

## Installing the Cab06R Battery Charger

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**Overview:** This document describes how to add four components into a Cab06R to enable the battery charger. The internal printed circuit board has been designed to accept these components and they just need to be soldered in place. This charger allows NIMH or NiCad batteries to be recharged anytime the Cab06R is plugged into the cab bus.

### Warnings:

- Enabling the charger requires the soldering small surface mount components to the internal printed circuit board and the modifications should be only attempted by those with sufficient electrical assembly skills.
- Once the charger is in place regular alkaline batteries CANNOT be used in the Cab06R. Charging standard batteries can cause them to leak, or worse possibly explode. I would strongly recommend that a label be stuck on the back of the battery door that says “**rechargeable batteries only**”.
- NCE does not officially support the charger and if asked about it they will say “what charger?” Note that if you proceed you are doing so at your own risk.
- **Remove the batteries before opening the case of the Cab06R!**

### Parts List:

Qty	Part Number	Description	Digikey #	Cost
1	LM317DCYR	Adjustable Regulator (TI, SOT-223-4 pkg.)	296-12602-1-ND	\$0.71 ea
1	0.1 uF, 50 volt, X7R	0805 surface mount capacitor	478-1395-1-ND *	\$0.44 for 10 (Avx)
1	24Ω, 5%, .1 watt	0805 surface mount resistor	P 24 ACT-ND *	\$0.04 ea (Panasonic)
1	1 amp, 50 volt	SMA pkg, surface mount diode, CGRA4001-G	641-1016-1-ND *	\$0.42 ea (Comchip)

Other notes: A good source for the surface mount diodes can be the stock lighting boards that come out of locos when you install your DCC decoders. Athearn Genesis units each contain 6 surface mount diodes that will work just fine. All of the other parts can be purchased online from Digikey electronics at <http://www.digikey.com>

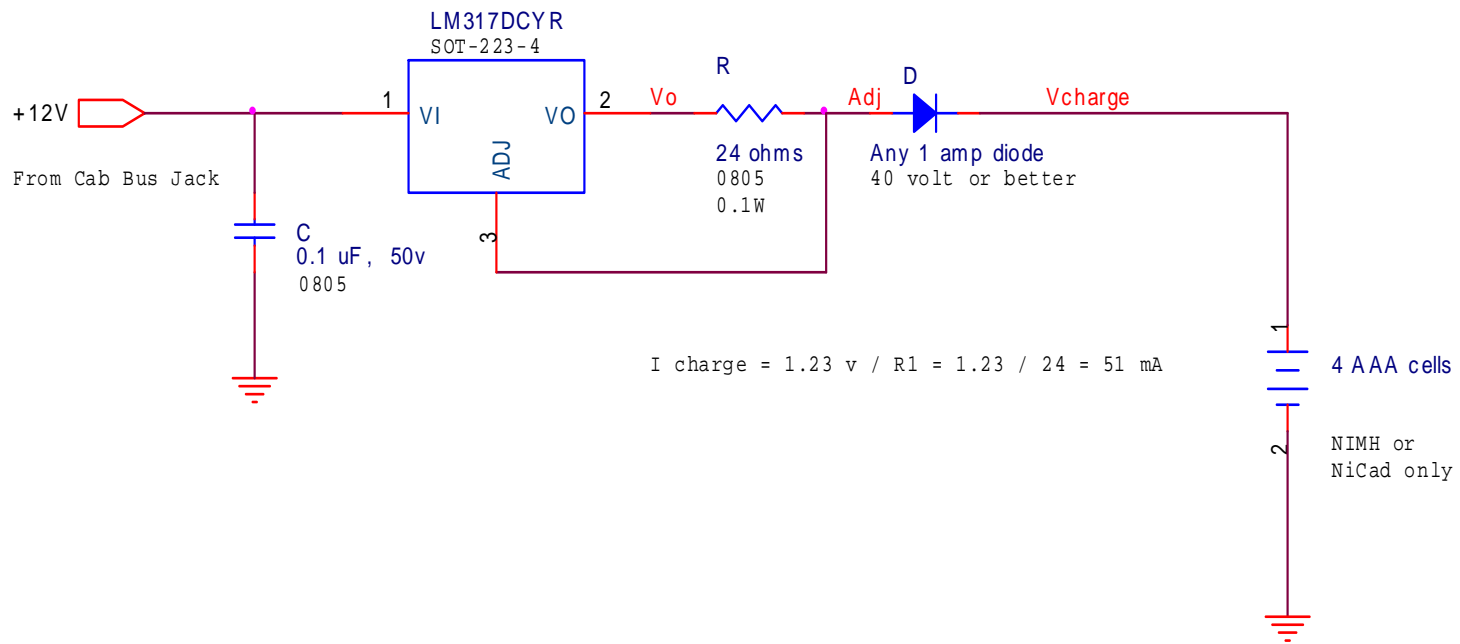
\* Digikey carries these parts from many different suppliers; only one part number is shown as an example.

