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Number 21 on your Feedback card

The Care and Feeding of NiCds

Some clever tips for long life, plus a neat home-brew charger.

In today's world of rechargeable lithium-ion, nickel metal hydride, and renewable alkaline batteries, traditional nickel cadmiums may still be your most logical and cost-effective choice. Here, long-time battery wizard K9TRG explains some ground floor facts and offers up an easy-brew charger for these gems.

There has been *much* misleading information about NiCds. First of all, memory in most *modern NiCds* is almost nonexistent today. Much has been written about completely discharging NiCds before recharging them. If a NiCd cell is discharged much below the standard test voltage of 1 or 1.1 volts per cell, you stand a good chance of permanent cell reversal and loss of cells.

Some electronic devices have a low voltage cutoff circuit that is supposed to stop the complete depletion of the battery. It's possible that this is what was meant by completely discharging the battery before recharging. The statement is misleading, as it is wrong to allow a NiCd battery discharge to even near *zero volts* per cell.

The standard test for NiCd cells is capacity in mA, times one hour. Thus, a 450 mA cell or battery should deliver 450 mA for 60 minutes before it drops below 1.1 volts per cell.

It is difficult to have long battery life with quick or rapid charging. Heat is the enemy of any type of battery. Rapid charge batteries use several methods to prevent overheating and are only partially successful.

The charger circuit I would like to show here will solve several problems. First, it is inexpensive, simple, and has only a few parts. Secondly, you will have *some* fast charge capability, but more important, you will be able to leave the charger on forever, with no overcharging. This design has been used for 15 years on some batteries, and they are still going strong. A view of the charger's PC board assembled and ready for use is shown in **Photo A**. A view of the PC board (only) is in **Photo B**, and its circuit diagram is in **Fig. 1**.

We take advantage of some fixed assets in this design, for cost, simplicity, and safety. Select your power transformer keeping the following in mind: NiCds should be charged at 10 percent of their rated capacity. A 450 mA battery should be initially charged at *approximately* 45 mA, so a 50–75 mA transformer is acceptable. This is one of the fixed assets, to prevent battery overcharging.

As for the AC output voltage, select a transformer with a voltage rating about 1.4 times the desired DC voltage, plus .75 volts for each of the 2 diodes and regulator. If, for example, you want to charge a 12 volt battery pack, the AC RMS voltage should be about 19 volts. Any more, and you will

