AlphaCell SMU

Technical Manual

AlphaCell SMU

Effective: January 2007

Alpha Technologies

Alpha Technologies

Power

AlphaCell SMU Technical Manual

745-680-B9-001, Rev. A

Effective Date: January, 2007

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NOTE:

Photographs contained in this manual are for illustrative purposes only. These photographs may not match your installation.

NOTE:

Operator is cautioned to review the drawings and illustrations contained in this manual before proceeding. If there are questions regarding the safe operation of this powering system, please contact Alpha Technologies or your nearest Alpha representative.

NOTE:

Alpha shall not be held liable for any damage or injury involving its enclosures, power supplies, generators, batteries, or other hardware if used or operated in any manner or subject to any condition not consistent with its intended purpose, or is installed or operated in an unapproved manner, or improperly maintained.

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Safety Notes

Review the drawings and illustrations contained in this manual before proceeding. If there are any questions regarding the safe installation or operation of this product, contact Alpha Technologies or the nearest Alpha representative. Save this document for future reference.

To reduce the risk of injury or death, and to ensure the continued safe operation of this product, the following symbols have been placed throughout this manual. Where these symbols appear, use extra care and attention.

ATTENTION:

The use of ATTENTION indicates specific regulatory/code requirements that may affect the placement of equipment and /or installation procedures.

NOTE:

A NOTE provide additional information to help complete a specific task or procedure.

CAUTION!

The use of CAUTION indicates safety information intended to PREVENT DAMAGE to material or equipment.

WARNING!

WARNING presents safety information to PREVENT INJURY OR DEATH to the technician or user.

Battery Safety Notes

WARNING!

Lead-acid batteries contain dangerous voltages, currents and corrosive material. Battery installation, maintenance, service and replacement must be performed only by authorized personnel.

Chemical Hazards

Any gelled or liquid leakage from a valve-regulated lead-acid (VRLA) battery contains dilute sulfuric acid, which is harmful to the skin and eyes. Emissions are electrolytic, electrically conductive, and corrosive.

To avoid injury:

- Servicing and connection of batteries shall be performed by, or under the direct supervision of, personnel knowledgeable of batteries and the required safety precautions.
- Always wear eye protection, rubber gloves, and a protective vest when working near batteries. Remove all metallic objects from hands and neck.
- Batteries produce explosive gases. Keep all open flames and sparks away from batteries.
- Use tools with insulated handles. Do not rest any tools on top of batteries.
- Lead-acid batteries contain or emit chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. Battery post terminals and related accessories contain lead and lead compounds. Wash hands after handling (California Proposition 65).
- Wear protective clothing (insulated gloves, eye protection, etc.) when installing, maintaining, servicing, or replacing batteries.
- If any battery emission contacts the skin, wash immediately and thoroughly with water. Follow your company's approved chemical exposure procedures.
- Neutralize any spilled battery emission with the special solution contained in an approved spill kit or with a solution of one pound bicarbonate of soda to one gallon of water. Report a chemical spill using your company's spill reporting structure and seek medical attention if necessary.
- Always replace batteries with those of an identical type and rating. Never install old or untested batteries.
- Do not charge batteries in a sealed container. Each individual battery should have at least 0.5 inches of space between it and all surrounding surfaces to allow for convection cooling.
- All battery compartments must have adequate ventilation to prevent accumulation of potentially dangerous gas. Ventilation should prevent trapped hydrogen gas pockets from exceeding a 1% concentration as per regulation 70E of the National Fire Protection Agency (NFPA).
- Prior to handling the batteries, touch a grounded metal object to dissipate any static charge that may have developed on your body.
- Never use uninsulated tools or other conductive materials when installing, maintaining, servicing, or replacing batteries.
- Use special caution when connecting or adjusting battery cabling. An improperly connected battery cable or an unconnected battery cable can make contact with an unintended surface that can result in arcing, fire, or possible explosion.
- A battery showing signs of cracking, leaking, or swelling should be replaced immediately by authorized personnel using a battery of identical type and rating.

Equipment Cautions

- Do not operate NiCd and lead-acid batteries in the same room. NiCd emissions will neutralize the lead-acid solution, rendering the battery useless.
- Overcharging the battery can result in a loss of capacity and excess release of gas.

Recycling and Disposal Instructions

Spent or damaged batteries are considered environmentally unsafe. Always recycle used batteries or dispose of the batteries in accordance with all federal, state and local regulations.

1.0 Introduction

The AlphaCell SMU battery with sealed gas recombination technology is specifically designed for telecommunication applications, and is available with capacities from 200Ah to 2,000Ah. The AlphaCell SMU Series of batteries require less space than conventional VRLA batteries and are structurally arranged to eliminate dislodging and slippage caused by vibrations over time.

Features and Benefits:

- 10+ year life
- Recombination efficiency approaching 99.9%
- Low self discharge maximizes shelf life
- Strong, corrosion resistant grid design
- Modular unit structure allows for minimal footprint
- Unique, flexible connectors that make for convenient installation and efficient connections
- Shockproof external design

2.0 Theory of Operation

Valve Regulated Lead Acid (VRLA) batteries make use of a process called recombination. By reforming the water lost during electrolysis, recombination eliminates the need for regular battery checks and for refilling the battery water. The chemical reactions are as follows:

$$Pb + PbO_2 + 2H_2SO_4 \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} 2PbSO_4 + 2H_2O$$