**Circuit Description:** The battery charger circuit is a constant current source built from a LM317 regulator IC. As shown on the next page the charger consists of four components, one capacitor, one LM317 regulator, one resistor, and one diode. The LM317 acts a constant current source because it always tries to maintain a constant voltage of 1.23 volts between the pins of VO (voltage out) and ADJ (adjust). By placing a resistor between these pins a constant current source equal to  $1.23 \text{ v} / (\text{value of } R1)$  is created. In this case a resistor of 24 ohms was chosen resulting in a current source of  $1.23 \text{ v} / 24\Omega = 51 \text{ mA}$ . A series diode on the charger output assures that the current will only flow into the batteries, preventing reverse current flow when the charger is not active.

Standard NIMH rechargeable AAA cells have a capacity that ranges from 750 mA hours to 850 mA hours depending on the battery brand. While NIMH batteries can be charged in under two hours this requires a complex charger that automatically turns off at full charge. The objective here is a simple charger that can be more or less left on indefinitely without the damaging the batteries. Battery chargers are typically rated based on that capacity of the batteries they are charging, if the battery is a 750 mA hour battery and the charger can charge at 750 mA then the charger would be rated at one C, where C equals the ratio of the charge rate compared to the capacity of the battery. If the charger charged at 375 mA and the battery capacity was 750 mA hours then the charge rate would be  $375 / 750 = \frac{1}{2} C$ .

Trickle chargers are typically defined by a charge rate of 0.1C or less. While NICAD batteries can be charged almost indefinitely at 0.1C without damage NIMH batteries are somewhat more sensitive from the documentation I can find. This charger is designed for a charge rate of 0.07C (51 mA / 750 mA hours) for a couple of reasons. The charge current is less than 0.1C to minimize the potential for battery damage due to long term over charging and to limit the amount of extra current pulled from the cab bus. Approximately 50 mA of charge current seemed to be a good compromise.

