

# Dr. NiCad

## BATTERY CONDITIONER/ RAPID CHARGER



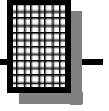
*Dr. Nicad is your best  
Rx for nicad batteries!*

**Ramsey Electronics Model No.**

**DN1**

*Stop shelling out a fortune on batteries ! Enjoy full performance from your NiCad batteries or battery packs with this sensational*

- **Quick charges batteries for laptop computers, hand-held radios and scanners, cordless/cellular phones, camcorders, RC models and more ! Charge many batteries in less than an hour !**
- **State-of-the-art battery monitor IC safely watches both battery voltage and charge time while fast charging your batteries !**
- **Eliminate “Memory Effect” common to NiCads - uses unique constant current circuitry.**
- **Safety First: circuit has “built in” timers and voltage sensors that monitor the cell for safety - it won’t let you charge a bad cell !**
- **Stop “cooking” and start conditioning your rechargeable batteries, no more leaving the charger plugged in for days on end !**
- **Charges single cells as well as NiCad packs from 1 to 10 cells !**
- **Automatic “top off” charge keeps batteries at their peak power until use.**
- **Unit runs on 12-15 volts DC.**
- **Convenient flashing LED indicates charging modes and eliminates guesswork.**



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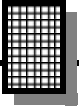


### DOCTOR NiCad BATTERY CONDITIONER KIT INSTRUCTION MANUAL

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## KIT ASSEMBLY AND INSTRUCTION MANUAL FOR

# Dr. NiCad NiCad BATTERY CHARGER/CONDITIONER

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**RAMSEY ELECTRONICS, INC.**  
590 Fishers Station Drive  
Victor, New York 14564  
Phone (585) 924-4560  
Fax (585) 924-4555  
[www.ramseykits.com](http://www.ramseykits.com)

## INTRODUCTION

With today's ever changing technologies, more appliances depend on battery power to enable their use. While this gives us greater freedom, it is often at the high cost of purchasing portable energy, or batteries, to run our portable electronic gizmos. Consider the cost of energy from our local electric company, about 8¢ for a KW hour, or about 450,000 joules of energy for a penny. On the other hand, that 500 mA-H NiCad that you just purchased for about \$1.75 can only supply 2250 joules of energy; that's about 13 joules for 1 cent. So it's fairly easy to see that energy costs about 35,000 times more when it's in a battery.

Nobody likes the idea of throwing all those batteries into a landfill. That's the reason for the recent emphasis on using "green" rechargeable cells. If a set of NiCad cells lasts you for a few months, they can save the equivalent volume of themselves many tens or hundred times in the trash. This is not only good for the environment, it's also great for the wallet!

Nicad rechargeable batteries have been around for years, but there are a few real disadvantages in their use. They usually require a long time (sixteen hours) to recharge. This "trickle charge" arrangement is quite common because it is much cheaper for the original product manufacturer to produce (the entire battery charger is typically a couple of rectifier diodes and a current limiting resistor), and works well given the draw back of a long charge time.

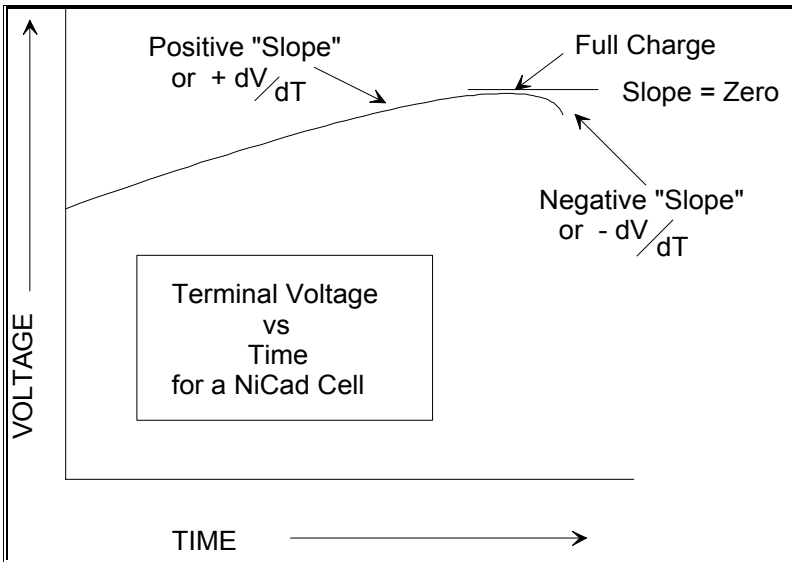
Another disadvantage to the "plug-in wall transformer charger" is that the charging cutoff action is regulated by the heat produced by the cells' chemical reaction when recharging. If you've ever opened up a rechargeable pack you have probably seen the thermal shutoff "mystery part" connected and mechanically touching one cell of the battery pack. While this will help if you leave your appliance charging for several days, notice that it is sampling only one cell in the pack, and assuming that the rest of the batteries are "behaving" in the same manner. Also, since the ambient temperature can change (i.e. recharging your cordless drill in the cool garage or basement, or your two way radio on the hot seat in the car), this heat sensing approach can vary considerably from undercharging your pack to overcharging until you "cook" the electrolyte solution right out of the battery.

Often times we cannot wait for the full recommended charging time or do not use the batteries until they're completely "dead". When this is repeated, the uncared for battery or pack can seem to "run out" rather quickly. This effect is caused by not completely discharging the cell before it is recharged and is known as the memory effect, since the battery appears to memorize the amount of energy it is called upon to produce.. By not completing the

oxidation reduction or "redox" chemical reaction in the cell, we effectively decrease the chemically active surface area inside the cell. The lower this surface area, the shorter the battery's life. Since you don't try to recharge conventional batteries, you've never noticed this property until you started to use rechargeable NiCad batteries.

