



PRODUCT GUIDE

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Introduction

PowerSafe SBS standby power batteries utilise advanced pure lead, thin plate technology to achieve exceptionally high performance, energy density, reliability and a long, low maintenance service life in a wide range of applications and operating environments. The range includes both top and front terminal designs for easy installation and maintenance on racks, shelves and in cabinets.

PowerSafe SBS combine the benefits of high performance and long life in a cost effective battery solution for tele-communications, UPS, electric utilities and engine starting applications.

PowerSafe SBS batteries are manufactured in ISO 9001 certified factories.

This manual describes the **PowerSafe** SBS product range, physical characteristics and electrical performance, and contains the basic information for the selection, storage, installation, operation and maintenance of **PowerSafe** SBS batteries.

Energys has earned an international reputation for quality and reliability based on more than 100 years experience in the manufacture of batteries, and is at the forefront of new product design to meet customers increasing power requirements.

PowerSafe SBS batteries are designed using proven gas recombination technology, which removes the need for regular water addition.

The use of gas recombination technology for lead acid batteries has completely changed the concept of standby power. This technology provides the user with the freedom to use lead acid batteries in a wide range of applications. The minimal level of gas production allows battery installation in cabinets or on stands, in offices or near main equipment, thus maximising space utilisation and reducing battery accommodation and maintenance costs.



Monobloc Specifications

Model	Nominal Voltage (V)	C ₈ to 1.75Vpc @ 25°C (77°F)	C ₁₀ to 1.80Vpc @ 20°C (68°F)	Terminal Fastener ¹	Dimensions mm (inches)			Weight kg (lbs)
					Length	Width	Height	
SBS8	12	7	7	M4 F	138 (5.4)	86 (3.4)	101 (4.0)	2.7 (5.9)
SBS15	12	14	14	M6 M	200 (7.9)	77 (3.0)	140 (5.5)	5.7 (12.5)
SBS30	12	26	26	M6 M	250 (9.8)	97 (3.8)	156 (6.1)	9.5 (20.9)
HB30	12	26	26	M6 M ²	250 (9.8)	97 (3.8)	156 (6.1)	9.6 (21.1)
SBS40	12	38	38	M6 M	250 (9.8)	97 (3.8)	206 (8.1)	12.7 (28.0)
SBS60	12	51	51	M6 M	220 (8.7)	121 (4.8)	260 (10.2)	18.5 (40.7)
SBS110	6	116	115	M8 M	200 (7.9)	208 (8.2)	239 (9.4) ³	21.2 (46.6)
SBS114	4	116	115	M8 M	200 (7.9)	208 (8.2)	239 (9.4) ³	15.7 (34.5)
SBS130	6	133	132	M8 M	200 (7.9)	208 (8.2)	239 (9.4) ³	22.7 (49.9)
SBS134	4	133	132	M8 M	200 (7.9)	208 (8.2)	239 (9.4) ³	26.8 (37.0)
SBS300	2	307	310	M8 M	200 (7.9)	208 (8.2)	239 (9.4) ³	21.7 (47.7)
SBS390	2	361	360	M8 M	200 (7.9)	208 (8.2)	239 (9.4) ³	23.2 (51.0)
SBSJ13	12	12	12	M6 F	178 (7.0)	87 (3.4)	132 (5.2)	5.7 (12.6)
SBSJ16	12	15	15	M6 F	186 (7.3)	79 (3.1)	171 (6.7)	6.7 (14.8)
SBSJ30	12	26	26	M6 F	178 (7.0)	168 (6.6)	127 (5.0)	11.8 (26.0)
SBSJ40	12	39	39	M6 F	201 (7.9)	171 (6.7)	173 (6.8)	17.4 (38.2)
SBSJ70	12	64	64	M6 F	328 (12.9)	166 (6.5)	175 (6.9)	28.8 (63.4)
SBSB8⁴	12	31	31	M8 F	280 (11.0)	97 (3.8)	150 (5.9) ⁵	10.3 (22.7)
SBSB10⁴	12	34	34	M8 F	280 (11.0)	97 (3.8)	175 (6.9) ⁵	12.8 (28.2)
SBSB14⁴	12	62	62	M8 F	280 (11.0)	97 (3.8)	256 (10.1) ⁵	19.1 (42.0)
SBSC11⁴	12	91	92	M8 F	395 (15.6)	105 (4.1)	264 (10.4)	28.0 (61.6)

Notes:

- 1 M = male stud, F = female thread
- 2 supplied with wiring harness
- 3 dimension includes top cover
- 4 SBSB8, B10, B14, and C11 are available with terminals on the top face or on the front face.
For front terminals add 'FT Adapter' to the model number
- 5 SBSB8, B10 and B14 are available with a venting manifold, with a spigot at the front or back.
The manifold increases monobloc height by 9mm.

Recombination Technology

How gas recombination works

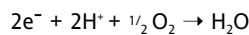
When a charge current flows through a fully charged conventional lead acid cell, electrolysis of water occurs to produce hydrogen from the negative electrode and oxygen from the positive electrode. This means that water is lost from the cell and regular topping up is needed.

However, evolution of oxygen gas and hydrogen gas does not occur simultaneously, because the efficiency of recharge of the positive electrode is not as good as the negative electrode. This means that oxygen is evolved from the positive plate before hydrogen is evolved from the negative plate.

At the same time that oxygen is evolved from the positive electrode, a substantial amount of highly active spongy lead exists on the negative electrode before it commences hydrogen evolution.

Therefore, provided oxygen can be transported to the negative electrode, conditions are ideal for a rapid reaction between lead and oxygen:

ie. This oxygen is electrochemically reduced on the negative electrode according to the following scheme,



and the final product is water.

The current flowing through the negative electrode drives this reaction instead of hydrogen generation which would occur in a flooded cell.

This process is called gas recombination. If this process was 100% efficient no water would be lost from the cell. By careful design of the constituents within the cell, gas recombination up to 99% is achieved.

Principle of the Oxygen Reduction Cycle

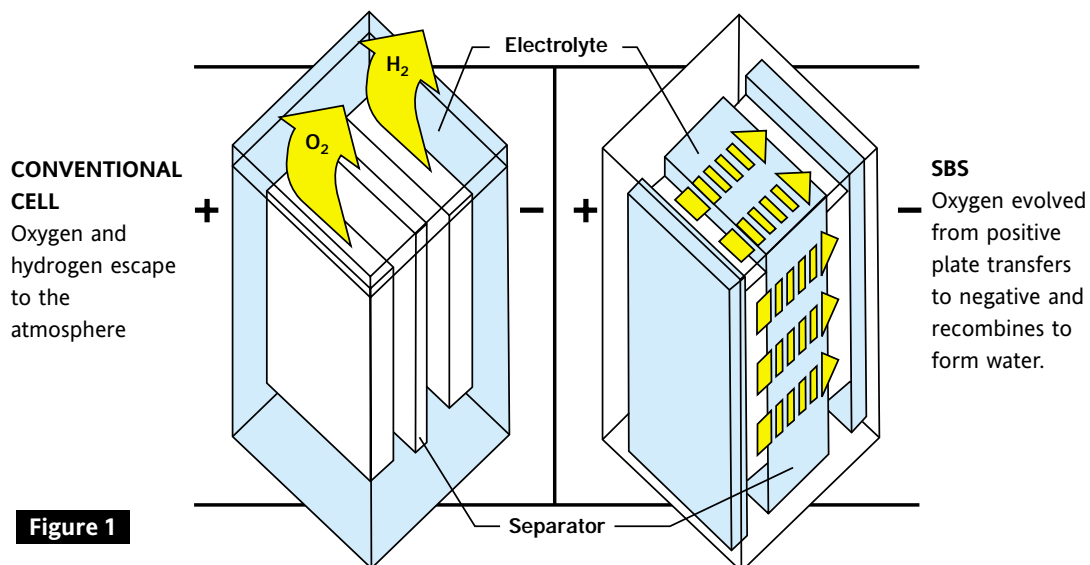


Figure 1

Recombination efficiency

Recombination efficiency is determined under specific conditions by measuring the volume of hydrogen emitted from the battery and converting this into its ampere hour equivalent. This equivalent value is then subtracted from the total ampere hours taken by the battery during the test period, and the remainder is the battery's recombination efficiency and is usually expressed as a percentage.

