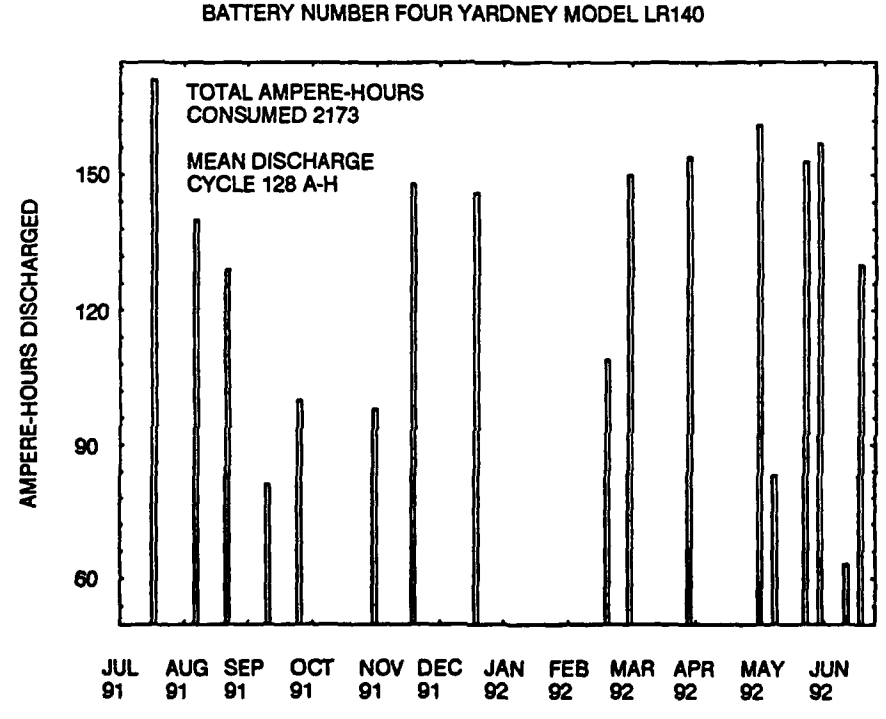

Figure 6. Battery number four Model LR140.

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APPENDIX A—CHARGING INSTRUCTIONS FOR BATTERY MONITOR

CONTENTS

I CONNECTIONS

The battery charging monitor system (BCMS) should be checked for proper hook-up. Disconnect the plugs that connect the cell monitor boards (CMB) to the connectors on the opposite ends of the battery boxes. Refer to AUSS drawing number 0128047, battery charging system interconnect diagram. The four cables labeled A, B, C, and D attached to the battery cell isolation relay PCBs in the battery room are connected in parallel with the CMB relay PCB plugs J2. Connect P1 through P5 on the charger relay control board for the charge configuration. AUSS drawing charger relay control board schematic (0127970) documents the electrical connections for P1 through P5 while NRaD drawing component layout relay control board (0126815) documents where the plugs are located on the charger relay control board. Next, connect charger power supply cables, plugs A, B, C, and D, to the after end of the battery packs.

> Note: Once these last set of plugs are mated to the battery boxes, total battery voltage is present through the molexes behind the computer rack.

First, turn on the computer. Next, turn on the monitor power supply, located behind computer. Use the lowest mounted toggle switch located on the side of the power supply, labeled "on" toward the wall. Next, switch the relay enable (24 V) control to the up position. Then, turn on the 120 Vac for the cooling fans, also "on" is up.

The Sytron power supplies are not turned on until the charge monitoring program has been loaded and then "run" to initiate a reset to the input/output (I/O) board digital-to-analog outputs. The I/O is configured so that a -2.5 Vdc is provided to the Sytron power supplies when commanded by a reset from the computer.

II PROGRAM INITIALIZATION AND OPERATION

The BCMS program is a GWBASIC program. The computer autoexec.bat file brings the computer "up" in the GWBASIC software. The program can be loaded by hitting the F3 key after the OK prompt is displayed once the computer has "booted" into GWBASIC. Once "LOAD" is displayed, type CHG and enter. Then type "Run" and press return(ENTER). Answer questions to the prompts as necessary for the charge configuration you are selecting. Note: Once in the GWBASIC program, do not hit the return key except after answering a question by making a numerical entry. Answering "y" or "n" to any question does not require a return key entry.

The first program prompt allows the operator to reset all the outputs, setting charging power supplies to zero current, opens any latched relays, and resets counters on CMB.

The second prompt requests an input for the total ampere-hours taken out of the battery during the previous dive. The discharge ampere-hour figure is then stored on the hard disc prior to the start of a charge.

The third prompt provides the operator the option to select desired relays for closing when the selected relay is sequenced during a battery monitor scan. This is necessary when restarting a charge that has already latched out cells that have reached the high-voltage cut-off.

The final prompt is for inputting the desired charge current and charge configuration. There are four charge configurations, both chargers at either the 7-A rate or the 2-A rate, one charger at the 7-A and the other at the 2-A rate, and both chargers at the 0-A charge rate. The selection of the charge rate sets up the charging configuration within the program.

III FUNCTION KEYS

The program has soft keys as described below. They allow the operator to monitor the charge at his discretion, e.g., make a printout, look at the high and low cells, send latest charge data to the hard disc for future reference, etc.

F1: The F1 function key directs the printer to print the most recent charge information. F1 can be used as a means for establishing a hard copy of the battery charge progress. The information printed includes: the time and date, the most recent cell voltages, relay latch conditions, the average cell voltage of all 80 cells, the total battery voltage, the total charge amp-hours for both chargers, the high- and low-cell voltages for both charger packs (charger pack one [1] refers to cells 1 through 40), and the power supply current, both the measured and commanded current. See table A.1.

F2: The F2 function key displays the same information as the F1 key, but the data are displayed on the computer screen. See table A.2.

F3: The F3 function key is used to toggle the displayed individual cell information on and off. When the F3 individual cell display is off, the F2 function is displayed automatically after all 80 cells have been updated. The F3 function key on causes each cell voltage to print to the display, this is the slower sample mode. The slower mode of operation is automatically switched off when any cell reaches the high-voltage level while at the 2-A rate.

F4: The F4 function key displays the 80 relay latch conditions. A number "1" indicates that the relay has been commanded to latch a 1-ohm resistor across that cell. See table A.3.

F6: The F6 function key allows the operator to make current supply adjustments. The instantaneous current measurements are displayed, and the program then prompts the operator to enter new values if desired.

Table A.1. Information is printed to printer when F1 is pressed, and to the hard disc when F7 is pressed.

14:15:17 DATE 01-09-1992

1	1.964V	RELAY IS	NOT LATCHED	2	1.964V	RELAY IS	NOT LATCHED
3	1.964V	RELAY IS	NOT LATCHED	4	1.964V	RELAY IS	NOT LATCHED
5	1.964V	RELAY IS	NOT LATCHED	6	1.964V	RELAY IS	NOT LATCHED
7	1.964V	RELAY IS	LATCHED	8	1.964V	RELAY IS	NOT LATCHED
9	1.964V	RELAY IS	NOT LATCHED	10	1.964V	RELAY IS	NOT LATCHED
11	1.964V	RELAY IS	NOT LATCHED	12	1.964V	RELAY IS	NOT LATCHED
13	1.964V	RELAY IS	NOT LATCHED	14	1.964V	RELAY IS	LATCHED
15	1.964V	RELAY IS	NOT LATCHED	16	1.964V	RELAY IS	NOT LATCHED
17	1.964V	RELAY IS	NOT LATCHED	18	1.964V	RELAY IS	NOT LATCHED
19	1.964V	RELAY IS	NOT LATCHED	20	1.964V	RELAY IS	NOT LATCHED
21	1.964V	RELAY IS	LATCHED	22	1.964V	RELAY IS	NOT LATCHED
23	1.964V	RELAY IS	NOT LATCHED	24	1.964V	RELAY IS	NOT LATCHED
25	1.964V	RELAY IS	NOT LATCHED	26	1.964V	RELAY IS	NOT LATCHED
27	1.964V	RELAY IS	NOT LATCHED	28	1.964V	RELAY IS	LATCHED
29	1.964V	RELAY IS	NOT LATCHED	30	1.964V	RELAY IS	NOT LATCHED
31	1.964V	RELAY IS	NOT LATCHED	32	1.964V	RELAY IS	NOT LATCHED
33	1.964V	RELAY IS	NOT LATCHED	34	1.964V	RELAY IS	NOT LATCHED
35	1.964V	RELAY IS	LATCHED	36	1.964V	RELAY IS	NOT LATCHED
37	1.964V	RELAY IS	NOT LATCHED	38	1.964V	RELAY IS	NOT LATCHED
39	1.964V	RELAY IS	NOT LATCHED	40	1.964V	RELAY IS	NOT LATCHED
41	1.964V	RELAY IS	NOT LATCHED	42	1.964V	RELAY IS	LATCHED
43	1.964V	RELAY IS	NOT LATCHED	44	1.964V	RELAY IS	NOT LATCHED
45	1.964V	RELAY IS	NOT LATCHED	46	1.964V	RELAY IS	NOT LATCHED
47	1.964V	RELAY IS	NOT LATCHED	48	1.964V	RELAY IS	NOT LATCHED
49	1.964V	RELAY IS	LATCHED	50	1.964V	RELAY IS	NOT LATCHED
51	1.964V	RELAY IS	NOT LATCHED	52	1.964V	RELAY IS	NOT LATCHED
53	1.964V	RELAY IS	NOT LATCHED	54	1.964V	RELAY IS	NOT LATCHED
55	1.964V	RELAY IS	NOT LATCHED	56	1.964V	RELAY IS	LATCHED
57	1.964V	RELAY IS	NOT LATCHED	58	1.964V	RELAY IS	NOT LATCHED
59	1.964V	RELAY IS	NOT LATCHED	60	1.964V	RELAY IS	NOT LATCHED
61	1.964V	RELAY IS	NOT LATCHED	62	1.964V	RELAY IS	NOT LATCHED
63	1.964V	RELAY IS	LATCHED	64	1.964V	RELAY IS	NOT LATCHED
65	1.964V	RELAY IS	NOT LATCHED	66	1.964V	RELAY IS	NOT LATCHED
67	1.964V	RELAY IS	NOT LATCHED	68	1.964V	RELAY IS	NOT LATCHED
69	1.964V	RELAY IS	NOT LATCHED	70	1.964V	RELAY IS	LATCHED
71	1.964V	RELAY IS	NOT LATCHED	72	1.964V	RELAY IS	NOT LATCHED
73	1.964V	RELAY IS	NOT LATCHED	74	1.964V	RELAY IS	NOT LATCHED
75	1.964V	RELAY IS	NOT LATCHED	76	1.964V	RELAY IS	NOT LATCHED
77	1.964V	RELAY IS	LATCHED	78	1.964V	RELAY IS	NOT LATCHED
79	1.964V	RELAY IS	NOT LATCHED	80	1.964V	RELAY IS	NOT LATCHED

CELL AVERAGE = 1.964 TOTAL BATTERY VOLTAGE = 138.9

** TOTAL AH CHG #1 = 78.2 ** TOTAL AH CHG #2 = 76.1

HIGH CELLS ARE CELL NO. 2 1.993 AND CELL NO. 77 1.992
LOW CELLS ARE CELL NO. 23 1.903 AND CELL NO. 49 1.905

	ACTUAL CURRENT	COMMANDED CURRENT
CHARGER #1 (CELLS 1 THRU 40) IS	1.99 AMPS	2.1 AMPS
CHARGER #2 (CELLS 41 THRU 80) IS	6.92 AMPS	6.9 AMPS

Table A.2. Information displayed on computer screen when function key F2 is pressed.

	1	2	3	4	5	6	7	8	9	10
1	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
11	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
21	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
31	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
41	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
51	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
61	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
71	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95

CELL AVERAGE = 0.000 ** TOTAL AH CHG #1 = 0.0 ** TOTAL AH CHG #2 = 0.0
HIGH CELLS ARE CELL NO. 0 0.000 AND CELL NO. 41 1.950
LOW CELLS ARE CELL NO. 1 1.950 AND CELL NO. 41 1.950
TOTAL NUMBER OF CELLS LATCHED FOR 1 THRU 40 0 FOR CELLS 41 THRU 80 0

COMMANDED CURRENT CHARGER # 1 IS 2 AMPS CHARGER # 2 IS 2 AMPS
ACTUAL MEASURED CURRENT CHARGER # 1 2.25 AMPS CHARGER # 2 2.35 AMPS

Table A.3. F4 function key displays the 80 relay latch conditions.

' FUNCTION KEY 4 DISPLAY TO SCREEN '

RELAY LATCH CONDITTIONS (0 = OPEN 1 = CLOSED)

	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	1	0	0	0
11	0	0	0	1	0	0	0	0	0	0
21	1	0	0	0	0	0	0	1	0	0
31	0	0	0	0	1	0	0	0	0	0
41	0	1	0	0	0	0	0	0	1	0
51	0	0	0	0	0	1	0	0	0	0
61	0	0	1	0	0	0	0	0	0	1
71	0	0	0	0	0	0	1	0	0	0

F7: The F7 function key records data to a hard disc file called "TEMP1." The data are the same information sent to the printer with the F1 key. The F7 function is automatically tasked every time the program completes 10 cycles through the battery pack. This function key allows the operator to command this task at anytime, i.e., right after the first 80-cell voltages when the charge is first started or prior to securing. However, the data are not transferred to the TEMP1 file until the present 80-cell sampling sequence is completed. Four beeps are sounded when the task has been executed.

F10: The F10 function key is used to toggle the continuous tone off, if tone does not go off then the program is not running. The operator must execute the control break (CTRL-BRK) to exit the program followed by an F2(RUN) and answer the first question with a "y," resetting the chargers to zero and opening the relays.

IV COMPUTER-GENERATED ALARMS

The following list summarizes the alarms and the appropriate operator response:

*** 2 "BEEPS" ***

Under program control the computer generates two beeps after a complete battery monitoring cycle, 80 new cell values. The short moment of time between the first and second beep would be a recommended time to press F1 and send the latest data to the printer or hard disc, since the most complete and recent data are available.

*** 4 "BEEPS ***

The computer has just sent the most recent data to the hard disc. The event can also occur whenever the F7 key is depressed during cell-voltage checks, but only after the two beeps are sounded indicating, the most recent data are available.

*** CONTINUOUS TONE ***

Several events can trigger this type of alarm. Every time this alarm is sounded the power supply affecting the cell that triggered the alarm is secured and the 40 relays that could be shunting resistors of that same group of 40 are opened. Then a message is printed indicating which cell caused the alarm, what change was made to the charge configuration, and why the alarm was initiated. Examples are

Cell voltage over 2.06 V.

Cell value over 2.00 V with the cell shunted by a 1-ohm resistor.

Cell value less than 1.30 Vdc, indicating possible hot-short during charge or cell not taking charge.

Current measures 1.0 A greater than the commanded current.

Current measures 0 A with relays enabled by the 2-A selection at the start of program. This prevents a relay from discharging a cell if the charge current stopped.

V SECURING THE BATTERY CHARGE

An emergency shutdown can be executed by turning the computer off followed by shutting off the Sytron power supplies. The power supply current should go to zero when the computer is secured.

A normal shut down sequence should include a printout and the recording of the latest data to the hard disc (Function keys F1 and F7). To complete a normal shut-down sequence, press F7 and then press F1 immediately after the first beep of the two-beep sequence. If the program is displaying individual cell voltages, toggle F3 to speed up the sample rate. Once the printout is complete and the four beeps have been heard, indicating that the "TEMP1" file was updated, execute a control break. The program is now stopped. Press F2, which restarts the program, and answer yes to the first question, setting power supplies to zero and resetting all other conditions. Then secure to the Sytrons, the monitor power supply, the fans, the 24-V relay enable switch, and finally the computer and printer.

APPENDIX B—DISCHARGING INSTRUCTIONS FOR BATTERY MONITOR

CONTENTS

I CONNECTIONS

All connections should be connected according to the charging instructions for battery monitor connections.

Turn on computer. Next turn on monitor power supply located behind computer. Use the lowest mounted toggle switch located on the side of the power supply labeled "on" to starboard. Next switch the relay enable (24 V) control to the up position. Then turn on the 120 Vac for the cooling fans, also "on" is up.

The batteries are connected to four high-wattage resistors for the high-current discharge as shown in figure B.1, high-current discharge load configuration. The current can be as high as 10.5 A during this discharge configuration, so first make sure the toggle switch is in the open position. The battery will start discharging through the resistors as soon as the toggle switch is closed. The program for discharging at the high-current rate should be loaded and running when the toggle switch is closed. The toggle switch is then opened and the molex connections removed once any one of the cells have reached the low-voltage limit. This condition will be indicated by a steady tone from the computer, so the high-current-rate discharge must be monitored frequently.

The discharge is then continued using the 1-ohm resistors on the relay/resistor circuit board with the low-discharge rate program explained below. NRaD drawing 0128047, battery charging system interconnect, should be referred to for initial discharge set-up.

II PROGRAM INITIALIZATION AND OPERATION

There are two discharge programs: the high-current discharge program labeled "DISCHGH," and the low-current discharge program labeled "DISCHGL." The programs are loaded in the same manner as the "CHG" program for the charging operation. The "DISCHGH" is used to monitor the discharge while in the high-current configuration, i.e., the high-wattage resistors shunting the four battery packs. The "DISCHGL" is for monitoring the discharge while the cells are shunted by the relay/resistor circuit card, thus allowing the computer to control the progress of the discharge.

The "DISCHGH" program monitors the cells at the high-sample rate. The discharge circuit is a semifixed arrangement, so when any cell reaches the low-voltage level the computer generates a continuous tone but cannot do anything to stop the discharge. The tone alerts the operator the high-current rate needs to be secured by opening the toggle switch in the resistor load circuit. Refer again to figure B.1. It is imperative that

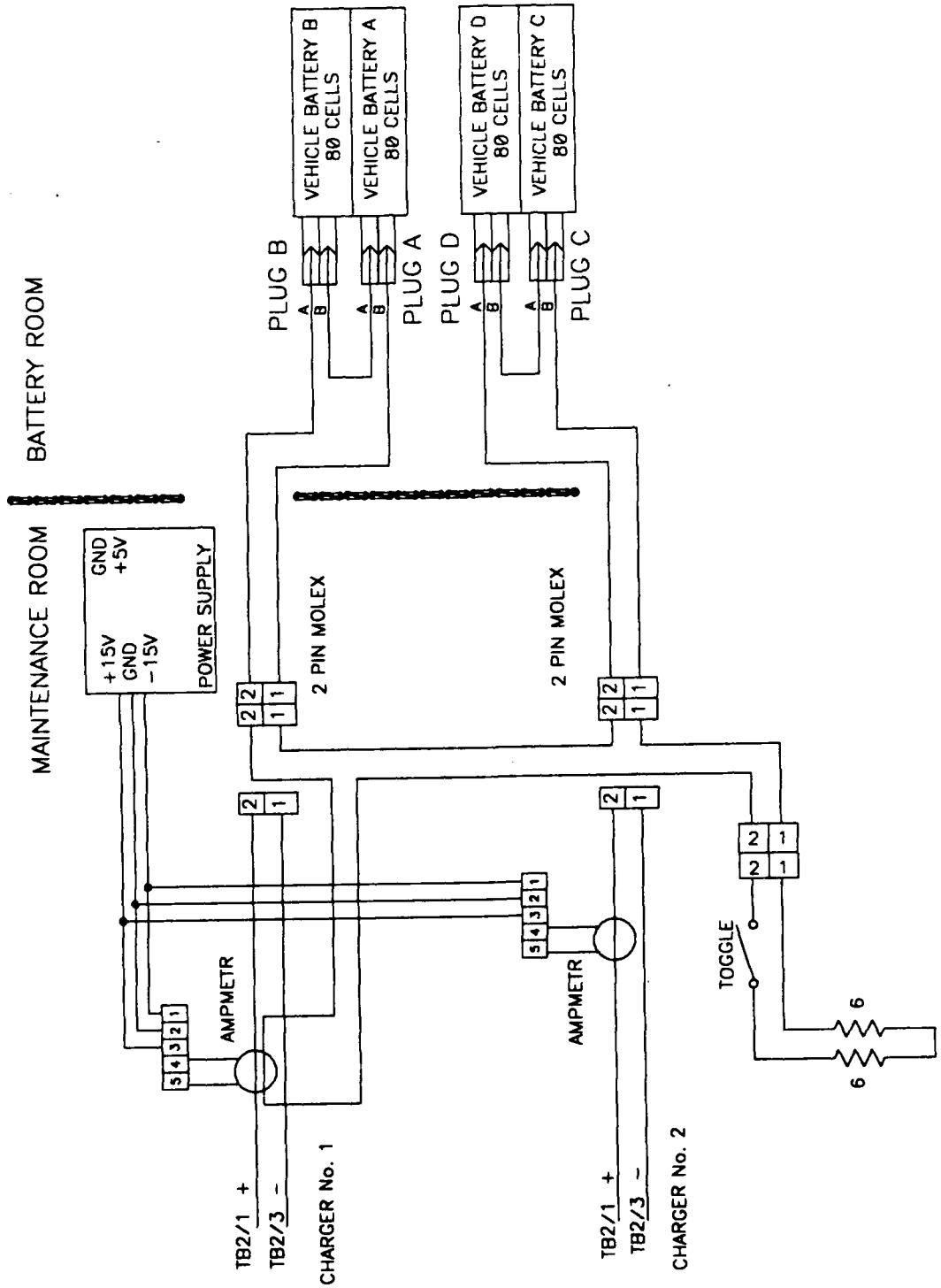

Figure B.1. High-current discharge load configuration.

the low cell, as displayed by the computer, be monitored frequently by the operator so as to note when the low cell is starting to reach the low-voltage cut-off. By anticipating the low-voltage alarm, the operator can stop the high-discharge current before cell damage can occur. The operator must then stop the program by simultaneously hitting the control and the break keys. The "DISCHGL" program is then loaded and run by typing "load dischgl" followed by a return, and then hitting the F2 key.