To keep your cells working like new and to eliminate this memory effect, we've built in an automatic discharge circuit that will properly discharge the cells before their recharging.

So, you can see recharging a NiCad battery correctly can be a tricky business. How can we charge the battery to its full potential, but not too much? The answer is to watch the  $\Delta V$  or change in voltage over time. As shown in the graph, the battery voltage continues to rise while charging but drops slightly when the cell is completely charged. By recognizing this point on the graph, a charger can put just enough charge into the cell. By virtue of this voltage -vs- time checking, it is also possible to charge the battery at a much higher charging current - and significantly reduce the battery charging time. Once this point is reached, it is best to "top off" the battery with a charge burst every now and then.



Enter the Benchmarq BQ2003 NiCad battery charger IC. This cell monitoring / charging IC performs all of the previously mentioned functions, and then some. This smart IC is the "doctor" in our NiCad recharging unit.

We designed our kit to change quickly and easily adapt to a variety of cell or battery pack types for anything from video camcorders to cordless phones. You can configure it for the number of batteries in your pack, discharge and charging rate. We'll discuss this later as we're assembling these sections of the circuit.

## **DN1 CIRCUIT DESCRIPTION**

Before we get into the technical jargon, let's take a walk around the BQ2003 Integrated Circuit . We'll start with some definitions of the abbreviations written on the chip in the schematic diagram.

### **Benchmark BQ2003 pin designations:**

<b>Pin No.</b>	<b>Abbreviation</b>	<b>Function</b>
<b>1</b>	CCMD	Charge command
<b>2</b>	DCMD	Discharge Before Charge Command
<b>3</b>	DVEN	- $\Delta V$ Enable Input
<b>4,5</b>	TM1 & 2	Timer Mode Outputs
<b>7</b>	BAT	Single Cell Voltage Input
<b>8</b>	VSS	Ground
<b>9</b>	SNS	Charging Current Sense Input
<b>11</b>	MCV	Maximum Cell Voltage Reference
<b>13</b>	CHG	Charging Status LED Output
<b>14</b>	MOD	Current Switching Control Output
<b>15</b>	DIS	Discharge Control Output
<b>16</b>	VCC	5 Volt input

The BQ2003 charger IC handles many of the functions related to our charger. Without trying to sound too much like a technical manual or data book, here's a closer look at some of the accompanying circuitry. Have a glance at the schematic diagram and follow along.

Since we want the voltage appearing at the IC to be equivalent to one cell, we first must “divide” the cell voltage by the number of cells in the pack. The ladder resistors R2 -R24 form an effective voltage divider circuit so that the BAT (pin 7) voltage will be about 1.25 V per cell. The switch can increase or decrease the BAT voltage by adding or subtracting “rungs” from the voltage divider ladder. Another divider network consists of resistors R14 and R16. This voltage sets up the MCV voltage for the BQ2003 IC. This should measure 1.8 V when in operation.

Seeing how you’ll want to charge your batteries quickly, you need a high charging current power supply to back you up. Transistors Q2, Q1, and components D1 and L1 form the “high current” portion of our “switched-mode-regulator” circuit. When the MOD output goes “high”, transistor Q2 is turned on, like a switch. This current then flows into the battery. Resistor R29 (and/or R27) is in series with the current flow and the voltage drop across it is sensed by IC pin 9, the sense pin. When the sense pin reaches its trigger point, the transistor is abruptly turned off. When this occurs, the magnetic field around the coil quickly collapses and causes a reverse voltage “spike” which is routed through the “catch” diode D1. This energy is recovered and delivered to the battery cells being charged. This is what provides us with the high current to quickly charge the cell, but does not dissipate power in the FET or NPN transistor, making the switched power much more efficient than a conventional pass transistor type of supply. Another contributing factor to the charging circuit is the charge rate setup, which is configured using resistors R26 and 27, as well as test points A - F.

Transistor Q3 is the integral part of our constant current discharging circuit. When the chip sees a positive going pulse at the DCMD pin, it initiates the DIS discharge output. With switch S1:10 closed diodes D2 and D4 are forward biased, causing 1.4VDC to be present at the base of Q3. With 1.4 V at the base, there is .7 VDC at the emitter, a diode drop in potential lost through the transistor. With the emitter at .7 VDC, the current through resistors R10 and R22 is about 140 mA, regardless of the cell voltages. If switch S1:10 is opened the potential increases to 1.4 VDC. increasing the current to 280 mA. This will continue to discharge the batteries until they reach a potential of about .9 volts per cell. The Benchmarq chip then initiates its own charging sequence.

A few final points concerning the TM1 and TM2 time-out, which are configured using points G - J. They are dependant on the charge capacity, or “C” of the pack. We’ll discuss this in more detail when it comes time to configure these jumpers.

## DN1 PARTS LIST

### RESISTORS

- 1 270 ohm [red-violet-brown] (R12)
- 2 .5 ohm ½ Watt [green-black-silver] (R26, 27)
- 3 10 ohm [brown-black-black] (R 2, 10, 22)
- 2 470 ohm [yellow-violet-brown] (R3, 7)
- 4 1K ohm [brown-black-red] (R1, 5, 9, 25)
- 2 10K ohm [brown-black-orange] (R11, 20)
- 1 10K ohm 1% [brown-black-black-red] (R16)
- 1 17.8K ohm 1% [brown-violet-grey-red] (R14)
- 11 47K ohm resistors [yellow-violet-orange] (R4,6,8,13,15,17,18,19,21, 23, 24)

### CAPACITORS

- 3 1uF electrolytic capacitors (C1,C3,C3A)
- 3 10 uF electrolytic capacitors (C2, 5, 6)