As recombination is never 100%, some hydrogen gas is emitted from SBS cells and batteries through the self-regulating valve. The volume of gas emitted is very small and for all practical purposes may be ignored.

1 Terminal Posts

High conductivity post for high rate discharge.

2 Pillar Seal

Compressed rubber grommet for superior integrity.

3 Container and Lid

Heat-sealed for maximum strength. SBS cases are made of ABS and SBS J are made of Noryl. Both materials are flame retardant (UL94 V-0).

4 One Way Valve

Ensures no oxygen can enter the cell. Optional remote venting systems are available. Vent adapters and a neoprene tubing system transport gases outside the battery compartment. This is only a safety measure because, under normal operating conditions, gas emission is virtually negligible.

5 Pure Lead Plates

Advanced thin grid technology and high purity materials for high performance, efficient charging and long life.

6 Negative Plates

Active material is balanced against the positive for optimum performance and recombination efficiency.

7 Flame Arrestor

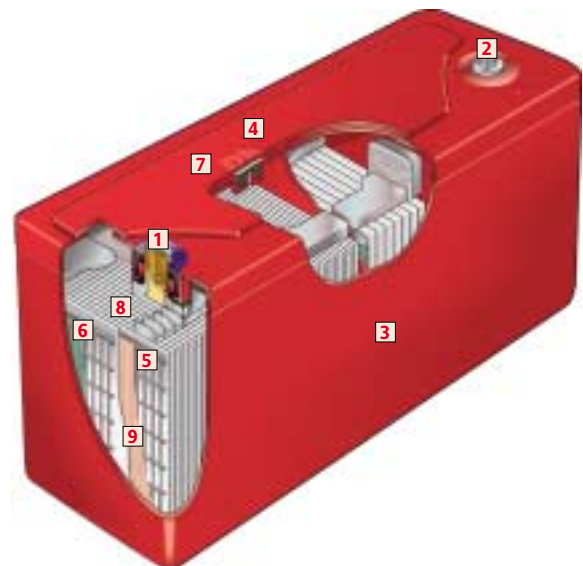
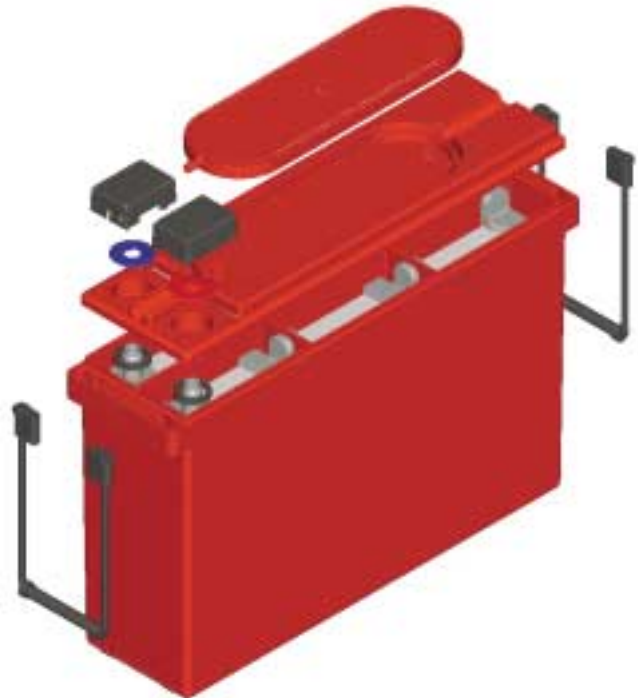
The valve retaining disc also functions as a flame Arrestor to prevent ingress of a spark or flame.

8 Separators

Separator material is resilient to scuffs and tears to minimise risk of internal shorts caused by a damaged separator.

9 Electrolyte

Medical grade dilute sulphuric acid is absorbed into separator material.



Features and Benefits

Design Life

- High purity materials give SBS batteries a long float life. On constant voltage float charge systems the design life expectancy is 10+ years at 25°C/77°F and 15+ years at 20°C/68°F.

Energy Density

- The advanced thin plate pure lead technology promotes exceptionally efficient utilisation of the active materials. SBS energy density is typically 12 to 30 % higher than conventional lead calcium VRLA batteries.

Operating Temperature

- The recommended operating temperature range for optimum life and performance is 20°C/68°F to 25°C/77°F.
- However, SBS can be operated in the temperature range -40°C/-40°F to 50°C/122°F, and by using the optional metal jacket the maximum operating temperature of the SBS J types is increased to 80°C/176°F.
- Operation at higher or lower temperature will effect battery life or performance respectively:

-40°C/-40°F to 19°C/66°F	20°C/68°F to 25°C/77°F	26°C/78°F to 50°C/122°F
Lower capacity	Optimum life and performance	Shorter life

Transportation

- SBS products are classified as “nonspillable wet electric storage batteries” and may be shipped by air or ground transportation without restriction.
- The batteries, their shipping container and external packaging must be labelled “nonspillable” or “nonspillable battery”.
- SBS batteries are in compliance with:
USA 49 Code of Federal Regulations section DOT 173.159
ICAO/IATA Packaging Instruction 806 and Special Provision A67
IMDG UN No 2800 Class 8 Exempt when securely packaged and protected against short circuits.

Orientation

The batteries can be installed in any orientation except upside down (vents on the bottom).

Terminal Position

- The SBS range comprises of both top and front terminal models, and JIS and unique SBS container sizes for maximum battery layout flexibility.

Low Gas Emission and Remote venting

- Under normal operating conditions, gas emission is virtually negligible. On SBS15-60, SBS J and front terminal models optional venting systems are available to vent gas outside the battery compartment. The remote venting system allows batteries to be installed in applications where there is little ventilation.



Battery capacity is affected by the discharge rate, end voltage, temperature and age.

Battery sizing calculations should include factors for temperature and loss of capacity over life. A battery usually is determined to have reached end of life when its capacity has fallen to 80% of its rated capacity.

Strings of the same SBS batteries can be connected in parallel to obtain higher capacities.

Telecom Applications

In general, telecom applications are a constant power or constant current load for a specified period, to a specified end voltage. The appropriate battery model can be selected by referring to the Discharge Tables.

EXAMPLE 1

The following information is needed:

- Nominal system voltage
- Minimum system voltage
- Load (constant current or constant power)
- Backup time
- Temperature range

A nominal 48V system requires a constant current of 9 Amps for 4 hours to a minimum of 42V at a minimum operating temperature of 20°C/68°F.

