Ten Most Asked Questions On The LTC4010 / 4011 NiCd / NiMH Battery Charger

(Part 1)

Question 1: I'm charging my 2500mA/hr NiMH battery at 500mA, but the charger always gives a FAULT condition, what am I doing wrong?

Answer: The charge rate (charge current) is much too low. The C/5 charge rate (500mA / 2500mA = C/5) is not high enough for the battery to produce the voltage and temperature profile that the charger requires for proper charge termination. A charge rate of C/2 to 1C is usually needed, although there have been some batteries that will terminate the charge cycle with a C/3 charge rate.

Question 2: Can I set the timer for more than 4.3 hours?

Answer: No. If it requires more than 4.3 hours to charge the battery, the charge rate is set too low for the charger to have a valid charge termination. Leaving the timer pin open sets the timer to it's maximum of approximately 4.3 hours.

Question 3: With a battery connected and the input voltage applied, my pc board READY and FAULT LEDs flash, what is happening?

Answer: The most likely cause of this is inadequate capacitive bypassing on the Vcc pin. A 1μF X5R ceramic capacitor located close to the Vcc and GND pins of the IC is recommended. Additional capacitance near the pc board edge may be necessary if long wires are used between the input supply and the charger.

Question 4: I want to use the timer to end the charge cycle, is this possible?

Answer: No. The timer is a fail-safe feature that will end the charge cycle and indicate a FAULT condition if a valid -dV/dt or dT/dt charge termination does not occur by the end of the time period. The FAULT usually indicates a bad battery or some other battery problem. A FAULT initiated by the timer is a latched mode requiring that the input power be removed and reapplied or the battery replace with a different battery before a new charge cycle can begin. Note; an excessive die temperature or excessive battery temperature, as sensed by a thermister, can also indicate a FAULT, but these FAULTs are not latching.

Question 5: Why does the LTC4010/4011 require 2V/cell + 300mV for the input supply voltage, don't the cells normally require about 1.5V when charging?

Answer: Yes, when charging, each cell can typically have from 1.4V to 1.7V depending on charge current, battery type, battery age, etc. The reason 2V is required is because the overvoltage threshold FAULT limit is 2V (1.95V typ). If something happens to the battery when charging, and the voltage rises above 2V/cell, the charge current will stop and the charger will go into a FAULT mode. If the input voltage is not at least 2V/cell (+300mV of headroom), the charger will not be able to exceed the 2V/cell threshold (measured on the V_{CELL} pin), and the charger could continue forcing constant current into a problem battery. One more comment, the constant current section of the charger can operate with an input voltage a few hundred mV above the battery voltage, although the overvoltage threshold limit can never be reached.

Question 6: Is it really necessary to use thermister when charging a battery?

Answer: No, but a thermister in contact with one or more cells in a battery pack is a very good idea for two reasons. It prevents charging below 5°C or above 45°C, which can be harmful to a battery. A more important reason is that it is the better of the two charge termination methods used by the LTC4011 because it minimizes overcharging resulting in an extended battery life.

Question 7: What changes occur in a nickel based battery as it approaches full charge?

Answer: The first indication that a cell is near full charge is a rapid increase in internal cell pressure, unfortunately, this is not easily detected. As the charge cycle continues, the next change occurring is a rapid rise in cell temperature, which can be detected using a thermister. The LTC4011 requires that the temperature rise exceed 1°C/minute for 2 minutes for a valid dT/dt charge termination for NiMH cells (2°C for NiCd cells). Lastly, because of the cell voltage negative temperature coefficient, the rising cell temperature causes the cell voltage to drop (after reaching a peak). This drop in cell voltage (10mV/cell for NiMH and 20mV/cell for NiCd) is used by the charger to initiate a -dV/dt charge termination. Since the drop in cell voltage is the last change to occur, by this time the cell could be in a substantial overcharge condition, which will shorten battery life.

Question 8: What are the differences between the NiCd and NiMH settings?

Answer: The only difference is in the charge termination methods. For NiCd, the -dV/dt threshold for charge termination is 20mV and 10mV for NiMH. The rate-of-temperature rise termination method (dT/dt) for NiCd cells is 2°C/minute for 2 minutes. For NiMH cells above 1.325V the temperature rise must exceed 1°C/minute for 2 minutes, and if charge termination is due to dT/dt, a TOP-OFF charge with reduced current for 1/3 of the total time period is added at the end of the charge cycle. There is no TOP-OFF for NiCd cells.

Question 9: My NiMH battery has completely discharged and the LTC4011 will not even start a charge cycle, why?

Answer: If a single cell voltage (voltage on the V_{CELL} pin of the LTC4010 or 4011) is below 350mV, the charger assumes that the battery is defective and no charging will begin. Unfortunately, many NiMH cells have a relatively high discharge rate which means that after sitting unused for a period of time, the cell voltage could be very low. There are a few modifications to the charger circuit to minimize this situation, which is beyond this question and answer article. Please contact the Applications Group for more information.

Question 10: When I charge my new battery for the first few times, it doesn't get fully charged or sometimes it goes into a FAULT mode, why is it doing this?

Answer: When a NiCd or NiMH battery is initially manufactured, it has no charge. After manufacture, a voltage is applied to the battery which begins to "form" the battery, causing the battery to start behaving like a typical battery and begins to accept charge. Often, manufacturers sell batteries that have only been partially "formed", resulting in strange results when the end user begins charging the battery. Typically, batteries require from 3 to 5 full-charge/full-discharge cycles before they begin to exhibit the charge voltage and temperature profile that the LTC4010/4011 require for proper charge termination. Batteries not fully formed can exhibit unusual voltage profiles resulting in a false charge termination.

Also, batteries that have not been charged for a long time, or that have been completely discharged may also require a few charge cycles before they will charge correctly.

10/31/2008