### INDUCTORS

- 1 Axial lead inductor [enameled wire wound on ferrite core] (L1)

### SEMICONDUCTORS AND INTEGRATED CIRCUITS

- 3 1N4148 diodes [glass case with black band] (D2, 4, 7)
- 2 1N4002 diode [epoxy case marked 1N4002] (D5, 6)
- 1 1N4937 fast recovery diode [ epoxy case marked 1N4937] (D1)
- 1 Light Emitting Diode [LED] (D3)
- 1 NPN small signal transistor [2N3904 or equivalent] (Q2)
- 1 NPN power type [marked TIP31C] (Q3)
- 1 Power FET [marked 7035] (Q1)
- 1 78L05 voltage regulator [marked 78L05] (VR1)
- 1 BQ2003 16 pin IC (U1)

### MISCELLANEOUS PARTS AND HARDWARE

- 1 2.5mm power jack (J3)
- 1 10 position DIP switch (S1)
- 2 DPDT pushbutton switch (S2, 3)
- 1 DN1 printed circuit board
- 1 TO-220 heatsink (HS1)
- 2 #4-40 screws and nuts
- 1 Insulated jumper wire
- 1 6" piece of two conductive wire (blk, red)



## **RAMSEY Learn-As-You-Build KIT ASSEMBLY**

There are numerous solder connections on the DN1 printed circuit board. Therefore, PLEASE take us seriously when we say that good soldering is essential to the proper operation of your Doctor Nicad!

- Use a 25-watt soldering pencil with a clean, sharp tip.
- Use only rosin-core solder intended for electronics use.
- Use bright lighting. A magnifying lamp or bench-style magnifier may be helpful.
- Do your work in stages, taking breaks to check your work. Carefully brush away wire cuttings so they don't lodge between solder connections.

We have a two-fold "strategy" for the order of the following kit assembly steps. First, we install parts in physical relationship to each other, so there's minimal chance of inserting wires into wrong holes. Second, whenever possible, we install in an order that fits our "Learn-As-You Build" kit building philosophy. This entails describing the circuit that you are building, instead of just blindly installing components. We hope that this will not only make assembly of our kits easier, but help you to understand the circuit you're constructing.

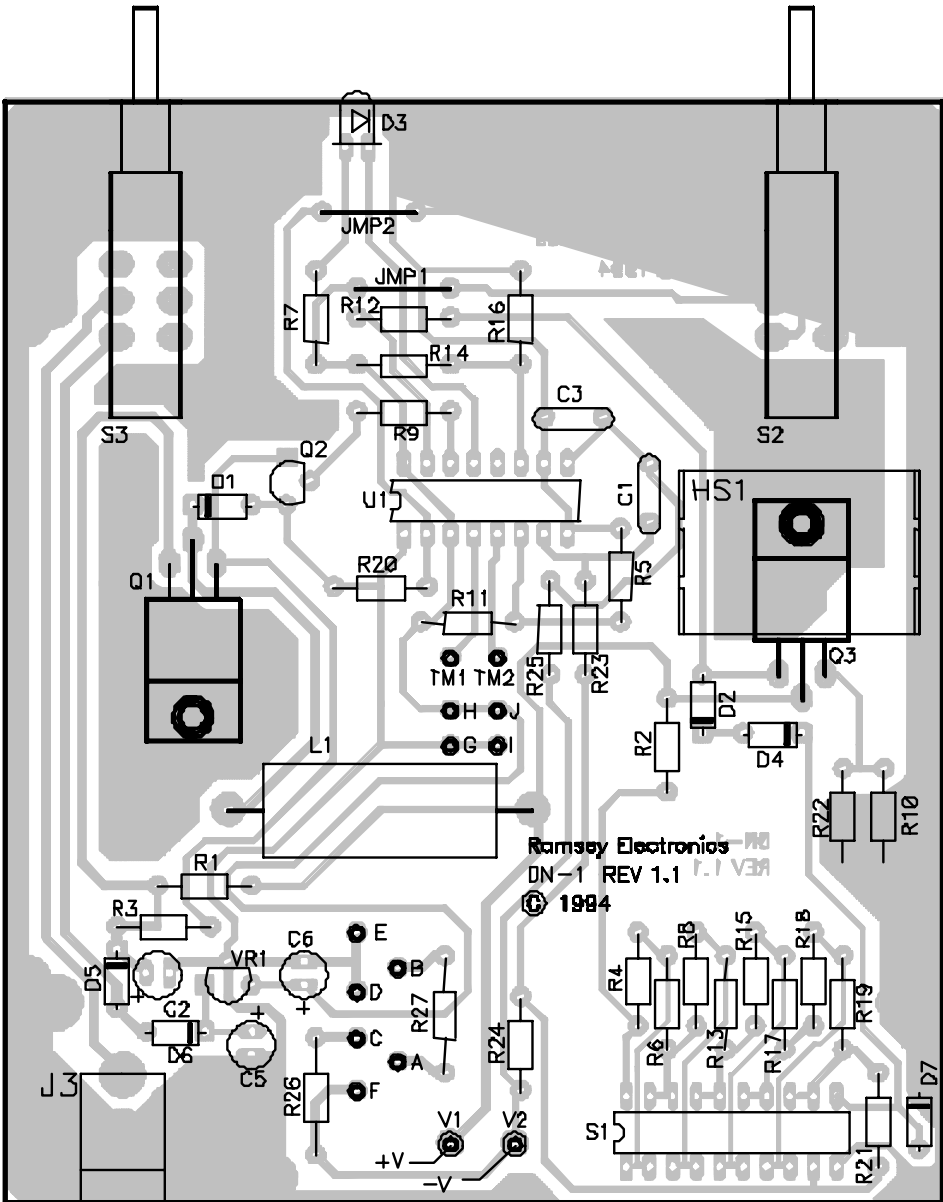
For each part, our word "Install" always means these steps:

1. Pick the correct part value to start with.
2. Insert it into the correct PC board location.
3. Orient it correctly, follow the PC board drawing and the written directions for all parts - especially when there's a right way and a wrong way to solder it in. (Diode bands, electrolytic capacitor polarity, transistor shapes, dotted or notched ends of IC's, and so forth.)
4. Solder all connections unless directed otherwise. Use enough heat and solder flow for clean, shiny, completed connections.