Step 1. Number of cells = nominal system voltage divided by nominal cell voltage:
 $48V/2V = 24$ cells

Step 2. Cell end voltage = minimum system voltage divided by the number of cells:
 $42V/24$ cells = 1.75 volts per cell

Step 3. Correct load for temperature and ageing:
Temperature factor = 1/Factor from Temperature Correction Chart = $1/0.978 = 1.022$
Ageing factor = $100/80 = 1.25$
9 amps x temperature factor x ageing factor =
 9 amps x 1.022 x $1.25 = 11.5$ Amps

Step 4. Refer to the constant current discharge table for an end voltage of 1.75 Vpc, and in the 4 hour column find the model that will provide the load current. In this example an SBS60 will provide 11.7 amps/4 Hrs/1.75Vpc SBS60 is a 12V six cell monobloc, so 4 blocs are required for a 48V battery.

UPS Applications

In general, UPS systems are rated in kVA, (kilo Volt Amperes). This is a multiplication of the output voltage in Kilo Volts and output current in amperes. The kVA rating is always an AC rating. The kVA rating may be converted to kW by simply multiplying the kVA by the Power Factor (PF).

$$\text{kW Rating of UPS} = (\text{kVA of UPS}) \times (\text{PF of UPS})$$
$$\text{kW Rating of UPS Battery} = \frac{\text{kVA} \times \text{PF}}{\text{Inverter Efficiency}}$$

EXAMPLE 2

This first example covers a basic sizing procedure with no power factor or efficiency involvement. This procedure details only the fundamental steps required.

In an example such as this the following information is needed as a minimum requirement:

- (i) system kilowatts
- (ii) required autonomy (run time)
- (iii) minimum DC voltage
- (iv) maximum DC voltage

If the load is given in kVA, then the PF and inverter efficiency values must also be known.

Therefore, for a UPS requiring the following autonomy,

Battery kW Rating: 10

Battery nominal voltage: 120

Battery end voltage: 1.67 Vpc

Battery run time: 10 minutes

Battery Sizing

Step 1. Number of cells needed per string
 = 120 (nom.volt) /2 (nominal cell voltage)
 = 60 cells

Step 2. Watts per cell required to support the load
 = 10,000 (Watts) /60 (cells)
 = 166.67 Watts per cell

Step 3. Refer to the constant power discharge tables for an end voltage of 1.67 Vpc, and in the 10 minute column find the model that can support a load of 166.67 Watts per cell.

SBS40 will provide 205 Wpc for 10 minutes.

Step 4. Calculate the number of blocs required to make up the battery string. The number of blocs
 = System Nominal Voltage/Bloc Nominal Voltage
 = 120V/12V = 10 blocs.

Therefore 10 SBS40 blocs are required to make up the battery string

EXAMPLE 3

This example is slightly more complex in that it takes into account both the power factor and the system efficiency.

- UPS kVA rating: 12.0
- Inverter power factor: 0.80
- Inverter efficiency: 85%
- Battery nominal voltage: 120
- Battery end-voltage: 1.67 Vpc
- Battery run time:15 minutes

Step 1. Total power required from battery

$$= \frac{\text{kVA} \times \text{PF}}{\text{Inverter Efficiency}}$$

$$= \frac{12.000(\text{kVA}) \times 0.80(\text{PF})}{0.85 (\text{Inv.eff})}$$

$$= 11.294 \text{ kW}$$

Step 2. Watts per cell required to support the load
 = $\frac{\text{Total power required from battery}}{\text{no. of cells}}$

= $\frac{11.294 \text{ (kW)}}{60 \text{ (cells)}}$
 = 188.2 Watts per cell

Step 3. Refer to the constant power discharge tables for an end voltage of 1.67 Vpc, and in the 15 minute column find the model that can support a load of 188.2 Watts per cell.

SBS60 will provide 206 Wpc for 15 minutes.

Step 4. Calculate the number of blocs required to make up the battery string. The number of blocs
 = System Nominal Voltage/Bloc Nominal Voltage
 = 120V/12V = 10 blocs.

Therefore 10 SBS60 blocs are required to make up the battery string

With both of these examples, by reference to the discharge tables, it is possible to use a parallel string system with smaller SBS models.

These are basic examples. For split duty regimes and other more complex sizings, contact our sales department.



Performance Data

Constant current discharge performance data



Constant Current Discharge (amps) to 1.85Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	33.6	21.7	16.3	13.2	11.1	9.61	8.49	7.62	6.92	5.44	3.01	2.11	1.63	1.34	1.14	1.00	0.89	0.80	0.73	0.40
SBS15	59.3	39.3	30.0	24.5	20.8	18.1	16.1	14.5	13.2	10.5	5.83	4.09	3.17	2.59	2.20	1.91	1.69	1.52	1.38	0.73
SBS30	110	73.1	55.7	45.4	38.2	33.3	29.6	26.6	24.3	19.3	10.8	7.56	5.85	4.79	4.07	3.53	3.13	2.81	2.61	1.43
SBS40	139	96.5	75.3	62.2	53.3	46.7	41.7	37.6	34.4	27.4	15.4	10.8	8.33	6.81	5.77	5.01	4.52	3.97	3.72	2.04
SBS60	173	123	97.0	80.7	68.7	60.5	54.2	49.1	45.0	36.1	20.6	14.6	11.4	9.34	7.94	6.91	6.13	5.50	5.00	2.68
SBS110	290	223	183	156	137	122	110	101	92.9	75.7	44.4	31.9	25.1	20.7	17.7	15.5	13.8	12.4	11.4	6.19
SBS130	370	268	215	181	157	140	126	115	106	86.3	50.8	36.6	28.8	23.8	20.3	17.8	15.8	14.3	13.0	6.94
SBS300	826	622	500	413	357	310	282	255	239	187	109	78.1	62.0	52.0	45.3	40.3	36.1	32.8	30.6	17.2
SBS390	866	683	567	488	429	385	349	319	295	241	142	102	79.7	65.8	55.9	48.7	43.5	39.0	35.7	19.0
SBS J13	47.2	31.9	24.6	20.2	17.2	15.1	13.4	12.1	11.0	8.79	4.92	3.46	2.68	2.19	1.85	1.61	1.42	1.28	1.16	0.61
SBS J16	57.4	39.6	30.7	25.4	21.7	19.0	16.9	15.3	13.9	11.1	6.20	4.34	3.35	2.73	2.31	2.00	1.77	1.59	1.44	0.75
SBS J30	105	72.8	56.4	46.3	39.5	34.5	30.6	27.6	25.1	19.9	11.0	7.67	5.92	4.83	4.09	3.55	3.14	2.82	2.56	1.36
SBS J40	142	100	78.5	65.1	55.9	49.1	43.8	39.6	36.2	28.9	16.3	11.4	8.84	7.22	6.12	5.31	4.70	4.21	3.82	2.01
SBS J70	235	166	130	108	92.8	81.5	72.7	65.8	60.1	47.8	26.7	18.6	14.4	11.7	9.87	8.54	7.53	6.74	6.10	3.16
B8	146	83.9	61.4	49.3	41.6	36.3	32.3	29.2	26.6	21.4	12.3	8.80	6.87	5.64	4.78	4.14	3.75	3.35	3.02	1.53
B10	129	92.7	72.6	59.9	51.0	44.5	39.5	35.5	32.3	25.5	13.9	9.66	7.45	6.09	5.17	4.51	4.13	3.91	3.74	2.10
B14	193	143	115	97.0	84.2	74.6	67.1	61.1	56.1	45.2	25.9	18.3	14.2	11.7	9.88	8.58	7.59	6.80	6.17	3.22
C11	248	184	149	126	110	97.4	87.8	80.1	73.7	59.7	34.8	24.9	19.6	16.1	13.8	12.1	11.1	10.0	9.08	4.92