The "DISCHGL" program has three prompts. The first prompt asks the operator if a system reset should be initiated. An answer of yes to this question will reset the monitor clock circuits, reset all relays open, and clear all variables within the program. The next prompt is for setting up the program to shunt all cells with 1-ohm resistors. This is accomplished once the program starts running and completes a full battery cycle, 80-cell samples. The cells selected by this prompt are shunted as the monitor cycles to each cell during a normal monitoring sequence. Once the monitor completes the first 80 samples, shunting the selected cells, the computer prompts the operator as to whether the connections for relay control during discharge have been changed. Refer to NRaD drawing 0127970 for the proper plug connections for discharge. At this point the plugs P1 through P5 are changed. This configuration now allows the computer to open the relay/resistor discharge path when a cell reaches the low-voltage limit. Once the operator has changed plugs P1 through P5, he answers the prompt with a "y."

The battery cells are now being discharged at a low-current rate under the control of the computer. This continues until all 80 relays have been latched open. The battery is now completely discharged.

III FUNCTION KEYS

The function keys operate the same as the charging function keys.

IV COMPUTER-GENERATED ALARMS

The computer-generated alarms operate the same as the charging alarms except as previously noted in these instructions.

V SECURING THE BATTERY DISCHARGE

The battery discharge will be secured one cell at a time until all cells have reached the low-voltage level. The computer and power supplies will have to be secured the same as the charging procedures describe.

APPENDIX C—AUSS SCHEMATIC DRAWINGS ASSOCIATED WITH BATTERY CHARGE/DISCHARGE MONITOR SYSTEM

NRaD DRAWING NO.	DRAWING TITLE
0122510	Cell Monitor Schematic
0122513	Cell Monitor Relay Schematic
0122772	Cell Relay/Resistor Isolation Schematic
0127970	Charger Relay Control Circuit Board
0127973	Computer Interface/Isolation Circuit Board
0128047	Battery Charging System Interconnect Diagram
0128048	Cell Monitor PCBs Charging Interconnect
0128049	Vicor DC–DC Interconnect Charging System
0126815	Component Layout Relay Control Board
0128050	Emergency Processor Battery Charger