### **Now, let's get building!**

Since you may appreciate some "warm-up" soldering practice as well as a chance to put some "landmarks" on the PC board, we'll first install some "hardware" components. This will also help us to get acquainted with the up - down, left - right orientation of the circuit board. Remember that the components will be mounted on the "component" side of the circuit board and soldered on the "solder" side of the circuit board.

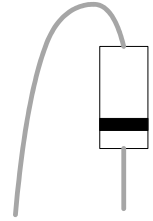
**DN1 PARTS FINDER DIAGRAM**



- ❑ 1. Identify and install DPDT switch S2. Be sure to push the switches flat to the circuit board. Solder all six connections.
- ❑ 2. Install the other DPDT toggle power switch S3. Once again, be sure to push the component flush to the circuit board before soldering.

We'll start our "learn-as-you build" instructions with the power supply section of the circuit.

- ❑ 3. Install the 2.5 mm power connector in the J3 position.
- ❑ 4. Install D6, a 1N4002 type diode. Notice that one end of this component is marked with a band. Diodes are "polarized", that is, like a battery, they have a positive (+) and negative (-) side. Be sure to follow the parts diagram carefully and orient the banded end as shown. Note also that this component will "stand up" in place. Form the component leads as shown before installing the part.
- ❑ 5. In the same manner, install diode D5, 1N4002 type. Be sure to orient it correctly! See the parts diagram for correct placement.



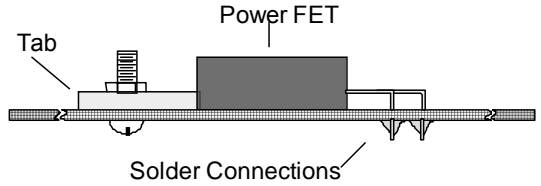
Diodes D5 and D6 act as circuit "protection". If the power is hooked up incorrectly D6 acts as an "open circuit" to prevent damage to the voltage regulator and the charger IC. Diode D5 prevents the battery pack under charge from powering the unit if the input power is accidentally removed.

- ❑ 6. Install C5, 10 uF electrolytic capacitor. Electrolytic capacitors are polarized with a (+) and a (-) lead and must be installed in the correct orientation. Ordinarily, only the negative side is marked on the capacitor body with a dark band and the (-) sign clearly shown, while PC boards will usually show the (+) hole location. Use care to ensure proper polarity. See the parts diagram for proper placement.
- ❑ 7. Install C6, 10 uF electrolytic capacitor. Watch the orientation! See the parts diagram for proper placement.
- ❑ 8. Identify VR1, the 78L05 voltage regulator (marked 7805). This device produces a stable 5 volt reference for the circuit. Notice that this component has a "flat" side with the writing imprinted on it. Be sure to place the part as shown in the parts diagram.
- ❑ 9. Install C2, 10 uF electrolytic. Observe the correct polarity! If installed incorrectly, this component can heat up and even explode!

That wasn't so bad, now was it! You have just completed the power section of your DN1. Take a moment now to recheck your solder connections and touch up any less than perfect connections. Have a second look at the component polarities in this section as the majority of these components have a (+) and (-) orientation.

- ❑ 10. Install R3, 470 ohm [yellow-violet-brown].

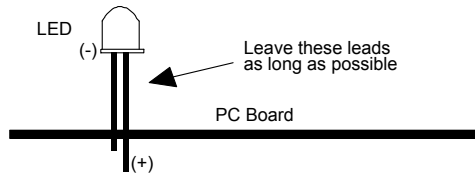
- ❑ 11. Install R1, 1K ohm [brown-black-red].
- ❑ 11. Install Q1, the power FET transistor [marked 7035]. Form the leads as shown prior to installation. Bolt the regulator to the circuit board.



- ❑ 12. Install L1, the large axial leaded wire wound inductor.
- ❑ 13. Install D1, 1N4937 fast recovery diode. Observe the correct polarity! Note also that this is another “stand up” diode, so form the leads as before for a proper fit.
- ❑ 14. Identify Q2, a 2N3904 NPN transistor. When installing Q2, observe correct placement of the flat side. Press the transistor snugly into the PC board so that only a minimum amount of wire lead is exposed above the board. In soldering, do not be afraid of using enough heat to make a good solid connection.
- ❑ 15. Install R9, 1K ohm [brown-black-red].

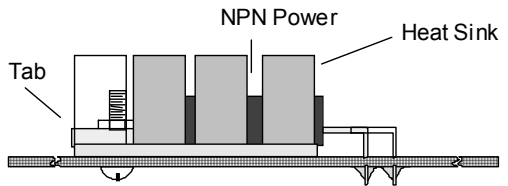
That’s it for the switching high current supply! This part of the circuit provides the “muscle” to charge the batteries.

- ❑ 16. Install LED D3. This component is polarized and must be oriented correctly. Examine the LED and notice how one lead is longer than the other. Most diodes also have a flat mold in one side of the component body. This flat side is on the same side as the shorter leg. When properly installed, the flat side should face towards S2. Leave the diode leads as long as possible, because this component will mount to the front panel as a charging status indicator.