Constant Current Discharge (amps) to 1.80Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	35.5	22.5	16.8	13.5	11.3	9.81	8.66	7.76	7.05	5.54	3.05	2.13	1.66	1.36	1.16	1.01	0.90	0.81	0.74	0.41
SBS15	62.8	40.6	30.8	25.0	21.2	18.4	16.3	14.7	13.4	10.6	5.91	4.15	3.22	2.63	2.23	1.94	1.72	1.54	1.40	0.74
SBS30	117	75.5	57.0	46.7	39.1	34.0	30.2	27.2	24.7	19.6	10.9	7.66	5.93	4.86	4.12	3.58	3.17	2.85	2.64	1.46
SBS40	149	101	78.0	64.1	54.6	47.8	42.6	38.4	35.0	27.9	15.6	10.9	8.46	6.91	5.86	5.08	4.59	4.03	3.77	2.06
SBS60	190	129	102	83.8	71.0	62.3	55.7	50.4	46.1	36.9	21.0	14.9	11.6	9.49	8.06	7.02	6.22	5.59	5.08	2.71
SBS110	321	239	193	163	142	126	114	104	95.7	77.6	45.3	32.5	25.5	21.0	18.0	15.7	14.0	12.6	11.5	6.26
SBS130	405	286	227	190	164	145	131	119	110	88.8	51.9	37.3	29.3	24.2	20.7	18.1	16.1	14.5	13.2	7.03
SBS300	870	664	548	471	400	346	313	282	253	201	116	83.7	66.2	54.3	47.8	41.6	37.4	34.3	31.0	17.3
SBS390	952	733	602	511	447	401	363	331	304	247	145	103	80.8	66.5	56.6	49.3	43.9	39.4	36.0	19.2
SBS J13	50.9	33.5	25.6	20.9	17.7	15.5	13.7	12.4	11.3	8.94	4.99	3.50	2.71	2.22	1.88	1.63	1.44	1.30	1.18	0.62
SBS J16	62.0	41.7	32.0	26.3	22.4	19.6	17.4	15.7	14.3	11.4	6.35	4.45	3.44	2.81	2.37	2.06	1.82	1.63	1.48	0.77
SBS J30	113	76.6	58.8	48.0	40.8	35.5	31.5	28.3	25.8	20.3	11.2	7.80	6.01	4.90	4.15	3.61	3.19	2.86	2.60	1.39
SBS J40	154	106	82.4	67.9	58.0	50.8	45.2	40.8	37.3	29.6	16.6	11.6	8.96	7.32	6.20	5.38	4.76	4.27	3.87	2.04
SBS J70	257	178	138	114	97.2	84.9	75.5	68.1	62.1	49.1	27.1	18.9	14.5	11.8	10.0	8.62	7.60	6.81	6.16	3.21
B8	148	86.5	63.5	51.0	43.1	37.4	33.3	30.0	27.4	21.9	12.5	8.89	6.93	5.68	4.81	4.17	3.79	3.38	3.05	1.58
B10	141	97.1	74.8	61.2	51.9	45.1	40.0	36.0	32.7	25.7	14.1	9.8	7.59	6.21	5.27	4.60	4.21	3.99	3.81	2.11
B14	212	154	122	102	88.2	77.8	69.7	63.2	57.9	46.4	26.2	18.4	14.3	11.7	9.88	8.58	7.59	6.80	6.17	3.24
C11	272	198	158	132	115	101	91.3	83.0	76.1	61.3	35.3	25.2	19.7	16.2	13.9	12.1	11.1	10.0	9.15	5.01

Constant Current Discharge (amps) to 1.75Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	37.3	23.3	17.2	13.8	11.6	10.0	8.83	7.91	7.17	5.62	3.09	2.16	1.68	1.38	1.17	1.02	0.91	0.82	0.75	0.41
SBS15	66.1	41.9	31.5	25.5	21.5	18.7	16.6	14.9	13.6	10.7	5.99	4.21	3.26	2.67	2.27	1.97	1.75	1.57	1.42	0.75
SBS30	124	78.3	58.6	47.4	40.0	34.7	30.7	27.6	25.1	19.9	11.1	7.76	6.01	4.92	4.17	3.63	3.21	2.88	2.67	1.48
SBS40	160	105	80.4	65.7	55.9	48.8	43.3	39.1	35.6	28.3	15.8	11.1	8.58	7.01	5.94	5.15	4.65	4.08	3.82	2.08
SBS60	206	136	105	85.8	73.1	64.0	57.0	51.6	47.1	37.6	21.3	15.1	11.7	9.63	8.18	7.12	6.31	5.66	5.14	2.82
SBS110	352	254	203	170	147	131	117	107	98.2	79.3	46.1	33.0	25.8	21.3	18.2	15.9	14.2	12.8	11.7	6.32
SBS130	440	303	238	198	171	151	135	123	113	91.1	52.9	37.9	29.8	24.6	21.0	18.3	16.3	14.7	13.4	7.1
SBS300	986	731	581	492	421	381	333	300	275	216	123	87.0	67.8	56.7	49.2	42.4	37.7	34.5	31.5	17.3
SBS390	1,041	780	630	534	465	414	373	340	314	254	148	105	81.9	67.4	57.2	50.1	44.3	39.7	36.2	19.3
SBS J13	54.4	35.0	26.5	21.5	18.2	15.8	14.0	12.6	11.5	9.08	5.06	3.55	2.75	2.25	1.90	1.65	1.46	1.31	1.19	0.63
SBS J16	66.4	43.6	33.2	27.1	23.0	20.1	17.8	16.1	14.6	11.6	6.49	4.55	3.52	2.87	2.43	2.11	1.87	1.67	1.52	0.79
SBS J30	121	80.2	61.0	49.5	41.9	36.4	32.2	28.9	26.3	20.7	11.4	7.91	6.10	4.98	4.21	3.66	3.24	2.91	2.64	1.41
SBS J40	166	112	86.0	70.4	59.9	52.3	46.5	41.9	38.2	30.2	16.8	11.8	9.08	7.42	6.28	5.45	4.82	4.32	3.92	2.07
SBS J70	279	189	146	119	101	88.0	78.0	70.2	63.8	50.3	27.6	19.1	14.7	11.9	10.1	8.70	7.68	6.87	6.23	3.26
B8	150	88.9	65.4	52.6	44.3	38.5	34.2	30.8	28.1	22.3	12.7	8.98	6.98	5.72	4.85	4.20	3.82	3.41	3.08	1.61
B10	153	101	76.8	62.3	52.7	45.7	40.5	36.3	33.0	26.0	14.3	10.0	7.73	6.33	5.38	4.69	4.30	4.06	3.88	2.13
B14	231	164	129	107	92.0	80.7	72.0	65.1	59.5	47.4	26.5	18.5	14.3	11.7	9.90	8.59	7.59	6.81	6.18	3.27
C11	295	211	167	139	120	105	94.4	85.6	78.3	62.7	35.7	25.4	19.8	16.3	13.9	12.2	11.2	10.1	9.21	5.09

Note: SBSB10 discharge rates are preliminary data and subject to revision.