APPENDIX D—BATTERY CHARGE PROGRAM "CHG.BAS"

```
10    '***********   CHG.BAS    as of 3/13/92    TIME  1345  **********
20    DEFINT A-Z          ' ASSIGN ALL LETTERS AS INTEGERS
30    LC1# = 3 : LC2# = 3  ' SET LOWEST CELLS FOR  #1 &  #2  CHARGERS ABOVE 0
40    WIDTH "lpt1:",78
50    BASE.ADDRESS     = &H2EC            'DT 2801 memory assignments
60    COMMAND.REGISTER = BASE.ADDRESS + 1
70    STATUS.REGISTER  = BASE.ADDRESS + 1
80    DATA.REGISTER    = BASE.ADDRESS
90    COMMAND.WAIT     = &H4
100    WRITE.WAIT       = &H2
110    READ.WAIT        = &H5
120   CCLEAR           = &H1
130   CADIN            = &HC  '&H8c = ext trigger, &Hc = continuous
140   CSTOP            = &HF
150   CDAOUT           = &H8
160   STCHG            = 0
170    DIM CV#(80)           'DIMENSION CELL VALUE (CV#)
180    DIM CEVS(80)           'DIMENSION CELL VALUE (CV#)
190    DIM CL#(80)           'DIMENSION CELL LATCH (CL#)
200    DIM COV(80)           'DIMENSION CELL OVER VOLTAGE (COV)
210    DIM Z(80)             'DIMENSION OVER VOLTAGE LOOP TWICE CHECK
220    A$ = "LATCHED"
230    B$ = "NOT LATCHED"
240    C$ = "CELL NUMBER  "
250    D$ = "V  RELAY IS "
260    OUT COMMAND.REGISTER, CSTOP
270    TEMP = INP(DATA.REGISTER)
280    GOSUB 1900
290    WAIT STATUS.REGISTER, COMMAND.WAIT
300    OUT COMMAND.REGISTER, CCLEAR
310    '   ********** PROMPT TO RESET OUTPUTS AT START UP   *******
320    PRINT "RESET ALL OUTPUTS? (y,n)"
330    RSTI$ = INPUT$(1)
340    IF RSTI$ = "y" THEN 370
350    IF RSTI$ = "n" THEN 450
360    GOTO 320
370    GOSUB  2110                  'set all analog and digital outputs to zero
380  '  ***  PROMPT TO INPUT AMP-HOURS OUT DURING DISCHARGE  ***
390   PRINT "STORE AMP-HOURS OUT OF BATTERY DURING DISCHARGE? (y,n)"
400   AHOUT$ = INPUT$(1)
410   IF AHOUT$ = "y" THEN GOSUB 6780 : GOTO 440
420   IF AHOUT$ = "n" THEN 440
430   GOTO 380
440   '  *********  INPUT RELAY ENABLE COUNT FROM PREVIOUS RUN  ***********
450    PRINT "INPUT RELAY CELL NUMBER? (y,n)"
460    RSTO$ = INPUT$(1)
470    IF RSTO$ = "y" THEN GOSUB 6690 : GOTO 540
480    IF RSTO$ = "n" THEN 540
490    GOTO 450
500  '  PRINT "RELAY CELL NUMBER ?"
510  '  INPUT CN
520  '  CEVS(CN) = 1
530  '  GOTO 420
540    '**************  PROMPT FOR DESIRED CHARGE CURRENT  ************
550    PRINT "IS CHARGE CURRENT THE SAME FOR BOTH CHARGERS?"
560    RSCHG$ = INPUT$(1)
570    GOSUB 6910 'SET VALUE FOR PREVIOUS TIME IN AMPHOUR CALCULATIONS
580    IF RSCHG$ = "y" THEN 730
590    IF RSCHG$ = "n" THEN GOSUB 6910 : GOTO 610
600    GOTO 550
610    PRINT "IS EITHER CHARGER AT THE  2 AMP RATE? (y,n)"
620    CHGRT$ = INPUT$(1)
630    IF CHGRT$ = "y" THEN 660
640    IF CHGRT$ = "n" THEN 710
650    GOTO 610
660    PRINT "    WHICH CHARGER IS AT THE  2 AMP RATE?   ( 1 OR 2 )"
670    INPUT CHGNO
680    IF CHGNO = 1 THEN CEVL = 1 : STCHG1 = 1 : GOSUB 5430 : GOTO 840
690    IF CHGNO = 2 THEN CEVH = 1 : STCHG2 = 1 : GOSUB 5430 : GOTO 840
700    GOTO 660
710    GOSUB 5430
720    GOTO 840
730    PRINT "  WHAT IS CHARGE CURRENT IN AMPS? ( TYPE 0, 2 OR 7 )" : PRINT
740    INPUT CHG.I
750    IF CHG.I = 0 THEN 790
760    IF CHG.I = 2 THEN  810
770    IF CHG.I = 7 THEN CHG.I = 100 : GOTO 830
780    GOTO 650
790    CHG.I = 0  : F$ = " 0 AMP RATE " : CHG.I1#=0 : CHG.I2#=0
800    GOTO  840
810    CHG.I1#=2: CHG.I2#=2:F$=" 2 AMP RATE": STCHG=2: CHG.I = 510 : STCHG1 = 1
: STCHG2 = 1 : GOSUB 5400  ' SRT CHGS  & AH CLOCK
820    GOTO 840
830    CHG.I1#= 7 : CHG.I2#= 7 : F$ = " 7 AMP RATE":GOSUB 5400
840    ON KEY(1) GOSUB 2320        'F1 key to PRN 80 cv# & cl# to Printer
850    ON KEY(2) GOSUB 4620        'F2 key display last 80 cells to 8 rows
860    ON KEY(3) GOSUB 5130        'F3 key to toggle displayed data on/off
870    ON KEY(4) GOSUB 5800        'F4 key to display last 80 latch conditions
880    ON KEY(6) GOSUB 5430        'F6 key allows for current changes
890    ON KEY(7) GOSUB 3800        'F7 key sends data to hard disc temp1
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900    ON KEY(10) GOSUB 5940        'F10 key STOPS CONTINUOUS ALARM
910    '********  OUTPUT PULSE TO RESET COUNTERS AND MONITOR  CIRCUIT  *******
920    GOSUB 6120     '  GO OUTPUT RESET
930    '
940    '************   Loop 80 times waiting each time for the sample Pusle   ***
950    TI = TI + 1
960    FOR LOOP = 1 TO  80                    'start 80 samples
970    GOSUB  2250                            'clock to incr monitor circuits
980    Y1 = 0 : Y2 = 0
990    SETGAIN = 2: SETCHAN = 7       'RANGE IS +/- 2.5   **** CELL.VALUE# **
1000    CVAVG# = 0
1010    FOR CVA = 1 TO 3        'AVERAGE CV# 5 TIMES
1020    GOSUB 2890              ' A/D CONVERSION FOR CV# VALUE
1030    CELL.VALUE# = (HIGH1# * 256 + LOW1#) * .0012207 - 2.5
1040    CELL.VALUE# = ABS (CELL.VALUE#)
1050    CVAVG# = CVAVG# + CELL.VALUE#
1060    NEXT
1070    CELL.VALUE# = CVAVG# / 3  'CALCULATE CELL.VALUE BASED ON 5 SAMPLES
1080   'IF LOOP = 85 THEN GOSUB 6200 : STOP
1090    GOSUB  2250        'output clock to trigger A/D on hardware
1100    IF LOOP = 19 THEN 1670
1110    IF LOOP = 20 THEN 1670
1120    IF LOOP = 39 THEN 1670
1130    IF LOOP = 40 THEN 1670
1140    IF LOOP = 59 THEN 1670
1150    IF LOOP = 60 THEN 1670
1160    IF LOOP = 79 THEN 1670
1170    IF LOOP = 80 THEN 1670
1180    IF CELL.VALUE# < 1.3 THEN F$ = "  CELL BELOW 1.50 VOLTS" : GOSUB  6570
1190  ' SETGAIN = 1: SETCHAN = 4       'RANGE IS +/- 5.0   **** READ CEV# ****
1200  ' GOSUB 2470                          ' A/D CONVERSION
1210    KEY(1) ON                          'enable F1 key
1220    KEY(2) ON                          'enable F2 key
1230    KEY(3) ON                          'enable F3 key
1240    KEY(4) ON                          'enable F4 key
1250    KEY(6) ON                          'enable F6 key
1260    'KEY(7) ON                          'enable F7 key
1270    KEY(10) ON                         'enable F10 key
1280  ' CEV# = (HIGH1#* 256 + LOW1#) *  .0024414 - 5 'calculate CEV# value
1290    KEY(6)STOP  'DISABLE F6  UNTIL NEXT KEY ON STATEMENT
1300    CEV# = 0
1310  '  CEV# = ABS(CEV#)                    'change bipolar to positive value
1320    IF CELL.VALUE# > 2.05 THEN CEV# = 5
1330    IF CEVS(LOOP) = 1 AND CELL.VALUE# > 2 THEN F$ = "CELL LATCHED TO RESISTO
R AND THE VOLTAGE WAS OVER 2.0 VOLTS    " : GOSUB 6570
1340    IF CEVS(LOOP) = 1 THEN  GOTO 1380 'GO RETRIGGER RELAY ENABLE
1350    IF CEV# > 3 THEN 1390          ' YES, GO CHECK IF 7 AMP
1360    LC$ = B$
1370    GOTO 1580
1380    LC$ = A$ : GOTO 1570
1390    IF STCHG < 2 THEN 1410       ' YES, GO CHECK 2 AMP RATE ON BOTH CHARGERS
1400    GOTO 1560
1410    IF LOOP > 40 THEN 1490
1420    IF CEVH = 1 THEN GOSUB 3760 : GOTO 810 'SET CHARGERS TO 2 AMPS PRINT MSG
1430    IF CEVL = 1 THEN 1560   'ALREADY AT TWO AMP RATE-GO ENABLE RELAY
1440    CHG.I1# = 2:CHG.I = 510 : GOSUB 5360 'GO OUTPUT NEW CURRENT on chg #1
1450    CEVL = 1 : STCHG1 = 1
1460   F$ = "CHARGER  #1 IS AT 2 AMP RATE  :  CHARGER #2 IS AT 7 AMP RATE"
1470   GOSUB 3480          'PRINT CHARGE RATE CHANGE TO PRINTER
1480   GOTO 1580           'RESUME CELL VALUE CHECKS
1490   IF CEVL = 1 THEN GOSUB 3760 : GOTO 810 'SET CHARGERS TO 2 AMPS PRINT MSG
1500   IF CEVH = 1 THEN 1560
1510   CHG.I2# = 2:CHG.I = 510 : GOSUB 5380  'GO OUTPUT NEW CURRENT on chg #2
1520   CEVH = 1 : STCHG2 = 1
1530   F$ = "CHARGER #1 IS AT 7 AMP RATE  :    CHARGER #2 IS AT 2 AMP RATE"
1540   GOSUB 3480          'PRINT CHARGE RATE CHANGE
1550   GOTO 1580
1560    CEVS(LOOP) = 1              ' CELL WAS NOT LATCHED, DO IT
1570    GOSUB 3690                  ' GO TRIGGER RELAY ENABLE
1580    CV#(LOOP) = CELL.VALUE#
1590   IF LOOP > 40 THEN 1630
1600   IF CV#(LOOP) > HC1# THEN GOSUB 6360  ' SET HIGH CELL 1st 40 TO CV(LOOP)
1610   IF CV#(LOOP) < LC1# THEN GOSUB 6610  ' SET LOW CELL 1st 40 TO CV(LOOP)
1620   GOTO 1650
1630   IF CV#(LOOP) > HC2# THEN GOSUB 6400  ' SET HIGH CELL 2nd 40 TO CV(LOOP)
1640   IF CV#(LOOP) < LC2# THEN GOSUB 6650  ' SET LOW CELL 2nd 40 TO CV(LOOP)
1650   IF CELL.VALUE# > 2.15 THEN GOSUB 1920
1660   IF TOGG = 0 THEN GOSUB 5190  '  GO PRINT CELL INFO TO SCREEN
1670   IF ICK > 7 THEN GOSUB 3010 : ICK = 0 : GOTO 1690  'CHECK  ACTUAL MEASURED
 CURRENT
1680   ICK = ICK + 1 : GOTO 1780
1690   IF Y1 = 1 THEN GOSUB 4370   'IF CHARGE CURRENT TOO HIGH SECURE # 1
1700   IF Y2 = 1 THEN GOSUB 4500   'IF CHARGE CURRENT TOO HIGH SECURE # 2
1710  'IF TI = 1 THEN 1770
1720   IF STCHG1 > 0 THEN 1740 'CHG #1 AT 2 AMP?
1730   GOTO 1750
1740   IF CHG1.1M# < .2  THEN F$="**** CHARGE CURRENT < .2 AMP WITH RELAY ENABLE
SET ON CHARGER NO. 1****":STCHG1=0:GOSUB 4370
1750   IF STCHG2 > 0 THEN 1770
1760   GOTO 1780
```

```
1770   IF CHGI.2M# < .2  THEN F$="**** CHARGE CURRENT < .2 AMP WITH RELAY ENABLE
SET ON CHARGER NO. 2***":STCHG2=0:GOSUB 4500
1780   NEXT                'loop back and wait for next clock for next cell
1790  GOSUB 6210  ' CHG1LAT AND CHG2LAT
1800   GOSUB 6000      ' GO COMPUTE CELL AVERAGE
1810   GOSUB 6960      ' GO SUM TOTAL AMP HOURS
1820   IF TOGG = 1 THEN GOSUB 4620 '  DISPLAY 80 CELLS TO SCREEN
1830   GOSUB 4270 : FOR DLY = 1 TO 5000 : NEXT : GOSUB 4270 'TWO BEEPS
1840   IF TI > 9 THEN GOSUB 3800 : TI = 0
1850   KEY(7) ON                       'enable F7 key
1860   HC1# = 0 : HC2# = 0
1870   LC1# = 3 : LC2# = 3
1880   KEY(7)STOP  'DISABLE F7 UNTIL NEXT KEY(7) ON STATEMENT
1890   GOTO 910        'go reset monitor ckts and start next 80
1900   WAIT STATUS.REGISTER, WRITE.WAIT,WRITE.WAIT
1910   RETURN
1920  '   ************   Cell voltage too high   *************
1930   IF LOOP > 40 THEN F$ = "CELL OVER VOLTAGE OCCURED " : GOSUB 4500 : RETURN
   'OPEN LAST 40 RELAYS AND SECURE CHARGER # 2 AND LOOP BACK
1940   F$ = "CELL OVER VOLTAGE OCCURED " : GOSUB 4370   'OPEN FIRST 40 RELAYS  A
ND SECURE CHARGER # 1
1950   RETURN        'LOOP BACK TO CONTINUE TO CHECK CELLS ON OTHER CHARGER
1960   '  ******   STOP CHARGE, RESET OUTPUTS       ********
1970   GOSUB 2110          'set all analog and digital outputs to zero
1980   PRINT:PRINT:PRINT:PRINT:PRINT:PRINT
1990   PRINT "  ************     BATTERY CHARGE SECURED    ********  "
2000   PRINT:PRINT:PRINT:PRINT:PRINT:PRINT
2010   GOSUB 2320          'GO PRINT LAST 80 TO "A:LAST80"
2020   PRINT "   ****  RELAYS HAVE BEEN LATCHED OPEN  *******
2030   GOSUB 3430           'GO SOUND THE AUDIO ALARM
2040   PRINT : PRINT F$ : PRINT
2050   END
2060   '  *****  SET HIGH AND LOW BYTES TO CHG.I VALUE COMMANDED "   ********
2070   HIGHBYTE = INT(CHG.I / 256)
2080   LOWBYTE = CHG.I - HIGHBYTE * 256
2090   GOSUB 3320                   'GOSUB D/A OUTPUT SELECTED CHANNEL (CHAN)
2100   RETURN
2110   '  *****   RESET ALL OUTPUT DIGITAL BITS AND ANALOG TO ZERO ********
2120   HIGHBYTE = 0 : LOWBYTE = 0
2130   FOR CHAN = 0 TO 1
2140   GOSUB 3320                  'GOSUB D/A OUTPUT CHANNELs 0 & 1
2150   NEXT
2160   DPORT = 0 : DWORD = 20      'BIT TO RESET ALL RELAYS
2170   GOSUB 3170                  'GOSUB  DIGITAL I/O PREPARATION
2180   GOSUB 3240                  'GOSUB  DIGITAL I/O OUTPUT
2190   DWORD = 0
2200   GOSUB 3240                  'GOSUB  DIGITAL I/O OUTPUT
2210   DPORT = 1 : DWORD = 0
2220   GOSUB 3170                  'GOSUB  DIGITAL I/O PREPARATION
2230   GOSUB 3240                  'GOSUB  DIGITAL I/O OUTPUT
2240   RETURN
2250   '*********    Output clock pulse on Port zero Bit zero   ***************
2260   DPORT = 0 : DWORD = 1
2270   GOSUB 3170                  'GOSUB  DIGITAL I/O PREPARATION
2280   GOSUB 3240                  'GOSUB  DIGITAL I/O OUTPUT
2290   DWORD = 0
2300   GOSUB 3240                  'GOSUB  DIGITAL I/O OUTPUT
2310   RETURN
2320 '*****    Go Print last 80  to A:LAST80  **********
2330    'OPEN "O",#2,"A:LAST80"    'OPEN FILE TO STORE LAST 80 CELL VALUES
2340    OPEN "lpt1:" FOR OUTPUT AS #2
2350    ON ERROR GOTO 7110 'PRINTER on line BUTTON NOT ENABLE
2360    PRINT#2, "   CHARGE IN PROGRESS LASTEST 80 CELL VALUES    "
2370    PRINT#2,TIME$;"   DATE  " ;DATE$     'ANNOTATE TIME
2380    PRINT#2,
2390    FOR P = 1 TO 80           'LOOP 80 TIMES TO GET MOST RECENT CELL VALUES
2400    IF CEVS(P) = 1 THEN 2430   'CHECKS TO SEE IF THAT CELL HAS BEEN LATCHED
2410    LC$ = B$
2420    GOTO  2440
2430    LC$ = A$
2440    IF PRNTFLG = 0 THEN 2520
2450    PRINT#2, "    ";           'PRINT CELL VALUE AND RELAY LATCH
2460    PRINT#2, USING " ##";P;
2470    PRINT#2, " ";           'PRINT CELL VALUE AND RELAY LATCH
2480    PRINT#2, USING " #.###";CV#(P);    'CONDITON
2490    PRINT#2, D$ ; LC$
2500    PRNTFLG = 0
2510    GOTO 2580
2520    PRINT#2, "  ";       'PRINT CELL VALUE AND RELAY LATCH
2530    PRINT#2, USING "##";P;
2540    PRINT#2, " ";       'PRINT CELL VALUE AND RELAY LATCH
2550    PRINT#2, USING"  #.###";CV#(P);    'CONDITON
2560    PRINT#2, D$ ; LC$;
2570    PRNTFLG = 1
2580    NEXT
2590    PRINT#2,
2600    PRINT#2, "CELL AVERAGE =  ";
2610    PRINT#2, USING "#.###";CELLAVG#;
2620    PRINT#2, "        TOTAL BATTERY VOLTAGE =  ";
2630    PRINT#2, USING "###.#";TOTCELL.VAL#
```

```
2640    PRINT#2,
2650    PRINT#2, " **  TOTAL  AH CHG #1 = ";
2660    PRINT#2, USING "###.#";TOTAL1.AH#;
2670    PRINT#2, " **  TOTAL  AH CHG #2 = ";
2680    PRINT#2, USING "###.#";TOTAL2.AH#
2690    PRINT#2,
2700    PRINT#2, "HIGH CELLS ARE CELL NO.  "; HC1N; "    ";
2710    PRINT#2, USING "#.###"; HC1#;
2720    PRINT#2, "     AND CELL NO.   " ;HC2N; "    ";
2730    PRINT#2, USING "#.###"; HC2#
2740    PRINT#2, "LOW  CELLS ARE CELL NO.  "; LC1N; "    ";
2750    PRINT#2, USING "#.###"; LC1#;
2760    PRINT#2, "     AND CELL NO.   " ;LC2N; "    ";
2770    PRINT#2, USING "#.###"; LC2#
2780    PRINT#2,
2790    PRINT#2, "          ACTUAL CURRENT    ";
2800    PRINT#2, "                              COMMANDED CURRENT"
2810    PRINT#2, "  CHARGER #1 (CELLS 1 THRU 40) IS  ";
2820    PRINT#2, USING  "#.###"; CHGI.1M#;
2830    PRINT#2, "  AMPS                  ";CHG.I1#;" AMPS"
2840    PRINT#2, "  CHARGER #2 (CELLS 41 THRU 80) IS  ";
2850    PRINT#2, USING  "#.###"; CHGI.2M#;
2860    PRINT#2, "  AMPS                  ";CHG.I2#;" AMPS"
2870    PRINT#2,
2880  CLOSE#2 : RETURN
2890  '*******  A/D CONVERSION      ***************
2900  GOSUB 1900
2910  OUT  COMMAND.REGISTER,  &HC  'start A/D conversion to measure SET CHAN
2920  GOSUB 1900
2930  OUT DATA.REGISTER, SETGAIN          'set gain
2940  GOSUB 1900
2950  OUT  DATA.REGISTER, SETCHAN    'A/D conversion on SET CHAN
2960  WAIT STATUS.REGISTER,  READ.WAIT
2970  LOW1# = INP(DATA.REGISTER)          'get data low byte
2980  WAIT STATUS.REGISTER,  READ.WAIT
2990  HIGH1# = INP(DATA.REGISTER)         'get data high byte
3000  RETURN
3010  '   ********   CHECK ACTUAL CHARGE CURRENT   **********
3020  SETGAIN = 3 : SETCHAN = 3     ' GAIN RANGE  +/- 1.25
3030  GOSUB 2890                          ' A/D CONVERSION
3040  CHGI.1M# = ((HIGH1#* 256 + LOW1#) *  .00061 - 1.25) * 12.5  '
3050  IF (CHGI.1M# - CHG.I1#) > 1.75 THEN GOTO 3070   'IS DIFF > .5 AMPS
3060  GOTO 3090
3070  Y1 = 1
3080  F$ = " MEASURED CHARGE CURRENT ON CHARGER # 1 > COMMANDED CURRENT"
3090  SETGAIN = 3 : SETCHAN = 2     ' GAIN RANGE  +/- 1.25
3100  GOSUB 2890                          ' A/D CONVERSION
3110  CHGI.2M# = ((HIGH1#* 256 + LOW1#) *  .00061 - 1.25) * 12.5  '
3120  IF (CHGI.2M# - CHG.I2#) > 1.75 THEN GOTO 3140   'IS DIFF > .5 AMPS
3130  GOTO 3160
3140  Y2 = 1
3150  F$ = " MEASURED CHARGE CURRENT ON CHARGER # 2 > COMMANDED CURRENT"
3160  RETURN
3170  '  *****  DIGITAL I/O PREPARE   *********
3180  GOSUB 1900
3190  WAIT STATUS.REGISTER,  COMMAND.WAIT
3200  OUT COMMAND.REGISTER, 5              'PREPARE I/O PORT FOR OUTPUT
3210  GOSUB 1900
3220  OUT DATA.REGISTER, DPORT             'SET PORT ZERO FOR OUTPUT
3230  RETURN
3240  '  *******  DIGITAL I/O OUTPUT   **********
3250  WAIT STATUS.REGISTER, COMMAND.WAIT
3260  OUT COMMAND.REGISTER, 7             'COMMAND IMMEDIATE DIGITAL OUTPUT
3270  GOSUB 1900
3280  OUT DATA.REGISTER, DPORT            'SELECTED OUTPUT PORT
3290  GOSUB 1900
3300  OUT DATA.REGISTER, DWORD            'BITS TO SET HGH
3310  RETURN
3320  '  ******  D/A OUTPUT ON SELECTED CHANNEL (CHAN)   *********
3330  GOSUB 1900
3340  WAIT STATUS.REGISTER, COMMAND.WAIT
3350  OUT COMMAND.REGISTER, CDAOUT            'IMMEDIATE D/A OUT
3360  GOSUB 1900
3370  OUT DATA.REGISTER, CHAN                 'D/A CHANNEL SELECTED
3380  GOSUB 1900
3390  OUT DATA.REGISTER, LOWBYTE
3400  GOSUB 1900
3410  OUT DATA.REGISTER, HIGHBYTE
3420  RETURN
3430   '    ********   SOUND CONTINUOUS AUDIO ALARM      ************
3440   DPORT = 1 :  DWORD = 2
3450   GOSUB 3170                  'GOSUB  DIGITAL I/O PREPARATION
3460   GOSUB 3240                  'GOSUB  DIGITAL I/O OUTPUT
3470   RETURN
3480  '  ******  STORE TIME OF CHARGE RATE CHANGE - SOUND TWO ALARMS   ****
3490   OPEN "LPT1:" FOR OUTPUT AS #3  'PRINT FOLLOWING ON THE PRINTER
3500   CHGRTCHN = 1 ' SET CHARGE RATE CHANGE FLAG FOR PRINTER ERROR ROUTN
3510   ON ERROR GOTO 7110 'PRINTER on line BUTTON NOT ENABLE
3520   PRINT#3, : PRINT#3, : PRINT#3,
3530   PRINT#3, DATE$;"    ";TIME$; "   ****  CHARGE CURRENT RATE CHANGE OCCURR
```

```
ED  *****"
3540    PRINT#3, "CELL NUMBER  "; LOOP ; "WAS  ";
3550    PRINT#3, USING " ##.###"; CELL.VALUE#;
3560    PRINT#3, "  V"
3570    PRINT#3, CEV$ : PRINT#3,
3580    PRINT#3, CLC$ : PRINT#3,
3590    PRINT#3, "******  ACTUAL CURRENT   *****  "
3600    PRINT#3, "CHARGER # 1  ";
3610    PRINT#3, USING  "###.##"; CHGI.1M#;
3620    PRINT#3, " AMPS";"              CHARGER # 2  ";