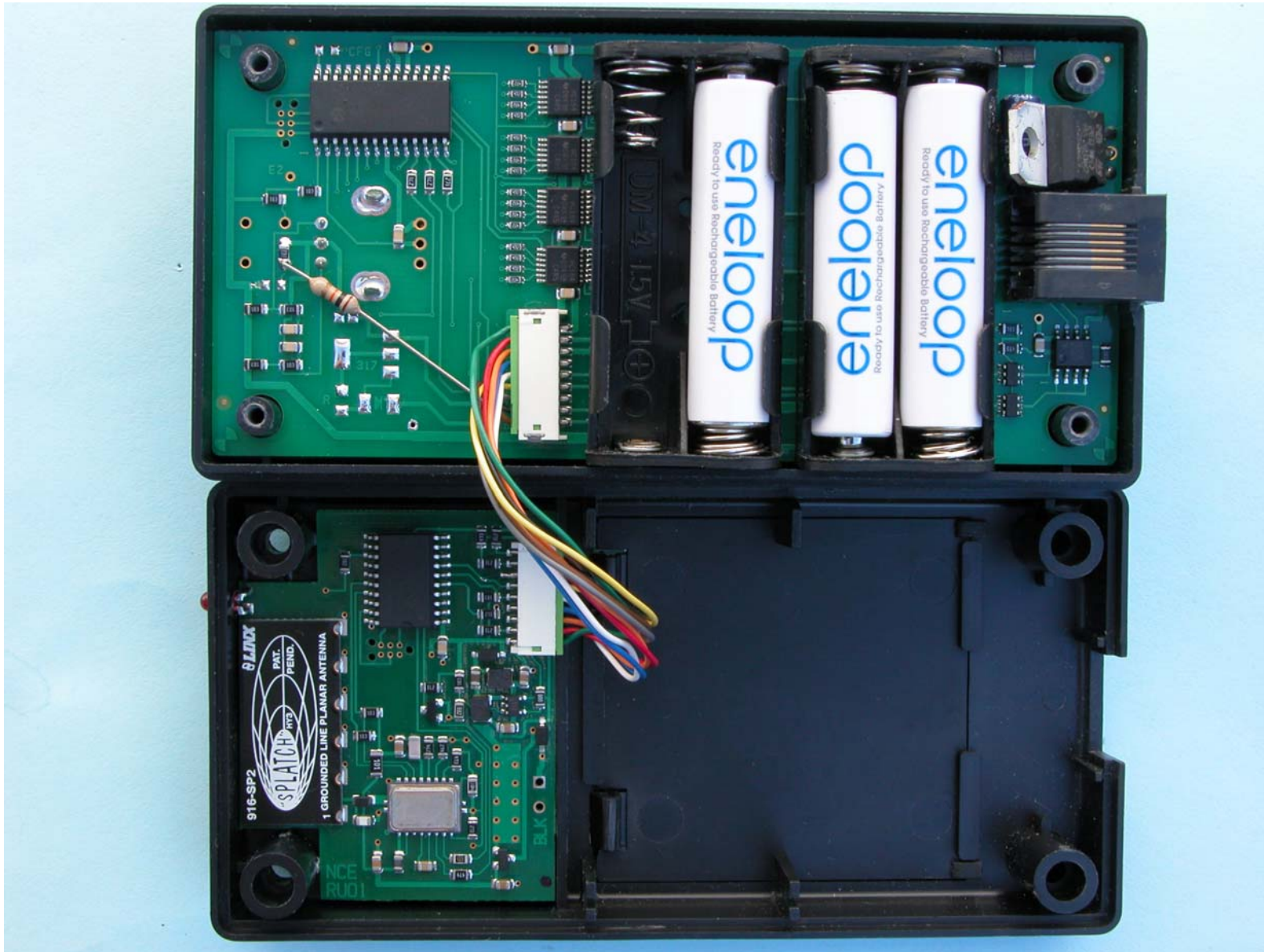
When charging a battery requires more energy than its capacity to be restored to a full charge. The amount of charge energy needed is typically 160% of the battery capacity. That is why the typical 0.1C (1/10 C) charger takes 16 hours to recharge instead of 10 hours. So for this trickle charger with a rate of 0.07C the time to fully charge the batteries will be  $160\% / 0.07 C = 23$  hours. Basically a nice round 24 hours to recharge.