Constant Current Discharge (amps) to 1.70Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	39.0	24.0	17.7	14.1	11.8	10.2	8.99	8.04	7.29	5.71	3.13	2.19	1.70	1.40	1.19	1.04	0.92	0.83	0.76	0.42
SBS15	69.1	43.0	32.1	25.9	21.8	18.9	16.8	15.1	13.7	10.8	6.05	4.26	3.30	2.71	2.30	2.00	1.77	1.59	1.44	0.8
SBS30	130	80.8	60.1	48.3	40.7	35.3	31.2	28.0	25.5	20.1	11.2	7.85	6.08	4.97	4.22	3.67	3.24	2.91	2.70	1.49
SBS40	169	109	82.5	67.1	56.9	49.6	44.0	39.7	36.1	28.6	16.0	11.2	8.69	7.10	6.01	5.22	4.71	4.13	3.86	2.09
SBS60	222	143	108	88.3	75.0	65.5	58.2	52.6	48.0	38.2	21.6	15.3	11.9	9.75	8.28	7.21	6.38	5.73	5.20	2.84
SBS110	382	268	211	176	152	134	120	109	100	80.8	46.7	33.4	26.2	21.6	18.5	16.1	14.4	12.9	11.8	6.38
SBS130	474	320	248	205	176	155	139	126	116	93.0	53.8	38.5	30.2	24.9	21.3	18.6	16.5	14.9	13.5	7.20
SBS300	1,062	772	614	518	448	390	353	316	289	221	127	88.6	68.8	58.0	49.6	42.8	38.0	34.8	31.6	17.3
SBS390	1,133	823	658	554	481	426	384	347	321	259	149	107	83.1	68.2	58.2	50.6	45.0	40.3	36.7	19.4
SBS J13	57.7	36.4	27.2	22.0	18.5	16.1	14.3	12.8	11.7	9.20	5.12	3.59	2.78	2.27	1.93	1.68	1.48	1.33	1.21	0.64
SBS J16	70.5	45.3	34.2	27.8	23.5	20.5	18.2	16.4	14.9	11.8	6.60	4.63	3.59	2.93	2.49	2.16	1.91	1.71	1.55	0.81
SBS J30	128	83.3	62.8	50.8	42.9	37.2	32.8	29.5	26.7	21.0	11.5	8.01	6.18	5.04	4.27	3.71	3.29	2.95	2.68	1.43
SBS J40	177	117	89.1	72.6	61.6	53.6	47.6	42.8	38.9	30.8	17.0	11.9	9.20	7.51	6.36	5.52	4.88	4.38	3.97	2.10
SBS J70	300	200	152	123	104	90.6	80.2	71.9	65.3	51.3	27.9	19.3	14.8	12.0	10.1	8.79	7.75	6.94	6.29	3.30
B8	152	91	67.2	54.0	45.5	39.5	35.0	31.5	28.7	22.8	12.8	9.07	7.04	5.76	4.88	4.23	3.85	3.44	3.11	1.65
B10	164	105	78.4	63.3	53.3	46.2	40.9	36.7	33.3	26.2	14.5	10.2	7.87	6.46	5.49	4.78	4.38	4.14	3.95	2.15
B14	249	174	135	112	95.2	83.2	74.1	66.8	60.9	48.2	26.7	18.6	14.4	11.7	9.92	8.60	7.61	6.83	6.20	3.29
C11	318	223	175	145	124	109	97.2	87.9	80.2	64.0	36.1	25.5	19.9	16.4	14.0	12.3	11.2	10.2	9.27	5.16

Constant Current Discharge (amps) to 1.67Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	39.9	24.4	18.0	14.3	12.0	10.3	9.08	8.13	7.36	5.77	3.16	2.21	1.72	1.41	1.20	1.05	0.93	0.84	0.77	0.42
SBS15	70.7	43.6	32.4	26.1	22.0	19.1	16.9	15.2	13.8	10.9	6.09	4.29	3.33	2.73	2.31	2.01	1.78	1.60	1.45	0.76
SBS30	134	82.1	60.8	48.8	41.1	35.6	31.4	28.2	25.7	20.2	11.3	7.89	6.12	5.01	4.24	3.69	3.26	2.93	2.71	1.49
SBS40	174	111	83.6	67.8	57.4	50.0	44.4	39.9	36.4	28.8	16.1	11.3	8.75	7.15	6.05	5.25	4.74	4.16	3.89	2.09
SBS60	230	146	110	89.6	76.0	66.2	58.9	53.1	48.4	38.5	21.8	15.4	12.0	9.82	8.34	7.25	6.42	5.77	5.23	2.86
SBS110	399	276	216	180	154	136	122	111	101	81.6	47.1	33.6	26.4	21.8	18.6	16.2	14.4	13.0	11.9	6.41
SBS130	493	329	254	209	179	158	141	128	117	94.1	54.3	38.8	30.4	25.1	21.4	18.7	16.6	15.0	13.6	7.24
SBS300	1,080	788	621	522	447	392	355	318	289	222.5	128.3	89.2	69.4	58.4	49.6	42.8	38.2	34.8	31.7	17.3
SBS390	1,186	849	675	565	487	432	387	354	323	261.5	150.6	107.2	83.9	68.9	58.6	50.9	45.2	40.5	36.9	19.4
SBS J13	59.5	37.1	27.6	22.3	18.7	16.2	14.4	12.9	11.7	9.27	5.15	3.61	2.80	2.29	1.94	1.69	1.49	1.34	1.22	0.64
SBS J16	72.8	46.2	34.7	28.1	23.8	20.7	18.4	16.5	15.0	11.9	6.66	4.68	3.62	2.97	2.51	2.18	1.93	1.73	1.57	0.82
SBS J30	132	85.0	63.8	51.5	43.3	37.5	33.1	29.7	27.0	21.2	11.6	8.07	6.22	5.08	4.30	3.74	3.31	2.97	2.70	1.45
SBS J40	184	120	90.8	73.7	62.4	54.2	48.1	43.2	39.3	31.0	17.2	12.0	9.26	7.56	6.40	5.56	4.92	4.41	4.00	2.11
SBS J70	312	205	155	126	106	91.9	81.2	72.8	66.0	51.8	28.1	19.4	14.9	12.1	10.2	8.84	7.80	6.98	6.33	3.33
B8	153	92.3	68.1	54.7	46.1	40.0	35.4	31.9	29.0	23.0	12.9	9.12	7.07	5.79	4.90	4.25	3.87	3.46	3.13	1.66
B10	169	106	79.3	63.8	53.7	46.5	41.1	36.9	33.5	26.4	14.6	10.3	7.96	6.53	5.56	4.84	4.43	4.19	4.00	2.16
B14	260	179	139	114	96.9	84.6	75.1	67.7	61.6	48.7	26.9	18.7	14.4	11.8	9.94	8.62	7.63	6.84	6.21	3.30
C11	332	230	180	148	127	111	98.7	89.1	81.3	64.6	36.3	25.6	20.0	16.4	14.0	12.3	11.3	10.2	9.30	5.19