3630    PRINT#3, USING  "###.##"; CHGI.2M#;
3640    PRINT#3, " AMPS"
3650    PRINT#3, "COMMANDED CURRENT CHARGER # 1 IS  ";CHG.I1#; " AMPS    CHARGER
 # 2 IS  " ;CHG.I2#;" AMPS"
3660    PRINT#3, : PRINT#3,
3670    PRINT#3, F$ : CLOSE#3 : GOSUB 4270 : GOSUB 4270  'SOUND TWO TONES
3680    RETURN
3690    '**********  TRIGGER CEV ENABLE ON PORT ONE BIT ZERO   *****
3700    DPORT = 1 : DWORD = 1
3710    GOSUB 3170                    'GOSUB  DIGITAL I/O PREPARATION
3720    GOSUB 3240                    'GOSUB  DIGITAL I/O OUTPUT
3730    DWORD = 0
3740    GOSUB 3240                    'GOSUB  DIGITAL I/O OUTPUT
3750    RETURN
3760    '**************   RECORD TO A:CEVCHGRT BOTH CHARGERS SET TO 2 AMP *******
3770    F$ = "  ***  BOTH CHARGERS SET TO 2 AMP RATE   ****"
3780    GOSUB 3480   'GO STORE TIME OF RATE CHANGE TO A:CEVCHGRT
3790    RETURN
3800     '   *******      PRINT TO C:\BAS\TEMP1     ***********
3810    IF TMP = 1 THEN TEMP1$ = "NOPRNT" : GOTO 3830
3820    TEMP1$ = "TEMP1"
3830    OPEN "a", #1, TEMP1$
3840    PRINT#1, : PRINT#1,
3850    PRINT#1, "   *****   ";DATE$; "   *****   ";  TIME$; "   ******"
3860    PRINT#1,
3870    FOR NW = 1 TO 80
3880    IF CEVS(NW) = 1 THEN 3910   'CHECKS TO SEE IF THAT CELL HAS BEEN LATCHED
3890    LC$ = B$
3900    GOTO  3920
3910    LC$ = A$
3920    IF PRNFLG = 0 THEN 3980
3930    PRINT#1, "     ";NW;                'PRINT CELL VALUE AND RELAY LATCH
3940    PRINT#1, USING " #.###";CV#(NW);    'CONDITON
3950    PRINT#1, D$ ; LC$
3960    PRNFLG = 0
3970    GOTO 4020
3980    PRINT#1, NW;                         'PRINT CELL VALUE AND RELAY LATCH
3990    PRINT#1, USING " #.###";CV#(NW);    'CONDITON
4000    PRINT#1, D$ ; LC$;
4010    PRNFLG = 1
4020    NEXT
4030    PRINT#1, "    CHARGER # 1  ";
4040    PRINT#1, USING  "##.##"; CHGI.1M#;
4050    PRINT#1, " AMPS";"          CHARGER # 2  ";
4060    PRINT#1, USING  "##.##"; CHGI.2M#;
4070    PRINT#1, " AMPS"
4080    PRINT#1, "    CHARGE AT  ";F$;
4090    PRINT#1, "       CELL AVERAGE =   ";
4100    PRINT#1, USING " #.###";CELLAVG#
4110    PRINT#1, "HIGH CELLS ARE CELL NO.  "; HC1N; "    ";
4120    PRINT#1, USING "#.###"; HC1#;
4130    PRINT#1, "     AND CELL NO.   " ;HC2N; "    ";
4140    PRINT#1, USING "#.###"; HC2#
4150    PRINT#1, "LOW  CELLS ARE CELL NO.  "; LC1N; "    ";
4160    PRINT#1, USING "#.###"; LC1#;
4170    PRINT#1, "     AND CELL NO.   " ;LC2N; "    ";
4180    PRINT#1, USING "#.###"; LC2#
4190    PRINT#1, " **  TOTAL  AH CHG #1 = ";
4200    PRINT#1, USING "###.#";TOTAL1.AH#;
4210    PRINT#1, " **  TOTAL  AH CHG #2 = ";
4220    PRINT#1, USING "###.#";TOTAL2.AH#
4230    PRINT#1, "   *****   ";DATE$; "   *****   ";  TIME$; "   ******"
4240    CLOSE#1
4250    GOSUB 4270 : GOSUB 4270 : GOSUB 4270 : GOSUB 4270   '4 BEEPS
4260    RETURN
4270    '   *************    SEND OUT A BEEP   ***************
4280    DPORT = 1 :  DWORD = 0
4290    GOSUB 3170                    'GOSUB  DIGITAL I/O PREPARATION
4300    GOSUB 3240                    'GOSUB  DIGITAL I/O OUTPUT
4310    DPORT = 1 :  DWORD = 2
4320    GOSUB 3240                    'GOSUB  DIGITAL I/O OUTPUT
4330    FOR Q = 1 TO 1000 : NEXT    'DELAY FOR TWO SECONDS
4340    DWORD = 0                     'TURN OFF ALARM
4350    GOSUB 3240                    'GOSUB  DIGITAL I/O OUTPUT
4360    RETURN
4370    '  ***  SECURE FIRST 40 RELAYS STOP CHARGER # 1   ***
4380    CHG.I = 0 : CHAN = 0 : GOSUB 2060  ' STOP CHARGER # 1
4390    DPORT = 0 : DWORD = 4        'RESET RELAYS 1 - 40   J2/48
4400    GOSUB 3170 : GOSUB 3240   'DIG I/O PREPARE : DIG I/O OUTPUT
4410    DWORD = 0 : GOSUB 3240
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4420   CEV$ = "  *****   CHARGER # 1 SECURED   ******"
4430   CLC$ = "  *****   RELAYS 1 THRU 40 RESET OPEN   ******"
4440   CHG.I1# = 0 : STCHG1 = 0
4450   GOSUB 3480      'SOUND TWO BEEPS AND PRINT MSGS
4460   GOSUB 3430      'GO SOUND CONTINUOUS ALARM
4470   FOR RSTCEVS = 1 TO 40 : CEVS(RSTCEVS) = 0 : NEXT
4480   RETURN
4490   '
4500   '  ***  SECURE LAST  40 RELAYS STOP CHARGER # 2   ***
4510   CHG.I = 0 : CHAN = 1 : GOSUB 2060  ' STOP CHARGER # 2
4520   DPORT = 0 : DWORD = 16        'RESET RELAYS 41 - 80   J2/47
4530   GOSUB 3170 : GOSUB 3240   'DIG I/O PREPARE : DIG I/O OUTPUT
4540   DWORD = 0 : GOSUB 3240
4550   CEV$ = "  *****   CHARGER # 2 SECURED   ******"
4560   CLC$ = "  *****   RELAYS 41 THRU 80 RESET OPEN   ******"
4570   CHG.I2# = 0 : STCHG2 = 0
4580   GOSUB 3480      'SOUND TWO BEEPS AND PRINT MSGS
4590   GOSUB 3430      'GO SOUND CONTINUOUS ALARM
4600   FOR RSTCEVS = 41 TO 80 : CEVS(RSTCEVS) = 0 : NEXT
4610   RETURN
4620   '   *****   print to screen all cell values
4630   '             and print the current from both chargers   *****
4640   PRINT
4650   PRINT "      1       2       3       4       5       6       7       8       9
   10"
4660   PRINT " 1";
4670   PRINT USING "  ##.##";CV#(1);CV#(2);CV#(3);CV#(4);CV#(5);CV#(6);CV#(7);CV
#(8);CV#(9);CV#(10)
4680   PRINT
4690   PRINT "11";
4700   PRINT USING "  ##.##";CV#(11);CV#(12);CV#(13);CV#(14);CV#(15);CV#(16);CV#
(17);CV#(18);CV#(19);CV#(20)
4710   PRINT
4720   PRINT "21";
4730   PRINT USING "  ##.##";CV#(21);CV#(22);CV#(23);CV#(24);CV#(25);CV#(26);CV#
(27);CV#(28);CV#(29);CV#(30)
4740   PRINT
4750   PRINT "31";
4760   PRINT USING "  ##.##";CV#(31);CV#(32);CV#(33);CV#(34);CV#(35);CV#(36);CV#
(37);CV#(38);CV#(39);CV#(40)
4770   PRINT
4780   PRINT "41";
4790   PRINT USING "  ##.##";CV#(41);CV#(42);CV#(43);CV#(44);CV#(45);CV#(46);CV#
(47);CV#(48);CV#(49);CV#(50)
4800   PRINT
4810   PRINT "51";
4820   PRINT USING "  ##.##";CV#(51);CV#(52);CV#(53);CV#(54);CV#(55);CV#(56);CV#
(57);CV#(58);CV#(59);CV#(60)
4830   PRINT
4840   PRINT "61";
4850   PRINT USING "  ##.##";CV#(61);CV#(62);CV#(63);CV#(64);CV#(65);CV#(66);CV#
(67);CV#(68);CV#(69);CV#(70)
4860   PRINT
4870   PRINT "71";
4880   PRINT USING "  ##.##";CV#(71);CV#(72);CV#(73);CV#(74);CV#(75);CV#(76);CV#
(77);CV#(78);CV#(79);CV#(80)
4890   PRINT
4900    PRINT "CELL AVERAGE = ";
4910    PRINT USING "#.###";CELLAVG#;
4920    PRINT " **  TOTAL  AH CHG #1 = ";
4930    PRINT USING "###.#";TOTAL1.AH#;
4940    PRINT " **  TOTAL  AH CHG #2 = ";
4950    PRINT USING "###.#";TOTAL2.AH#
4960  PRINT "HIGH CELLS ARE CELL NO.  "; HC1N; "    ";
4970  PRINT USING "#.###"; HC1#;
4980  PRINT "     AND CELL NO.   " ;HC2N; "    ";
4990  PRINT USING "#.###"; HC2#
5000  PRINT "LOW  CELLS ARE CELL NO.  "; LC1N; "    ";
5010  PRINT USING "#.###"; LC1#;
5020  PRINT "     AND CELL NO.   " ;LC2N; "    ";
5030  PRINT USING "#.###"; LC2#
5040   PRINT "TOTAL NUMBER OF CELLS LATCHED FOR 1 THRU 40   "; CHG1LAT; "   FOR
CELLS 41 THRU 80   ";CHG2LAT
5050    PRINT "  COMMANDED CURRENT CHARGER # 1 IS  " ; CHG.I1#; " AMPS   CHARGER
 # 2 IS  "; CHG.I2#; " AMPS"
5060   PRINT "  ACTUAL MEASURED CURRENT CHARGER # 1  ";
5070   PRINT USING  "##.##"; CHGI.1M#;
5080   PRINT " AMPS";"   CHARGER # 2  ";
5090   PRINT USING  "##.##"; CHGI.2M#;
5100   PRINT "  AMPS"
5110   RETURN
5120   '   *********     TOGGLE DISPLAY ON/OFF     *********
5130   IF TOGG = 1 THEN 5150
5140   IF TOGG = 0 THEN 5160
5150   TOGG = 0 : GOTO 5170
5160   TOGG = 1
5170   RETURN
5180   '
5190   '   *****   PRINT CELL VALUE AND CHARGER CURRENT TO DISPLAY     *****
5200   '
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5210    PRINT "CELL NUMBER " ; LOOP ; LC$; "            CELL VALUE IS";
5220    PRINT USING "###.###"; CELL.VALUE#
5230  ' PRINT "TOTAL NUMBER OF CELLS LATCHED IS "; TOT.CELL;
5240  ' PRINT "          "; F$
5250    PRINT "CHARGER # 1  ";
5260    PRINT USING  "###.##"; CHGI.1M#;
5270    PRINT " AMPS";"               CHARGER # 2  ";
5280    PRINT USING  "###.##"; CHGI.2M#;
5290    PRINT " AMPS"
5300    PRINT "COMMANDED CURRENT CHARGER # 1 IS  ";CHG.I1#; "AMPS    CHARGER # 2
 IS  " ;CHG.I2#;"AMPS"
5310    PRINT : PRINT
5320    FOR PRDL = 1 TO 2000 : NEXT
5330    RETURN
5340    '
5350    '  ********    ADJUST CHG.I FOR OUTPUT CURRENT CHANGES  **************
5360    '  ***   CHARGER # 1 CURRENT CHANGE ONLY   ******
5370    CHAN = 0 : GOSUB 2060 : RETURN
5380    '  ***   CHARGER # 2 CURRENT CHANGE ONLY   ******
5390    CHAN = 1 : GOSUB 2060 : RETURN
5400    '  ***   CHANGE CURRENT ON BOTH CHARGERS   ******
5410    GOSUB 5360 : GOSUB 5380 : RETURN
5420    '
5430    '  ********   DISPLAY MEASURED CURRENT     ******
5440    FOR CC = 1 TO 5
5450    GOSUB 3010       ' GET CHGI.1M# AND CHGI.2M#
5460    PRINT "CHARGER # 1  ";
5470    PRINT USING  "###.##"; CHGI.1M#;
5480    PRINT " AMPS";"               CHARGER # 2  ";
5490    PRINT USING  "###.##"; CHGI.2M#;
5500    PRINT " AMPS"
5510    PRINT : PRINT
5520    FOR CCO = 1 TO 1000 : NEXT
5530    NEXT
5540    PRINT "IS CURRENT MEASURED OK? (y,n)"
5550    CCQ$ = INPUT$(1)
5560    IF CCQ$ = "y" THEN RETURN
5570    IF CCQ$ = "n" THEN 5590
5580    GOTO 5540
5590    PRINT "IS CHARGER # 1 CURRENT VALUE OK? (y,n)"
5600    CCQ$ = INPUT$(1)
5610    IF CCQ$ = "y" THEN 5720
5620    IF CCQ$ = "n" THEN 5640
5630    GOTO 5590
5640    PRINT  "COMMANDED CURRENT ON CHARGER # 1 IS " ; CHG.I1# : PRINT
5650    PRINT "INPUT DESIRED VALUE FOR CHARGER # 1"
5660    INPUT CHG.I1#
5670    IF STCHG OR STCHG1 > 0 THEN 5690 '2 AMP RATE RELAY ENABLE SET
5680    GOTO 5700
5690    IF CHG.I1# > 2.5 THEN GOSUB 6440 : GOTO 5640
5700    CHG.I = CHG.I1# * 255
5710    GOSUB 5360 : GOTO 5440
5720    PRINT  "COMMANDED CURRENT ON CHARGER # 2 IS " ; CHG.I2# : PRINT
5730    PRINT "INPUT DESIRED VALUE FOR CHARGER # 2"
5740    INPUT CHG.I2#
5750    IF STCHG OR STCHG2 > 0 THEN 5770 '2 AMP RATE RELAY ENABLE SET
5760    GOTO 5780
5770    IF CHG.I2# > 2.2 THEN GOSUB 6440 : GOTO 5720
5780    CHG.I = CHG.I2# * 255
5790    GOSUB 5380 : GOTO 5440
5800    '   ********    PRINT RELAY LATCH CONDITIONS    **********
5810    PRINT
5820    PRINT "     RELAY LATCH CONDITTIONS ( 0 = OPEN   1 = CLOSED )" : PRINT
5830    PRINT "      1       2       3       4       5       6       7       8
     9       10"
5840    PRINT : PRINT
5850    PRINT "     ";CEVS(1);"     ";CEVS(2);"     ";CEVS(3);"     ";CEVS(4);"
   ";CEVS(5);"     ";CEVS(6);"     ";CEVS(7);"     ";CEVS(8);"     ";CEVS(9);"
   ";CEVS(10)
5860    PRINT "     ";CEVS(11);"     ";CEVS(12);"     ";CEVS(13);"     ";CEVS(14)
;"     ";CEVS(15);"     ";CEVS(16);"     ";CEVS(17);"     ";CEVS(18);"     ";CEV
S(19);"     ";CEVS(20)
5870    PRINT "     ";CEVS(21);"     ";CEVS(22);"     ";CEVS(23);"     ";CEVS(24)
;"     ";CEVS(25);"     ";CEVS(26);"     ";CEVS(27);"     ";CEVS(28);"     ";CEV
S(29);"     ";CEVS(30)
5880    PRINT "     ";CEVS(31);"     ";CEVS(32);"     ";CEVS(33);"     ";CEVS(34)
;"     ";CEVS(35);"     ";CEVS(36);"     ";CEVS(37);"     ";CEVS(38);"     ";CEV
S(39);"     ";CEVS(40)
5890    PRINT "     ";CEVS(41);"     ";CEVS(42);"     ";CEVS(43);"     ";CEVS(44)
;"     ";CEVS(45);"     ";CEVS(46);"     ";CEVS(47);"     ";CEVS(48);"     ";CEV
S(49);"     ";CEVS(50)
5900    PRINT "     ";CEVS(51);"     ";CEVS(52);"     ";CEVS(53);"     ";CEVS(54)
;"     ";CEVS(55);"     ";CEVS(56);"     ";CEVS(57);"     ";CEVS(58);"     ";CEV
S(59);"     ";CEVS(60)
5910    PRINT "     ";CEVS(61);"     ";CEVS(62);"     ";CEVS(63);"     ";CEVS(64)
;"     ";CEVS(65);"     ";CEVS(66);"     ";CEVS(67);"     ";CEVS(68);"     ";CEV
S(69);"     ";CEVS(70)
5920    PRINT "     ";CEVS(71);"     ";CEVS(72);"     ";CEVS(73);"     ";CEVS(74)
;"     ";CEVS(75);"     ";CEVS(76);"     ";CEVS(77);"     ";CEVS(78);"     ";CEV
S(79);"     ";CEVS(80)
```

```
5930   RETURN
5940    '     ********   SECURE AUDIO ALARM      ************
5950    DPORT = 1 :  DWORD = 0
5960    GOSUB 3170                    'GOSUB  DIGITAL I/O PREPARATION
5970    GOSUB 3240                    'GOSUB  DIGITAL I/O OUTPUT
5980    RETURN
5990   '
6000    '   *********     COMPUTE CELL AVERAGE     *********
6010    CELLAVG# = 0 : TOTCELL.VAL# = 0
6020    FOR CA = 1 TO 80
6030    TOTCELL.VAL# = TOTCELL.VAL# + CV#(CA)
6040    NEXT
6050    CELLAVG# = TOTCELL.VAL# / 72
6060    RETURN
6070   '     **********  print test cell and return to stop     **************
6080   PRINT "cell number "; LOOP;" is ";
6090   PRINT USING "#.###"; CELL.VALUE#;
6100   PRINT "  volts"
6110   RETURN
6120   '********  OUTPUT PULSE TO RESET COUNTERS AND MONITOR  CIRCUIT  *******
6130   DPORT = 0
6140   GOSUB 3170                    'GOSUB  DIGITAL I/O PREPARATION
6150   DWORD = 8
6160   GOSUB 3240                    'GOSUB  DIGITAL I/O OUTPUT
6170   DWORD = 0
6180   GOSUB 3240                    'GOSUB  DIGITAL I/O OUTPUT
6190   GOSUB  2250                     'OUTPUT CLOCK TO IGNOR FIRST A/D SAMPLE
6200   RETURN
6210   '   ***   record cevs totals for both chargers and tot.cell   *****
6220   TOT.CELL = 0 : CHG1LAT = 0 : CHG2LAT = 0
6230   FOR CLTS = 1 TO 40
6240   IF CEVS(CLTS) = 1 THEN 6260     '   SUM LATCHED CELLS FOR CHG #1
6250   GOTO 6270
6260   CHG1LAT = CHG1LAT + 1
6270   NEXT
6280   FOR CLTS = 41 TO 80
6290   IF CEVS(CLTS) = 1 THEN 6310    ' SUM LATCHED CELLS FOR CHG #2
6300   GOTO 6320
6310   CHG2LAT = CHG2LAT + 1
6320   NEXT
6330    IF CHG1LAT => 38 THEN CHG1LAT = 0 : F$ = "   ********* 95% OF FIRST 40 L
ATCHED   ******************** : GOSUB 4370   '  SECURE CHG #1 AND OPEN RELAYS 1-40
6340    IF CHG2LAT => 38 THEN CHG2LAT = 0 : F$ = "   ********* 95% OF LAST 40 LA
TCHED   ************ : GOSUB 4500 '   SECURE CHG #2 AND OPEN RELAYS 41-80
6350    RETURN
6360   '   ****   SET HC1# TO CV#(LOOP)   ****
6370   HC1# = CV#(LOOP)
6380   HC1N = LOOP
6390   RETURN
6400   '   ****   SET HC2# TO CV#(LOOP)   ****
6410  HC2# = CV#(LOOP)
6420   HC2N = LOOP
6430   RETURN
6440   '*********     ALERT OPERATOR TO SET CURRENT BELOW 2.2 AMPS     ***********
6450    PRINT
6460   PRINT "RELAY ENABLE IS SET FOR THE CELLS AFFECTED BY THIS CHARGER !!"
6470   PRINT : PRINT "  *********   2 AMPS OR LESS  ***********"
6480   PRINT : PRINT " PRESS ANY KEY TO CONTINUE  "
6490   CONTINUE$ = INPUT$(1)
6500   RETURN
6510   '*****   SECURE CHARGER NO. 1,  NO CHARGER CURRENT  *****
6520  F$ = "***   NO CHARGER CURRENT WITH RELAY ENABLE SET  ON CHARGER NO. 1  **
** : GOSUB 4370 : STCHG = 0 : STCHG1 = 0
6530  RETURN
6540   '*****   SECURE CHARGER NO. 2,  NO CHARGER CURRENT  *****
6550  F$ = "***   NO CHARGER CURRENT WITH RELAY ENABLE SET  ON CHARGER NO. 2  **
** : GOSUB 4500 : STCHG = 0 : STCHG2 = 0
6560  RETURN
6570  '***  CHECK IF LOOP ON 1-40 OR 41-80  THEN SECURE APPLICABLE CHARGER  ***
6580   IF LOOP < 41 THEN GOSUB 4370 : RETURN
6590   GOSUB 4500
6600   RETURN
6610   '   ****   SET HIGH CELL (LC1#) TO CV#(LOOP)   ****
6620   LC1# = CV#(LOOP)
6630   LC1N = LOOP
6640   RETURN
6650   '   ****   SET LOW CELL (LC2#) TO CV#(LOOP)   ****
6660   LC2# = CV#(LOOP)
6670   LC2N = LOOP
6680   RETURN
6690   '  ***** SET CELL ENABLE VOLTAGE RELAY LATCH (CEVS) ******
6700   PRINT "RELAY CELL NUMBER ?"
6710   INPUT CN
6720   CEVS(CN) = 1
6730   PRINT "INPUT RELAY CELL NUMBER? (y,n)"
6740   RCVS$ = INPUT$(1)
6750   IF RCVS$ = "y" THEN  GOTO 6690
6760   IF RCVS$ = "n" THEN RETURN
6770   GOTO 6730
6780   '*****  STORE AMP-HOURS OUT TO HARD DISC   *****
```

```
6790   PRINT "INPUT AMP-HOURS FROM BATTERY DISCHARGE"
6800   INPUT AMPHOUR
6810   OPEN "A", #1, "TEMP1"
6820   PRINT#1, : PRINT#1, : PRINT#1,
6830   PRINT#1, TIME$; "   DATE  ";DATE$  'ANNOTATE TIME AND DATE
6840   PRINT#1, : PRINT#1,
6850   PRINT#1, : PRINT#1,
6860   PRINT#1, "     *****     AMP HOURS OUT SINCE LAST CHARGE IS     ";
6870   PRINT#1, AMPHOUR; "      *******      'PRINT AMPHOUR FROM DISCHARGE
6880   PRINT#1, : PRINT#1,
6890   CLOSE#1
6900    RETURN
6910  ' **** SET PREDECTIME# FOR AMPHOUR SUMS AT START OF CURRENT COMMAND ***
6920  GOSUB 7050    ' RETURNS VASLUE FOR TIME (DECTIME#); IN HOURS
6930  DECTIMESTART# = DECTIME#
6940  PREVDECTIME# = DECTIME#-1/3600
6950  RETURN
6960  ' *****  SUM THE TOTAL AMP-HOURS TOTAL1.AH# AND TOTAL2.AH#   *********
6970  GOSUB 7050
6980  DELTATIME# = DECTIME# - PREVDECTIME#
6990  DELTA1.AH# = CHGI.1M# * DELTATIME#
7000  DELTA2.AH# = CHGI.2M# * DELTATIME#
7010  TOTAL1.AH# = TOTAL1.AH# + DELTA1.AH#
7020  TOTAL2.AH# = TOTAL2.AH# + DELTA2.AH#
7030  PREVDECTIME# = DECTIME#
7040  RETURN
7050  '  *******    GET DECIMAL TIME (DECTIME#); IN HOURS   *********
7060  HR = VAL(MID$(TIME$,1,2))
7070  MIN# = VAL(MID$(TIME$,4,2))/60
7080  SEC# = VAL(MID$(TIME$,7,2))/3600
7090  DECTIME# = HR + MIN# + SEC#
7100  RETURN
7110  '****   printer error subroutine  *******
7120   GOSUB 3430     'CONTINUOUS TONE
7130   TMP = 1
7140   PRINT
7150   PRINT
7160   PRINT
7170   PRINT "PRINTER NOT ON LINE"
7180   PRINT
7190   PRINT F$
7200   GOSUB 2110  'RESETS RELAYS AND CHARGERS
7210   PRINT
7220   PRINT "  *****   CHARGERS # 1  &  # 2 SECURED   ******"
7230   PRINT
7240   PRINT "  *****   RELAYS 1 THRU 80 RESET OPENED ******"
7250   PRINT
7260   IF CHGRTCHN = 1 THEN 7290
7270   GOSUB 7370 ' PRINT PUT PRINTER ON LINE
7280   GOSUB 2360 : STOP  'GO PRINT LAST 80 THEN STOP
7290  PRINT "CHARGE SECURED DO YOU WISH TO PRINT MSG ?"
7300  PRNRS$ = INPUT$(1)
7310  IF PRNRS$ = "y" THEN  GOTO 7340
7320  IF PRNRS$ = "n" THEN GOTO 7350
7330  GOTO 7290
7340  GOSUB 7370 : GOSUB  3520 : STOP
7350  PRINT "  DATA TO HARD DISC FILE -- NOPRNT  "
7360  GOSUB 3800 : STOP  'DATA TO HARD DISC
7370  ' **** PRINT MSG TO PUT PRINTER ON LINE ****  "
7380  PRINT "PUT PRINTER ON LINE AND PRESS ANY KEY"
7390  CONTT$ = INPUT$(1)
7400  GOSUB 4270  'TURN OFF CONTINUOUS BEEP
7410  PRINT "PROGRAM SECURED  "
7420  RETURN
```