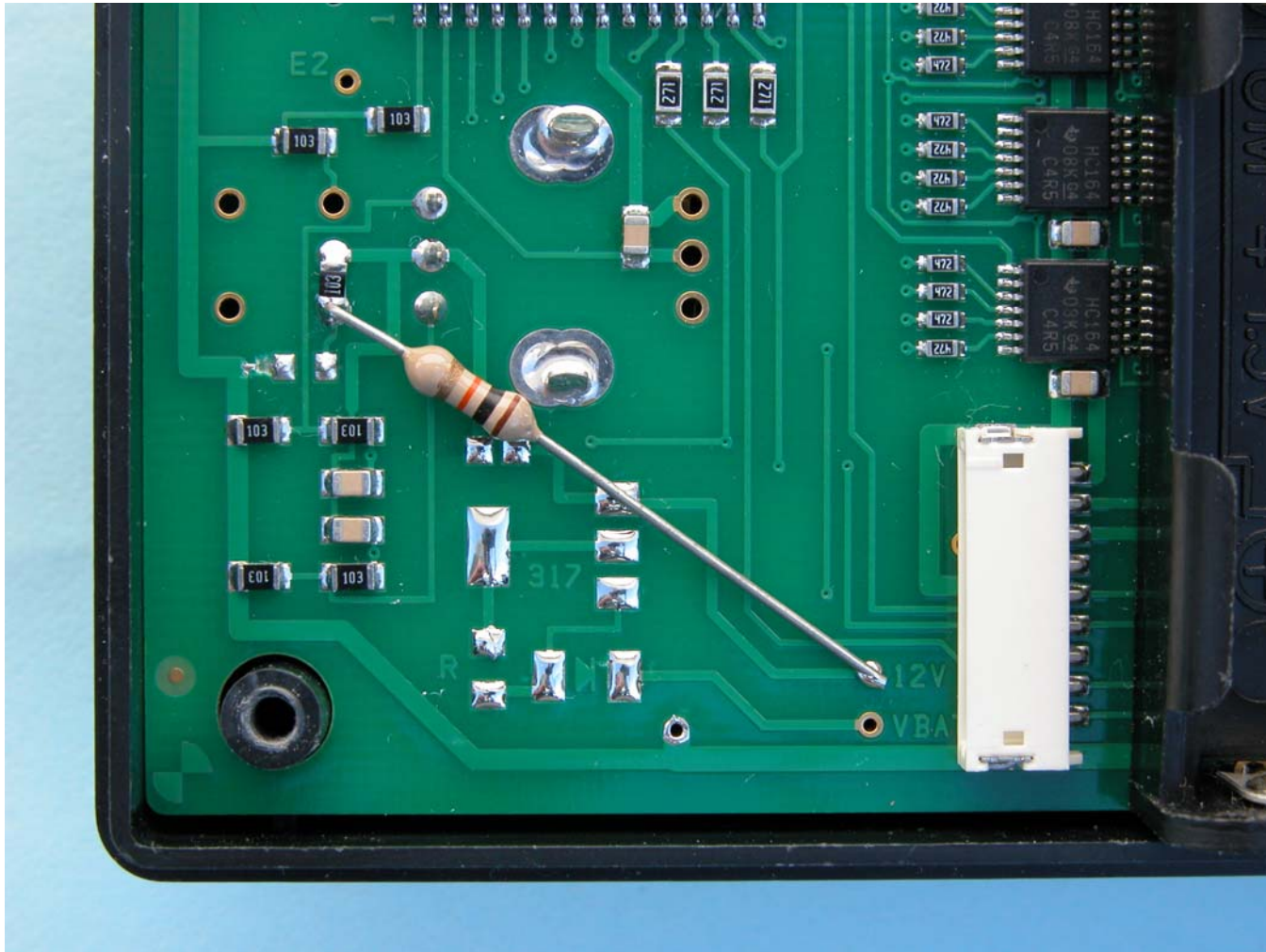
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## Installation Procedure:

Step 1: Take the batteries out of the Cab06R and then remove four screws on the back cover to open up the cab. Once opened the cab should look like this.