Constant Current Discharge (amps) to 1.65Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	40.5	24.7	18.1	14.4	12.1	10.4	9.15	8.18	7.41	5.80	3.18	2.23	1.73	1.42	1.21	1.05	0.94	0.84	0.77	0.42
SBS15	71.6	43.9	32.6	26.2	22.1	19.1	16.9	15.2	13.8	10.9	6.11	4.30	3.34	2.74	2.32	2.02	1.79	1.61	1.46	0.76
SBS30	136	82.8	61.2	49.1	41.3	35.7	31.6	28.4	25.8	20.3	11.3	7.92	6.14	5.03	4.26	3.70	3.28	2.94	2.72	1.52
SBS40	177	112	84.2	68.2	57.7	50.2	44.5	40.1	36.5	28.9	16.2	11.4	8.79	7.18	6.08	5.27	4.76	4.17	3.90	2.09
SBS60	235	148	111	90.4	76.6	66.7	59.3	53.4	48.7	38.7	21.9	15.4	12.0	9.86	8.37	7.28	6.45	5.79	5.25	2.9
SBS110	410	281	219	181	156	137	123	111	102	82.1	47.3	33.8	26.5	21.9	18.7	16.3	14.5	13.1	11.9	6.42
SBS130	506	335	257	212	181	159	142	129	118	94.7	54.6	39.0	30.5	25.2	21.5	18.8	16.7	15.0	13.7	7.26
SBS300	1,105	800	633	532	449	395	354	318	290	226	130	89.7	69.7	58.9	49.8	43.1	38.2	35.0	31.8	17.3
SBS390	1,223	863	684	571	492	434	390	354	325	264	152	109	84.3	69.4	58.8	51.3	45.5	40.8	37.1	19.4
SBS J13	60.6	37.5	27.9	22.4	18.9	16.3	14.4	13.0	11.8	9.30	5.17	3.63	2.81	2.30	1.95	1.69	1.50	1.35	1.22	0.64
SBS J16	74.3	46.7	35.0	28.3	23.9	20.8	18.5	16.6	15.1	12.0	6.69	4.70	3.65	2.98	2.53	2.20	1.94	1.74	1.58	0.82
SBS J30	135	86.0	64.3	51.8	43.6	37.7	33.3	29.9	27.1	21.3	11.6	8.10	6.25	5.10	4.32	3.76	3.33	2.99	2.72	1.45
SBS J40	188	121	91.7	74.4	62.9	54.6	48.4	43.5	39.5	31.2	17.2	12.0	9.30	7.60	6.43	5.59	4.94	4.43	4.02	2.12
SBS J70	320	208	157	127	107	92.6	81.8	73.3	66.5	52.1	28.2	19.5	14.9	12.1	10.2	8.87	7.83	7.01	6.35	3.34
B8	155	93.0	68.7	55.2	46.5	40.3	35.7	32.1	29.2	23.2	13.0	9.15	7.10	5.80	4.92	4.26	3.88	3.47	3.14	1.67
B10	173	107	79.7	64.1	53.9	46.6	41.2	37.0	33.6	26.5	14.7	10.3	8.02	6.58	5.60	4.88	4.47	4.22	4.03	2.17
B14	267	183	141	115	97.9	85.3	75.7	68.2	62.0	49.0	26.9	18.7	14.4	11.8	9.95	8.64	7.64	6.85	6.22	3.31
C11	340	235	182	151	128	111	99.6	89.9	81.9	65.0	36.4	25.7	20.0	16.5	14.1	12.3	11.3	10.2	9.32	5.21

Note: SBSB10 discharge rates are preliminary data and subject to revision.

Constant Current Discharge (amps) to 1.63Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	41.0	24.9	18.3	14.6	12.9	10.5	9.21	8.23	7.46	5.84	3.20	2.24	1.74	1.43	1.21	1.06	0.94	0.85	0.77	0.42
SBS15	72.4	44.2	32.7	26.3	22.1	19.2	17.0	15.3	13.9	11.0	6.13	4.32	3.35	2.75	2.33	2.03	1.80	1.61	1.46	0.76
SBS30	138	83.5	61.6	49.4	41.5	35.9	31.7	28.5	25.9	20.4	11.3	7.95	6.16	5.04	4.28	3.72	3.29	2.95	2.73	1.53
SBS40	180	113	84.7	68.6	58.0	50.4	44.7	40.3	36.6	29.0	16.2	11.4	8.82	7.21	6.10	5.29	4.77	4.18	3.91	2.11
SBS60	240	150	113	91.1	77.1	67.1	59.6	53.7	49.0	38.9	21.9	15.5	12.1	9.89	8.40	7.31	6.47	5.81	5.27	2.87
SBS110	421	285	222	183	157	138	124	112	103	82.5	47.5	33.9	26.6	21.9	18.72	16.37	14.55	13.12	11.95	6.44
SBS130	518	340	260	214	183	160	143	130	119	95.2	54.8	39.1	30.7	25.3	21.6	18.8	16.7	15.1	13.7	7.29
SBS300	1,123	800	640	539	450	396	354	318	290	227	130	90.2	69.1	59.0	49.8	43.4	38.3	35.0	31.8	17.3
SBS390	1,260	879	692	576	497	439	394	356	327	265	153	109	84.7	69.7	59.1	51.4	45.6	41.0	37.3	19.4
SBS J13	61.6	37.9	28.1	22.5	19.0	16.4	14.5	13.0	11.8	9.34	5.19	3.64	2.82	2.31	1.96	1.70	1.51	1.35	1.23	0.64
SBS J16	75.6	47.2	35.3	28.5	24.1	20.9	18.5	16.7	15.2	12.0	6.72	4.73	3.67	3.00	2.54	2.21	1.96	1.75	1.59	0.83
SBS J30	137	86.9	64.8	52.2	43.8	37.9	33.5	30.0	27.2	21.3	11.7	8.14	6.28	5.13	4.34	3.77	3.34	3.00	2.73	1.46
SBS J40	191	123	92.6	74.9	63.3	54.9	48.6	43.7	39.7	31.3	17.3	12.1	9.34	7.63	6.46	5.61	4.96	4.45	4.04	2.13
SBS J70	327	211	159	128	108	93.3	82.3	73.7	66.8	52.3	28.3	19.6	15.0	12.2	10.3	8.91	7.86	7.04	6.38	3.35
B8	155	93.7	69.2	55.6	46.8	40.6	35.9	32.3	29.4	23.3	13.0	9.19	7.12	5.82	4.93	4.28	3.89	3.48	3.15	1.68
B10	175	108	80.1	64.3	54.1	46.8	41.4	37.1	33.7	26.6	14.8	10.4	8.08	6.64	5.64	4.92	4.50	4.25	4.06	2.17
B14	274	186	143	116	98.8	86.0	76.3	68.6	62.4	49.2	27.0	18.8	14.5	11.8	9.97	8.65	7.65	6.87	6.23	3.32
C11	348	239	185	152	129	113	100	90.5	82.5	65.4	36.5	25.7	20.0	16.5	14.1	12.3	11.3	10.2	9.34	5.23