APPENDIX E—BATTERY DISCHARGE PROGRAMS "DISCHGL.BAS" AND "DISCHGH.BAS"

```
10    '************   DISCHGL.BAS   as of 04/08/92    TIME  1500  **********
20    '    CELL VALUE < 1.30 UNLATCHES RELAY
30    DEFINT A-Z          'assign all letters as integers
40    OPEN "A", #1, "TEMP1"
50    PRINT#1, DATE$
60     CLOSE#1
70    WIDTH "lpt1:",78
80    BASE.ADDRESS     = &H2EC            'DT 2801 memory assignments
90    COMMAND.REGISTER = BASE.ADDRESS + 1
100    STATUS.REGISTER  = BASE.ADDRESS + 1
110    DATA.REGISTER    = BASE.ADDRESS
120    COMMAND.WAIT     = &H4
130    WRITE.WAIT       = &H2
140    READ.WAIT        = &H5
150   CCLEAR           = &H1
160   CADIN            = &HC  '&H8c = ext trigger, &Hc = continuous
170   CSTOP            = &HF
180   CDAOUT           = &H8
190   STCHG            = 0
200   LOWCELL# = 1.6
210    DIM CV#(80)           'DIMENSION CELL VALUE (CV#)
220    DIM CEVS(80)           'DIMENSION CELL VALUE (CV#)
230    DIM CL#(80)           'DIMENSION CELL LATCH (CL#)
240    DIM COV(80)           'DIMENSION CELL OVER VOLTAGE (COV)
250    DIM Z(80)             'DIMENSION OVER VOLTAGE LOOP TWICE CHECK
260    A$ = "LATCHED"
270    B$ = "NOT LATCHED"
280    C$ = "CELL NUMBER  "
290    D$ = "V  RELAY IS "
300    OUT COMMAND.REGISTER, CSTOP
310    TEMP = INP(DATA.REGISTER)
320    GOSUB 1460
330    WAIT STATUS.REGISTER, COMMAND.WAIT
340    OUT COMMAND.REGISTER, CCLEAR
350    '   ********** PROMPT FOR RESET OUTPUTS AT START UP   *******
360    PRINT "RESET ALL OUTPUTS? (y,n)"
370    RST1$ = INPUT$(1)
380    IF RST1$ = "y" THEN 410
390    IF RST1$ = "n" THEN 430
400    GOTO 360
410    GOSUB  1720                  'set all analog and digital outputs to zero
530    TOT.CELL = 0
760    ON KEY(1) GOSUB 5740        'F1 key to PRINT 80 cv#.cl# to PRINTER
770    ON KEY(2) GOSUB 3710        'F2 key display last 80 cells to 8 rows
780    ON KEY(3) GOSUB 4120        'F3 key to toggle displayed data on/off
790    ON KEY(4) GOSUB 4750        'F4 key to display last 80 latch conditions
800    ON KEY(6) GOSUB 4440        'F6 key allows for current changes
810    ON KEY(10) GOSUB 4890        'F10 key STOPS CONTINUOUS ALARM
820    PRINT "DO YOU WANT TO SET ALL RELAYS?"
830    SETR$ = INPUT$(1)
840   IF SETR$ = "y" THEN GOSUB 5360 : GOTO 870
850   IF SETR$ = "n" THEN 870
860   GOTO 820
870    LOWCELL# = 1.7 : HIGHCELL# = 1!
880    '********  OUTPUT PULSE TO RESET COUNTERS AND MONITOR  CIRCUIT  *******
890    DPORT = 0
900    GOSUB 2210                   'GOSUB  DIGITAL I/O PREPARATION
910    DWORD = 8
920    GOSUB 2280                   'GOSUB  DIGITAL I/O OUTPUT
930    DWORD = 0
940    GOSUB 2280                   'GOSUB  DIGITAL I/O OUTPUT
950    GOSUB  1860                    'OUTPUT CLOCK TO IGNOR FIRST A/D SAMPLE
960   '
970   '************   Loop 80 times waiting each time for the sample Pusle   ***
980    IF TI > 9 THEN GOSUB 3070 : TI = 0
990    TI = TI + 1
1000    FOR LOOP = 1 TO  80                  'start 80 samples
1010    GOSUB  1860                          'clock to incr monitor circuits
1020    Y1 = 0 : Y2 = 0
1030    SETGAIN = 2: SETCHAN = 7       'RANGE IS +/- 2.5   **** CELL.VALUE# **
1040    CVAVG# = 0
1050    FOR CVA = 1 TO 3        'AVERAGE CV# 5 TIMES
1060    GOSUB 1930              ' A/D CONVERSION FOR CV# VALUE
1070    CELL.VALUE# = (HIGH1# * 256 + LOW1#) * .0012207 - 2.5
1080    CELL.VALUE# = ABS (CELL.VALUE#)
1090    CVAVG# = CVAVG# + CELL.VALUE#
1100    NEXT
1110    CELL.VALUE# = CVAVG# / 3  'CALCULATE CELL.VALUE BASED ON 5 SAMPLES
1120   'IF LOOP = 85 THEN GOSUB 5340 : STOP
1130    GOSUB  1860         'output clock to trigger A/D on hardware
1140   IF LOOP = 19 THEN 1380
1150   IF LOOP = 20 THEN 1380
1160   IF LOOP = 39 THEN 1380
1170   IF LOOP = 40 THEN 1380
1180   IF LOOP = 59 THEN 1380
1190   IF LOOP = 60 THEN 1380
1200   IF LOOP = 79 THEN 1380
1210   IF LOOP = 80 THEN 1380
1220    KEY(1) ON                    'enable F1 key
1230    KEY(2) ON                    'enable F2 key
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1240    KEY(3) ON                          'enable F3 key
1250    KEY(4) ON                          'enable F4 key
1260    KEY(6) ON                          'enable F6 key
1270    KEY(10) ON                          'enable F10 key
1280    IF CELL.VALUE# < 1.3 THEN GOTO 1300  'reset relay to open discharge path
1290    GOTO 1320
1300    GOSUB 2960                  ' GO TRIGGER RELAY ENABLE
1310    CEVS(LOOP) = 0 : GOSUB 5640 ' SET CEVS INDICATOR AND SUM TOT.CELLS
1320    CV#(LOOP) = CELL.VALUE#
1330    IF CV#(LOOP) < LOWCELL# THEN GOSUB 5320  ' GO SET LCNUM TO loop
1340    IF CV#(LOOP) > HIGHCELL# THEN GOSUB 5700  ' GO SET HCNUM TO loop
1350   IF TOT.CELL => 80 THEN F$ = "   80 RELAYS HAD LATCHED"
1360   IF CELL.VALUE# < 1.185 THEN 5220  'GO PRINT CELL LESS THAN 1.185 VOLTS
1370   IF TOGG = 0 THEN GOSUB 4170 'GO PRINT EACH CELL VALUE AND INFO
1380   NEXT               'loop back and wait for next clock for next cell
1390   GOSUB 3320 : GOSUB 5620 : GOSUB 3320  'BEEP,DELAY,BEEP
1400   GOSUB 4950      ' GO COMPUTE CELL AVERAGE
1410   IF TOGG < 1 THEN 1430
1420   GOSUB 3710     ' go print to screen 80 cells and low cell
1430   LOWCELL# = 1.7 : HIGHCELL# = 1!
1440  ' next
1450   GOTO 880         'go reset monitor ckts and start next 80
1460   WAIT STATUS.REGISTER, WRITE.WAIT,WRITE.WAIT
1470   RETURN
1480  '   ************   Cell voltage too high   *************
1490   IF COV(LOOP) > 0  THEN 1540           'HAS COV OCCURED BEFORE
1500   COV(LOOP) = 1                 'THE CELL HAS COV SO INDICATE FOR NEXT CHECK
1510    PRINT USING "#.###";
1520   RETURN                        'RETURN TO LOOP FOR NEXT CELL.VALUE
1530    PRINT " V"
1540   IF LOOP > 40 THEN F$ = "CELL OVER VOLTAGE OCCURED TWICE" : GOSUB 3600 : R
ETURN   'OPENED LAST 40 RELAYS AND SECURED CHARGER # 2 AND LOOP BACK
1550   F$ = "CELL OVER VOLTAGE OCCURED TWICE CELL" : GOSUB 3480   'OPENED FIRST
40 RELAYS  AND SECURED CHARGER # 1
1560   RETURN             'LOOP BACK TO CONTINUE TO CHECK CELLS ON OTHER CHARGER
1570   '  ******   STOP CHARGE, RESET OUTPUTS      ********
1580   GOSUB 1720          'set all analog and digital outputs to zero
1590   PRINT:PRINT:PRINT:PRINT:PRINT:PRINT
1600   PRINT "  ************     BATTERY CHARGE SECURED    ********  "
1610   PRINT:PRINT:PRINT:PRINT:PRINT:PRINT
1620   GOSUB 1900          'GO PRINT LAST 80 TO "A:LAST80"
1630   PRINT "   ****  RELAYS HAVE BEEN LATCHED OPEN  *******
1640   GOSUB 2480          'GO SC'ND THE AUDIO ALARM
1650   PRINT : PRINT F$ : PRINT
1660   END
1670   '  *****  SET HIGH AND LOW BYTES TO CHG.I VALUE COMMANDED "   ********
1680   HIGHBYTE = INT(CHG.I / 256)
1690   LOWBYTE = CHG.I - HIGHBYTE * 256
1700   GOSUB 2370                    'GOSUB D/A OUTPUT SELECTED CHANNEL (CHAN)
1710   RETURN
1720   '  *****   RESET ALL OUTPUT DIGITAL BITS AND ANALOG TO ZERO ********
1730   HIGHBYTE = 0 : LOWBYTE = 0
1740   FOR CHAN = 0 TO 1
1750   GOSUB 2370                    'GOSUB D/A OUTPUT CHANNELs 0 & 1
1760   NEXT
1770   DPORT = 0 : DWORD = 20        'BIT TO RESET ALL RELAYS
1780   GOSUB 2210                    'GOSUB  DIGITAL I/O PREPARATION
1790   GOSUB 2280                    'GOSUB  DIGITAL I/O OUTPUT
1800   DWORD = 0
1810   GOSUB 2280                    'GOSUB  DIGITAL I/O OUTPUT
1820   DPORT = 1 : DWORD = 0
1830   GOSUB 2210                    'GOSUB  DIGITAL I/O PREPARATION
1840   GOSUB 2280                    'GOSUB  DIGITAL I/O OUTPUT
1850   RETURN
1860   '**********    Output clock pulse on Port zero Bit zero   ***************
1870   DPORT = 0 : DWORD = 1
1880   GOSUB 2210                    'GOSUB  DIGITAL I/O PREPARATION
1890   GOSUB 2280                    'GOSUB  DIGITAL I/O OUTPUT
1900   DWORD = 0
1910   GOSUB 2280                    'GOSUB  DIGITAL I/O OUTPUT
1920   RETURN
1930   '********  A/D CONVERSION      *****************
1940   GOSUB 1460
1950   OUT  COMMAND.REGISTER,  &HC  'start A/D conversion to measure SET CHAN
1960   GOSUB 1460
1970   OUT DATA.REGISTER, SETGAIN          'set gain
1980   GOSUB 1460
1990   OUT  DATA.REGISTER, SETCHAN    'A/D conversion on SET CHAN
2000   WAIT STATUS.REGISTER,  READ.WAIT
2010   LOW1# = INP(DATA.REGISTER)          'get data low byte
2020   WAIT STATUS.REGISTER,  READ.WAIT
2030   HIGH1# = INP(DATA.REGISTER)         'get data high byte
2040   RETURN
2050   '   *********   CHECK ACTUAL CHARGE CURRENT   **********
2060   SETGAIN = 3 : SETCHAN = 3     ' GAIN RANGE  +/- 1.25
2070   GOSUB 1930                           ' A/D CONVERSION
2080   CHGI.1M# = ((HIGH1#* 256 + LOW1#) *  .00061 - 1.25) * 12.5  '
2090   IF (CHGI.1M# - CHG.I1#) > 1.75 THEN GOTO 2180   'IS DIFF > .5 AMPS
2100   GOTO 2130
2110   Y1 = 1
```

```
2120   F$ = " MEASURED CHARGE CURRENT ON CHARGER # 1 > COMMANDED CURRENT"
2130   SETGAIN = 3 : SETCHAN = 2      ' GAIN RANGE  +/- 1.25
2140   GOSUB 1930                                ' A/D CONVERSION
2150   CHGI.2M# = ((HIGH1#* 256 + LOW1#) *  .00061 - 1.25) * 12.5  '
2160   IF (CHGI.2M# - CHG.I2#) > 1.75 THEN GOTO 2180   'IS DIFF > .5 AMPS
2170   GOTO 2200
2180   Y2 = 1
2190   F$ = " MEASURED CHARGE CURRENT ON CHARGER # 2 > COMMANDED CURRENT"
2200   RETURN
2210   '  *****  DIGITAL I/O PREPARE   *********
2220   GOSUB 1460
2230   WAIT STATUS.REGISTER,  COMMAND.WAIT
2240   OUT COMMAND.REGISTER, 5                'PREPARE I/O PORT FOR OUTPUT
2250   GOSUB 1460
2260   OUT DATA.REGISTER, DPORT               'SET PORT ZERO FOR OUTPUT
2270   RETURN
2280   '  *******  DIGITAL I/O OUTPUT   **********
2290   GOSUB 1460
2300   WAIT STATUS.REGISTER, COMMAND.WAIT
2310   OUT COMMAND.REGISTER, 7               'COMMAND IMMEDIATE DIGITAL OUTPUT
2320   GOSUB 1460
2330   OUT DATA.REGISTER, DPORT              'SELECTED OUTPUT PORT
2340   GOSUB 1460
2350   OUT DATA.REGISTER, DWORD              'BITS TO SET HGH
2360   RETURN
2370   '  ******  D/A OUTPUT ON SELECTED CHANNEL (CHAN)   *********
2380   GOSUB 1460
2390   WAIT STATUS.REGISTER, COMMAND.WAIT
2400   OUT COMMAND.REGISTER, CDAOUT             'IMMEDIATE D/A OUT
2410   GOSUB 1460
2420   OUT DATA.REGISTER, CHAN                  'D/A CHANNEL SELECTED
2430   GOSUB 1460
2440   OUT DATA.REGISTER, LOWBYTE
2450   GOSUB 1460
2460   OUT DATA.REGISTER, HIGHBYTE
2470   RETURN
2480    '     ********   SOUND CONTINUOUS AUDIO ALARM      ************
2490    DPORT = 1 :  DWORD = 2
2500    GOSUB 2210                    'GOSUB  DIGITAL I/O PREPARATION
2510    GOSUB 2280                    'GOSUB  DIGITAL I/O OUTPUT
2520    RETURN
2530  '   ********    SOUND THREE ALARMS AND APPEND CELL NUMBER TO
2540  '           FILE  *  CV#DIFF  *      **************
2550    GOSUB 3320 : GOSUB 3320 : GOSUB 3320
2560  ' OPEN "A",#4,"A:CV#DIFF"   'OPEN FILE TO STORE LAST 80 CELL VALUES
2570    OPEN "LPT1:" FOR OUTPUT AS #4  'PRINT FOLLOWING ON THE PRINTER
2580    PRINT#4, : PRINT#4, : PRINT#4,
2590    PRINT#4, "    "; TIME$ ;"    DATE  "; DATE$
2600    PRINT#4, CEV$ : PRINT#4,
2610    PRINT#4, "CELL ";LOOP; "VALUE IS ";
2620    PRINT#4, USING"  ###.###";CELL.VALUE#;
2630    PRINT#4, "  VOLTS"
2640    PRINT#4, CLC$
2650    PRINT#4,
2660    PRINT#4, "******  ACTUAL CURRENT IS  *****  "
2670    PRINT#4, "CHARGER # 1  ";
2680    PRINT#4, USING  "###.##"; CHGI.1M#;
2690    PRINT#4, "AMPS";"              CHARGER # 2  ";
2700    PRINT#4, USING "###.##"; CHGI.2M#;
2710    PRINT#4, " AMPS"
2720    PRINT#4, "COMMANDED CURRENT CHARGER # 1 IS  ";CHG.I1#; "AMPS    CHARGER
# 2 IS  " ;CHG.I2#;"AMPS"
2730    PRINT#4, : PRINT#4,
2740    CLOSE#4
2750    RETURN
2760    '  ******  STORE TIME OF CHARGE RATE CHANGE - SOUND TWO ALARMS   ****
2770  ' OPEN "A", #3, "A:CEVCHGRT"
2780    OPEN "LPT1:" FOR OUTPUT AS #3  'PRINT FOLLOWING ON THE PRINTER
2790    PRINT#3, : PRINT#3, : PRINT#3,
2800    PRINT#3, TIME$; "  ****  CHARGE CURRENT RATE CHANGE OCCURRED   *****"
2810    PRINT#3, "CELL NUMBER  "; LOOP ; "WAS  ";
2820    PRINT#3, USING " ##.###"; CELL.VALUE#;
2830    PRINT#3, "  V"
2840    PRINT#3, CEV$ : PRINT#3,
2850    PRINT#3, CLC$ : PRINT#3,
2860    PRINT#3, "******  ACTUAL CURRENT   *****  "
2870    PRINT#3, "CHARGER # 1  ";
2880    PRINT#3, USING  "###.##"; CHGI.1M#;
2890    PRINT#3, " AMPS";"              CHARGER # 2  ";
2900    PRINT#3, USING  "###.##"; CHGI.2M#;
2910    PRINT#3, " AMPS"
2920    PRINT#3, "COMMANDED CURRENT CHARGER # 1 IS  ";CHG.I1#; " AMPS    CHARGER
 # 2 IS  " ;CHG.I2#;" AMPS"
2930    PRINT#3, : PRINT#3,
2940    PRINT#3, F$ : CLOSE#3 : GOSUB 3320 : GOSUB 3320  'SOUND TWO TONES
2950    RETURN
2960    '**********  TRIGGER CEV ENABLE ON PORT ONE BIT ZERO   *****
2970    DPORT = 1 : DWORD = 1
2980    GOSUB 2210                    'GOSUB  DIGITAL I/O PREPARATION
2990    GOSUB 2280                    'GOSUB  DIGITAL I/O OUTPUT
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```
3000   DWORD = 0
3010   GOSUB 2280                    'GOSUB  DIGITAL I/O OUTPUT
3020   RETURN
3030   '*************   RECORD TO A:CEVCHGRT BOTH CHARGERS SET TO 2 AMP *******
3040   F$ = "  ***  BOTH CHARGERS SET TO 2 AMP RATE   ****"
3050   GOSUB 2760   'GO STORE TIME OF RATE CHANGE TO A:CEVCHGRT
3060   RETURN
3070    '   *******      PRINT TO C:\BAS\TEMP1     **********
3080    OPEN "a", #1, "DISCHGL.TEM"
3090    PRINT#1, : PRINT#1, : PRINT#1,
3100    PRINT#1, "    "; TIME$ ;"    DATE  "; DATE$
3110    FOR NW = 1 TO 80
3120    IF CEVS(NW) = 1 THEN 3150   'CHECKS TO SEE IF THAT CELL HAS BEEN LATCHED
3130    LC$ = B$
3140    GOTO  3160
3150    LC$ = A$
3160    PRINT#1, NW;                          'PRINT CELL VALUE AND RELAY LATCH
3170    PRINT#1, USING " #.###";CV#(NW);    'CONDITON
3180    PRINT#1, D$ ; LC$
3190    NEXT
3191    PRINT#1, "    "; TIME$ ;"    DATE  "; DATE$
3200    GOSUB 3320 : GOSUB 3320 : GOSUB 3320 : GOSUB 3320   '4 BEEPS
3210    PRINT#1, "HIGH CELL NO. IS   "; HCNUM; "    ";
3220    PRINT#1, USING "#.###"; HIGHCELL#
3230    PRINT#1, "LOW  CELL NO. IS   "; LCNUM; "    ";
3240    PRINT#1, USING "#.###"; LOWCELL#
3250    PRINT#1,
3260    PRINT#1, " TOTAL CELLS ABOVE LOW VOLTAGE CUTOFF AND STILL LATCHED IS  ";
3261    PRINT#1, USING "##"; TOT.CELL
3270    PRINT "CELL AVERAGE =   ";
3280    PRINT USING " #.###";CELLAVG#
3290    PRINT#1, DATE$
3300    CLOSE#1
3310    RETURN
3320    '   *************    SEND OUT A BEEP   ***************
3330    DPORT = 1 :  DWORD = 2
3340    GOSUB 2210                    'GOSUB  DIGITAL I/O PREPARATION
3350    GOSUB 2280                    'GOSUB  DIGITAL I/O OUTPUT
3360    FOR Q = 1 TO 1000 : NEXT    'DELAY FOR TWO SECONDS
3370    DWORD = 0                     'TURN OFF ALARM
3380    GOSUB 2280                    'GOSUB  DIGITAL I/O OUTPUT
3390    RETURN
3400  '  *****  INCREMENT COUNT OF RESPECTIVE GROUP OF 40   *****
3410    IF LOOP < 41 THEN 3440
3420    CHG2LAT = CHG2LAT + 1
3430    GOTO 3450
3440    CHG1LAT = CHG1LAT + 1
3450    IF CHG1LAT => 40 THEN CHG1LAT = 0 : F$ = "   *********   FIRST 40 HAD LA
TCHED   ****************** : GOSUB 3480
3460    IF CHG2LAT => 40 THEN CHG2LAT = 0 : F$ = "   *********   LAST 40 HAD LAT
CHED   ********** : GOSUB 3600
3470    RETURN
3480    '  ***  SECURE FIRST 40 RELAYS STOP CHARGER # 1   ***
3490    CHG.I = 0 : CHAN = 0 : GOSUB 1670  ' STOP CHARGER # 1
3500    DPORT = 0 : DWORD = 4         'RESET RELAYS 1 - 40   J2/48
3510    GOSUB 2210 : GOSUB 2280   'DIG I/O PREPARE : DIG I/O OUTPUT
3520    DWORD = 0 : GOSUB 2280
3530    CEV$ = "  *****   CHARGER # 1 SECURED   ******"
3540    CLC$ = "  *****   RELAYS 1 THRU 40 RESET OPEN   ******"
3550    GOSUB 2760      'SOUND TWO BEEPS AND PRINT MSGS
3560    GOSUB 2480      'GO SOUND CONTINUOUS ALARM
3570    FOR RSTCEVS = 1 TO 40 : CEVS(RSTCEVS) = 0 : NEXT
