

## CHARGE METHODS FOR NICKEL METAL HYDRIDE BATTERIES

Charge is the process of restoring a discharged battery to its original capacity. In order for a battery to be usable for a long period of time, it must be charged via the proper charge method. Various methods are used to charge rechargeable cells, but Panasonic recommends the charge methods described below to charge its nickel-metal hydride batteries.

- (1) Rapid charge current: 1CmA (rapid charge temperature range: 0°C to 40°C). In order to exercise proper control to stop rapid charge, it is recommended that batteries be charged at over 0.5CmA but less than 1CmA. Charging batteries at a current in excess of 1CmA may cause the safety vent to be activated by a rise in the internal pressure of the batteries, thereby resulting in electrolyte leakage. When the temperature of the batteries is detected by a thermistor or other type of sensor, and their temperature is under 0°C or over 40°C at the commencement of the charge, then trickle charge, rather than rapid charge, must be performed. Rapid charge is stopped when any one of the values among the types of control described in (4), (5), (6), and (11) reaches the prescribed level.
- (2) Allowing a high current to flow to excessively discharged or deep-discharged batteries during charge may make it impossible to sufficiently restore the capacity of the batteries. To charge excessively discharged or deep-discharged batteries, first allow a trickle current to flow, and then proceed with the rapid charge current once the battery voltage has risen.
- (3) Rapid charge start voltage: Approx. 0.8V/cell  
Rapid charge transition voltage restoration current: 0.2 ~ 0.3 CmA
- (4) Upper battery voltage limit control: Approx. 1.8V/cell. The charge method is switched over to trickle if the battery voltage reaches approximately 1.8V/cell due to trouble or malfunctioning of some kind.
- (5)  $\Delta V$  value: 5 to 10mV/cell. When the battery voltage drops from its peak to 5 to 10mV/cell during rapid charge, rapid charge is stopped, and the charge method is switched over to trickle charge.
- (6)  $dT/dt$  value: Approx. 1 to 2°C/min. When a rise in the battery temperature per unit time is detected by a thermistor or other type of temperature sensor during rapid charge, and the prescribed temperature rise is sensed, rapid charge is stopped and the charge method is switched over to trickle charge.
- (7) TCO: 55°C (for A, AA and D sizes), 50°C (for QA, AAA and prismatic sizes), 60°C (for L-A, L-fatA and SC sizes). The cycle life and other characteristics of batteries are impaired if the batteries are allowed to become too hot during charge. In order to safeguard against this, rapid charge is stopped and the charge method is switched over to trickle charge when the battery temperature has reached the prescribed level.
- (8) Initial delay timer: to 10 min. This prevents the  $-\Delta V$  detection circuit from being activated for a specific period of time after rapid charge has commenced. However, the  $dT/dt$  detection circuit is allowed to be activated during this time. As with Ni-Cd batteries, the charge voltage of nickel-metal hydride batteries may show signs of swinging (pseudo  $-\Delta V$ ) when they have been kept standing for a long time or when they have discharged excessively, etc. The initial delay timer is needed to prevent charge from stopping (to prevent malfunctioning) due to this pseudo  $-\Delta V$ .
- (9) Trickle current: 0.033 to 0.05CmA. When the trickle current is set higher, the temperature rise of the batteries is increased, causing the battery characteristics to deteriorate.
- (10) Rapid charge transfer timer: 60 min.
- (11) Rapid charge timer: 90 min. (at 1It charge)
- (12) Total timer: 10 to 20 hours.

The overcharging of nickel-metal hydride batteries, even by trickle charging, causes a deterioration in the characteristics of the batteries. To prevent overcharging by trickle charging or any other charging method, the provision of a timer to regulate the total charging time is recommended.

**Note:** The temperature and voltage of nickel-metal hydride batteries varies depending on the shape of the battery pack, the number of cells, the arrangement of the cells and other factors. Therefore Panasonic should be consulted for more detailed information on the referenced charge control values. The charge methods described previously can be applied also when both nickel-metal hydride batteries and Ni-Cd batteries are employed in a product, but Panasonic should be consulted for the control figures and other details.