- ❑ 17. Using scrap component lead, form a “jumper” wire and install it in the JMP2 position. A jumper acts as an electronic bridge to carry power and signal over the traces run underneath.
- ❑ 18. Form and install another jumper, JMP1.
- ❑ 19. Install R7, 470 ohm [yellow-violet-brown].
- ❑ 20. Install R12, 270 ohm [red-violet-brown].
- ❑ 21. Install R14, 17.8K ohm 1% [brown-violet-grey-red].
- ❑ 22. Install R16, 10K ohm 1% [brown-black-black-red].

- ❑ 23. Select two of the 1uF electrolytic capacitors and solder the ground leads together. Install them as C3. Bend the ground leads away from U1.
- ❑ 24. Install C1, the remaining 1uF capacitor. The positive side should be facing R5.
- ❑ 25. Install the Benchmark BQ2003 IC. Notice that one end of the chip is marked with a dot, notch, or band. Be sure to orient this end as shown in the parts diagram. Pin 1 is located directly below the notch when the IC is positioned so that the notch is to the left. If you prefer to use an IC socket, you may install one if you wish. Be aware, however, that our techs find more repair problems due to sockets than due to chips burned out from overheating with a soldering iron. Be extra careful not to “bridge” the printed circuit traces together.
- ❑ 25a. On the bottom side of the board, install a short piece of insulated wire between pins 1 and 8 of U1. Be sure to select the right pins.
- ❑ 26. Install R5, 1K ohm [brown-black-red].
- ❑ 27. Install transistor Q3, the NPN power type. When installing, be sure to form the leads as shown to allow an easy fit. Usually it is easier to mechanically mount the component with its heatsink and then solder the connections. Install the screw through the heat sink and the component. Tighten the nut securely.
- ❑ 28. Install D2, 1N4148 type diode [glass case with dark band]. Be sure to orient the banded end as shown in the parts diagram.
- ❑ 29. Install D4, 1N4148 diode. Watch that polarity! See the parts diagram for proper placement.
- ❑ 30. Install R22, 10 ohm [brown-black-black].
- ❑ 31. Install R10, also 10 ohm [brown-black-black].
- ❑ 32. Install D7, 1N4148 diode [glass case with dark band]. Be sure to observe the correct polarity.



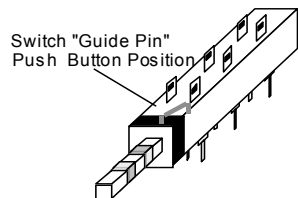
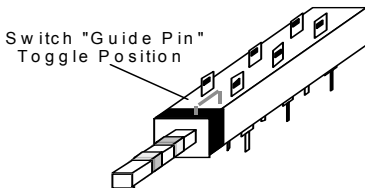
You've just completed the constant current battery discharging portion of the circuit. This section, when initiated, will discharge the battery at a constant rate until the Benchmark IC senses that the cell voltage is low enough for a complete recharge. Recheck your work for any solder “bridges” (especially on the IC) or incomplete solder connections. A bright light and a magnifying lens can be helpful for this.

We'll continue building the final section of the Doctor NiCad circuit, the voltage sense inputs and voltage “divider”. Notice the resistor ladder in the schematic diagram. By configuring the switches to the proper number of cells in the pack, we “divide” the battery input voltage by the number of cells

present, giving us an accurate representation of one cell contained in the pack.

- ❑ 33. Install R21, 47K ohm [yellow-violet-orange].
- ❑ 34. Install DIP switch S1 (D)ual (I)nline (P)ackage. Make sure that the switchable contacts face toward the outside of the circuit board, allowing for easy changing of number of cells to charge.
- ❑ 35. Install 47K ohm resistors R19, R18, R17, R15, R13, R8, R6, and R4 [yellow-violet-orange]. Pay extra attention in soldering not to create any solder “bridges” between circuit traces.
- ❑ 36. Install R24, 47K ohm [yellow-violet-orange].
- ❑ 37. Install R27 and R26, both .5 ohm ½ watt [green-black-silver].
- ❑ 38. Install R2, 10 ohm [brown-black-black].
- ❑ 39. Install R23, also 47K ohm [yellow-violet-orange].
- ❑ 40. Install R25, 1K ohm [brown-black-red].
- ❑ 41. Install R11, 10K ohm [brown-black-orange].
- ❑ 42. Install R20, 10K ohm [brown-black-orange].
- ❑ 43. Lastly, install the provided hookup wire (red to the +V, black to the -V) into the circuit board. Due to numerous types of battery packs used, this “two wire “ type of hookup is as far as we go. Many types of battery holders can be found quite reasonably priced at your local electronics store. Please understand that it was nearly impossible for us to predict the type of pack that was to be charged with this kit.
- ❑ 44. Since the S2 switch that was previously installed comes from the factory as a “toggle” switch but our application uses a “pushbutton” input, we’ll need to make a small modification to the mechanics of the switch to suit our purpose.

Locate the switch “guide pin” on switch S2. With a small pliers, gently lift the pin and rotate it so it does not remain in the toggle “groove”. See the accompanying diagrams for help.



## CONGRATULATIONS

You have just completed your DN1 NiCad battery conditioner unit. Take a well deserved break now. Give your eyes a rest. When you return, be sure to check over your work on the entire circuit board. Energizing the circuit board with solder “bridges” or misplaced components can damage your kit. Don’t throw away all your scrap component leads just yet, however, you’ll still need a couple to set up your kit for its final operation.

## DOCTOR NiCad BATTERY CONDITIONER SETUP

Its time to configure your Doctor NiCad for your individual application. We’ll discuss a little theory first to more clearly understand the proper settings.