3580    RETURN
3590    '
3600    '  ***  SECURE LAST  40 RELAYS STOP CHARGER # 2   ***
3610    CHG.I = 0 : CHAN = 1 : GOSUB 1670  ' STOP CHARGER # 2
3620    DPORT = 0 : DWORD = 16        'RESET RELAYS 41 - 80   J2/47
3630    GOSUB 2210 : GOSUB 2280   'DIG I/O PREPARE : DIG I/O OUTPUT
3640    DWORD = 0 : GOSUB 2280
3650    CEV$ = "  *****   CHARGER # 2 SECURED   ******"
3660    CLC$ = "  *****   RELAYS 41 THRU 80 RESET OPEN   ******"
3670    GOSUB 2760      'SOUND TWO BEEPS AND PRINT MSGS
3680    GOSUB 2480      'GO SOUND CONTINUOUS ALARM
3690    FOR RSTCEVS = 41 TO 80 : CEVS(RSTCEVS) = 0 : NEXT
3700    RETURN
3710    '   *****   print to screen all cell values
3720    '             and print the current from both chargers   *****
3730    PRINT
3740    PRINT "      1       2       3       4       5       6       7       8       9
   10"
3750    PRINT " 1";
3760    PRINT USING "  ##.##";CV#(1);CV#(2);CV#(3);CV#(4);CV#(5);CV#(6);CV#(7);CV
#(8);CV#(9);CV#(10)
3770    PRINT
3780    PRINT "11";
3790    PRINT USING "  ##.##";CV#(11);CV#(12);CV#(13);CV#(14);CV#(15);CV#(16);CV#
(17);CV#(18);CV#(19);CV#(20)
3800    PRINT
3810    PRINT "21";
3820    PRINT USING "  ##.##";CV#(21);CV#(22);CV#(23);CV#(24);CV#(25);CV#(26);CV#
```

```
(27);CV#(28);CV#(29);CV#(30)
3830   PRINT
3840   PRINT "31";
3850   PRINT USING "  ##.##";CV#(31);CV#(32);CV#(33);CV#(34);CV#(35);CV#(36);CV#
(37);CV#(38);CV#(39);CV#(40)
3860   PRINT
3870   PRINT "41";
3880   PRINT USING "  ##.##";CV#(41);CV#(42);CV#(43);CV#(44);CV#(45);CV#(46);CV#
(47);CV#(48);CV#(49);CV#(50)
3890   PRINT
3900   PRINT "51";
3910   PRINT USING "  ##.##";CV#(51);CV#(52);CV#(53);CV#(54);CV#(55);CV#(56);CV#
(57);CV#(58);CV#(59);CV#(60)
3920   PRINT
3930   PRINT "61";
3940   PRINT USING "  ##.##";CV#(61);CV#(62);CV#(63);CV#(64);CV#(65);CV#(66);CV#
(67);CV#(68);CV#(69);CV#(70)
3950   PRINT
3960   PRINT "71";
3970   PRINT USING "  ##.##";CV#(71);CV#(72);CV#(73);CV#(74);CV#(75);CV#(76);CV#
(77);CV#(78);CV#(79);CV#(80)
3980   PRINT
3990    PRINT "CELL AVERAGE =  ";
4000    PRINT USING "#.###";CELLAVG#
4010    PRINT "LOW CELL     =  ";
4020    PRINT USING "#.###";LOWCELL#;
4030    PRINT "       THE LOW CELL NUMBER IS       # "; LCNUM;"   ";
4040    PRINT "HIGH CELL    =  ";
4050    PRINT USING "#.###";HIGHCELL#;
4060    PRINT "       THE HIGH CELL NUMBER IS      # "; HCNUM
4070   PRINT
4071   CELLSDIS = 72 - TOT.CELL
4080   PRINT "  TOTAL CELLS DISCHARGED IS      ";
4090   PRINT USING  "##"; CELLSDIS
4100   RETURN
4110   '   *********     TOGGLE DISPLAY ON/OFF     *********
4120   IF TOGG = 1 THEN 4140
4130   IF TOGG = 0 THEN 4150
4140   TOGG = 0 : GOTO 4160
4150   TOGG = 1
4160   RETURN
4170   '   *****   PRINT CELL VALUE AND CHARGER CURRENT TO DISPLAY     *****
4180    PRINT "CELL NUMBER " ; LOOP ; LC$; "            CELL VALUE IS";
4190    PRINT USING "###.###"; CELL.VALUE#
4200    PRINT
4210    PRINT "TOTAL NUMBER OF CELLS LATCHED IS "; TOT.CELL
4220    PRINT
4230    PRINT "    THE HIGH CELL NUMBER IS  # ";
4240    PRINT USING "##";HCNUM;
4250    PRINT "          ";
4260    PRINT USING "#.###"; HIGHCELL#;
4270    PRINT " V"
4280    PRINT "    THE LOW CELL NUMBER IS   # ";
4290    PRINT USING "##";LCNUM;
4300    PRINT "          ";
4310    PRINT USING "#.###"; LOWCELL#;
4320    PRINT " V"
4330    PRINT : PRINT : PRINT : PRINT
4340    FOR PRDL = 1 TO 5000 : NEXT
4350    RETURN
4360    '  ********    ADJUST CHG.I FOR OUTPUT CURRENT CHANGES  **************
4370    '  ***   CHARGER # 1 CURRENT CHANGE ONLY   ******
4380    CHAN = 0 : GOSUB 1670 : RETURN
4390    '  ***   CHARGER # 2 CURRENT CHANGE ONLY   ******
4400    CHAN = 1 : GOSUB 1670 : RETURN
4410    '  ***   CHANGE CURRENT ON BOTH CHARGERS   ******
4420    GOSUB 4370 : GOSUB 4390 : RETURN
4430   '
4440    '  ********   DISPLAY MEASURED CURRENT     ******
4450    FOR CC = 1 TO 5
4460    GOSUB 2050      ' GET CHGI.1M# AND CHGI.2M#
4470    PRINT "CHARGER # 1  ";
4480    PRINT USING  "###.##"; CHGI.1M#;
4490    PRINT " AMPS";"              CHARGER # 2  ";
4500    PRINT USING  "###.##"; CHGI.2M#;
4510    PRINT " AMPS"
4520    PRINT : PRINT
4530    FOR CCO = 1 TO 1000 : NEXT
4540    NEXT
4550    PRINT "IS CURRENT MEASURED OK? (y,n)"
4560    CCQ$ = INPUT$(1)
4570    IF CCQ$ = "y" THEN RETURN
4580    IF CCQ$ = "n" THEN 4600
4590    GOTO 4550
4600    PRINT "IS CHARGER # 1 CURRENT VALUE OK? (y,n)"
4610    CCQ$ = INPUT$(1)
4620    IF CCQ$ = "y" THEN 4700
4630    IF CCQ$ = "n" THEN 4650
4640    GOTO 4600
4650    PRINT  "COMMANDED CURRENT ON CHARGER # 1 IS " ; CHG.I1# : PRINT
```

```
4660    PRINT "INPUT DESIRED VALUE FOR CHARGER # 1"
4670    INPUT CHG.I1#
4680    CHG.I = CHG.I1# * 255
4690    GOSUB 4370 : GOTO 4450
4700    PRINT  "COMMANDED CURRENT ON CHARGER # 2 IS " ; CHG.I2# : PRINT
4710    PRINT "INPUT DESIRED VALUE FOR CHARGER # 2"
4720    INPUT CHG.I2#
4730    CHG.I = CHG.I2# * 255
4740    GOSUB 4390 : GOTO 4450
4750   '   ********    PRINT RELAY LATCH CONDITIONS    ***********
4760    PRINT
4770    PRINT "     RELAY LATCH CONDITTIONS ( 0 = OPEN   1 = CLOSED )" : PRINT
4780    PRINT "      1       2       3       4       5       6       7       8
     9       10"
4790    PRINT : PRINT
4800    PRINT "     ";CEVS(1);"     ";CEVS(2);"     ";CEVS(3);"     ";CEVS(4);"
   ";CEVS(5);"     ";CEVS(6);"     ";CEVS(7);"     ";CEVS(8);"     ";CEVS(9);"
   ";CEVS(10)
4810    PRINT "     ";CEVS(11);"     ";CEVS(12);"     ";CEVS(13);"     ";CEVS(14)
;"     ";CEVS(15);"     ";CEVS(16);"     ";CEVS(17);"     ";CEVS(18);"     ";CEV
S(19);"     ";CEVS(20)
4820    PRINT "     ";CEVS(21);"     ";CEVS(22);"     ";CEVS(23);"     ";CEVS(24)
;"     ";CEVS(25);"     ";CEVS(26);"     ";CEVS(27);"     ";CEVS(28);"     ";CEV
S(29);"     ";CEVS(30)
4830    PRINT "     ";CEVS(31);"     ";CEVS(32);"     ";CEVS(33);"     ";CEVS(34)
;"     ";CEVS(35);"     ";CEVS(36);"     ";CEVS(37);"     ";CEVS(38);"     ";CEV
S(39);"     ";CEVS(40)
4840    PRINT "     ";CEVS(41);"     ";CEVS(42);"     ";CEVS(43);"     ";CEVS(44)
;"     ";CEVS(45);"     ";CEVS(46);"     ";CEVS(47);"     ";CEVS(48);"     ";CEV
S(49);"     ";CEVS(50)
4850    PRINT "     ";CEVS(51);"     ";CEVS(52);"     ";CEVS(53);"     ";CEVS(54)
;"     ";CEVS(55);"     ";CEVS(56);"     ";CEVS(57);"     ";CEVS(58);"     ";CEV
S(59);"     ";CEVS(60)
4860    PRINT "     ";CEVS(61);"     ";CEVS(62);"     ";CEVS(63);"     ";CEVS(64)
;"     ";CEVS(65);"     ";CEVS(66);"     ";CEVS(67);"     ";CEVS(68);"     ";CEV
S(69);"     ";CEVS(70)
4870    PRINT "     ";CEVS(71);"     ";CEVS(72);"     ";CEVS(73);"     ";CEVS(74)
;"     ";CEVS(75);"     ";CEVS(76);"     ";CEVS(77);"     ";CEVS(78);"     ";CEV
S(79);"     ";CEVS(80)
4880    RETURN
4890     '    ********   SECURE AUDIO ALARM      ************
4900     DPORT = 1 :  DWORD = 0
4910     GOSUB 2210                    'GOSUB  DIGITAL I/O PREPARATION
4920     GOSUB 2280                    'GOSUB  DIGITAL I/O OUTPUT
4930     RETURN
4940    '
4950     '   *********     COMPUTE CELL AVERAGE     *********
4960     CELLAVG# = 0
4970     TOTCELL.VAL# = 0
4980     FOR CA = 1 TO 80
4990    IF CA = 19 THEN 5090
5000    IF CA = 20 THEN 5090
5010    IF CA = 39 THEN 5090
5020    IF CA = 40 THEN 5090
5030    IF CA = 59 THEN 5090
5040    IF CA = 60 THEN 5090
5050    IF CA = 79 THEN 5090
5060    IF CA = 80 THEN 5090
5070     CELLAVG# = CELLAVG# + CV#(CA)
5080     TOTCELL.VAL# = TOTCELL.VAL# + CV#(CA)
5090     NEXT
5100     CELLAVG# = CELLAVG# / 72
5110     RETURN
5120    '
5130    ' *********   CELL.VALUE# GREATER THAN 2.3 VOLTS RESET CEV# TO 0   ******
5140    CEV# = 0 : CELL.VALUE# = CELL.VALUE#/2
5150    RETURN
5160    '
5170    '     **********  print test cell and return to stop     *************
5180    PRINT "cell number "; LOOP;" is ";
5190    PRINT USING "#.###"; CELL.VALUE#;
5200    PRINT "  volts"
5210    RETURN
5220   ' *********      STOP DISCHARGE CELL BELOW 1.185V   *******
5221   CEV$ = "      *****  CELL BELOW 1.20 VOLTS   ******"
5222   CLC$ = "   ALL RELAYS LATCHED OPEN  :  DISCHARGE SECURED   "
5230   GOSUB 2530     ' SOUND THRE BEEPS AND PRINT PROBLEM CELL
5240   GOSUB 3320     ' BEEP
5250   GOSUB 1720     ' RESET ALL OUTPUTS TO OPEN RELAYS AND STOP DISCHG
5260   GOSUB 1900
5270   PRINT " DO YOU WISH TO CONTINUE PROGRAM?  (y,n)"
5280   QUEST$ = INPUT$(1)
5290   IF QUEST$ = "y" THEN GOTO 320
5300   IF QUEST$ = "n" THEN STOP
5310   GOTO 5270
5320   ' **** SET LCNUM TO LOOP   ****  *
5330   LOWCELL# = CV#(LOOP)
5340   LCNUM = LOOP
5350   RETURN
5360  '  *****      SET ALL RELAYS FOR RESISTOR  DISCHARGE   ******
```

```
5370   DPORT = 0
5380   GOSUB 2210                    'GOSUB  DIGITAL I/O PREPARATION
5390   DWORD = 8
5400   GOSUB 2280                    'GOSUB  DIGITAL I/O OUTPUT
5410   DWORD = 0
5420   GOSUB 2280                    'GOSUB  DIGITAL I/O OUTPUT
5430   GOSUB 1860                    'output clock
5440   GOSUB 1860  ' OUTPUT CLOCK
5450   FOR DLOOP = 1 TO 80
5460   GOSUB 1860  ' OUTPUT CLOCK
5470   PRINT "LATCH CELL RELAY NUMBER ";DLOOP; "?"
5480   RLAT$ = INPUT$(1)
5490   IF RLAT$ = "y" THEN 5520
5500   IF RLAT$ = "n" THEN 5530
5510   GOTO 5470
5520   GOSUB 2960 : CEVS(DLOOP) = 1  ' TRIGGER CEV ENABLE ON HARDWARE
5530   GOSUB 1860  ' OUTPUT CLOCK
5540   GOSUB 5620  ' GO SUB TO DELAY
5550   NEXT
5560   GOSUB 5640   ' GO COMPUTE THE TOTAL CELLS LATCHED
5570   PRINT "ARE THE CONNECTORS CHANGED? "
5580 CCNG$ = INPUT$(1)
5590 IF CCNG$ = "y" THEN 5610
5600 GOTO 5570
5610 RETURN
5620 FOR DLY = 1 TO 1000 : NEXT
5630 RETURN
5640   '**** SUM THE TOTAL CELLS (TOT.CELL) FROM CEVS(1-80) ******
5650    TOT.CELL = 0
5660    FOR TOTCELL = 1 TO 80
5670    TOT.CELL = TOT.CELL + CEVS(TOTCELL)
5680    NEXT
5690    RETURN
5700    ' ****   SET HCNUM TO LOOP   ****  *
5710  HIGHCELL# = CV#(LOOP)
5720  HCNUM = LOOP
5730  RETURN
5740 '*****    Go Print last 80  to PRINTER   **********
5750    OPEN "lpt1:" FOR OUTPUT AS #2
5760    PRINT#2,
5770    PRINT#2, "        ****   DISCHARGE IN PROGRESS AT LOW CURRENT RATE   ***
***
5780    PRINT#2,
5810    PRINT#2,"        ";TIME$;"       DATE  " ;DATE$     'ANNOTATE TIME
5820    PRINT#2,
5830    FOR P = 1 TO 80           'LOOP 80 TIMES TO GET MOST RECENT CELL VALUES
5840    IF CEVS(P) = 1 THEN 5870   'CHECKS TO SEE IF THAT CELL HAS BEEN LATCHED
5850    LC$ = B$        ' B$ = NOT LATCHED
5860    GOTO  5880
5870    LC$ = A$       '  A$ = LATCHED  D$ = V    RELAY IS
5880    IF PRNTFLG = 0 THEN 5940
5881    PRINT#2,"    ";
5890    PRINT#2, USING " ##";P;
5900    PRINT#2, USING "  #.###";CV#(P);
5910    PRINT#2, USING "\            \";D$ ;
5911    PRINT#2, USING "\          \"; LC$
5920    PRNTFLG = 0
5930    GOTO 5980
5940    PRINT#2, USING" ##";P;
5950    PRINT#2, USING"  #.###";CV#(P);    'CONDITON
5960    PRINT#2, USING "\            \";D$ ;
5961    PRINT#2, USING "\          \"; LC$;
5970    PRNTFLG = 1
5980    NEXT
5990    PRINT#2,
6000    PRINT#2, "CELL AVERAGE =  ";
6010    PRINT#2, USING "#.###";CELLAVG#;
6020    PRINT#2, "          TOTAL BATTERY VOLTAGE =  ";
6030    PRINT#2, USING "###.#";TOTCELL.VAL#
6040    PRINT#2,
6050    PRINT#2, "HIGH CELL NO. IS   "; HCNUM; "    ";
6060    PRINT#2, USING "#.###"; HIGHCELL#
6070    PRINT#2, "LOW  CELL NO. IS   "; LCNUM; "    ";
6080    PRINT#2, USING "#.###"; LOWCELL#
6090    PRINT#2,
6100    PRINT#2, " TOTAL CELLS ABOVE LOW VOLTAGE CUTOFF AND STILL LATCHED IS  ";
6110    PRINT#2, USING "##"; TOT.CELL
6120    CLOSE#2 : RETURN
```

```
10    '***********   DISCHGH.BAS    as of 01/03/92    TIME  1230  **********
20    '
30    DEFINT A-Z            ' ASSIGN ALL LETTERS AS INTEGERS
40    LC1# = 3 : LC2# = 3  ' SET LOWEST CELLS FOR  #1 &  #2  CHARGERS ABOVE 0
50    WIDTH "lpt1:",78
60    BASE.ADDRESS     = &H2EC            'DT 2801 memory assignments
70    COMMAND.REGISTER = BASE.ADDRESS + 1
80    STATUS.REGISTER  = BASE.ADDRESS + 1
90    DATA.REGISTER    = BASE.ADDRESS
100    COMMAND.WAIT     = &H4
110    WRITE.WAIT       = &H2
120    READ.WAIT        = &H5
130   CCLEAR           = &H1
140   CADIN            = &HC  '&H8c = ext trigger, &Hc = continuous
150   CSTOP              &HF
160   CDAOUT           = &H8
170   STCHG            = 0
180    DIM CV#(80)            'DIMENSION CELL VALUE (CV#)
190    DIM CEVS(80)            'DIMENSION CELL VALUE (CV#)
200    DIM CL#(80)            'DIMENSION CELL LATCH (CL#)
210    DIM COV(80)            'DIMENSION CELL OVER VOLTAGE (COV)
220    DIM Z(80)              'DIMENSION OVER VOLTAGE LOOP TWICE CHECK
230    A$ = "LATCHED"
240    B$ = "NOT LATCHED"
250    C$ = "CELL NUMBER  "
260    D$ = "V  RELAY IS "
270    OUT COMMAND.REGISTER, CSTOP
280    TEMP = INP(DATA.REGISTER)
290    GOSUB 1920
300    WAIT STATUS.REGISTER, COMMAND.WAIT
310    OUT COMMAND.REGISTER, CCLEAR
320    '   ********** PROMPT TO RESET OUTPUTS AT START UP   *******
330    PRINT "RESET ALL OUTPUTS? (y,n)"
340    RST1$ = INPUT$(1)
350    IF RST1$ = "y" THEN 380
360    IF RST1$ = "n" THEN 460
370    GOTO 330
380    GOSUB  2130                  'set all analog and digital outputs to zero
390  '  ***  PROMPT TO INPUT AMP-HOURS OUT DURING DISCHARGE  ***
400   PRINT "STORE AMP-HOURS OUT OF BATTERY DURING DISCHARGE? (y,n)"
410   AHOUT$ = INPUT$(1)
420   IF AHOUT$ = "y" THEN GOSUB 6970 : GOTO 450
430   IF AHOUT$ = "n" THEN 450
440   GOTO 390
450   '  *********  INPUT RELAY ENABLE COUNT FROM PREVIOUS RUN  ************
460    PRINT "INPUT RELAY CELL NUMBER? (y,n)"
470    RSTO$ = INPUT$(1)
480    IF RSTO$ = "y" THEN GOSUB 6880 : GOTO 550
490    IF RSTO$ = "n" THEN 550
500    GOTO 460
510 '  PRINT "RELAY CELL NUMBER ?"
520 '  INPUT CN
530 '  CEVS(CN) = 1
540 '  GOTO 420
550    '***************  PROMPT FOR DESIRED CHARGE CURRENT  ************
560    PRINT "IS CHARGE CURRENT THE SAME FOR BOTH CHARGERS?"
570    RSCHG$ = INPUT$(1)
580   GOSUB 7100
590    IF RSCHG$ = "y" THEN 740
600    IF RSCHG$ = "n" THEN GOSUB 7100 : GOTO 620
610    GOTO 560
620    PRINT "IS EITHER CHARGER AT THE  2 AMP RATE? (y,n)"
630    CHGRT$ = INPUT$(1)
640    IF CHGRT$ = "y" THEN 670
650    IF CHGRT$ = "n" THEN 720
660    GOTO 620
670    PRINT "    WHICH CHARGER IS AT THE  2 AMP RATE?   ( 1 OR 2 )"
680    INPUT CHGNO
690    IF CHGNO = 1 THEN CEVL = 1 : STCHG1 = 1 : GOSUB 5580 : GOTO 850
700    IF CHGNO = 2 THEN CEVH = 1 : STCHG2 = 1 : GOSUB 5580 : GOTO 850
710    GOTO 670
720    GOSUB 5580
730    GOTO 850
740    PRINT "  WHAT IS CHARGE CURRENT IN AMPS? ( TYPE 0, 2 OR 7 )" : PRINT
750    INPUT CHG.I
760    IF CHG.I = 0 THEN 800
770    IF CHG.I = 2 THEN  820
780    IF CHG.I = 7 THEN CHG.I = 100 : GOTO 840
790    GOTO 660
800    CHG.I = 0  : F$ = " 0 AMP RATE " : CHG.I1#=0 : CHG.I2#=J
810    GOTO  850
820    CHG.I1#=2: CHG.I2#=2:F$=" 2 AMP RATE": STCHG=2: CHG.I = 510 : STCHG1 = 1
: STCHG2 = 1 : GOSUB 5550  ' SRT CHGS  & AH CLOCK
830    GOTO 850
840    CHG.I1#= 7 : CHG.I2#= 7 : F$ = " 7 AMP RATE":GOSUB 5550
850    ON KEY(1) GOSUB 2340        'F1 key to PRN 80 cv# & cl# to Printer
860    ON KEY(2) GOSUB 4770        'F2 key display last 80 cells to 8 rows
870    ON KEY(3) GOSUB 5280        'F3 key to toggle displayed data on/off
880    ON KEY(4) GOSUB 5950        'F4 key to display last 80 latch conditions
890    ON KEY(6) GOSUB 5580        'F6 key allows for current changes
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900    ON KEY(7) GOSUB 3990          'F7 key sends data to hard disc temp1
910    ON KEY(10) GOSUB 6090         'F10 key STOPS CONTINUOUS ALARM
920    '********  OUTPUT PULSE TO RESET COUNTERS AND MONITOR  CIRCUIT  *******
930    GOSUB 6270     '  GO OUTPUT RESET
940    '
950    '************   Loop 80 times waiting each time for the sample Pusle   ***