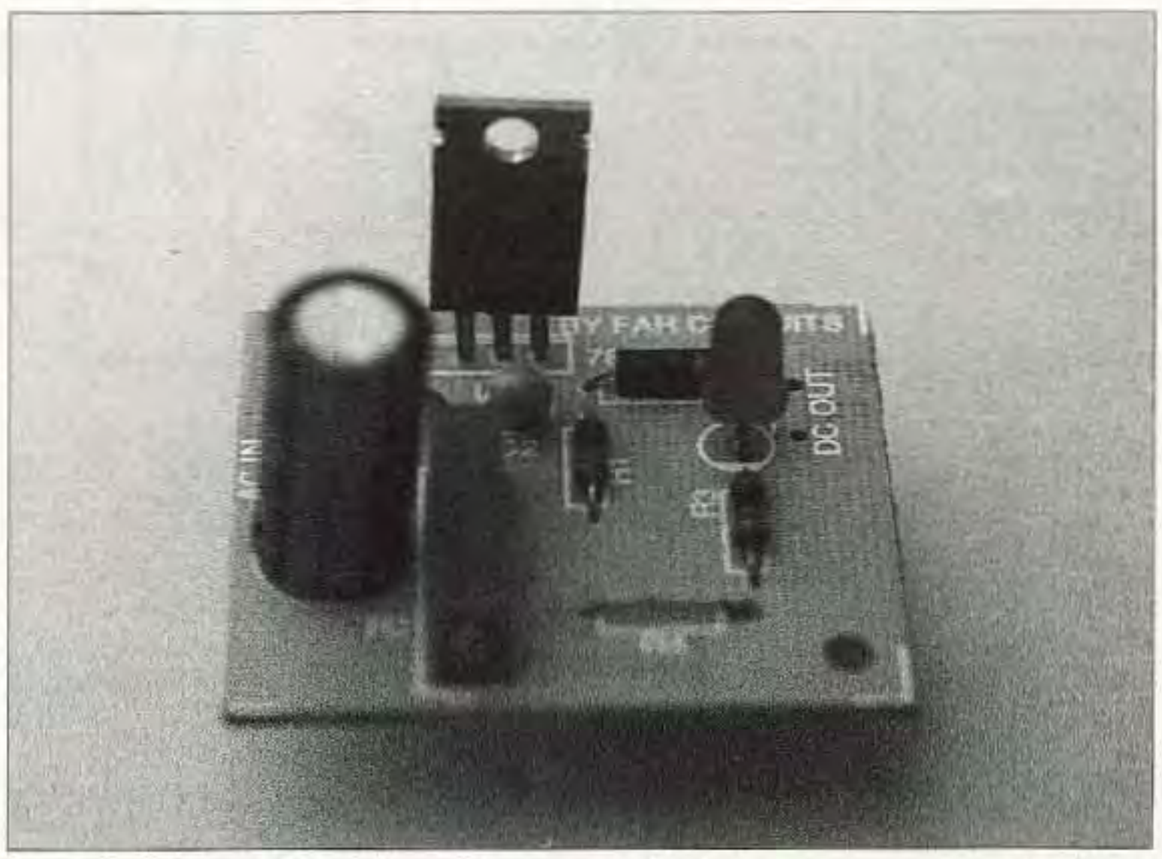

Photo A. *The K9TRG multipurpose NiCd charger assembled and ready for interconnection to an external transformer, as discussed in text. Board is only 1.5 inches square. Photo by K4TWJ.*