- NiCad batteries have a capacity rating, or “C” value, associated with them. This value is usually defined in an Ampere-Hour rating. Typically, the larger the battery cell, the larger the Amp·Hr rating.
- The quality of the NiCad is proportional to the charging rate of the battery. That's why you have seen the exact same “looking” batteries (i. e. same size, shape, and weight) while one is called a “fast charge” cell and may cost twice as much! Many portable motor driven devices like portable drills have higher capacity batteries for longer life. The higher the quality of the cell the faster one can charge it, as high as a rate of 4 times the capacity (4C) of the cell. ***Be aware, however. that trying to fast charge a cell not intended for this type of charge can cause the cell to build up internal gasses too quickly and explode, regardless of the complexity of the charger. If you cannot determine the proper charging rate for your cell, the rate of C/2 is recommended.***
- Once the charging rate is determined, you can easily calculate the safety “time” out required for worry-free operation. This time is roughly 1½ times the charge capacity of the cells. This “time out” feature ensures that your batteries will not be charged for too long.

*Here’s an example of how to determine the correct setup:*

We have a battery pack consisting of 4 “AA” type cells. The pack is marked as having 500mA hr cells with a quick charge rate of 1 Amp.

With a charging rate of 1 Amp, the cell is storing charge at a rate of twice the capacity, or (2·C), The battery in an ideal situation will acquire a full charge in one-half hours time, or mathematically speaking,  $1 \text{ A} \cdot .5\text{Hr} = .5\text{A}\cdot\text{Hr}$  or 500mA·Hr. Notice in the Safety Time Out Jumpering Chart (page 17) that for a charge rate of 2C the time out will be 45 minutes.

Fill in the chart with the ratings imprinted on your batteries. This should help you to determine the proper jumper settings

Battery Type	Number of Cells	Charge Capacity (A•Hr)	Charge Current (mA)	Time Out Setting (Min.)

**DN1 FINAL ASSEMBLY INSTRUCTIONS**

Use scrap resistor leads to form the proper “jumper” wires to configure your conditioner. Use the parts diagram to identify the proper holes for the jumper wires

Charging Current	Jumpers Used
250 mA	A-C, B-D
500 mA	C-D
1 A	A-F, C-D, B-E

**REMEMBER.....**

Setting the charge current too high can cause the cell to explode! Consult the battery manufacturers specifications for proper charge current specifications.

**CHARGING CURRENT SETUP**

**SAFETY TIME OUT CONFIGURATION SETUP**

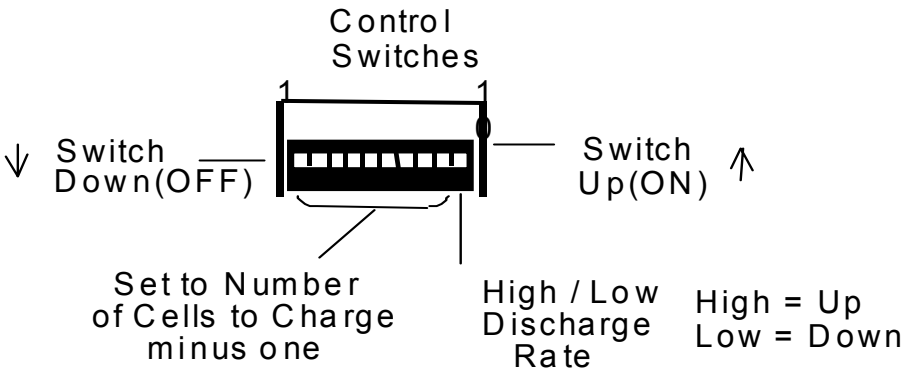
Charge Rate	Jumper TM1 to..	Jumper TM2 to...	Charging Time (Min)
C/2	H	No Connection	180
C	G	J	90
2C	No Connection	J	45
4C	H	J	23

## SETTING UP THE SWITCHES

You'll need to configure the row of DIP switches for your battery pack now. Since the minimum number of cells is at least one, the conditioner is already set up for a single battery to begin with.

Switch No. 10 is reserved for the discharging current setup. When it is closed the Doctor is in low current discharge mode, or about 140 mA drain from your batteries. When Switch No. 10 is opened the discharging current is increased to 280 mA, or the high current discharge.

Switches 1 - 9 should be set for the number of cells in the pack *minus one* (remember, Dr. NiCad is set up for one cell to start, meaning that the first resistor in the network is always in the circuit [R24]).



**(i.e. 4 Cell Pack, Switches 1,2, and 3 Up, or "ON"**

## TESTING YOUR DOCTOR NiCad BATTERY CONDITIONER / CHARGER

Well, here it is, the moment of truth. Although you're probably anxious to get "charging", now is the best time to double-check your work. It is far better to discover a solder bridge, misplaced component, or incorrectly set switch now before the circuit is energized than risk permanent component damage from being too hasty! Review your configuration setups also.

## DN1 CHARGE STATUS LED INDICATOR

When powered up, Dr. NiCad's front panel LED is much more than a power

Charger Status	Status LED "ON" time	Status LED "OFF" time
No Battery	No Light	No Light
Battery Connected Awaiting Command	1/8 sec.	1/8 sec.
Discharging	1 3/8 sec	1/8 sec.
Fast Charging	Continuous	N/A
Charge Complete	1/8 sec.	1/8 sec.
Topping Off	1/8 sec.	1/8 sec.

indicator. By changing the ON / OFF times this LED becomes a charging status indicator! Use the following chart for an indication of what the doctor is telling you.

## **POWER SUPPLY CONSIDERATIONS**

The power supply used for the Dr. NiCad can vary greatly depending on how you set up your charger to work. While you may be able to "get away with" many different types of supplies, what's recommended is a regulated 12-14VDC supply capable of supplying at least 1.5 Amps of current continuously. When using the doctor in the "field", a 12 VDC car battery works well as a power source. Be sure to remember that the center pin of the input power connector, J3, should be connected to the positive ( + ) terminal of the supply and the outer connector is attached to the negative, or ( - ) terminal.