$$2Pb + O_2 \longrightarrow 2PbO$$

$$PbO + H_2SO_4 \longrightarrow PbSO_4 + H_2O$$

3.0 Specifications

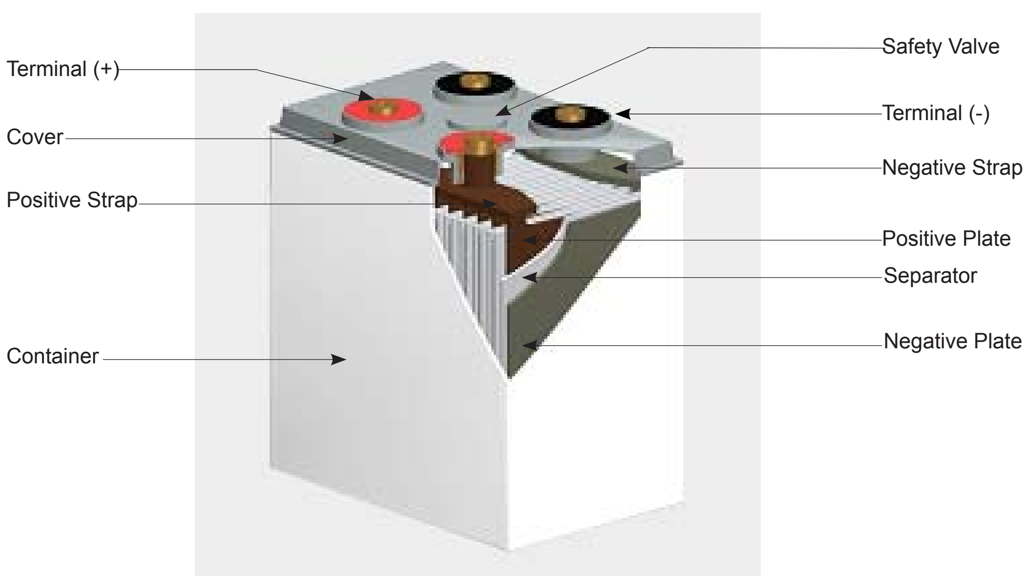

Fig. 3-1, Battery Construction

3.1 General Specifications

Model	Rated Voltage	Rated Capacity (Ah)			Dimensions (in/mm)			Number of Poles	Weight (lb./Kg)
		10hr. to 1.80Vpc (C_{10})	3hr. to 1.80Vpc (C_3)	1hr. to 1.80Vpc (C_1)	Length	Width	Height		
SMU 2-200-FR	2	200	150	110	4.25/120	8/200	15/385	2	35/16
SMU 2-300-FR	2	300	225	165	6/161	8/200	15/385	2	50/23
SMU 2-400-FR	2	400	300	220	8/201	8/200	15/385	2	66/30
SMU2 -500-FR	2	500	375	275	9.5/242	8/200	15/385	2	84/38
SMU 2-600-FR	2	600	450	330	11/283	8/200	15/385	4	99/45
SMU 2-800-FR	2	800	600	440	7/183	9.5/244	24.5/629	4	136/62
SMU 2-1000-FR	2	1000	750	550	8.5/218	9.5/244	24.5/629	4	167/76
SMU 2-1500-FR	2	1500	1125	825	12/305	9.5/244	24.5/629	6	244/111
SMU 2-2000-FR	2	2000	1500	1100	14.5/369	9/228	24.25/617	8	337/153

Table 3-1, General Specifications

3.2 Battery Internal Resistance

Battery internal resistance is a nonlinear parameter that changes with changes in battery temperature and discharge state. The internal resistance is lowest when the battery is fully charged. At full charge and 25°C the internal resistances and short circuit currents are as follows:

Model	Internal Resistance (m Ω)	Short Circuit Current (A)
SMU 2-200-FR	0.514	3940
SMU 2-300-FR	0.363	5588
SMU 2-400-FR	0.297	6816
SMU2 -500-FR	0.218	9361
SMU 2-600-FR	0.175	11576
SMU 2-800-FR	0.223	9153
SMU 2-1000-FR	0.189	10804
SMU 2-1500-FR	0.152	13237
SMU 2-2000-FR	0.115	17391

Table 3-2, Internal Resistance and Short Circuit Current (25°C)

CAUTION!

A short circuit will drop the battery voltage to zero and physically damage its internal components, poles, and connectors.

4.0 Temperature, Battery Capacity, and Battery Life

There are several factors that affect the capacity and the life-span of a battery. These include charging method, discharge depth, end voltages, and ambient temperature. The most significant of these is temperature. In order to maximize capacity and life-span, ambient temperature should be controlled and the battery's float voltage should be set to the appropriate value (for float voltage specifications see section 5.1).

CAUTION!

Excessive temperatures (over 50°C, 120°F) may cause the heat generated in the recombination process to exceed the rate at which the heat can be transferred out of the battery and thermal runaway may begin. Thermal runaway is a dangerous cycle that can severely damage equipment.

4.1 Battery Capacity and Ambient Temperature

The capacity of the battery is directly linked to ambient temperature: The lower the temperature the lower the capacity; the higher the temperature the higher the capacity. The standard capacity data are based on an optimal 25°C ambient temperature. The effect of temperature on capacity is as follows:

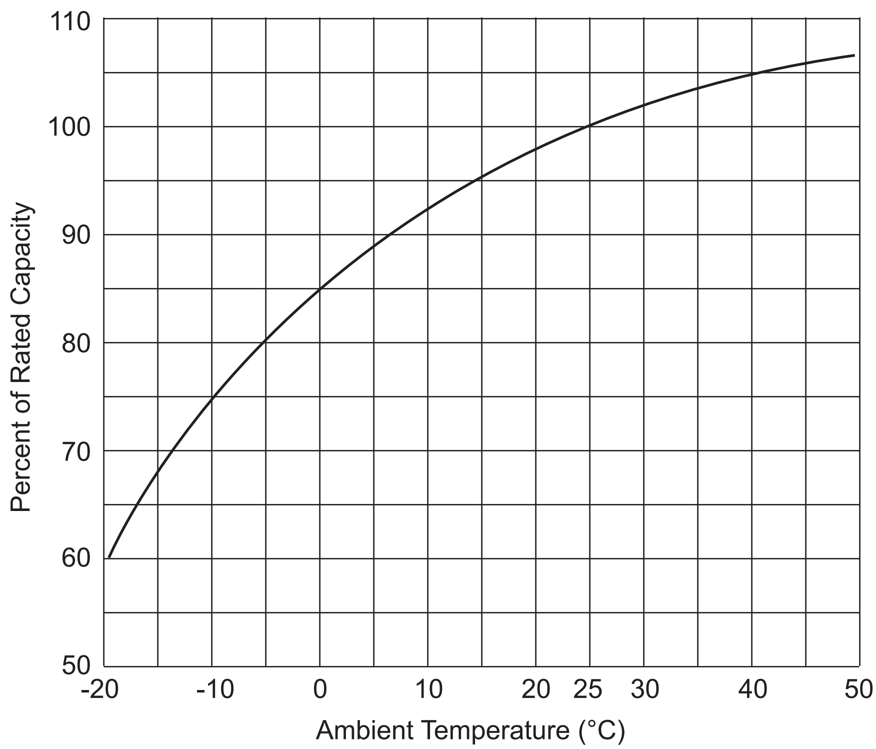

Fig. 4-1, Capacity as a Function of Temperature

4.2 Battery Life and Ambient Temperature

The expectant life-span of 10+ years is based on a 25°C ambient temperature. Temperatures above this optimum increase the rate of plate corrosion and of water loss, which shortens battery life. For temperatures above 25°C, the relationship between temperature and life-span is expressed in the following equation:

$$t_T = t_{25} / 2^{(T-25)/10}$$

Where, t_T= the actual life span; T= the actual temperature; t_{25}= the rated life span at 25°C.

For example, if the actual ambient temperature is 35°C then the expectant life-span is 5 years.

NOTE:

While an ambient temperature slightly below 25°C may help the battery reach its potential life-span, it will not significantly increase that life-span. In addition, the capacity of the battery and it's ability to discharge significantly decrease at temperatures below 5°C. The battery's optimal operating range is 15°C to 25°C.

5.0 Charging

In order to ensure the battery performs to its potential, it is very important that it is:

- Float-charged in order to remain in a fully charged condition
- Completely recharged as soon as possible after a discharge, in order to ensure maximum battery life
- Charged properly

5.1 Floating Charge Voltage and Ambient Temperature

The float charge keeps the battery in a fully charged state with a small but constant current which automatically covers capacity lost from self and other discharges.

In order to maximize capacity and life span, the battery's float voltage must be set for the ambient temperature range in which the battery operates.

Ambient Temperature (°C)	Float Voltage (Vpc) +/-5%
0–10	2.29
11–15	2.26
16–25	2.23
26–30	2.21
31–35	2.20
36–40	2.19

Table 5-1, Floating Voltage and Temperature

CAUTION!