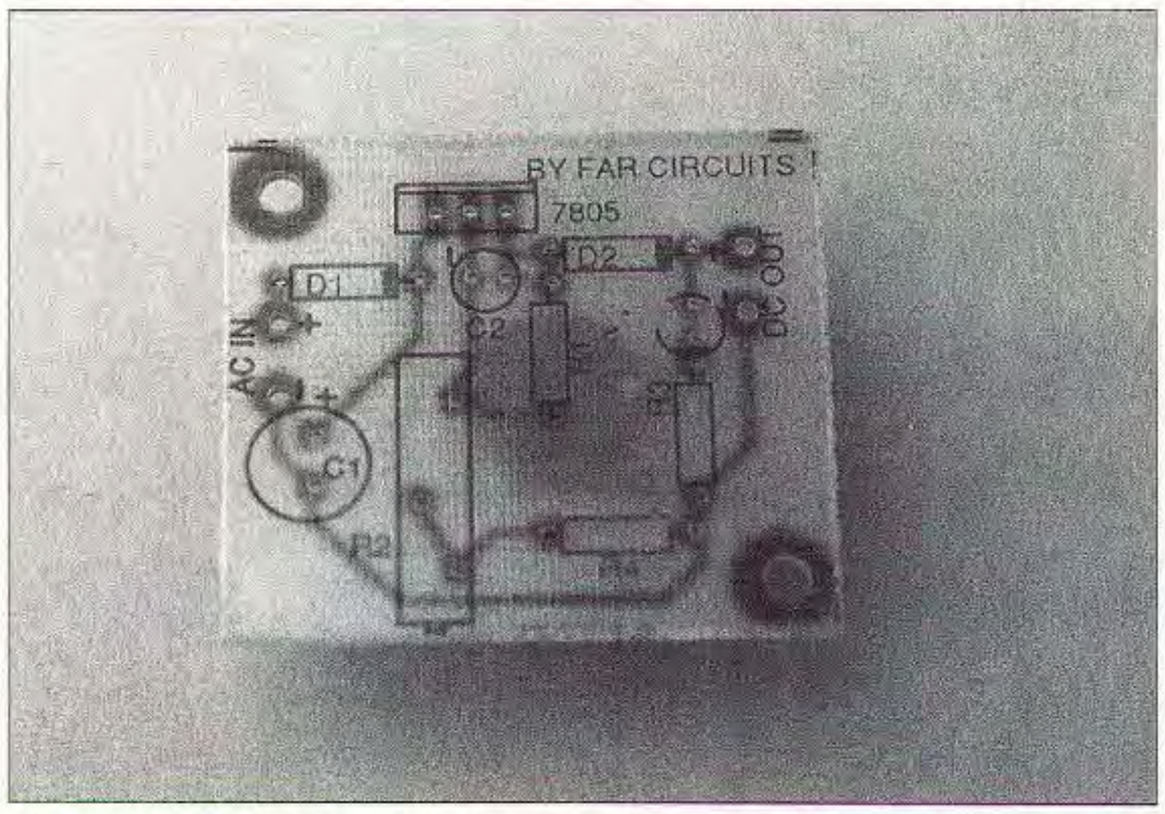

Photo B. *FAR Circuits' PC board of the K9TRG multipurpose NiCd charger is pre-drilled and silk-screened, with a parts placement guide for easy and foolproof home assembly. Photo by K4TWJ.*

Parts List		
Name	**RS No.**	**Cost**
D1, D2	276-1101 or 276-1102	2 for $.49
D3	276-026	2 for $1.29
C1	272-1030	$.99 ea.
C2	272-1435B	$.69 ea.
7805	276-1770	$1.19 ea.
R1, R3	271-1321	4 for $.49
R2	271-342	$1.49 ea.
PCB	Far Circuits, 18N640 Field Court, Dundee IL 60118; fax (847) 836-9148; $3.00 ea.	

Table 1. *Parts list.*

have excessive heat to dissipate; any less, and you will not have enough voltage to reach the full rated charge current. The excess heat is not a problem for the regulator, provided you use the proper heat sink. Wall transformers are a good choice, as they are plentiful and inexpensive at hamfests.

The next fixed asset we take advantage of is the 7805 regulator. It is rated at 1 amp if properly heat sinked, but more importantly, it has thermal limiting. The 7805 regulator is normally fixed at 5 volts; however, with 2 extra resistors it can be configured for any output voltage from 5 to 30 volts.

To describe the circuit and the built-in safety features we mentioned earlier, we use the current limiting of the transformer as part of the method to avoid overcharging the battery. The fixed asset of the 7805 voltage regulator is its internal thermal overload protection. Unless you are charging high current batteries (that need over 200 mA), we recommend you delete the heat sink. The regulator will pass 100–200 mA with out it for some time and will shut down automatically if you accidentally draw more current for some period of time. This *also* protects the battery from overcharge.

D1–D2 can be almost any silicon diodes; 1N4001s should work well here, as they are rated at 1 amp and have a PIV of 50 volts. For the 10 cells used for this article, R1 is 1000 ohms and R2 is a 1000 ohm, 15-turn Radio Shack pot for easy vernier fine tuning. R2 ideally should be closer to 1500 ohms, but is not easily available; add 1-2-300 ohms for more R4 if a little more output voltage is required. Be sure to place a jumper in its place if you use the FAR Circuits PC board, and do not use the extra resistor. R3 is 1000 ohms and D3 is an LED to indicate power; both may be deleted if desired. C2 is a 2.2 µF. tantalum, C1 is 470 µF, and both can be rated at 25 to 50 volts. D2 prevents a back voltage of the battery from destroying the regulator. Charging *voltage* for *NiCds* should be about 1.4 to 1.45 volts per cell at full charge, or approximately 10 x 1.43 = 14.30 *volts* for a battery pack. NiCds like some AC component in their charging. In fact, some inexpensive chargers use 115 volts AC from the line with a current limiting resistor, or pilot light, and a diode, period.

Now we need a little patience to adjust *properly*. Set R2 to maximum voltage, and monitor the charge *current*. Adjust R2 for about 10 percent of the rated capacity of the battery or pack. Leave this setting for 24 hours. Then *slowly* adjust R2 so that the charge current is about 1 or 2 percent of the battery capacity; the charge voltage should be about 14.32 volts. Leave this set for another day or so, then reset R2,

