SPECIFICATION

For
Rechargeable Li-Ion Cell

MODEL 2993

Greatbatch Medical

11,900 Walden Avenue
Alden, NY 14004 U.S.A

Cell, Rechargeable Li-Ion,
Model 2993

	DOCUMENT NO.	REV.
	2993	B

REV	ECO NO.	DESCRIPTION OF CHANGE	ORIGINATOR	DATE
A	**13547**	Release of Specification for Li Ion Model 2993	M. Roy	03 NOV 09
B	**14305**	Add Sec. 4.1.4 for cell thickness, update Fig. 1 dimension and replace Fig. 4	M. Roy	21 FEB 11

1.0 PURPOSE

To define the requirements for Greatbatch, Inc. (GB) Model 2993 rechargeable Li-Ion cell.

2.0 REFERENCES

2.1 ST/SG/AC.10/11, *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*, Part III, sub-Section 38.3 (Lithium Batteries).

2.2 MIL-STD-202, *Test Methods for Electronic and Electrical Component Parts*.

2.3 MIL-STD-883, *Test Methods and Procedures for Microelectronics*.

2.4 1QUL-0531, *GB Qualification Protocol for Li-Ion Rechargeable Cells*.

3.0 DEFINITIONS

3.1 **C/X:** A calculation used in the rechargeable cell industry to determine charge and discharge rates based on cell capacity, where C is the nominal, theoretical capacity of the cell and X is the theoretical number of hours it would take to discharge the cell.

3.2 **State-of-Charge**: Refers to the percent capacity currently stored in the cell relative to the nominal fully-charged theoretical battery capacity.

3.3 **Self-Discharge:** Discharge that takes place while the cell is at open circuit voltage. Defined as the difference between the cell capacity prior to a defined storage period and the capacity retained after the storage period divided by the nominal fully-charged capacity.

3.4 **AC Impedance:** A measured AC impedance of a cell at 1KHz, 10mA (r.m.s.) condition.

3.5 **Formation:** Sequence of charges and discharges applied to the battery after construction but before shipment.

4.0 SPECIFICATION REQUIREMENTS

4.1 MECHANICAL

4.1.1 **Configuration:** The nominal design envelope is shown in Figure 1.

4.1.2 **Materials:**

Case:	Titanium, Grade 5 or 23
Top and Bottom Lid:	Titanium, Grade 1 or 2
Positive Terminal Pin:	Molybdenum
Positive Terminal Seal:	Compression, Corrosion Resistant Sealing Glass

4.1.3 **Hermeticity:** Prior to shipment, the cells shall have a standard equivalent leak rate (L) of less than 1.0×10^{-7} atm cc/sec helium when tested in accordance with MIL-STD-883, Method 1014, test condition A2 or equivalent.

4.1.4 **Cell Thickness:** The case thickness will increase to a maximum of 0.223" when fully charged and discharged (2.75 V) 1000 times per conditions in section 4.2.7.

4.1.5 **Terminal Pins -** When tested per MIL-STD-202, Method 211, or equivalent, the terminal pins shall withstand 5 pounds axial pull without breakage or loss of hermeticity.

4.1.6 **Cell Markings:** As a minimum, each cell shall be marked with the following:
- Manufacturer's identification and model number.
- Serial number unique to each cell.
- Positive (+) terminal pin identification.
- An optional manufacturer's 2D ID matrix.

4.1.7 **Volume:** The nominal cell volume shall be 3.22 cubic centimeters.

4.2 ELECTRICAL

4.2.1 **Operating Voltage Range:** The nominal operating voltage range of the cell is 4.10 to 2.75 V. The maximum voltage is 4.150 V and the minimum voltage is 2.700 V.

4.2.2 **Charging Protocol:** GB recommends a constant current charge at a rate up to C/2 (108 mA) to 4.10 V followed by a constant voltage charge at 4.10 V to a C/20 (11 mA) cut-off, as shown in Figure 2.

4.2.3 **Capacity:** At shipment, the capacity of any cell charged per 4.2.2 will be at least 199 mAh when discharged at C/5 (43 mA) to a 2.75 volt cut-off and at a temperature of 37±2°C (Figure 3). The nominal capacity of the cell is 215 mAh.

4.2.4 **Maximum Continuous Discharge Current:** The maximum continuous discharge current is 1C (215 mA).