A float voltage set higher than specified accelerates the corruption of the grid, shortens the life of the battery, and increases the risk of thermal runaway. A float voltage set lower than specified inhibits the battery from holding a charge; this increases sulfation on the plates, decreases the capacity and shortens the life of the battery.

5.2 Boost Charging

NOTE:

- In general a boost charge should not take more than three hours. If it does, either the batteries or the charger are likely defective.
- Take and record measurements before and after charging and during discharge to help track changes and problems. Wait two hours after charging before you take final measurements so the electrolyte can cool sufficiently.

The conditions under which the battery needs to be boost charged beyond its float charging are:

- The cell floating charge voltage is less than 2.18V.
- The battery has been in a unused state for more than 3 months.
- The battery has been running in a state of floating charge for over one year.

The preferred boost charging method is:

- Charge the battery with a current less than .25 C_{10}A (0.1 C_{10}A to 0.2 C_{10}A is recommended) at a charge voltage of 2.30 to 2.35 Vpc.
- The charge is finished when the current drops to less than 0.006 C_{10}A.

6.0 Maintenance

The SMU battery is maintenance free only in regards to the electrolyte. For assurance of reliability it is important to perform the recommended periodic maintenance.

WARNING!

To avoid damage to the equipment or injury to the technician, follow these precautions:

- All maintenance work should be performed by a trained technician.
- Remove all jewelry.
- Do not smoke or use fire near batteries.
- Use insulted tools when installing or maintaining the batteries. Do not lay metal tools on the batteries.
- Do not remove the safety valves from the batteries or add anything to the batteries.
- Do not clean the batteries with organic cleaners.
- Do not use defective or damaged batteries.

6.1 Monthly Maintenance

- Make sure the battery room is clean.
- Measure and record the ambient temperature of the battery room.
- Make sure the batteries are clean.
- Check for damage, or evidence of over-heating on the terminals, containers, and lids.
- Measure and record the total voltage and floating current of the battery system.

6.2 Quarterly Maintenance

- Repeat monthly inspection.
- Measure and record the floating voltage of every cell. If more than two cells' voltages are less than 2.18V, the batteries need to be boost charged (see Section 5.2). If the problem persists, conduct annual and then three-year maintenance.

6.3 Yearly Maintenance

- Repeat quarterly maintenance and inspection.
- Ensure all connections are clean and tight.
- Check the load of the batteries by conducting a capacity (discharge) test: discharge the batteries to between 30% and 40% of rated capacity.

6.4 Three-year Maintenance

- Conduct a capacity (discharge) test. Replace any battery with a capacity less than 80% of rated capacity.

7.0 Storage

Storage procedures:

- Before storing, fully charge the batteries. Storing a battery in a discharged state will negatively affect its life span and capacity.
- All lead acid batteries experience self-discharge in open circuit. The self-discharge rate is largely determined by ambient temperature: the lower the temperature, the lower the discharge rate and the higher the temperature, the higher the discharge rate. Store batteries in a clean, well ventilated location with temperatures between 0°C and 35°C.
- In order to avoid permanent damage to the plate caused by self-discharge, the batteries should be boost charged after every three months in storage (see section 5.2).
- Record all dates and services performed. See page 22 for form.

8.0 Installation

About the site:

- Maintain a distance of at least 20" (508mm) between the battery and electrical switches and outlets.
- Do not expose the battery to organic solvents and corrosive gasses.
- Maintain a distance of at least 7.87" (200mm) between batteries and battery groups to provide proper ventilation.
- Create a pathway at least 47.24" (1200mm) wide next to each battery group for access during routine maintenance.
- Verify that the maximum weight capacity of the floor is not exceeded.
- The ideal operating temperature is 77ºF (25ºC). If possible, install air-conditioning or forced ventilation to keep temperatures between 59ºF (15ºC) and 95ºF (30ºC).

CAUTION!

All the cells in the system must be of the same capacity. Alpha recommends the cells be close in age.

Tools needed:

- Socket and wrench sets
- Torque wrench

Procedure:

1. Check the cells and frame modules for damage. Do not install damaged cells.
2. Remove the retaining bars and the cells from the frame modules.
3. Fasten the two channel bars to one module with M8x30 bolts, nuts, flat washers, and lock washers. The bigger diameter holes on the channel bars should face down for anchoring to the floor. The channel bars can be mounted with their open side facing either in or out depending on installation and maintenance convenience.
4. Fasten the second frame module to the top of the first with four M8x20 bolts, nuts, flat washers, and lock washers. Continue stacking and fastening together modules. Alpha recommends stacking no more than four modules. However, the system can accommodate up to six. If applicable, blot parallel stacks to each other with two bolts, one in the front and one in the back, on each row.
5. Torque all nuts to 130 in/lb. (15N/m).
6. Fasten the two lead terminals to the top module. One terminal can be fastened to each side of the module or both can be fastened to the same side.
7. Starting with the bottom module (to prevent tipping), slide the battery cells into the assembled frame. Orient the positive and negative poles of the batteries as shown in Fig 8-3.
8. Fasten the retaining bars to the modules to secure the cells.
9. Connect the cells using the flexible connectors according to color and polarity (red=positive; blue=negative), as shown in Figures 8-2 and 8-3. Torque all connections to 130 in/lb. (15N/m).
10. Check the voltage and polarity of the battery string with a voltameter.
11. Connect the positive poles of the cell at one end of the string to the positive terminal. Connect the negative poles of the cell on the other end of the string to the negative terminal (see Fig. 8-3).

CAUTION!

Take care not to create a short circuit when connecting the battery string to the lead terminals.