## **THROTTLE UP !**

With all our configuring steps behind us, it's time to use the doctor!

- 1. Connect the battery (or batteries) to be charged to the +V (red) and -V wires.
- 2. Connect the power input to the circuit.
- 3. Switch S3 to the "ON" position. The Status LED should come up in either the "Fast Charging" mode or "Awaiting Command" mode.
- 4. To cycle the batteries, depress pushbutton switch S2. The Status LED should display the discharging mode.

Once the batteries are discharging, Dr. NiCad will take it from there. The conditioner will first discharge the cells to about .9 - 1.0 Volts per cell and

begin the Fast Charging mode.

The Benchmark IC will constantly monitor the pack and turn off the fast charge when the cells are charged just to full capacity. Once this is accomplished, it will periodically “top off” the cells with a high current burst, and allow a slight trickle charge to flow.

Unfortunately, about the only thing to do for this initial check out is to watch the lights blink - but it is also a good time to “measure” the capacity of your cell. Start “timing” the charger just when it goes into fast charge mode. Knowing the charge current rate (whatever you previously set it up at) and the time for a full charge, (Amperes • Hours), you can get a fairly good approximation of the health (capacity value) of your batteries.

### What about those “mystery” batteries ?!

Often times the batteries are “hidden” in elaborate packs designed to fit in video cameras, cordless phones, or RC racecars. The easiest way to determine the number of cells in such a pack is to take the nameplate voltage and divide by the number 1.2, the voltage of a single cell. For example, a 7.2 V pack contains  $7.2 \div 1.2 = 6$  cells.

It can also be quite frustrating to connect the charger to these “oddball” type packs. An inexpensive design idea is to fabricate your own holder with assorted bits of wood and plastic. Surely a kitbuilder like you already has a “junkbox” full of those priceless gems just waiting to be put to use to hold your batteries. For example, an old discarded relay usually contains some high current spring loaded contacts that make great connecting terminals for such packs.

Be absolutely sure that you have the proper polarity identified on the battery pack. Most are marked with a sticker or mark in the plastic case. If you can't figure out the charge capacity, go to your local home electronics store. Ask about replacement cells; most likely the salesman will know what you need.

### BATTERY WORKOUT

To keep your NiCad cells at their peak capacity, here are a few suggestions:

- 1) Always deep cycle your batteries. Run them until they just begin to quit. It is best to depress the “discharge” pushbutton after you initially hook up the pack to Dr. NiCad.
- 2) Even when not in use, periodically “top off” the pack. This is also

handled by the doctor, but if you have several packs, be sure to rotate them (or maybe buy a few more Dr. NiCad Chargers).

## **BATTERY REPAIR ???!**

Many times we have older batteries or packs that don't seem to hold a charge at all, but they were so expensive that we couldn't bear to toss them in the trash. Well, your frugality (some people call it being cheap) has finally paid off! Most of these extreme memory conditions can be "cycled" right out of the pack. Simply configure your Dr. NiCad for the proper voltage, install the pack, and press the discharge button. For best results, if you are charging a cell greater than 1.5V (these are made up of many 1.5V cells), charge the first few times on the C/2 (250 mA) setting. Additionally, you should use the lower discharge setting also. This will give the cells a chance to equalize their voltages, bringing more life back to the pack. Dr. NiCad will run your batteries through a discharge/charge cycle. By continuing this process over and over (the number of times depends on how bad the pack was to start with) you can gradually build up your batteries capacity to full strength again. This is probably the most satisfying use of your Dr. NiCad charger (see, I told you I could fix 'em)!

If when you initially hook up these "sick" battery packs the front panel indicator wont let you discharge, don't worry. The lower current trickle charger is bringing the pack up to the correct minimum cell voltage to begin rapid charging. Another method of "jump starting" a very old or abused pack is to initially open one additional switch in the voltage divider ladder. This will make the pack voltage appear higher to the charger, so the high current charge will be initiated. Use caution when doing so, however, and after a few minutes of charging be sure to reconfigure the switches for the proper voltage setting. This method is only to be used as a last resort to save a battery pack.

## **TROUBLESHOOTING INSTRUCTIONS**

While we had hoped that it wouldn't come to this, if you are having trouble with your charger, here are a few suggestions.

By far the most common source of problems is due to misplaced parts or poor solder connections. It's always best to take a break before searching for bad connections. A good way of checking component placement is to double check the assembly steps going backwards from the last steps to the first. Bright lighting and a magnifying aid can be helpful in identifying soldering problems. We've all made silly mistakes and never been able to see them ourselves, so have a friend check your work, as well.

Use a methodical, logical troubleshooting technique. Most problems can be solved using common sense. A volt-ohm meter and a clear head are usually all that are needed to correct any problem. Please understand that it is nearly impossible to “troubleshoot” by phone; any specific questions should be documented and sent to us by mail.

The Benchmarq IC has been double checked to its ensure reliability and probably isn't the problem if your kit doesn't run.