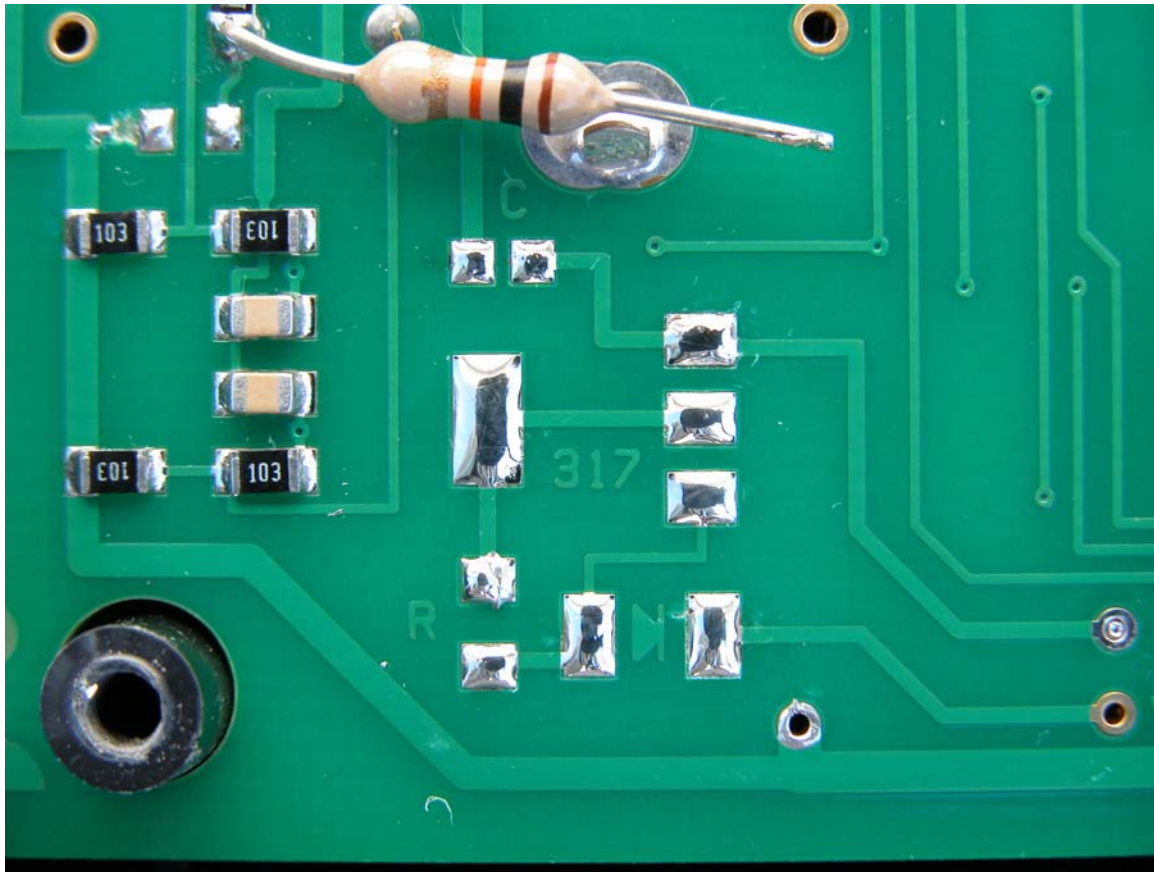


Step 2: Unplug the 9 pin cable from the connector on the Cab and set the back cover and the radio module aside. Your cab should look like the picture below.