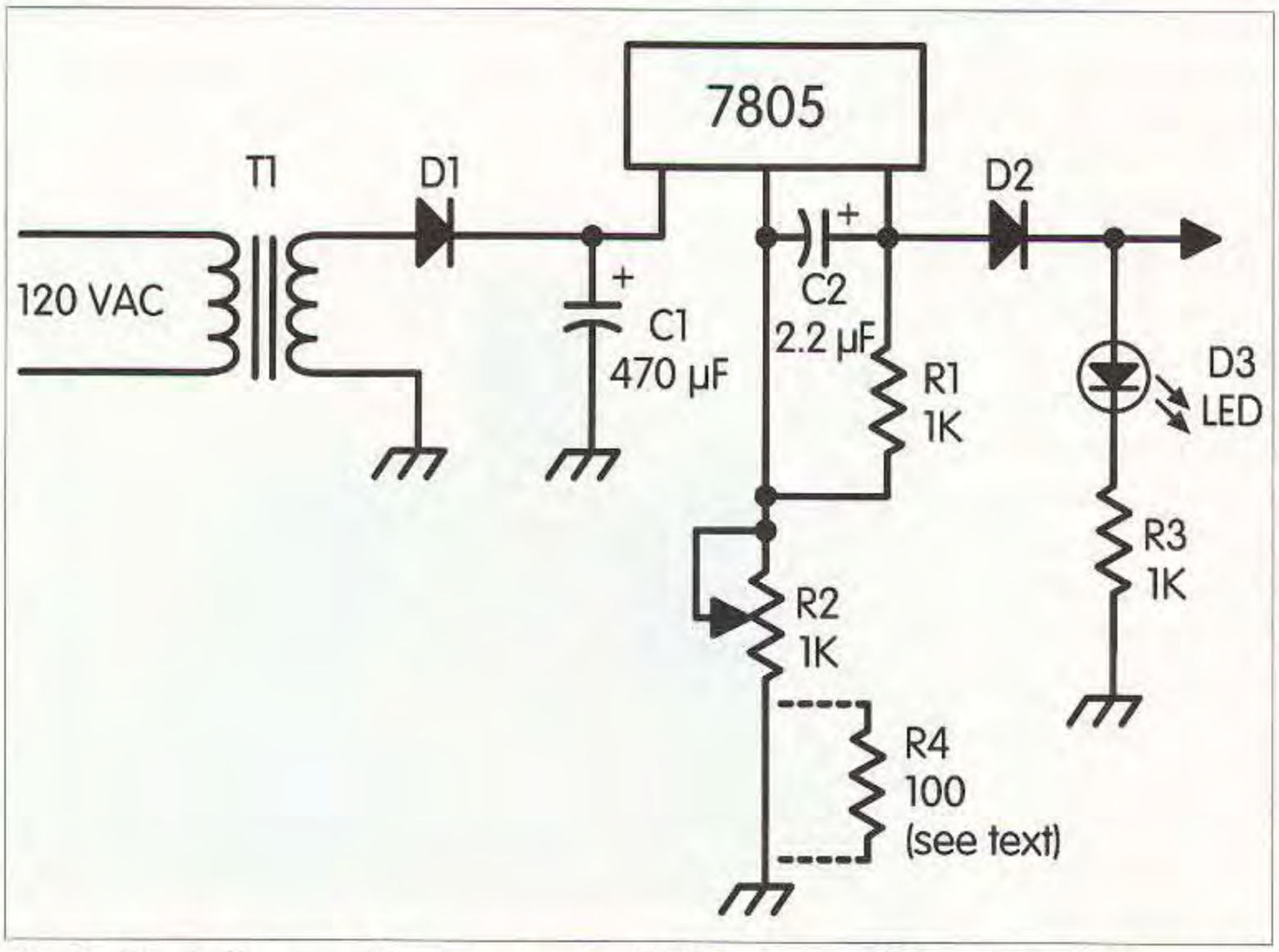

Fig. 1. *Circuit diagram of the multipurpose K9TRG charger. PC boards for easy assembly available from FAR Circuits.*

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so that the current is still about 1–2 percent of the rated battery current. What we are doing is setting the trickle charge current to the internal resistance of a fully charged battery or pack.

To test the circuit, attach any kind of small load to the battery for just a *few seconds.* Now turn on the charger again and watch the current. You should see the current go up, to something less than the maximum of the power transformer and the regulator. It will *slowly taper back down* to the *safe* 1 to 2 percent of the rated battery capacity. The transformer, regulator, and proper setting of R2 will result in an *automatic* charger that will give you some fast charge in the beginning *and a safe* trickle charge that you can maintain connected forever.