## **COMMON QUESTIONS**

- Q. *When I charge my battery pack, the discharge and charge cycles are short, and the battery doesn't seem to have the capacity it should have.*
- A. A battery is made up of 1.5V cells. If these do not have equal voltages, your battery capacity may be very short. To correct this, charge the battery on the C/2 (250 mA) setting, and discharge it using the low current discharge setting four or five times. For further information, please see the section labeled BATTERY REPAIR.
- Q. *When I energize the circuit the indicator light just blinks in the awaiting command mode ? I press the discharge start button but nothing happens.*
- A. Check the number of cells switch settings. Be sure that it is set to the number of cells minus one. Dr. NiCad “thinks” that you need more cells in your pack.  
This can also occur when the pack is severely discharged. If you're sure that the DIP switch settings are correct, Leave the pack connected to the charger. The circuit includes a low current “trickle charger” designed to bring the cell up to an acceptable level before fast charging. The doctor will then begin its fast charge sequence all on its own.
- Q. *The unit was working before, but now when I turn it on the indicator light stay off.*
- A. Again, check the number of cell switch settings. Dr. NiCad “sees” more batteries connected than what you have called out with the switches.
- Q. *The batteries don't seem to take a full charge, that is, the time required at the charging rate that I've selected seems way too short. I can hear the switching supply “whistle” coming from the circuit board.*
- A. This happened to us, too ! Turns out that if you turn the input voltage too high that the higher currents created cause the large inductor in the switching supply to “saturate” magnetically and lose its inductive properties. Try reducing the input voltage to 12 - 14VDC, as this took care of our fast charge problem.

# The Ramsey Kit Warranty

**Please read carefully BEFORE calling or writing in about your kit. Most problems can be solved without contacting the factory.**

Notice that this is not a "fine print" warranty. We want you to understand your rights and ours too! All Ramsey kits will work if assembled properly. The very fact that your kit includes this new manual is your assurance that a team of knowledgeable people have field-tested several "copies" of this kit straight from the Ramsey Inventory. If you need help, please read through your manual carefully, all information required to properly build and test your kit is contained within the pages!

**1. DEFECTIVE PARTS:** It's always easy to blame a part for a problem in your kit. Before you conclude that a part may be bad, thoroughly check your work. Today's semiconductors and passive components have reached incredibly high reliability levels, and it's sad to say that our human construction skills have not! But on rare occasions a sour component can slip through. All our kit parts carry the Ramsey Electronics Warranty that they are free from defects for a full ninety (90) days from the date of purchase. Defective parts will be replaced promptly at our expense. If you suspect any part to be defective, please mail it to our factory for testing and replacement. Please send only the defective part (s), not the entire kit. The part(s) MUST be returned to us in suitable condition for testing. Please be aware that testing can usually determine if the part was truly defective or damaged by assembly or usage. Don't be afraid of telling us that you 'blew-it', we're all human and in most cases, replacement parts are very reasonably priced.

**2. MISSING PARTS:** Before assuming a part value is incorrect, check the parts listing carefully to see if it is a critical value such as a specific coil or IC, or whether a RANGE of values is suitable (such as "100 to 500 uF"). Often times, common sense will solve a mysterious missing part problem. If you're missing five 10K ohm resistors and received five extra 1K resistors, you can pretty much be assured that the '1K ohm' resistors are actually the 'missing' 10 K parts ("Hum-m-m, I guess the 'red' band really does look orange!") Ramsey Electronics project kits are packed with pride in the USA. If you believe we packed an incorrect part or omitted a part clearly indicated in your assembly manual as supplied with the basic kit by Ramsey, please write or call us with information on the part you need and proof of kit purchase

### **3. FACTORY REPAIR OF ASSEMBLED KITS:**

To qualify for Ramsey Electronics factory repair, kits MUST:

1. NOT be assembled with acid core solder or flux.
2. NOT be modified in any manner.
3. BE returned in fully-assembled form, not partially assembled.
4. BE accompanied by the proper repair fee. No repair will be undertaken until we have received the MINIMUM repair fee (1/2 hour labor) of \$25.00, or authorization to charge it to your credit card account.
5. INCLUDE a description of the problem and legible return address. DO NOT send a separate letter; include all correspondence with the unit. Please do not include your own hardware such as non-Ramsey cabinets, knobs, cables, external battery packs and the like. Ramsey Electronics, Inc., reserves the right to refuse repair on ANY item in which we find excessive problems or damage due to construction methods. To assist customers in such situations, Ramsey Electronics, Inc., reserves the right to solve their needs on a case-by-case basis.

The repair is \$50.00 per hour, regardless of the cost of the kit. Please understand that our technicians are not volunteers and that set-up, testing, diagnosis, repair and repacking and paperwork can take nearly an hour of paid employee time on even a simple kit. Of course, if we find that a part was defective in manufacture, there will be no charge to repair your kit (But please realize that our technicians know the difference between a defective part and parts burned out or damaged through improper use or assembly).

**4. REFUNDS:** You are given ten (10) days to examine our products. If you are not satisfied, you may return your unassembled kit with all the parts and instructions and proof of purchase to the factory for a full refund. The return package should be packed securely. Insurance is recommended. Please do not cause needless delays, read all information carefully.

## DN1 Dr. NiCad BATTERY CONDITIONER Quick Reference Page Guide

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### REQUIRED TOOLS

- Soldering Iron (WLC100)
- Thin Rosin Core Solder (RTS12)
- Needle Nose Pliers (MPP4 or RTS05)
- Small Diagonal Cutters (RTS04)

### TOTAL SOLDER POINTS

165

### ESTIMATED ASSEMBLY TIME

Beginner.....5.0 hrs  
Intermediate .....2.8 hrs  
Advanced .....2.1 hrs

### ADDITIONAL SUGGESTED ITEMS

- Helping Hands Holder for PC Board/Parts (HH3)
- Technician's Tool Kit (TK405)
- Desoldering Braid (RTS08)

Price: \$5.00

Ramsey Publication No. MDN1

Assembly and Instruction manual for:

**RAMSEY MODEL NO. DN1 Dr. NiCad BATTERY  
CHARGER / CONDITIONER KIT**



**RAMSEY ELECTRONICS, INC.**

**590 Fishers Station Drive**

**Victor, New York 14564**

**Phone (585) 924-4560**

**Fax (585) 924-4555**

**www.ramseykits.com**