960    TI = TI + 1
970    FOR LOOP = 1 TO  80                    'start 80 samples
980    GOSUB  2270                            'clock to incr monitor circuits
990    Y1 = 0 : Y2 = 0
1000    SETGAIN = 2: SETCHAN = 7       'RANGE IS +/- 2.5   **** CELL.VALUE# **
1010    CVAVG# = 0
1020    FOR CVA = 1 TO 3         'AVERAGE CV# 5 TIMES
1030    GOSUB 2860               ' A/D CONVERSION FOR CV# VALUE
1040    CELL.VALUE# = (HIGH1# * 256 + LOW1#) * .0012207 - 2.5
1050    CELL.VALUE# = ABS (CELL.VALUE#)
1060    CVAVG# = CVAVG# + CELL.VALUE#
1070    NEXT
1080    CELL.VALUE# = CVAVG# / 3  'CALCULATE CELL.VALUE BASED ON 5 SAMPLES
1090   'IF LOOP = 85 THEN GOSUB 6200 : STOP
1100    GOSUB  2270          'output clock to trigger A/D on hardware
1110    IF LOOP = 19 THEN 1690
1120    IF LOOP = 20 THEN 1690
1130    IF LOOP = 39 THEN 1690
1140    IF LOOP = 40 THEN 1690
1150    IF LOOP = 59 THEN 1690
1160    IF LOOP = 60 THEN 1690
1170    IF LOOP = 79 THEN 1690
1180    IF LOOP = 80 THEN 1690
1190    IF CELL.VALUE# < 1.2 THEN F$ = "  CELL BELOW 1.20 VOLTS" : GOSUB  6660
1200   ' SETGAIN = 1: SETCHAN = 4       'RANGE IS +/- 5.0   **** READ CEV# ****
1210   ' GOSUB 2470                              ' A/D CONVERSION
1220    KEY(1) ON                       'enable F1 key
1230    KEY(2) ON                       'enable F2 key
1240    KEY(3) ON                       'enable F3 key
1250    KEY(4) ON                       'enable F4 key
1260    KEY(6) ON                       'enable F6 key
1270    'KEY(7) ON                       'enable F7 key
1280    KEY(10) ON                       'enable F10 key
1290   ' CEV# = (HIGH1#* 256 + LOW1#) *  .0024414 - 5 'calculate CEV# value
1300    KEY(6)STOP  'DISABLE F6  UNTIL NEXT KEY ON STATEMENT
1310    CEV# = 0
1320   '  CEV# = ABS(CEV#)                  'change bipolar to positive value
1330    IF CELL.VALUE# > 2.05 THEN CEV# = 5
1340    IF CEVS(LOOP) = 1 AND CELL.VALUE# > 2 THEN F$ = "CELL LATCHED TO RESISTO
R AND THE VOLTAGE WAS OVER 2.0 VOLTS   " : GOSUB 6760
1350    IF CEVS(LOOP) = 1 THEN  GOTO 1390 '
1360    IF CEV# > 3 THEN 1400         ' YES, GO CHECK IF 7 AMP
1370    LC$ = B$
1380    GOTO 1590
1390    LC$ = A$ : GOTO 1580
1400    IF STCHG < 2 THEN 1420       ' YES, GO CHECK 2 AMP RATE ON BOTH CHAARGERS
1410    GOTO 1570
1420    IF LOOP > 40 THEN 1500
1430    IF CEVH = 1 THEN GOSUB 3950 : GOTO 820 'SET CHARGERS TO 2 AMPS PRINT MSG
1440    IF CEVL = 1 THEN 1570
1450    CHG.I1# = 2:CHG.I = 510 : GOSUB 5510 'GO OUTPUT NEW CURRENT on chg #1
1460    CEVL = 1 : STCHG1 = 1
1470   F$ = "CHARGER  #1 IS AT 2 AMP RATE  :  CHARGER #2 IS AT 7 AMP RATE"
1480   GOSUB 3680          'PRINT CHARGE RATE CHANGE TO A:CEVCHGRT
1490   GOTO 1590           'RESUME CELL VALUE CHECKS
1500   IF CEVL = 1 THEN GOSUB 3950 : GOTO 820 'SET CHARGERS TO 2 AMPS PRINT MSG
1510   IF CEVH = 1 THEN 1570
1520   CHG.I2# = 2:CHG.I = 510 : GOSUB 5530  'GO OUTPUT NEW CURRENT on chg #2
1530   CEVH = 1 : STCHG2 = 1
1540   F$ = "CHARGER #1 IS AT 7 AMP RATE  :    CHARGER #2 IS AT 2 AMP RATE"
1550   GOSUB 3680          'PRINT CHARGE RATE CHANGE TO A:CEVCHGRT
1560   GOTO 1590
1570    CEVS(LOOP) = 1              ' CELL WAS NOT LATCHED, DO IT
1580    GOSUB 3880                  ' GO TRIGGER RELAY ENABLE
1590    CV#(LOOP) = CELL.VALUE#
1600   IF LOOP > 40 THEN 1640
1610   IF CV#(LOOP) > HC1# THEN GOSUB 6510  ' SET HIGH CELL 1st 40 TO CV(LOOP)
1620   IF CV#(LOOP) < LC1# THEN GOSUB 6800  ' SET LOW CELL 1st 40 TO CV(LOOP)
1630   GOTO 1660
1640   IF CV#(LOOP) > HC2# THEN GOSUB 6550  ' SET HIGH CELL 2nd 40 TO CV(LOOP)
1650   IF CV#(LOOP) < LC2# THEN GOSUB 6840  ' SET LOW CELL 2nd 40 TO CV(LOOP)
1660  'IF OVF > 0 THEN 1670 ' If overvoltage flag set don't stop program
1670  'IF CELL.VALUE# > 2.075 THEN GOSUB 1940
1680   IF TOGG = 0 THEN GOSUB 5340  '  GO PRINT CELL INFO TO SCREEN
1690   IF ICK > 7 THEN GOSUB 2980 : ICK = 0 : GOTO 1710  'CHECK  ACTUAL MEASURED
 CURRENT
1700    ICK = ICK + 1 : GOTO 1800
1710    IF Y1 = 1 THEN GOSUB 4520   'IF CHARGE CURRENT TOO HIGH SECURE # 1
1720    IF Y2 = 1 THEN GOSUB 4650   'IF CHARGE CURRENT TOO HIGH SECURE # 2
1730   'IF TI = 1 THEN 1770
1740    IF STCHG1 > 0 THEN 1760 'CHG #1 AT 2 AMP?
1750    GOTO 1770
1760    IF CHGI.1M# < .2  THEN F$="**** CHARGE CURRENT < .2 AMP WITH RELAY ENABLE
SET ON CHARGER NO. 1****":STCHG1=0:GOSUB 4520
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1770   IF STCHG2 > 0 THEN 1790
1780   GOTO 1800
1790   IF CHG1.2M# < .2  THEN F$="**** CHARGE CURRENT < .2 AMP WITH RELAY ENABLE
SET ON CHARGER NO. 2***":STCHG2=0:GOSUB 4650
1800   NEXT                    'loop back and wait for next clock for next cell
1810  GOSUB 6360  ' CHG1LAT AND CHG2LAT
1820   GOSUB 6150      ' GO COMPUTE CELL AVERAGE
1830   GOSUB 7150      ' GO SUM TOTAL AMP HOURS
1840   IF TOGG = 1 THEN GOSUB 4770 '  DISPLAY 80 CELLS TO SCREEN
1850   GOSUB 4440 : FOR DLY = 1 TO 5000 : NEXT : GOSUB 4440 'TWO BEEPS
1860   IF TI > 9 THEN GOSUB 3990 : TI = 0
1870   KEY(7) ON                       'enable F7 key
1880   HC1# = 0 : HC2# = 0
1890   LC1# = 3 : LC2# = 3
1900   KEY(7)STOP  'DISABLE F7 UNTIL NEXT KEY(7) ON STATEMENT
1910   GOTO 920        'go reset monitor ckts and start next 80
1920   WAIT STATUS.REGISTER, WRITE.WAIT,WRITE.WAIT
1930   RETURN
1940  '   ************   Cell voltage too high   *************
1950   IF LOOP > 40 THEN F$ = "CELL OVER VOLTAGE OCCURED " : GOSUB 4650 : RETURN
   'OPEN LAST 40 RELAYS AND SECURE CHARGER # 2 AND LOOP BACK
1960   F$ = "CELL OVER VOLTAGE OCCURED " : GOSUB 4520   'OPEN FIRST 40 RELAYS  A
ND SECURE CHARGER # 1
1970   RETURN        'LOOP BACK TO CONTINUE TO CHECK CELLS ON OTHER CHARGER
1980   '  ******   STOP CHARGE, RESET OUTPUTS      ********
1990   GOSUB 2130          'set all analog and digital outputs to zero
2000   PRINT:PRINT:PRINT:PRINT:PRINT:PRINT
2010   PRINT "  ************     BATTERY CHARGE SECURED    ********  "
2020   PRINT:PRINT:PRINT:PRINT:PRINT:PRINT
2030   GOSUB 2340          'GO PRINT LAST 80 TO "A:LAST80"
2040   PRINT "   ****  RELAYS HAVE BEEN LATCHED OPEN  *******
2050   GOSUB 3400          'GO SOUND THE AUDIO ALARM
2060   PRINT : PRINT F$ : PRINT
2070   END
2080   '  *****  SET HIGH AND LOW BYTES TO CHG.I VALUE COMMANDED "   ********
2090   HIGHBYTE = INT(CHG.I / 256)
2100   LOWBYTE = CHG.I - HIGHBYTE * 256
2110   GOSUB 3290                      'GOSUB D/A OUTPUT SELECTED CHANNEL (CHAN)
2120   RETURN
2130   '  *****   RESET ALL OUTPUT DIGITAL BITS AND ANALOG TO ZERO ********
2140   HIGHBYTE = 0 : LOWBYTE = 0
2150   FOR CHAN = 0 TO 1
2160   GOSUB 3290                     'GOSUB D/A OUTPUT CHANNELs 0 & 1
2170   NEXT
2180   DPORT = 0 : DWORD = 20         'BIT TO RESET ALL RELAYS
2190   GOSUB 3140                     'GOSUB  DIGITAL I/O PREPARATION
2200   GOSUB 3210                     'GOSUB  DIGITAL I/O OUTPUT
2210   DWORD = 0
2220   GOSUB 3210                     'GOSUB  DIGITAL I/O OUTPUT
2230   DPORT = 1 : DWORD = 0
2240   GOSUB 3140                     'GOSUB  DIGITAL I/O PREPARATION
2250   GOSUB 3210                     'GOSUB  DIGITAL I/O OUTPUT
2260   RETURN
2270   '*********    Output clock pulse on Port zero Bit zero   **************
2280   DPORT = 0 : DWORD = 1
2290   GOSUB 3140                     'GOSUB  DIGITAL I/O PREPARATION
2300   GOSUB 3210                     'GOSUB  DIGITAL I/O OUTPUT
2310   DWORD = 0
2320   GOSUB 3210                     'GOSUB  DIGITAL I/O OUTPUT
2330   RETURN
2340 '*****    Go Print last 80  to A:LAST80  **********
2350    'OPEN "O",#2,"A:LAST80"    'OPEN FILE TO STORE LAST 80 CELL VALUES
2360    OPEN "lpt1:" FOR OUTPUT AS #2
2370    PRINT#2, "   *************    A: LAST80   ****************
2380    PRINT#2,TIME$;"   DATE   " ;DATE$     'ANNOTATE TIME
2390    PRINT#2,
2400    FOR P = 1 TO 80           'LOOP 80 TIMES TO GET MOST RECENT CELL VALUES
2410    IF CEVS(P) = 1 THEN 2440   'CHECKS TO SEE IF THAT CELL HAS BEEN LATCHED
2420    LC$ = B$
2430    GOTO  2450
2440    LC$ = A$
2450    IF PRNTFLG = 0 THEN 2510
2460    PRINT#2, "    "; P;" ";          'PRINT CELL VALUE AND RELAY LATCH
2470    PRINT#2, USING " #.###";CV#(P);    'CONDITON
2480    PRINT#2, D$ ; LC$
2490    PRNTFLG = 0
2500    GOTO 2550
2510    PRINT#2, "  "; P;" ";        'PRINT CELL VALUE AND RELAY LATCH
2520    PRINT#2, USING"  #.###";CV#(P);    'CONDITON
2530    PRINT#2, D$ ; LC$;
2540    PRNTFLG = 1
2550    NEXT
2560    PRINT#2,
2570    PRINT#2, "CELL AVERAGE =  ";
2580    PRINT#2, USING "#.###";CELLAVG#;
2590    PRINT#2, "      TOTAL BATTERY VOLTAGE =  ";
2600    PRINT#2, USING "###.#";TOTCELL.VAL#
2610    PRINT#2,
2620    PRINT#2, " **  TOTAL  AH CHG #1 = ";
2630    PRINT#2, USING "###.#";TOTAL1.AH#;
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2640    PRINT#2, " **  TOTAL  AH CHG #2 = ";
2650    PRINT#2, USING "###.#";TOTAL2.AH#
2660    PRINT#2,
2670    PRINT#2, "HIGH CELLS ARE CELL NO.  "; HC1N; "    ";
2680    PRINT#2, USING "#.###"; HC1#;
2690    PRINT#2, "     AND CELL NO.   " ;HC2N; "    ";
2700    PRINT#2, USING "#.###"; HC2#
2710    PRINT#2, "LOW  CELLS ARE CELL NO.  "; LC1N; "    ";
2720    PRINT#2, USING "#.###"; LC1#;
2730    PRINT#2, "     AND CELL NO.   " ;LC2N; "    ";
2740    PRINT#2, USING "#.###"; LC2#
2750    PRINT#2,
2760    PRINT#2, "          ACTUAL CURRENT    ";
2770    PRINT#2, "                                  COMMANDED CURRENT"
2780    PRINT#2, "  CHARGER #1 (CELLS 1 THRU 40) IS  ";
2790    PRINT#2, USING  "#.###"; CHGI.1M#;
2800    PRINT#2, "  AMPS                    ";CHG.I1#;" AMPS"
2810    PRINT#2, "  CHARGER #2 (CELLS 41 THRU 80) IS  ";
2820    PRINT#2, USING  "#.###"; CHGI.2M#;
2830    PRINT#2, "  AMPS                    ";CHG.I2#;" AMPS"
2840    PRINT#2,
2850    CLOSE#2 : RETURN
2860    '*******  A/D CONVERSION      ***************
2870    GOSUB 1920
2880    OUT  COMMAND.REGISTER,  &HC  'start A/D conversion to measure SET CHAN
2890    GOSUB 1920
2900    OUT DATA.REGISTER, SETGAIN          'set gain
2910    GOSUB 1920
2920    OUT  DATA.REGISTER, SETCHAN     'A/D conversion on SET CHAN
2930    WAIT STATUS.REGISTER,  READ.WAIT
2940    LOW1# = INP(DATA.REGISTER)          'get data low byte
2950    WAIT STATUS.REGISTER,  READ.WAIT
2960    HIGH1# = INP(DATA.REGISTER)         'get data high byte
2970    RETURN
2980    '   ********   CHECK ACTUAL CHARGE CURRENT   **********
2990    SETGAIN = 3 : SETCHAN = 3      ' GAIN RANGE  +/- 1.25
3000    GOSUB 2860                              ' A/D CONVERSION
3010    CHGI.1M# = ((HIGH1#* 256 + LOW1#) *  .00061 - 1.25) * 12.5  '
3020    IF (CHGI.1M# - CHG.I1#) > 8.75 THEN GOTO 3040   'IS DIFF > .5 AMPS
3030    GOTO 3060
3040    Y1 = 1
3050    F$ = " MEASURED CHARGE CURRENT ON CHARGER # 1 > COMMANDED CURRENT"
3060    SETGAIN = 3 : SETCHAN = 2      ' GAIN RANGE  +/- 1.25
3070    GOSUB 2860                              ' A/D CONVERSION
3080    CHGI.2M# = ((HIGH1#* 256 + LOW1#) *  .00061 - 1.25) * 12.5  '
3090    IF (CHGI.2M# - CHG.I2#) > 8.75 THEN GOTO 3110   'IS DIFF > .5 AMPS
3100    GOTO 3130
3110    Y2 = 1
3120    F$ = " MEASURED CHARGE CURRENT ON CHARGER # 2 > COMMANDED CURRENT"
3130    RETURN
3140    '  *****  DIGITAL I/O PREPARE   *********
3150    GOSUB 1920
3160    WAIT STATUS.REGISTER,  COMMAND.WAIT
3170    OUT COMMAND.REGISTER, 5              'PREPARE I/O PORT FOR OUTPUT
3180    GOSUB 1920
3190    OUT DATA.REGISTER, DPORT             'SET PORT ZERO FOR OUTPUT
3200    RETURN
3210    '  *******  DIGITAL I/O OUTPUT   **********
3220    WAIT STATUS.REGISTER, COMMAND.WAIT
3230    OUT COMMAND.REGISTER, 7              'COMMAND IMMEDIATE DIGITAL OUTPUT
3240    GOSUB 1920
3250    OUT DATA.REGISTER, DPORT             'SELECTED OUTPUT PORT
3260    GOSUB 1920
3270    OUT DATA.REGISTER, DWORD             'BITS TO SET HGH
3280    RETURN
3290    '  ******  D/A OUTPUT ON SELECTED CHANNEL (CHAN)   *********
3300    GOSUB 1920
3310    WAIT STATUS.REGISTER, COMMAND.WAIT
3320    OUT COMMAND.REGISTER, CDAOUT             'IMMEDIATE D/A OUT
3330    GOSUB 1920
3340    OUT DATA.REGISTER, CHAN                  'D/A CHANNEL SELECTED
3350    GOSUB 1920
3360    OUT DATA.REGISTER, LOWBYTE
3370    GOSUB 1920
3380    OUT DATA.REGISTER, HIGHBYTE
3390    RETURN
3400    '     ********   SOUND CONTINUOUS AUDIO ALARM      ************
3410    DPORT = 1 :  DWORD = 2
3420    GOSUB 3140                   'GOSUB  DIGITAL I/O PREPARATION
3430    GOSUB 3210                   'GOSUB  DIGITAL I/O OUTPUT
3440    RETURN
3450    '   *******    SOUND THREE ALARMS AND APPEND CELL NUMBER TO
3460    '           FILE  *  CV#DIFF  *      ***************
3470    GOSUB 4440 : GOSUB 4440 : GOSUB 4440
3480    ' OPEN "A",#4,"A:CV#DIFF"   'OPEN FILE TO STORE LAST 80 CELL VALUES
3490    OPEN "LPT1:" FOR OUTPUT AS #4  'PRINT FOLLOWING ON THE PRINTER
3500    PRINT#4, : PRINT#4, : PRINT#4,
3510    PRINT#4, "    "; TIME$ ;"    DATE  "; DATE$
3520    PRINT#4, CEV$ : PRINT#4,
3530    PRINT#4, "CELL ";LOOP; "VALUE IS ";
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3540    PRINT#4, USING"  ###.###";CELL.VALUE#;
3550    PRINT#4, "  VOLTS"
3560    PRINT#4, CLC$
3570    PRINT#4,
3580    PRINT#4, "*****  ACTUAL CURRENT IS  *****  "
3590    PRINT#4, "CHARGER # 1  ";
3600    PRINT#4, USING  "###.##"; CHGI.1M#;
3610    PRINT#4, "AMPS";"                  CHARGER # 2  ";
3620    PRINT#4, USING  "###.##"; CHGI.2M#;
3630    PRINT#4, " AMPS"
3640    PRINT#4, "COMMANDED CURRENT CHARGER # 1 IS  ";CHG.I1#; "AMPS    CHARGER
# 2 IS  " ;CHG.I2#;"AMPS"
3650    PRINT#4, : PRINT#4,
3660    CLOSE#4
3670    RETURN
3680   '  ******  STORE TIME OF CHARGE RATE CHANGE - SOUND TWO ALARMS   ****
3690  ' OPEN "A", #3, "A:CEVCHGRT"
3700    OPEN "LPT1:" FOR OUTPUT AS #3  'PRINT FOLLOWING ON THE PRINTER
3710    PRINT#3, : PRINT#3, : PRINT#3,
3720    PRINT#3, TIME$; "  ****  CHARGE CURRENT RATE CHANGE OCCURRED   *****"
3730    PRINT#3, "CELL NUMBER  "; LOOP ; "WAS  ";
3740    PRINT#3, USING " ##.###"; CELL.VALUE#;
3750    PRINT#3, "  V"
3760    PRINT#3, CEV$ : PRINT#3,
3770    PRINT#3, CLC$ : PRINT#3,
3780    PRINT#3, "******  ACTUAL CURRENT   *****  "
3790    PRINT#3, "CHARGER # 1  ";
3800    PRINT#3, USING  "###.##"; CHGI.1M#;
3810    PRINT#3, " AMPS";"                  CHARGER # 2  ";
3820    PRINT#3, USING  "###.##"; CHGI.2M#;
3830    PRINT#3, " AMPS"
3840    PRINT#3, "COMMANDED CURRENT CHARGER # 1 IS  ";CHG.I1#; " AMPS    CHARGER
 # 2 IS  " ;CHG.I2#;" AMPS"
3850    PRINT#3, : PRINT#3,
3860    PRINT#3, F$ : CLOSE#3 : GOSUB 4440 : GOSUB 4440  'SOUND TWO TONES
3870    RETURN
3880   '***********  TRIGGER CEV ENABLE ON PORT ONE BIT ZERO   *****
3890   DPORT = 1 : DWORD = 1
3900   GOSUB 3140                    'GOSUB  DIGITAL I/O PREPARATION
3910   GOSUB 3210                    'GOSUB  DIGITAL I/O OUTPUT
3920   DWORD = 0
3930   GOSUB 3210                    'GOSUB  DIGITAL I/O OUTPUT
3940   RETURN
3950   '*************   RECORD TO A:CEVCHGRT BOTH CHARGERS SET TO 2 AMP *******
3960   F$ = "  ***  BOTH CHARGERS SET TO 2 AMP RATE   ****"
3970   GOSUB 3680   'GO STORE TIME OF RATE CHANGE TO A:CEVCHGRT
3980   RETURN
3990    '   *******       PRINT TO C:\BAS\TEMP1     ***********
4000    OPEN "a", #1, "temp1"
4010    PRINT#1, : PRINT#1,
4020    PRINT#1, "   *****  ";DATE$; "   *****   ";  TIME$; "   ******"
4030    PRINT#1,
4040    FOR NW = 1 TO 80
4050    IF CEVS(NW) = 1 THEN 4080   'CHECKS TO SEE IF THAT CELL HAS BEEN LATCHED
4060    LC$ = B$
4070    GOTO  4090
4080    LC$ = A$
4090    IF PRNFLG = 0 THEN 4150
4100    PRINT#1, "     ";NW;                  'PRINT CELL VALUE AND RELAY LATCH
4110    PRINT#1, USING " #.###";CV#(NW);    'CONDITON
4120    PRINT#1, D$ ; LC$