4.2.5 **Open Circuit Voltage at Shipment:** Cells are shipped at 20% state of charge. Room temperature open circuit voltage shall be a minimum of 3.71 volts and a maximum of 3.77 volts prior to shipment.

4.2.6 **AC Impedance:** The AC impedance of any cell at shipment will be less than or equal to 0.250 Ω when measured at 1 kHz. AC impedance is measured at 20% state of charge and 20 ± 5°C.

4.2.7 Production Sample Testing (Life Test): Cells will be cycled 1000 times between 4.10 and 2.75 V at 37 ± 2°C (Figure 4). Cells will be charged per paragraph 4.2.2. Cells will be discharged at C/10 (22 mA). The sampling plan will be as follows:

Shipment Volume	Sample Cells
0-5,000	1.0%
5,001-10,000	0.5%
>10,000	0.1%

4.2.8 Self Discharge: At 20 ± 5°C, cells will have an annual self-discharge rate of:<10% at 100% SOC and <5% at 20% SOC.

4.2.9 Shelf Life: Cells at 20% state-of-charge and a temperature of 20 ± 5°C will not require recharge for a period of 3 years from the formation date.

4.2.10 Overcharge: Cells shall be capable of withstanding an overcharge current of C/2 (108 mA) for 2.5 hours without venting, disassembly, rupture or fire.

4.2.11 Zero Voltage Storage: The irreversible capacity loss shall be less than 10% if a cell is discharged to near zero voltage with a 100 ohm resistor for one month at 37°C.

4.3 ENVIRONMENTAL

4.3.1 General: Cells shall meet all the safety requirements for the applicable tests for rechargeable cells referenced in ST/SG/AC.10/11, paragraph 38.3. For items 4.3.2 to 4.3.6, the cells shall not leak, vent or catch on fire and the open circuit voltage of cells after testing shall be at least 90% of their voltage immediately prior to the testing.

4.3.2 Low Pressure / Altitude Simulation: Cells shall be capable of storage at a pressure of 11.6 kPa (or approximately 50k ft.) or less for six hours at ambient temperature (20 ± 5 °C).

4.3.3 Thermal Shock: Cells shall be capable of withstanding ten (10) cycles as follows:
+75°C for 6 hours minimum.
-40°C for 6 hours minimum.
The transition time between each temperature change is 30 minutes maximum.

4.3.4 Vibration: Cells shall be capable of withstanding 12 cycles of sinusoidal waveform vibration (each cycle with a total time of 15 minutes) in each of three mutually perpendicular mounting positions as follows:
-7 Hz, $1g_n$ acceleration to 18 Hz.
-0.8 mm amplitude with increasing frequency to acceleration of 8 g_n.
-Acceleration of 8 g_n to a frequency of 200 Hz.
-Return to 7 Hz.

4.3.5 Transportation Shock: Cells shall be capable of withstanding three half-sine shocks in both the positive and negative direction of three mutually perpendicular mounting positions with peak acceleration of 150G, and pulse duration of 6 milliseconds.

4.3.6 Mechanical Shock: Cells shall be capable of withstanding three shocks of 1000G and 0.5 msec duration in two directions for each of three orthogonal axes.

4.3.7 External Short Circuit: Cells shall be capable of withstanding an external short circuit at 55°C with a circuit resistance less than 0.1 ohm without the cell external temperature exceeding 170°C and without leakage, venting, rupture or fire.

4.3.8 Impact: Cells shall be capable of withstanding a 9.1 kg mass dropped from a height of 61 cm onto a 15.8 mm diameter bar across the center of the wide or narrow faces of the cell without the cell external temperature exceeding 170°C and without rupture or fire.

4.3.9 Transportation Temperature Range: Cells shall be capable of withstanding -20°C to +60°C for 72 hours. Cells shall be capable of supplying a minimum of 80% of nominal capacity at a C/10 rate discharge within this storage temperature range.

5.0 OTHER REQUIREMENTS

5.1 Packaging: Batteries shall be packaged to prevent damage or electrical shorting by placing each battery in an individual compartment. The term “damage” includes dents, gouges, deformities, or bends in the two terminal pins. A temperature sensing label is included in each package to indicate exposure to temperatures in excess of 60°C. Cells will be shipped per DOT regulations.