12. Install the plastic terminal covers to the terminals and the cover plate to the top of the top module.

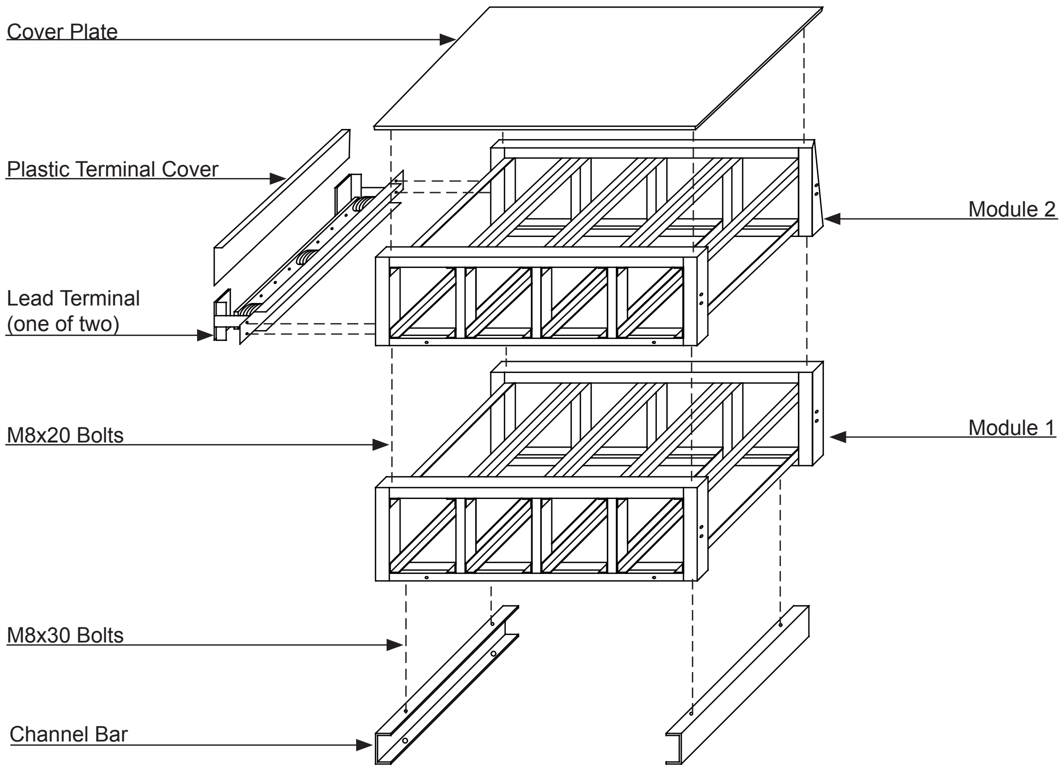

Fig. 8-1, Frame Construction

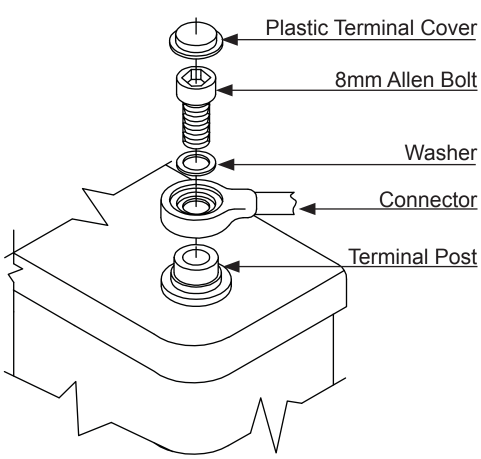

Fig. 8-2, Battery Connector Detail

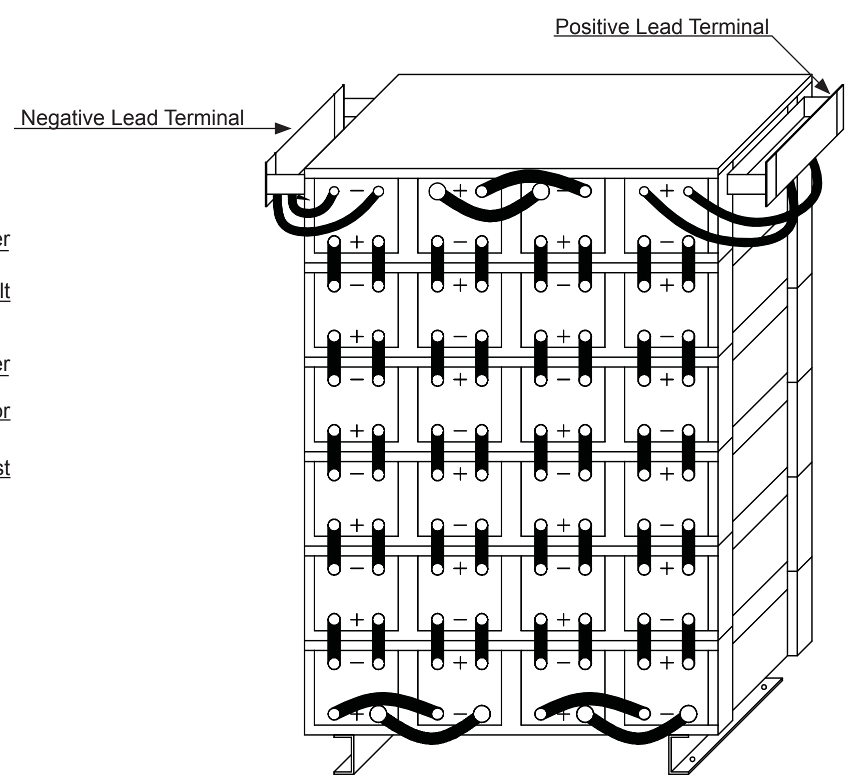

Fig. 8-3, Sample Battery Installation (SMU-500)