4130    PRNFLG = 0
4140    GOTO 4190
4150    PRINT#1, NW;                         'PRINT CELL VALUE AND RELAY LATCH
4160    PRINT#1, USING " #.###";CV#(NW);    'CONDITON
4170    PRINT#1, D$ ; LC$;
4180    PRNFLG = 1
4190    NEXT
4200    PRINT#1, "    CHARGER # 1  ";
4210    PRINT#1, USING  "##.##"; CHGI.1M#;
4220    PRINT#1, " AMPS";"          CHARGER # 2  ";
4230    PRINT#1, USING  "##.##"; CHGI.2M#;
4240    PRINT#1, " AMPS"
4250    PRINT#1, "    CHARGE AT  ";F$;
4260    PRINT#1, "       CELL AVERAGE =   ";
4270    PRINT#1, USING " #.###";CELLAVG#
4280    PRINT#1, "HIGH CELLS ARE CELL NO.  "; HC1N; "    ";
4290    PRINT#1, USING "#.###"; HC1#;
4300    PRINT#1, "     AND CELL NO.   " ;HC2N; "    ";
4310    PRINT#1, USING "#.###"; HC2#
4320    PRINT#1, "LOW  CELLS ARE CELL NO.  "; LC1N; "    ";
4330    PRINT#1, USING "#.###"; LC1#;
4340    PRINT#1, "     AND CELL NO.   " ;LC2N; "    ";
4350    PRINT#1, USING "#.###"; LC2#
4360    PRINT#1, " **  TOTAL  AH CHG #1 = ";
4370    PRINT#1, USING "###.#";TOTAL1.AH#;
4380    PRINT#1, " **  TOTAL  AH CHG #2 = ";
4390    PRINT#1, USING "###.#";TOTAL2.AH#
4400    PRINT#1, "   *****   ";DATE$; "   *****   ";  TIME$; "   ******"
4410    CLOSE#1
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4420    GOSUB 4440 : GOSUB 4440 : GOSUB 4440 : GOSUB 4440   '4 BEEPS
4430    RETURN
4440    '   *************    SEND OUT A BEEP   ***************
4450    DPORT = 1 :  DWORD = 2
4460    GOSUB 3140                    'GOSUB  DIGITAL I/O PREPARATION
4470    GOSUB 3210                    'GOSUB  DIGITAL I/O OUTPUT
4480    FOR Q = 1 TO 1000 : NEXT     'DELAY FOR TWO SECONDS
4490    DWORD = 0                     'TURN OFF ALARM
4500    GOSUB 3210                    'GOSUB  DIGITAL I/O OUTPUT
4510    RETURN
4520    '  ***  SECURE FIRST 40 RELAYS STOP CHARGER # 1   ***
4530    CHG.I = 0 : CHAN = 0 : GOSUB 2080  ' STOP CHARGER # 1
4540    DPORT = 0 : DWORD = 4        'RESET RELAYS 1 - 40   J2/48
4550    GOSUB 3140 : GOSUB 3210   'DIG I/O PREPARE : DIG I/O OUTPUT
4560    DWORD = 0 : GOSUB 3210
4570    CEV$ = "  *****   CHARGER # 1 SECURED   ******"
4580    CLC$ = "  *****   RELAYS 1 THRU 40 RESET OPEN   ******"
4590    CHG.I1# = 0 : STCHG1 = 0
4600    GOSUB 3680      'SOUND TWO BEEPS AND PRINT MSGS
4610    GOSUB 3400      'GO SOUND CONTINUOUS ALARM
4620    FOR RSTCEVS = 1 TO 40 : CEVS(RSTCEVS) = 0 : NEXT
4630    RETURN
4640    '
4650    '  ***  SECURE LAST  40 RELAYS STOP CHARGER # 2   ***
4660    CHG.I = 0 : CHAN = 1 : GOSUB 2080  ' STOP CHARGER # 2
4670    DPORT = 0 : DWORD = 16        'RESET RELAYS 41 - 80   J2/47
4680    GOSUB 3140 : GOSUB 3210   'DIG I/O PREPARE : DIG I/O OUTPUT
4690    DWORD = 0 : GOSUB 3210
4700    CEV$ = "  *****   CHARGER # 2 SECURED   ******"
4710    CLC$ = "  *****   RELAYS 41 THRU 80 RESET OPEN   ******"
4720    CHG.I2# = 0 : STCHG2 = 0
4730    GOSUB 3680      'SOUND TWO BEEPS AND PRINT MSGS
4740    GOSUB 3400      'GO SOUND CONTINUOUS ALARM
4750    FOR RSTCEVS = 41 TO 80 : CEVS(RSTCEVS) = 0 : NEXT
4760    RETURN
4770    '   *****   print to screen all cell values
4780    '            and print the current from both chargers   *****
4790    PRINT
4800    PRINT "      1       2       3       4       5       6       7       8       9
   10"
4810    PRINT " 1";
4820    PRINT USING "  ##.##";CV#(1);CV#(2);CV#(3);CV#(4);CV#(5);CV#(6);CV#(7);CV
#(8);CV#(9);CV#(10)
4830    PRINT
4840    PRINT "11";
4850    PRINT USING "  ##.##";CV#(11);CV#(12);CV#(13);CV#(14);CV#(15);CV#(16);CV#
(17);CV#(18);CV#(19);CV#(20)
4860    PRINT
4870    PRINT "21";
4880    PRINT USING "  ##.##";CV#(21);CV#(22);CV#(23);CV#(24);CV#(25);CV#(26);CV#
(27);CV#(28);CV#(29);CV#(30)
4890    PRINT
4900    PRINT "31";
4910    PRINT USING "  ##.##";CV#(31);CV#(32);CV#(33);CV#(34);CV#(35);CV#(36);CV#
(37);CV#(38);CV#(39);CV#(40)
4920    PRINT
4930    PRINT "41";
4940    PRINT USING "  ##.##";CV#(41);CV#(42);CV#(43);CV#(44);CV#(45);CV#(46);CV#
(47);CV#(48);CV#(49);CV#(50)
4950    PRINT
4960    PRINT "51";
4970    PRINT USING "  ##.##";CV#(51);CV#(52);CV#(53);CV#(54);CV#(55);CV#(56);CV#
(57);CV#(58);CV#(59);CV#(60)
4980    PRINT
4990    PRINT "61";
5000    PRINT USING "  ##.##";CV#(61);CV#(62);CV#(63);CV#(64);CV#(65);CV#(66);CV#
(67);CV#(68);CV#(69);CV#(70)
5010    PRINT
5020    PRINT "71";
5030    PRINT USING "  ##.##";CV#(71);CV#(72);CV#(73);CV#(74);CV#(75);CV#(76);CV#
(77);CV#(78);CV#(79);CV#(80)
5040    PRINT
5050     PRINT "CELL AVERAGE = ";
5060     PRINT USING "#.###";CELLAVG#;
5070     PRINT " **  TOTAL  AH CHG #1 = ";
5080     PRINT USING "###.#";TOTAL1.AH#;
5090     PRINT " **  TOTAL  AH CHG #2 = ";
5100     PRINT USING "###.#";TOTAL2.AH#
5110  PRINT "HIGH CELLS ARE CELL NO.  "; HC1N; "    ";
5120  PRINT USING "#.###"; HC1#;
5130  PRINT "     AND CELL NO.   " ;HC2N; "    ";
5140  PRINT USING "#.###"; HC2#
5150  PRINT "LOW  CELLS ARE CELL NO.  "; LC1N; "    ";
5160  PRINT USING "#.###"; LC1#;
5170  PRINT "     AND CELL NO.   " ;LC2N; "    ";
5180  PRINT USING "#.###"; LC2#
5190   PRINT "TOTAL NUMBER OF CELLS LATCHED FOR 1 THRU 40   "; CHG1LAT; "   FOR
CELLS 41 THRU 80   ";CHG2LAT
5200    PRINT "  COMMANDED CURRENT CHARGER # 1 IS  " ; CHG.I1#; " AMPS   CHARGER
 # 2 IS  "; CHG.I2#; " AMPS"
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5210   PRINT "  ACTUAL MEASURED CURRENT CHARGER # 1  ";
5220   PRINT USING  "##.##"; CHGI.1M#;
5230   PRINT " AMPS";"   CHARGER # 2  ";
5240   PRINT USING  "##.##"; CHGI.2M#;
5250   PRINT "  AMPS"
5260   RETURN
5270   '   *********     TOGGLE DISPLAY ON/OFF     *********
5280   IF TOGG = 1 THEN 5300
5290   IF TOGG = 0 THEN 5310
5300   TOGG = 0 : GOTO 5320
5310   TOGG = 1
5320   RETURN
5330   '
5340   '   *****   PRINT CELL VALUE AND CHARGER CURRENT TO DISPLAY     *****
5350   '
5360    PRINT "CELL NUMBER " ; LOOP ; LC$; "            CELL VALUE IS";
5370    PRINT USING "###.###"; CELL.VALUE#
5380   ' PRINT "TOTAL NUMBER OF CELLS LATCHED IS "; TOT.CELL;
5390   ' PRINT "          "; F$
5400    PRINT "CHARGER # 1  ";
5410    PRINT USING  "###.##"; CHGI.1M#;
5420    PRINT " AMPS";"               CHARGER # 2  ";
5430    PRINT USING  "###.##"; CHGI.2M#;
5440    PRINT " AMPS"
5450    PRINT "COMMANDED CURRENT CHARGER # 1 IS  ";CHG.I1#; "AMPS    CHARGER # 2
 IS  " ;CHG.I2#;"AMPS"
5460    PRINT : PRINT
5470    FOR PRDL = 1 TO 2000 : NEXT
5480    RETURN
5490    '
5500    '  ********    ADJUST CHG.I FOR OUTPUT CURRENT CHANGES  **************
5510    '  ***   CHARGER # 1 CURRENT CHANGE ONLY   ******
5520    CHAN = 0 : GOSUB 2080 : RETURN
5530    '  ***   CHARGER # 2 CURRENT CHANGE ONLY   ******
5540    CHAN = 1 : GOSUB 2080 : RETURN
5550    '  ***   CHANGE CURRENT ON BOTH CHARGERS   ******
5560    GOSUB 5510 : GOSUB 5530 : RETURN
5570    '
5580    '  ********   DISPLAY MEASURED CURRENT     ******
5590    FOR CC = 1 TO 5
5600    GOSUB 2980      ' GET CHGI.1M# AND CHGI.2M#
5610    PRINT "CHARGER # 1  ";
5620    PRINT USING  "###.##"; CHGI.1M#;
5630    PRINT " AMPS";"               CHARGER # 2  ";
5640    PRINT USING  "###.##"; CHGI.2M#;
5650    PRINT " AMPS"
5660    PRINT : PRINT
5670    FOR CCO = 1 TO 1000 : NEXT
5680    NEXT
5690    PRINT "IS CURRENT MEASURED OK? (y,n)"
5700    CCQ$ = INPUT$(1)
5710    IF CCQ$ = "y" THEN RETURN
5720    IF CCQ$ = "n" THEN 5740
5730    GOTO 5690
5740    PRINT "IS CHARGER # 1 CURRENT VALUE OK? (y,n)"
5750    CCQ$ = INPUT$(1)
5760    IF CCQ$ = "y" THEN 5870
5770    IF CCQ$ = "n" THEN 5790
5780    GOTO 5740
5790    PRINT  "COMMANDED CURRENT ON CHARGER # 1 IS " ; CHG.I1# : PRINT
5800    PRINT "INPUT DESIRED VALUE FOR CHARGER # 1"
5810    INPUT CHG.I1#
5820    IF STCHG OR STCHG1 > 0 THEN 5840 '2 AMP RATE RELAY ENABLE SET
5830    GOTO 5850
5840    IF CHG.I1# > 2.5 THEN GOSUB 6590 : GOTO 5790
5850    CHG.I = CHG.I1# * 255
5860    GOSUB 5510 : GOTO 5590
5870    PRINT  "COMMANDED CURRENT ON CHARGER # 2 IS " ; CHG.I2# : PRINT
5880    PRINT "INPUT DESIRED VALUE FOR CHARGER # 2"
5890    INPUT CHG.I2#
5900    IF STCHG OR STCHG2 > 0 THEN 5920 '2 AMP RATE RELAY ENABLE SET
5910    GOTO 5930
5920    IF CHG.I2# > 2.2 THEN GOSUB 6590 : GOTO 5870
5930    CHG.I = CHG.I2# * 255
5940    GOSUB 5530 : GOTO 5590
5950    '   ********    PRINT RELAY LATCH CONDITIONS    ***********
5960    PRINT
5970    PRINT "     RELAY LATCH CONDITTIONS ( 0 = OPEN   1 = CLOSED )" : PRINT
5980    PRINT "      1       2       3       4       5       6       7       8
      9       10"
5990    PRINT : PRINT
6000    PRINT "     ";CEVS(1);"     ";CEVS(2);"     ";CEVS(3);"     ";CEVS(4);"
   ";CEVS(5);"     ";CEVS(6);"     ";CEVS(7);"     ";CEVS(8);"     ";CEVS(9);"
   ";CEVS(10)
6010    PRINT "     ";CEVS(11);"     ";CEVS(12);"     ";CEVS(13);"     ";CEVS(14)
;"     ";CEVS(15);"     ";CEVS(16);"     ";CEVS(17);"     ";CEVS(18);"     ";CEV
S(19);"     ";CEVS(20)
6020    PRINT "     ";CEVS(21);"     ";CEVS(22);"     ";CEVS(23);"     ";CEVS(24)
;"     ";CEVS(25);"     ";CEVS(26);"     ";CEVS(27);"     ";CEVS(28);"     ";CEV
S(29);"     ";CEVS(30)
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6030   PRINT "     ";CEVS(31);"     ";CEVS(32);"     ";CEVS(33);"     ";CEVS(34)
;"     ";CEVS(35);"     ";CEVS(36);"     ";CEVS(37);"     ";CEVS(38);"     ";CEV
S(39);"     ";CEVS(40)
6040   PRINT "     ";CEVS(41);"     ";CEVS(42);"     ";CEVS(43);"     ";CEVS(44)
;"     ";CEVS(45);"     ";CEVS(46);"     ";CEVS(47);"     ";CEVS(48);"     ";CEV
S(49);"     ";CEVS(50)
6050   PRINT "     ";CEVS(51);"     ";CEVS(52);"     ";CEVS(53);"     ";CEVS(54)
;"     ";CEVS(55);"     ";CEVS(56);"     ";CEVS(57);"     ";CEVS(58);"     ";CEV
S(59);"     ";CEVS(60)
6060   PRINT "     ";CEVS(61);"     ";CEVS(62);"     ";CEVS(63);"     ";CEVS(64)
;"     ";CEVS(65);"     ";CEVS(66);"     ";CEVS(67);"     ";CEVS(68);"     ";CEV
S(69);"     ";CEVS(70)
6070   PRINT "     ";CEVS(71);"     ";CEVS(72);"     ";CEVS(73);"     ";CEVS(74)
;"     ";CEVS(75);"     ";CEVS(76);"     ";CEVS(77);"     ";CEVS(78);"     ";CEV
S(79);"     ";CEVS(80)
6080   RETURN
6090    '     ********   SECURE AUDIO ALARM      ************
6100    DPORT = 1 :  DWORD = 0
6110    GOSUB 3140                    'GOSUB  DIGITAL I/O PREPARATION
6120    GOSUB 3210                    'GOSUB  DIGITAL I/O OUTPUT
6130    RETURN
6140    '
6150    '   *********     COMPUTE CELL AVERAGE     *********
6160    CELLAVG# = 0 : TOTCELL.VAL# = 0
6170    FOR CA = 1 TO 80
6180    TOTCELL.VAL# = TOTCELL.VAL# + CV#(CA)
6190    NEXT
6200    CELLAVG# = TOTCELL.VAL# / 72
6210    RETURN
6220    '     **********  print test cell and return to stop     *************
6230    PRINT "cell number "; LOOP;" is ";
6240    PRINT USING "#.###"; CELL.VALUE#;
6250    PRINT "  volts"
6260    RETURN
6270    '********  OUTPUT PULSE TO RESET COUNTERS AND MONITOR  CIRCUIT  *******
6280    DPORT = 0
6290    GOSUB 3140                    'GOSUB  DIGITAL I/O PREPARATION
6300    DWORD = 8
6310    GOSUB 3210                    'GOSUB  DIGITAL I/O OUTPUT
6320    DWORD = 0
6330    GOSUB 3210                    'GOSUB  DIGITAL I/O OUTPUT
6340    GOSUB  2270                     'OUTPUT CLOCK TO IGNOR FIRST A/D SAMPLE
6350    RETURN
6360    '   ***   record cevs totals for both chargers and tot.cell   *****
6370    TOT.CELL = 0 : CHG1LAT = 0 : CHG2LAT = 0
6380    FOR CLTS = 1 TO 40
6390    IF CEVS(CLTS) = 1 THEN 6410     '   SUM LATCHED CELLS FOR CHG #1
6400    GOTO 6420
6410    CHG1LAT = CHG1LAT + 1
6420    NEXT
6430    FOR CLTS = 41 TO 80
6440    IF CEVS(CLTS) = 1 THEN 6460    ' SUM LATCHED CELLS FOR CHG #2
6450    GOTO 6470
6460    CHG2LAT = CHG2LAT + 1
6470    NEXT
6480     IF CHG1LAT => 38 THEN CHG1LAT = 0 : F$ = "   ********* 95% OF FIRST 40 L
ATCHED   ****************** : GOSUB 4520   '  SECURE CHG #1 AND OPEN RELAYS 1-40
6490     IF CHG2LAT => 38 THEN CHG2LAT = 0 : F$ = "   ********* 95% OF LAST 40 LA
TCHED   *********** : GOSUB 4650 '   SECURE CHG #2 AND OPEN RELAYS 41-80
6500     RETURN
6510    '   ****   SET HC1# TO CV#(LOOP)   ****
6520    HC1# = CV#(LOOP)
6530    HC1N = LOOP
6540    RETURN
6550    '   ****   SET HC2# TO CV#(LOOP)   ****
6560   HC2# = CV#(LOOP)
6570    HC2N = LOOP
6580    RETURN
6590    '********     ALERT OPERATOR TO SET CURRENT BELOW 2.2 AMPS     ***********
6600     PRINT
6610    PRINT "RELAY ENABLE IS SET FOR THE CELLS AFFECTED BY THIS CHARGER !!"
6620    PRINT : PRINT "  *********   2 AMPS OR LESS  **********"
6630    PRINT : PRINT " PRESS ANY KEY TO CONTINUE  "
6640    CONTINUE$ = INPUT$(1)
6650    RETURN
6660    '   *****     SECURE CHARGER ON LOW CELL DETECT     *****
6670    IF LOOP < 41 THEN GOSUB 4520 : GOTO 6690
6680    GOSUB 4650   'SECURE CHARGER #2 AND LAST 40 RELAYS
6690    RETURN
6700    '*****   SECURE CHARGER NO. 1,  NO CHARGER CURRENT  *****
6710   F$ = "***   NO CHARGER CURRENT WITH RELAY ENABLE SET  ON CHARGER NO. 1  **
** : GOSUB 4520 : STCHG = 0 : STCHG1 = 0
6720   RETURN
6730    '*****   SECURE CHARGER NO. 2,  NO CHARGER CURRENT  *****
6740   F$ = "***   NO CHARGER CURRENT WITH RELAY ENABLE SET  ON CHARGER NO. 2  **
** : GOSUB 4650 : STCHG = 0 : STCHG2 = 0
6750   RETURN
6760   '***  CHECK IF LOOP ON 1-40 OR 41-80  THEN SECURE APPLICABLE CHARGER  ***
6770    IF LOOP < 41 THEN GOSUB 4520 : RETURN
6780    GOSUB 4650
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6790  RETURN
6800  '   ****   SET HIGH CELL (LC1#) TO CV#(LOOP)   ****
6810  LC1# = CV#(LOOP)
6820  LC1N = LOOP
6830  RETURN
6840  '   ****   SET LOW CELL (LC2#) TO CV#(LOOP)   ****
6850  LC2# = CV#(LOOP)
6860  LC2N = LOOP
6870  RETURN
6880  '  ***** SET CELL ENABLE VOLTAGE RELAY LATCH (CEVS) ******
6890  PRINT "RELAY CELL NUMBER ?"
6900  INPUT CN
6910  CEVS(CN) = 1
6920  PRINT "INPUT RELAY CELL NUMBER? (y,n)"
6930  RCVS$ = INPUT$(1)
6940  IF RCVS$ = "y" THEN  GOTO 6880
6950  IF RCVS$ = "n" THEN RETURN
6960  GOTO 6920
6970  '*****  STORE AMP-HOURS OUT TO HARD DISC   *****
6980   PRINT "INPUT AMP-HOURS FROM BATTERY DISCHARGE"
6990   INPUT AMPHOUR
7000   OPEN "A", #1, "TEMP1"
7010   PRINT#1, : PRINT#1, : PRINT#1,
7020   PRINT#1, TIME$; "   DATE  ";DATE$  'ANNOTATE TIME AND DATE
7030   PRINT#1, : PRINT#1,
7040   PRINT#1, : PRINT#1,
7050   PRINT#1,  "      *****    AMP HOURS OUT SINCE LAST CHARGE IS     ";
7060   PRINT#1, AMPHOUR; "      *******       'PRINT AMPHOUR FROM DISCHARGE
7070   PRINT#1, : PRINT#1,
7080   CLOSE#1
7090    RETURN
7100  ' **** SET PREDECTIME# FOR AMPHOUR SUMS AT START OF CURRENT COMMAND ***
7110  GOSUB 7240    ' RETURNS VASLUE FOR TIME (DECTIME#); IN HOURS
7120  DECTIMESTART# = DECTIME#
7130  PREVDECTIME# = DECTIME#-1/3600
7140  RETURN
7150  ' *****  SUM THE TOTAL AMP-HOURS TOTAL1.AH# AND TOTAL2.AH#   *********
7160  GOSUB 7240
7170  DELTATIME# = DECTIME# - PREVDECTIME#
7180  DELTA1.AH# = CHGI.1M# * DELTATIME#
7190  DELTA2.AH# = CHGI.2M# * DELTATIME#
7200  TOTAL1.AH# = TOTAL1.AH# + DELTA1.AH#
7210  TOTAL2.AH# = TOTAL2.AH# + DELTA2.AH#
7220  PREVDECTIME# = DECTIME#
7230  RETURN
7240  '  *******    GET DECIMAL TIME (DECTIME#); IN HOURS   *********
7250  HR = VAL(MID$(TIME$,1,2))
7260  MIN# = VAL(MID$(TIME$,4,2))/60
7270  SEC# = VAL(MID$(TIME$,7,2))/3600
7280  DECTIME# = HR + MIN# + SEC#
7290  RETURN
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Described in this report is the Advanced Unmanned Search System (AUSS) main battery charge/discharge monitor system and its components. The emergency processor battery charger is also discussed. Charging/discharging instructions for the battery monitor, a list of AUSS schematic drawings of the battery monitor and its components, and the computer programs for battery charges and discharges are included.

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