5.2 Certification: A Certificate of Compliance is provided with each shipment stating that cells comply with the requirements of this document.

5.3 Traceability: GB shall maintain traceability of all materials and processes to individual cell serial numbers for a period of 10 years.

5.4 **Test Data:** Cell shipments are accompanied by the following data per serial number: capacity (mAh), AC impedance, formation date and open circuit voltage.

5.5 **Manufacturing Controls:** A control system is used to maintain documentation and processes that ensures consistency and reliability of the cell.

5.6 **Safety Considerations: CAUTION:** Both electrical and mechanical abuse may result in degradation of cell performance or more serious hazards, such as leak or explosion.

5.6.1 Do not short circuit, overcharge or over-discharge cells.
5.6.2 Do not crush, puncture, disassemble, incinerate or heat above 60°C.
5.6.3 Exposure to temperatures above 130°C could result in explosion.
5.6.4 Do not immerse cells in water.

5.7 **Cell Management:** GB is not responsible for fuel gauging, battery pack supervision or cell protection. Cell voltage must be maintained between 2.70 volts minimum and 4.15 volts maximum.

5.8 When soldering or welding to the terminals of the cell (battery), exercise proper precautions to prevent damage to the cell which may result in loss of cell capacity, seal, leakage, and/or cell explosion. Never solder directly to the cell body.