9.0 Appendix A, Specifications

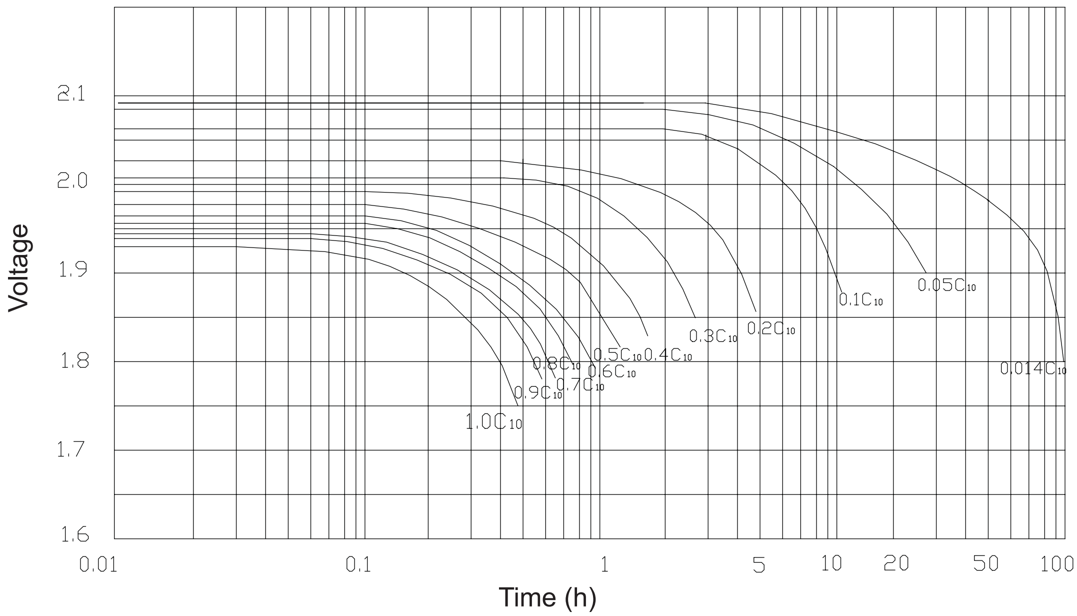

Fig. 9-1, Discharge Performance

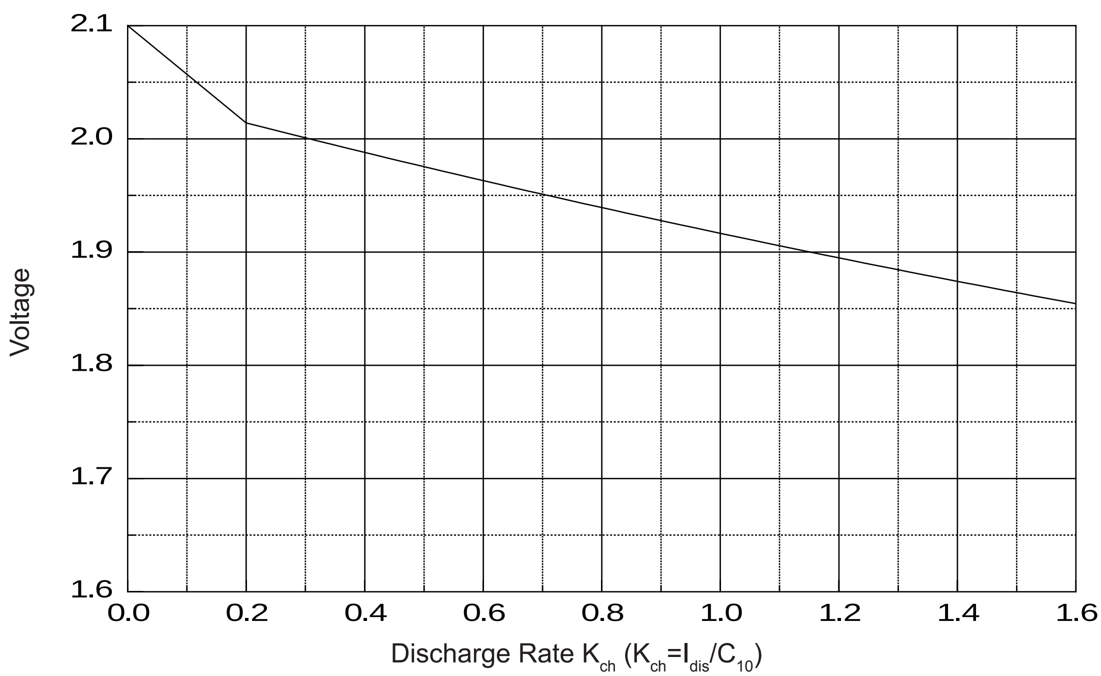

Fig. 9-2, Discharge Curve at One Minute (25°C)

9.0 Appendix A: Specifications, continued

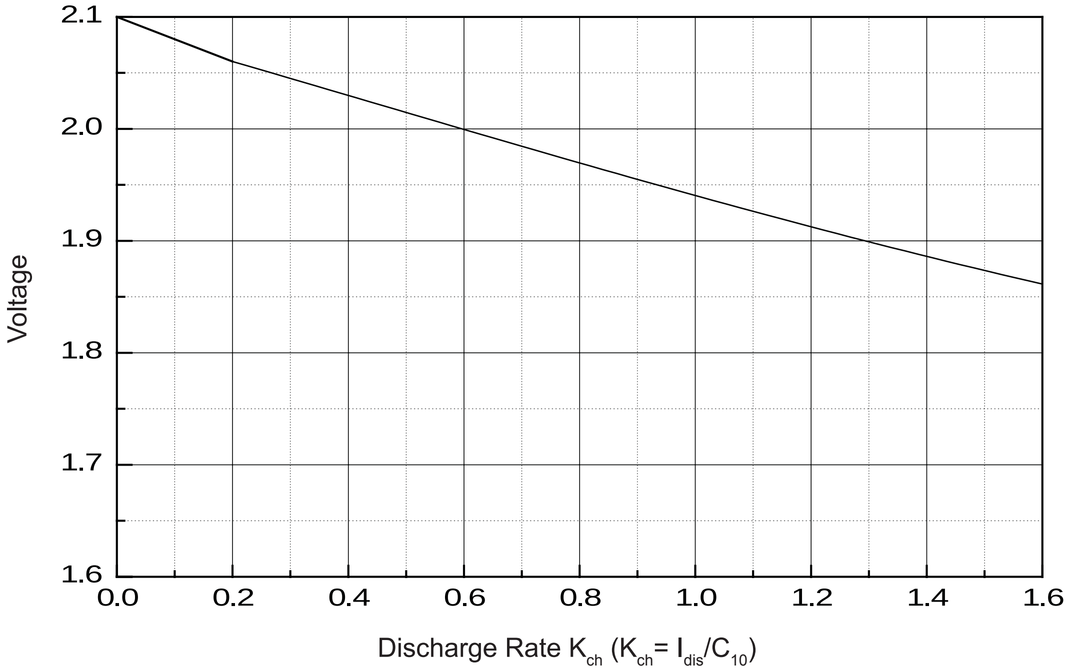

Fig. 9-3, Discharge Curve at Five Seconds (25°C)

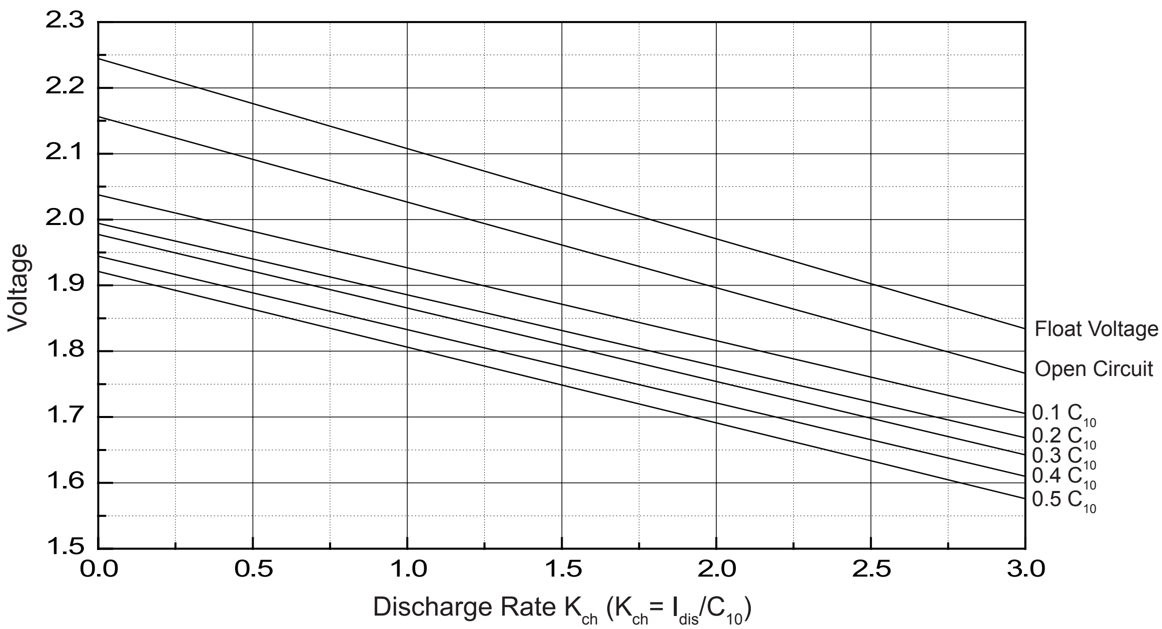

Fig. 9-4, Shock Discharge Curve at Different Rates after Discharge of One Hour (25°C)