Constant Current Discharge (amps) to 1.60Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	41.8	25.3	18.5	14.7	12.3	10.6	9.30	8.31	7.53	5.89	3.23	2.26	1.75	1.44	1.22	1.07	0.95	0.86	0.78	0.43
SBS15	73.5	44.6	33.0	26.5	22.2	19.3	17.1	15.3	13.9	11.0	6.16	4.34	3.37	2.76	2.35	2.04	1.80	1.62	1.47	0.77
SBS30	140	84.3	62.0	49.7	41.7	36.0	31.8	28.6	26.0	20.5	11.4	7.99	6.19	5.07	4.30	3.74	3.30	2.96	2.74	1.53
SBS40	184	114	85.4	69.0	58.3	50.6	44.9	40.6	36.8	29.2	16.3	11.5	8.87	7.25	6.13	5.32	4.80	4.20	3.93	2.1
SBS60	246	153	114	92.1	77.8	67.7	60.0	54.1	49.3	39.1	22.1	15.6	12.1	9.94	8.44	7.34	6.50	5.83	5.29	2.88
SBS110	435	291	225	186	159	139	125	113	103	83.0	47.7	34.1	26.7	22.1	18.8	16.5	14.6	13.2	12.0	6.46
SBS130	536	347	265	217	185	162	145	131	120	95.9	55.1	39.4	30.8	25.4	21.7	19.0	16.8	15.2	13.8	7.32
SBS300	1,148	806	650	547	453	397	351	320	290	230	131	90.5	70.5	59.4	50.1	43.4	38.3	35.1	31.9	17.3
SBS390	1,315	899	703	584	503	443	396	360	329	267	154	110	85.7	70.5	59.6	52.0	46.1	41.3	37.5	19.4
SBS J13	63.0	38.4	28.3	22.7	19.1	16.5	14.6	13.1	11.9	9.38	5.21	3.66	2.84	2.32	1.97	1.71	1.52	1.36	1.23	0.64
SBS J16	77.4	47.9	35.6	28.7	24.2	21.0	18.6	16.7	15.2	12.1	6.75	4.76	3.69	3.02	2.56	2.23	1.97	1.77	1.60	0.84
SBS J30	140	88.0	65.4	52.5	44.1	38.1	33.6	30.1	27.3	21.4	11.7	8.18	6.31	5.16	4.37	3.80	3.36	3.02	2.74	1.46
SBS J40	197	125	93.6	75.6	63.8	55.3	48.9	43.9	39.9	31.5	17.4	12.2	9.40	7.68	6.50	5.65	5.00	4.48	4.07	2.14
SBS J70	337	215	161	130	109	94.0	82.9	74.2	67.2	52.6	28.5	19.7	15.1	12.3	10.3	8.96	7.91	7.08	6.42	3.37
B8	156	94.6	69.8	56.1	47.2	40.9	36.3	32.6	29.6	23.5	13.1	9.23	7.15	5.85	4.95	4.29	3.90	3.49	3.16	1.69
B10	179	109	80.6	64.6	54.3	47.0	41.5	37.3	33.9	26.7	14.9	10.5	8.18	6.72	5.71	4.98	4.56	4.30	4.10	2.19
B14	283	190	145	118	100	86.9	77.0	69.2	62.8	49.5	27.1	18.8	14.5	11.8	10.0	8.68	7.68	6.89	6.25	3.33
C11	360	245	188	154	131	114	102	91.4	83.2	65.8	36.7	25.8	20.1	16.5	14.1	12.4	11.3	10.3	9.36	5.26

Constant Current Discharge (amps) to 1.50Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	43.5	26.1	19.1	15.2	12.7	10.9	9.58	8.57	7.76	6.07	3.33	2.33	1.81	1.49	1.26	1.10	0.98	0.88	0.80	0.44
SBS15	75.3	45.2	33.3	26.7	22.4	19.4	17.2	15.4	14.1	11.1	6.22	4.39	3.41	2.80	2.37	2.06	1.83	1.64	1.48	0.77
SBS30	144	85.4	62.5	49.9	41.9	36.2	32.0	28.7	26.1	20.6	11.5	8.09	6.27	5.14	4.36	3.78	3.35	3.00	2.78	1.55
SBS40	191	116	86.0	69.3	58.5	50.8	45.1	40.6	37.0	29.3	16.5	11.6	8.99	7.34	6.20	5.37	4.84	4.23	3.95	2.14
SBS60	256	157	116	93.6	78.9	68.6	60.8	54.7	49.8	39.5	22.3	15.7	12.2	10.0	8.53	7.42	6.56	5.89	5.34	2.89
SBS110	470	304	232	190	162	142	126	114	104	83.8	48.2	34.4	27.0	22.3	19.1	16.7	14.8	13.4	12.2	6.50
SBS130	581	364	273	222	189	165	147	133	121	97.0	55.7	39.8	31.2	25.8	22.0	19.2	17.1	15.4	14.0	7.38
SBS300	1,201	818	648	547	452	397	352	317	290	231	132	91.0	70.8	59.8	50.3	43.5	38.3	35.1	31.9	17.4
SBS390	1,478	949	725	595	510	448	402	365	336	271	157	113	88.1	72.4	61.5	53.5	47.3	42.3	38.3	19.4
SBS J13	65.8	39.1	28.6	22.9	19.2	16.6	14.7	13.2	12.0	9.45	5.28	3.72	2.88	2.36	2.00	1.74	1.54	1.38	1.25	0.65
SBS J16	81.2	48.8	35.9	28.8	24.2	21.0	18.6	16.7	15.2	12.0	6.77	4.79	3.73	3.06	2.60	2.27	2.01	1.80	1.64	0.85
SBS J30	148	89.7	66.0	52.8	44.2	38.2	33.7	30.2	27.3	21.5	11.8	8.27	6.40	5.23	4.44	3.86	3.42	3.07	2.78	1.47
SBS J40	209	128	94.9	76.2	64.1	55.5	49.1	44.1	40.0	31.6	17.6	12.3	9.55	7.82	6.63	5.77	5.10	4.58	4.16	2.18
SBS J70	359	221	163	131	109	94.3	83.1	74.4	67.4	52.8	28.8	20.0	15.3	12.5	10.5	9.14	8.06	7.22	6.54	3.40
B8	161	96.4	71.1	57.0	48.0	41.6	36.9	33.1	30.1	23.9	13.3	9.39	7.27	5.94	5.02	4.35	3.95	3.54	3.19	1.69
B10	184	109	80.9	64.9	54.6	47.3	41.9	37.7	34.3	27.2	15.4	10.9	8.50	6.99	5.94	5.18	4.73	4.47	4.25	2.22
B14	308	198	149	121	102	88.1	77.9	69.9	63.4	49.9	27.3	19.0	14.7	12.0	10.14	8.80	7.79	6.99	6.35	3.37
C11	391	258	196	158	134	117	103	92.9	84.4	66.6	36.9	26.0	20.2	16.6	14.2	12.4	11.4	10.3	9.43	5.30

Note: SBSB10 discharge rates are preliminary data and subject to revision.

