

# EduCALC TECHNICAL NOTES

27953 CABOT ROAD LAGUNA NIGUEL, CA 92677

## HP-41 POWER SOURCES Ni-Cads But No AC Adapter Yet

Hand held calculators, like the HP-41, pack a great deal of electronics into a small package. The choice of the power source to run an ever increasing number of circuits is a major problem for calculator designers. In the early and mid 1970s, the display was segmented light emitting diodes, LEDs. These devices required a great deal of power to run and battery life was only a few hours. The LED designs did not have continuous memory and programs and data were lost when the power was turned off. LED calculators used AC adapters so that the user could operate all day without having to turn off the power.

Today's machines use less than 1/100th of the power of the LED designs. Memory is powered continuously even when the power switch is off. The LED designs used Nickel Cadmium rechargeable batteries, Ni-Cads, and today's machines use small alkaline batteries, some of which are the size of a thick quarter or dime. The HP-41 uses four N size alkaline batteries. Letters are used to designate battery designs with the D cell and C cell being the most common. AA (82240A IR printer) and AAA cells (HP-71B calculator) are also familiar to HP calculator users. The N cell is slightly shorter and smaller in diameter than the AA cell. The likeliest batteries to be found in a drug or department store would be D, C, AA, AAA, and N.

The standard letter designated battery sizes are now available in the rechargeable Ni-Cad design. The AAA size only recently became available. Many calculator users remember the rechargeable battery packs of the '70s and they want to save money using Ni-Cads in their HP-41s. Ni-Cad N cells are available from EduCALC. The early calculator designs had built-in rechargers, but Ni-Cads used in the HP-41 must have an external charger and several systems are available.

Table 1: Alkaline vs Ni-Cad Cells

Characteristic	Alkaline	Ni-Cad	Remarks
Terminal Voltage	1.50	1.25	Typical
HP-41 Battery	6.0	5.0	4 cells in battery
Capacity	500 Ma Hr	150 Ma Hr	Alkalines 3 times capacity
End Life Voltage	Steady	Fast Drop	Danger MEMORY LOST with Ni-Cad
Energy Life	3 Years	<1/3 Yr	Ni-Cad self discharges 1%/day
Cost (Cat 37)	\$0.98	\$2.50	Ni-Cads are low cost
Availability	Common	Rare	Only two companies make

HP-41 Ni-Cad users should know the limits and advantages of using Ni-Cads in their calculators. The main advantage is cost. A set of batteries can cost from \$4 to \$5. A heavy HP-41 user who has a card reader could require a set of batteries every three weeks. The average use of batteries is very difficult to determine but may range from 4 to 9 months. Table 2 shows the current drain of the three power-use states. In one year 17 sets of batteries would be used at \$4 each for a cost of \$68 excluding taxes, shipping, gasoline, and time. Ni-Cad batteries, if properly used, will last five years and 1,000 charge/discharge cycles. Most Ni-Cad batteries fail due to overheating because of continuous charging. At \$4 per cycle, this is the equivalent of \$4,000 worth of batteries. A more realistic consideration is to evaluate the five year life at 17 cycles per year or 85 sets of batteries worth \$340.

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Table 2: HP Current Drain

State	CURRENT		Remarks
	Typical	Maximum	
Run	10 Ma	15 Ma	48-52 hours continuous running
Standby	1 Ma	1 Ma	
Sleep (off)	10 ua	30 ua	

The limits of Ni-Cad usage based on Table 1 dictate that when using Ni-Cads you should stop using the machine as soon as the BAT annunciator comes on. To avoid MEMORY LOST, do not read a card or make another run of a program. Replace the Ni-Cads with your back-up alkalines. For maximum life, fully discharge the cells the prescribed amount of time, stop charging, and run the HP-41 until the BAT annunciator comes on. Recharge, etc. Avoid recharging when only partially discharged. Avoid heating the battery by continuously charging. This is important, as many users think of the HP 82120 Ni-Cad battery and the 82059 recharger as an AC adapter and they leave the machine plugged in for extended periods of time. Overcharging is not so much a problem as drying out the cell due to elevated temperatures. HP originally planned on producing an AC adapter but never did. Two gold ball contacts for connecting a 6 volt DC source to the machine have long since been eliminated. For the average user, alkalines are adequate and for the heavy user, Ni-Cads work fairly well. You should always keep a spare set of alkalines handy for use when the Ni-Cads go dead. You can use alkaline batteries for several weeks after the BAT annunciator comes on because the terminal voltage does not fall rapidly and MEMORY LOST is less likely to happen. Three Ni-Cad systems are available from EduCALC.

The original HP design is the 82120. This battery holder size pack uses  $\frac{1}{2}$  size Ni-Cads with the charger electronics taking the remaining space. The 82059 recharger (wall transformer) is used to recharge the 82120. Total cost is \$51.90. The small size is convenient, but many users treat the system as an AC adapter and the 'cook' their 82120 to an early death. Compared to other systems, the capacity is less than  $\frac{1}{2}$  that of normal Ni-Cads. The 92266A uses an AC wall transformer with a cable to a box that holds the cells. The cost is \$36.95. The lowest cost system is the 41-835 Multi-Charger. It is one piece and will charge N, AA, AAA, and 9 volt batteries for \$19.95.

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