9.0 Appendix A: Specifications, continued

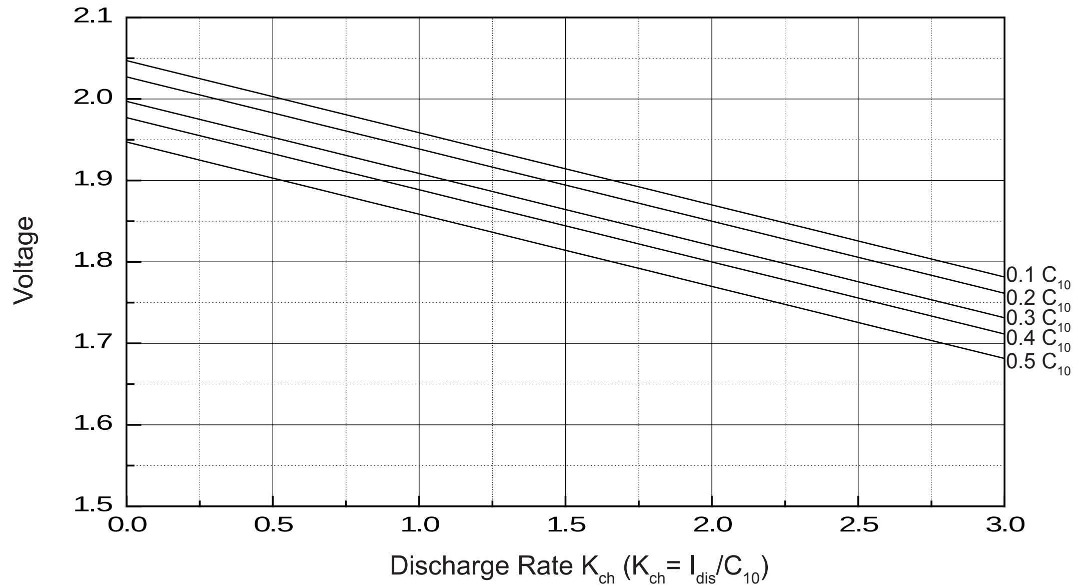

Fig. 9-5, Shock Discharge Curves at Different Rates After .5h Discharge (25°C)

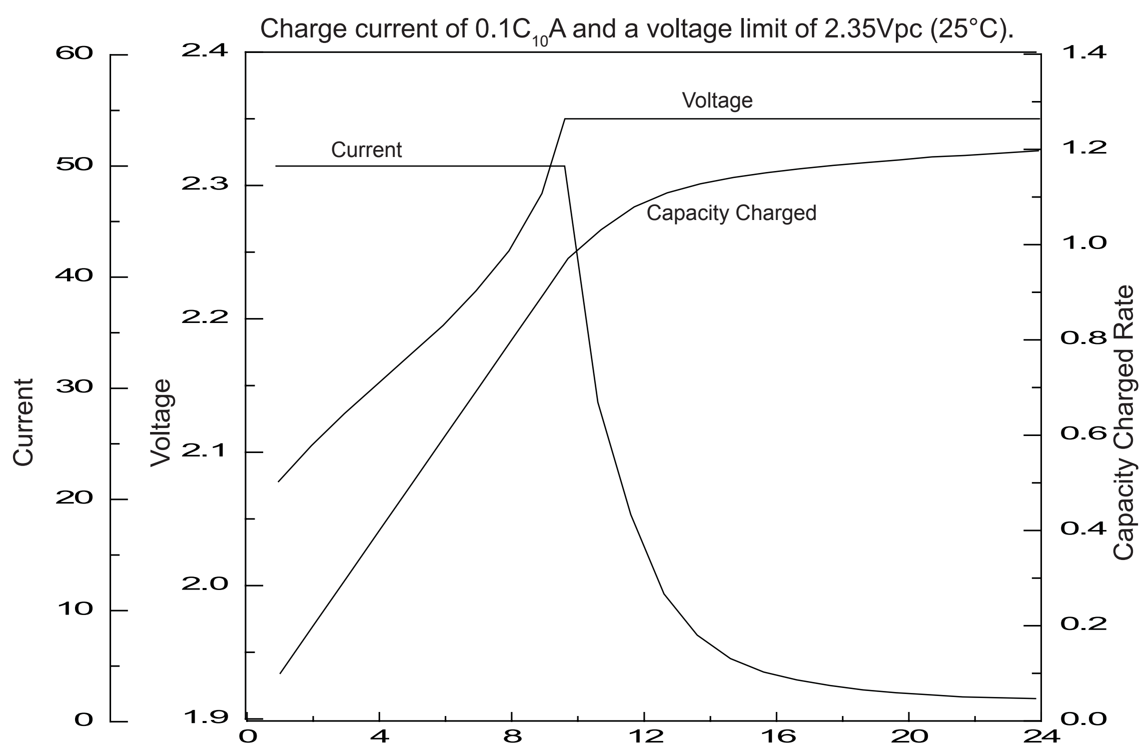

Fig. 9-6, Recharge Characteristics of a 100% discharged SMU-500.

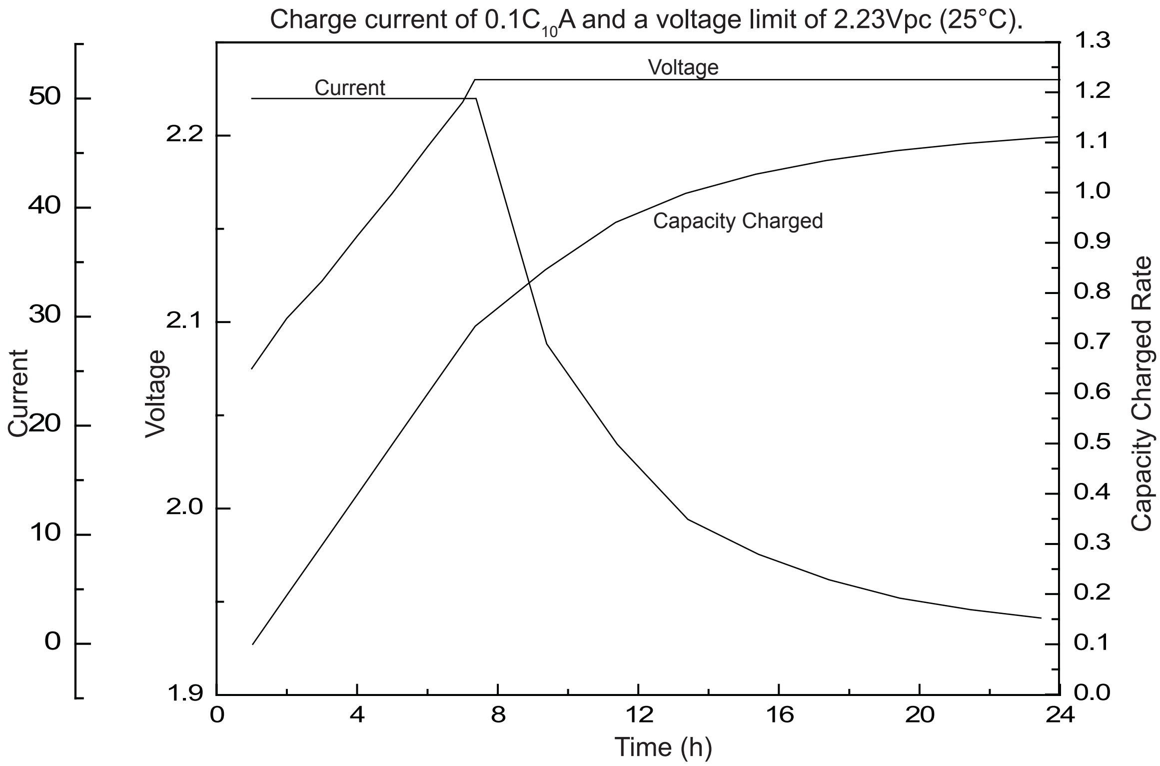

Fig. 9-7, Recharge Characteristics of a 100% discharged SMU-500.