Rework resistor connected to 12V hole

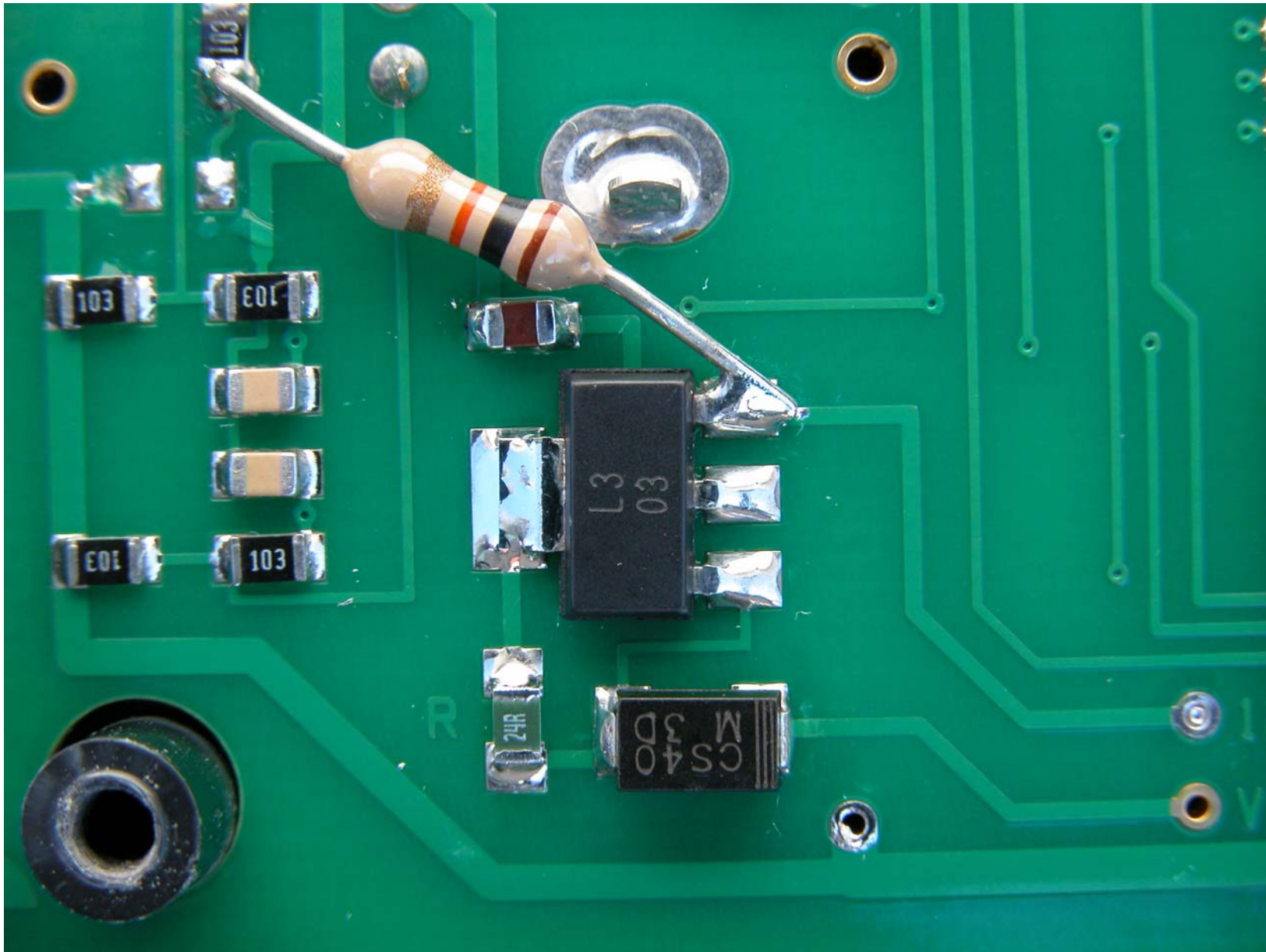
Step 3: Unsolder one end of the rework resistor and move it out of the way so that you can access the area where the charger parts need to be installed.



This photo shows the area of the printed circuit board where the four charger components will be installed. The labels indicate where the parts get installed.

- “C” - 0.1uF capacitor
- “R” - 24 ohm resistor
- “317” - LM317DCYR
- “>|” - Diode

Step 4: Solder the four parts in place as shown. Make sure that the banded end of the diode is installed facing towards the right. (towards the hole that says VBAT) After installing the parts in place solder the end of the rework resistor back in place. If the resistor lead isn't long enough to reach the 12V hole it can be attached to the pad on the LM317 as shown in the picture below:



Step 5: Testing the charger.

1. Reconnect the radio board to the cab by plugging the 9 pin cable into the white connector.
2. Install four NIMH or Nicad rechargeable batteries.
3. Connect a cord to the cab and plug it into a live cab bus jack.
4. Use a multimeter set on DC volts and measure the voltage across the 24 ohm resistor. The 24 ohm resistor is the part marked with "24R" in the photo above. If the charger is working you should measure +1.23 volts across the resistor, with red multimeter lead going to the upper end of the resistor, and the black lead going to the lower end of the resistor. (When oriented as shown in the photo above). If you read 1.23 volts or so the charger is working.

Step 6: Reassemble the cab by securing the four screws into the back cover.

Step 7: Place a label on the battery cover that says "Rechargeable batteries only"

### **Other Considerations:**

With a charger installed the cab will draw more current when plugged into the cab bus. If more than a few Cab06R's are going to be plugged into the cab bus it becomes important to provide an additional +12 voltage source to the cab bus. NCE's or Tony's UTP patch panel provides a convenient jack that can be connected to an external wall wart supply.

The extra wall wart supply also allows you to charge your radio Cab06Rs without having to power up your command station. After an operating session just power down the command station and plug your Cab06Rs into the command bus and they will be fully recharged the next day.

### **Closing:**

If you have any questions I can be contacted by email at [mark@markschutzer.com](mailto:mark@markschutzer.com) . This write-up can be found at <http://markschutzer.com> .