FIGURE 1: Drawing of cell

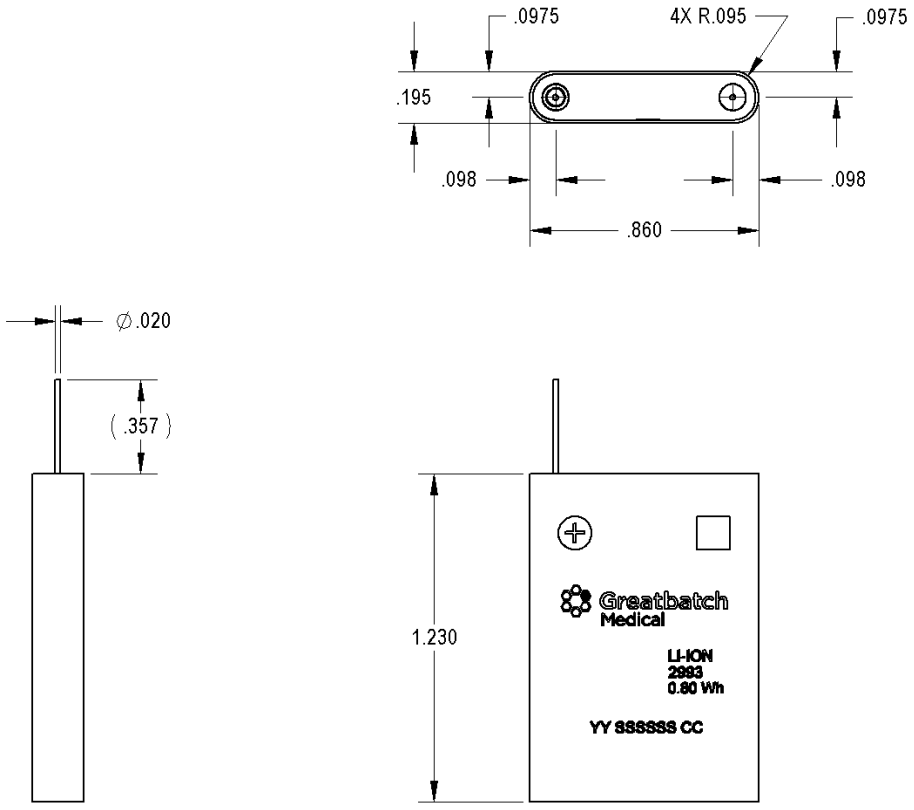

FIGURE 2: Typical charging curve with C/2 charge current

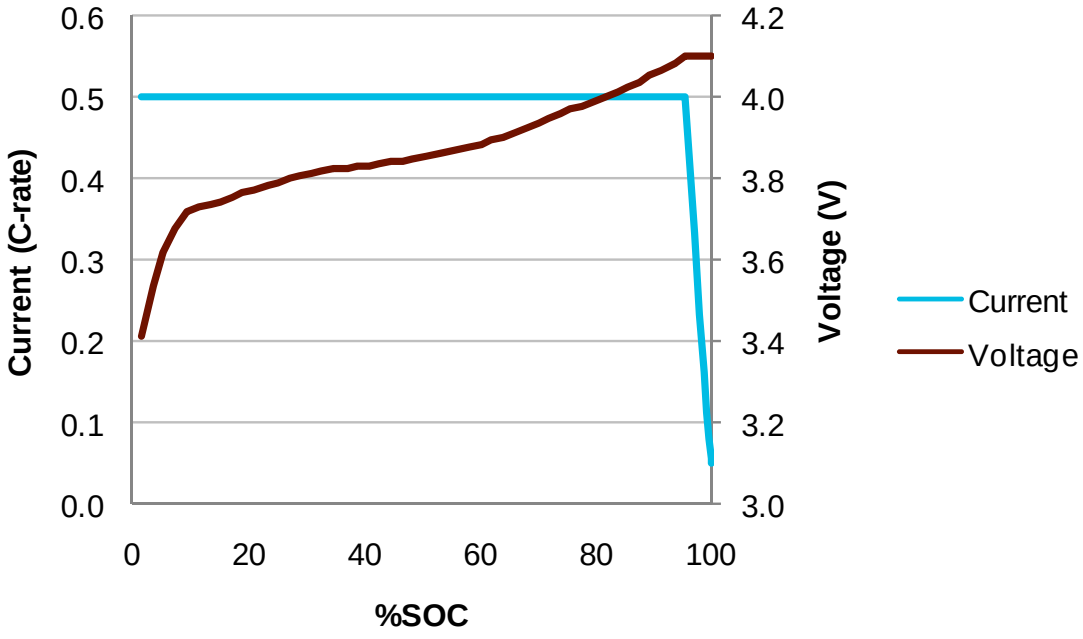

FIGURE 3: Typical discharge curves at cycle 1 (C/100, C/10, C/5, C/2, 1C)

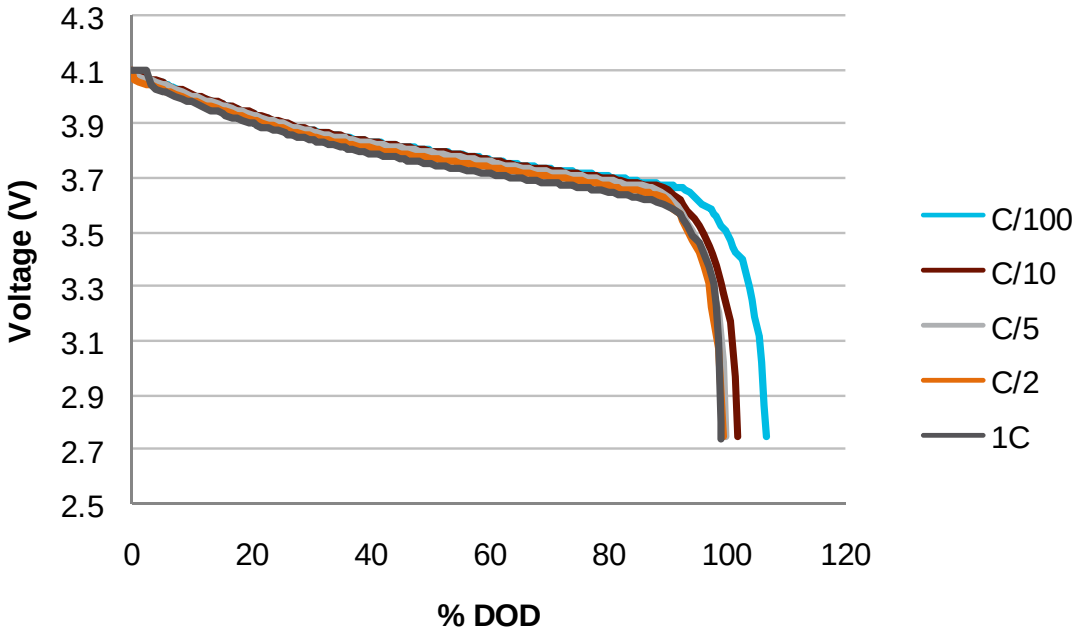

FIGURE 4: Plot of typical % of nominal capacity vs. cycle number per cycling conditions in 4.2.7.