End Discharge Voltage 1.75/Cell (Amps)

Type	Minutes									Hours										
	5	10	15	20	30	40	50	60	90	2	3	4	5	6	7	8	9	10	12	24
SMU 2-200-FR	277.1	252.8	233.3	213.2	171.0	148.0	128.8	114.0	86.4	70.6	52.4	42.8	36.4	32.0	28.3	25.5	23.2	21.2	18.0	9.8
SMU 2-300-FR	415.6	379.2	350.0	319.7	256.5	222.0	193.2	171.0	129.6	106.0	78.6	64.2	54.6	48.0	42.5	38.2	34.7	31.9	27.0	14.6
SMU 2-400-FR	554.1	505.6	466.7	426.3	342.0	296.0	257.6	228.0	172.8	141.3	104.8	85.6	72.8	64.0	56.6	51.0	46.3	42.5	36.0	19.5
SMU 2-500-FR	692.6	632.1	583.3	532.9	427.5	370.0	322.0	285.0	216.0	176.6	131.0	107.0	91.0	80.0	70.8	63.7	57.9	53.1	45.0	24.4
SMU 2-600-FR	831.1	758.5	700.0	639.5	513.0	444.0	386.4	342.0	259.2	211.9	157.2	128.4	109.2	96.0	85.0	76.4	69.5	63.7	54.0	29.3
SMU 2-800-FR	972.7	897.9	825.4	755.7	615.2	547.2	491.2	446.4	349.9	292.8	216.0	174.2	147.2	127.3	112.3	101.1	92.0	84.3	72.4	39.2
SMU 2-1000-FR	1215.8	1122.4	1031.7	944.6	769.0	684.0	614.0	558.0	437.3	366.0	270.0	217.8	184.0	159.1	140.4	126.4	115.0	105.4	90.5	49.0
SMU 2-1500-FR	1823.8	1683.6	1547.5	1416.9	1153.5	1026.0	921.0	837.0	656.0	549.0	405.0	326.6	276.0	238.7	210.6	189.6	172.5	158.1	135.8	73.4
SMU 2-2000-FR	2431.7	2244.8	2063.4	1889.2	1538.0	1368.0	1228.0	1116.0	874.7	732.0	540.0	435.5	368.0	318.2	280.9	252.8	230.0	210.8	181.0	97.9

End Discharge Voltage 1.80/Cell (Amps)

Type	Minutes									Hours										
	5	10	15	20	30	40	50	60	90	2	3	4	5	6	7	8	9	10	12	24
SMU 2-200-FR	266.5	240.2	220.0	201.1	160.0	137.2	120.0	106.8	81.4	67.6	50.8	41.4	35.6	31.2	27.8	25.0	22.7	20.8	17.6	9.6
SMU 2-300-FR	399.7	360.3	330.0	301.6	240.0	205.8	180.0	160.2	122.1	101.4	76.2	62.0	53.3	46.8	41.8	37.5	34.0	31.1	26.3	14.4
SMU 2-400-FR	533.0	480.4	440.0	402.1	320.0	274.4	240.0	213.6	162.8	135.2	101.6	82.7	71.1	62.4	55.7	50.0	45.4	41.5	35.1	19.2
SMU 2-500-FR	666.2	600.5	550.0	502.6	400.0	343.0	300.0	267.0	203.5	169.0	127.0	103.4	88.9	78.0	69.6	62.5	56.7	51.9	43.9	24.0
SMU 2-600-FR	799.5	720.5	660.0	603.2	480.0	411.6	360.0	320.4	244.2	202.8	152.4	124.1	106.7	93.6	83.5	75.0	68.0	62.3	52.7	28.8
SMU 2-800-FR	918.9	841.1	769.7	697.9	576.0	519.2	460.8	424.0	336.0	284.0	211.2	171.2	143.8	124.8	110.5	99.2	90.8	83.2	71.6	38.3
SMU 2-1000-FR	1148.6	1051.4	962.2	872.4	720.0	649.0	576.0	530.0	420.0	355.0	264.0	214.0	179.8	156.0	138.1	124.0	113.4	104.0	89.5	47.9
SMU 2-1500-FR	1723.0	1577.0	1443.2	1308.5	1080.0	973.5	864.0	795.0	630.0	532.5	396.0	321.0	269.7	234.0	207.2	186.0	170.2	156.0	134.3	71.9
SMU 2-2000-FR	2297.3	2102.7	1924.3	1744.7	1440.0	1298.0	1152.0	1060.0	840.0	710.0	528.0	428.0	359.6	312.0	276.3	248.0	226.9	208.0	179.0	95.8

Table 9-1, Discharge Specifications

10.0 Appendix B: Choosing the Right Capacity

10.1 Telecom Applications

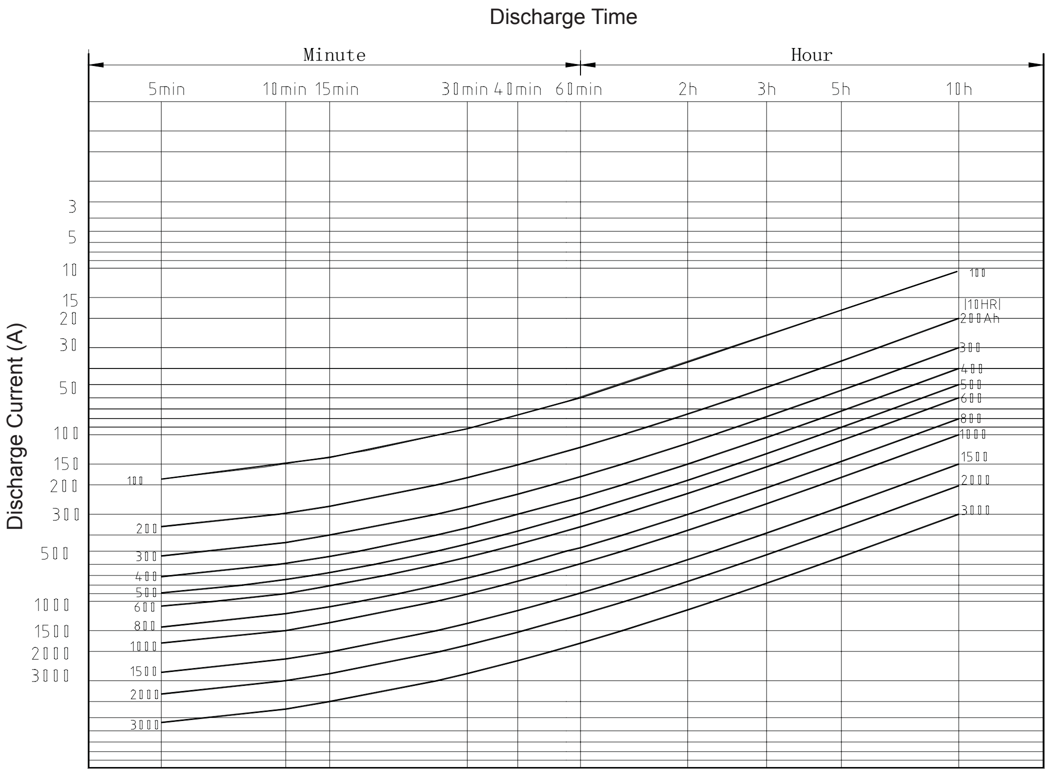

Fig. 10-1, Single Cell Discharge Curves (Final Voltage: 1.80 Vpc; 25°C)