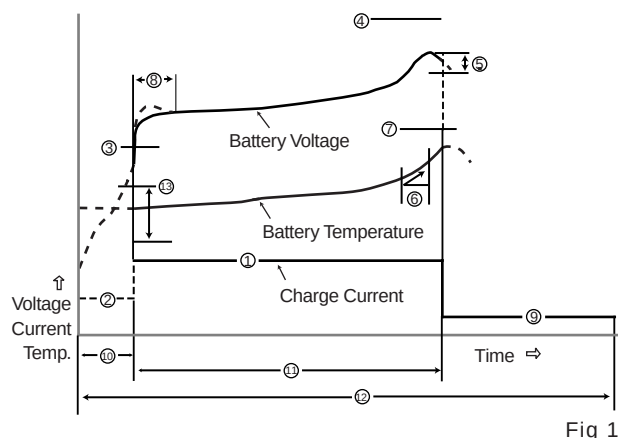
# CHARGE METHODS FOR NICKEL METAL HYDRIDE BATTERIES - CONTINUED

- Recommended nickel-metal hydride battery charge system\*

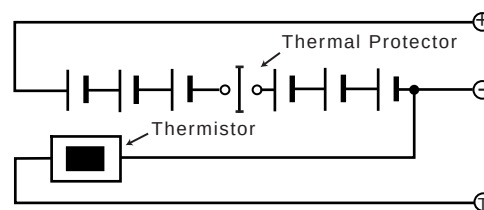
|                                                         |                                                                                                               |
|---------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| (1) Rapid charge current                                | Max. 1CmA to 0.5CmA                                                                                           |
| (2) Rapid charge transition voltage restoration current | 0.2 to 0.3CmA                                                                                                 |
| (3) Rapid charge start voltage                          | Approx. 0.8V/cell                                                                                             |
| (4) Charge terminating voltage                          | 1.8V/cell                                                                                                     |
| (5) $-\Delta V$ value                                   | 5 to 10mV/cell                                                                                                |
| (6) Battery temperature rising rate $dT/dt$ value       | 1 to 2°C/min                                                                                                  |
| (7) Maximum battery temperature TCO                     | 60°C (for L-A, L-fatA and SC sizes)<br>55°C (for A, AA and D sizes)<br>50°C (for QA, AAA and prismatic sizes) |
| (8) Initial $-\Delta V$ detection disabling timer       | 5 to 10 min                                                                                                   |
| (9) Trickle current (after rapid charge)                | 0.033 to 0.05CmA                                                                                              |
| (10) Rapid charge transfer timer                        | 60 min                                                                                                        |
| (11) Rapid charge timer                                 | 90 min (at 1CmA charge)                                                                                       |
| (12) Total timer                                        | 10 to 20 hours                                                                                                |
| (13) Rapid charge temperature range                     | 0 to 40°C                                                                                                     |

- \* Matching test is required because these values vary depending on rapid charge current, number of cells, configuration of battery pack, etc.

- Example of a Rapid Charge System



- Basic Pack Configuration Circuit



## NiMH "H" Series Recommended Charge System for back-up power applications (Applies to HHR210AH & HHR350AH Cylindrical cells)

The optimal charge system for the NiMH "H" Series for back-up power applications is an intermittent timer charge. An intermittent timer charge improves charge efficiency, extends battery life (-vs-trickle charge) and reduces electricity consumption up to 30% compared to trickle\* charge.

Intermittent Timer Charge: (see diagram below)  
At the beginning of the charge, an IC timer is started and charging is activated at a current of 0.1It until the timer stops and the charge is terminated. When the batteries self discharge down to a set point (1.3V), the timer charge is re-activated.

\*Trickle charge is not recommended for NiMH batteries. Please consult Panasonic on any NiMH applications requiring trickle charge.

- Example of intermittent timer charger system:  
Average Charge Current: 0.1 ItA  
Re-charge time: 16 hours  
Pulse charging can be used