10.2 Power Applications

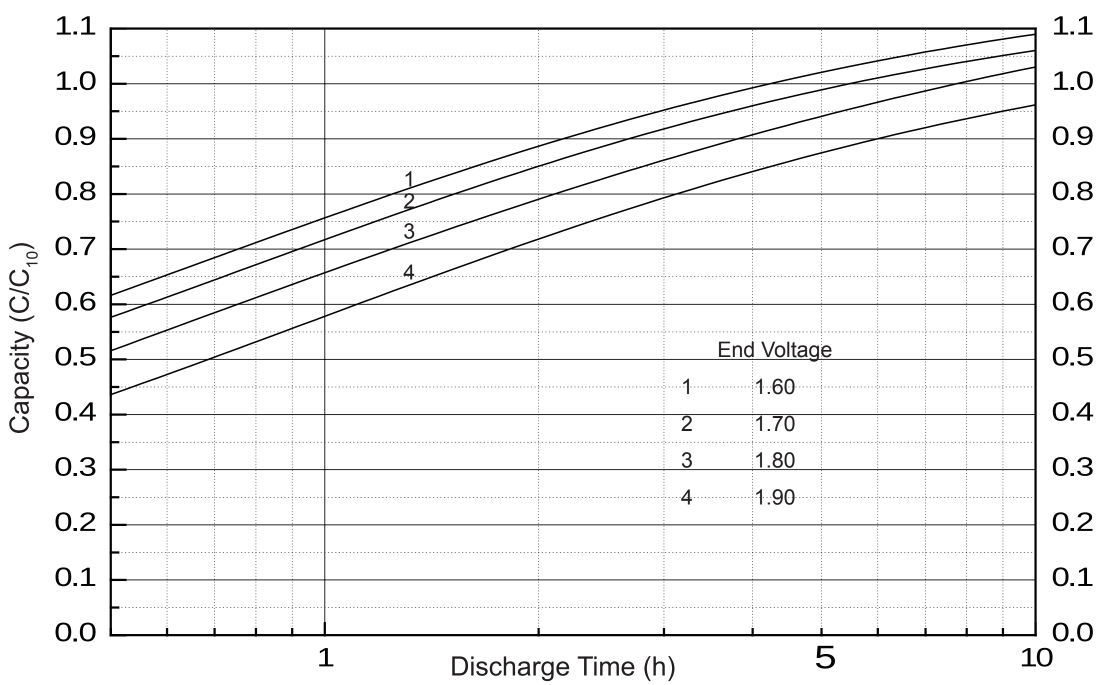

Fig. 10-2, Curves With Stairs Loading Calculation Method (25°C)

10.0 Appendix B: Choosing the Right Capacity, continued

10.2 Power Applications, continued

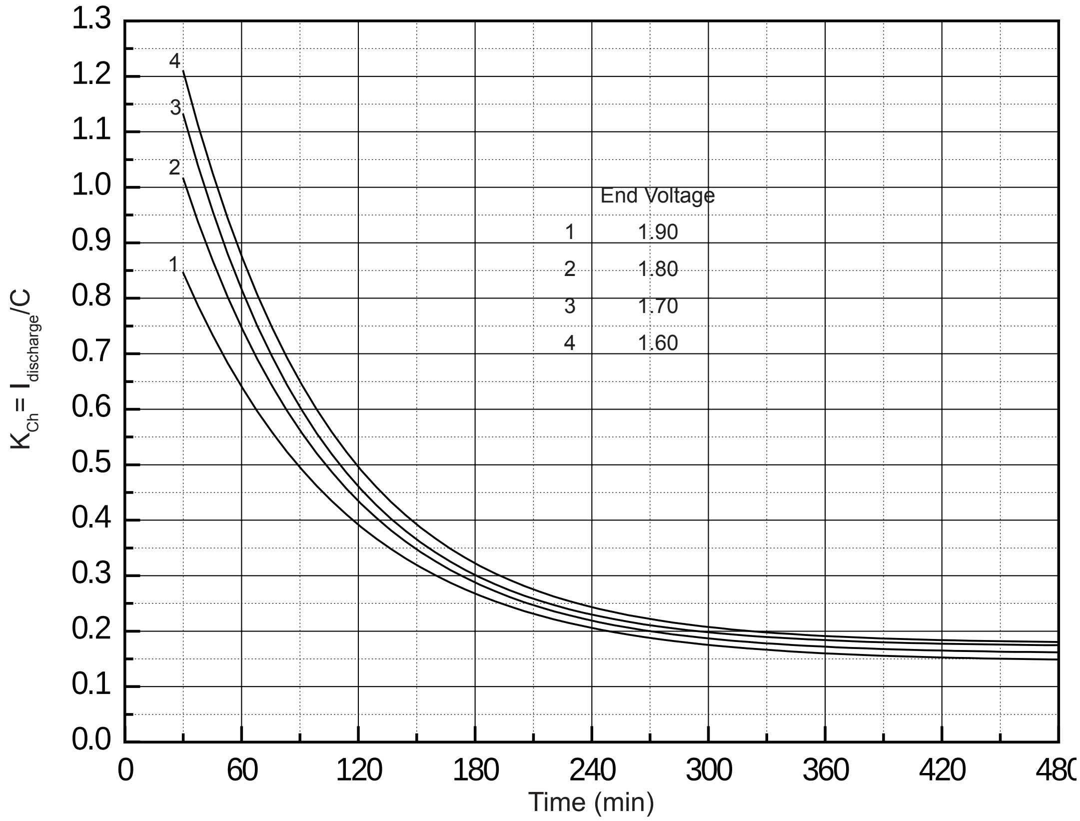

Fig. 10-3, Curves with Voltage Control Method (25°C)

11.0 Forms

Charging Recording Form

Record before charging and two hours after

Model of Battery		Date	
Battery Bank No.		Room Temperature	
Charging Current		Total Battery Voltage	

Remarks	

Cell #	Voltage	Siemans Conductance Rating	Notes

NOTE:

Wait two hours after charging before you take final measurements so the electrolyte can cool sufficiently.

Discharge Recording Form

Model of Battery	Date
Battery No.	Room Temperature
Charging Current	Total Battery Voltage

Remarks

Cell #	Initial Voltage	Cell Voltage at Time Period End							
		15min	30min	1hr	2hr	3hr	4hr	4:30hr	5 hr

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