Performance Data

Constant power discharge performance data

Constant Power Discharge (watts per cell) to 1.85Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	63.3	45.7	38.8	29.4	25.0	21.7	19.2	17.2	15.5	12.1	6.33	4.27	3.22	2.59	2.17	1.86	1.64	1.46	1.32	0.69
SBS15	112	75.2	58.0	47.6	40.7	35.6	31.7	28.7	26.2	20.9	11.8	8.32	6.47	5.31	4.51	3.92	3.48	3.12	2.84	1.51
SBS30	208	140	108	88.4	74.6	65.2	58.1	52.4	47.9	38.1	21.5	15.1	11.8	9.62	8.17	7.10	6.29	5.64	5.23	2.87
SBS40	262	184	145	121	104	91.2	81.6	73.9	67.6	54.1	30.6	21.6	16.7	13.7	11.6	10.1	9.11	8.00	7.49	4.10
SBS60	326	235	187	156	134	118	106	96.3	88.4	71.3	41.1	29.2	22.8	18.8	16.0	13.9	12.3	11.1	10.1	5.40
SBS110	532	402	329	281	247	221	200	184	170	139	83.8	61.1	48.5	40.4	34.7	30.5	27.3	24.7	22.6	12.5
SBS130	693	509	411	349	304	271	245	224	207	169	101	72.9	57.5	47.6	40.7	35.7	31.7	28.6	26.1	14.0
SBS300	1,169	1,053	901	793	701	630	565	516	456	381	206	148	119	101	87.3	77.9	70.4	64.9	59.9	33.2
SBS390	1,574	1,267	1,064	923	822	735	671	617	569	468	277	201	158	130	113	98.2	87.4	78.8	71.5	38.4
SBS J13	94.3	64.1	49.2	40.2	34.1	29.7	26.3	23.6	21.4	16.9	9.19	6.36	4.88	3.96	3.34	2.89	2.55	2.28	2.07	1.09
SBS J16	111	75.8	58.9	48.7	41.7	36.6	32.7	29.6	27.0	21.6	12.2	8.64	6.71	5.50	4.67	4.06	3.60	3.23	2.93	1.54
SBS J30	200	140	110	90.4	77.3	67.7	60.3	54.4	49.6	39.4	21.9	15.3	11.8	9.68	8.20	7.12	6.30	5.66	5.14	2.75
SBS J40	270	193	152	127	109	96.1	86.0	78.0	71.4	57.1	32.4	22.8	17.7	14.5	12.3	10.7	9.43	8.47	7.68	4.05
SBS J70	442	317	250	208	179	157	141	127	116	92.5	51.4	35.7	27.4	22.2	18.7	16.1	14.1	12.6	11.4	5.74
B8	275	161	118	96.0	81.4	71.0	63.4	57.4	52.5	42.2	24.6	17.6	13.8	11.3	9.60	8.30	7.55	6.74	6.08	3.09
B10	242	177	140	116	99.6	87.1	77.6	69.9	63.7	50.4	27.8	19.4	15.0	12.2	10.4	9.08	8.32	7.88	7.54	4.23
B14	363	273	222	188	164	146	131	120	110	89.2	51.5	36.5	28.4	23.3	19.8	17.2	15.2	13.6	12.4	6.47
C11	466	352	286	244	213	189	172	157	144	117	69.2	46.8	39.1	32.4	27.7	24.2	22.2	20.0	18.3	9.92

Constant Power Discharge (watts per cell) to 1.80Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	66.3	46.9	36.4	29.8	25.3	21.9	19.3	17.3	15.7	12.2	6.39	4.33	3.27	2.63	2.20	1.89	1.67	1.49	1.34	0.70
SBS15	117	77.1	58.9	48.2	41.1	35.9	32.0	28.9	26.4	21.0	11.9	8.39	6.53	5.36	4.55	3.96	3.51	3.16	2.87	1.51
SBS30	219	143	109	90.2	75.9	66.3	58.9	53.2	48.5	38.6	21.7	15.3	11.9	9.74	8.27	7.19	6.36	5.71	5.29	2.92
SBS40	277	191	149	123	106	92.8	82.9	75.0	68.6	54.9	31.1	21.9	17.0	13.9	11.8	10.2	9.25	8.12	7.60	4.13
SBS60	353	244	193	161	137	121	108	98.2	90.1	72.4	41.7	29.7	23.2	19.0	16.2	14.1	12.5	11.3	10.2	5.45
SBS110	582	432	350	297	259	231	209	192	177	145	86.3	62.7	49.6	41.3	35.4	31.1	27.8	25.1	23.0	12.6
SBS130	745	537	430	362	315	280	252	231	213	173	103	74.1	58.4	48.4	41.4	36.2	32.2	29.0	26.4	14.1
SBS300	1,480	1,240	1,037	870	752	664	594	541	497	401	235	165	129	109	92.7	81.9	73.3	66.7	61.2	33.2
SBS390	1,699	1,335	1,108	956	850	754	690	635	584	477	284	204	160	132	114	99.3	88.3	79.5	72.2	38.6
SBS J13	98.3	65.6	50.1	40.8	34.6	30.1	26.7	24.0	21.8	17.2	9.45	6.56	5.04	4.10	3.46	3.00	2.65	2.37	2.15	1.12
SBS J16	117	78.9	60.9	50.1	42.8	37.5	33.5	30.3	27.6	22.1	12.5	8.83	6.87	5.63	4.78	4.16	3.68	3.31	3.00	1.58
SBS J30	213	146	113	93.1	79.3	69.3	61.6	55.6	50.6	40.1	22.3	15.6	12.0	9.82	8.32	7.23	6.40	5.75	5.23	2.80
SBS J40	289	202	158	131	112	98.8	88.2	79.8	73.0	58.3	32.8	23.1	17.9	14.7	12.4	10.8	9.56	8.58	7.79	4.11
SBS J70	477	336	263	217	186	163	145	131	119	94.6	52.2	36.2	27.7	22.5	18.9	16.3	14.3	12.8	11.5	5.86
B8	276	164	122	96	83.6	72.9	65.0	58.8	53.7	43.1	24.9	17.8	13.9	11.4	9.66	8.38	7.62	6.80	6.14	3.18
B10	263	184	143	117	101	87.8	78.1	70.4	64.1	50.7	28.1	19.6	15.2	12.5	10.6	9.26	8.48	8.03	7.68	4.26
B14	392	290	233	196	170	151	135	123	113	90.9	52.0	36.7	28.5	23.4	19.8	17.2	15.2	13.7	12.4	6.54
C11	502	373	300	253	221	196	177	161	148	120	70.0	50.2	39.4	32.6	27.9	24.4	22.4	20.2	18.4	10.1

Constant Power Discharge (watts per cell) to 1.75Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	69.1	47.8	36.9	30.1	25.4	22.0	19.4	17.4	15.7	12.2	6.46	4.38	3.32	2.67	2.24	1.93	1.70	1.52	1.37	0.72
SBS15	122	78.8	59.8	48.8	41.5	36.2	32.2	29.1	26.5	21.1	12.0	8.46	6.58	5.41	4.60	4.00	3.55	3.19	2.89	1.52
SBS30	229	147	112	90.8	77.1	67.2	59.7	53.8	49.1	39.0	22.0	15.5	12.0	9.85	8.36	7.27	6.44	5.78	5.35	2.95
SBS40	292	197	152	126	107	94.2	84.0	76.0	69.5	55.5	31.4	22.2	17.2	14.1	11.9	10.4	9.36	8.22	7.69	4.16
SBS60	377	255	198	163	140	123	110	100	91.6	73.6	42.2	30.1	23.5	19.3	16.4	14.3	12.7	11.4	10.4	5.68
SBS110	631	460	369	311	271	241	218	199	183	149	88.6	64.2	50.7	42.1	36.1	31.7	28.3	25.5	23.3	12.7
SBS130	795	562	447	374	324	288	259	236	218	177	104	75.3	59.3	49.1	41.9	36.7	32.6	29.4	26.8	14.3
SBS300	1,575	1,247	1,042	877	758	671	602	547	503	409	238	168	131	110	93.9	82.8	74.0	67.2	61.6	33.3
SBS390	1,813	1,399	1,152	989	876	776	709	651	598	487	289	207	162	134	113	101	89.5	80.6	73.1	39.0
SBS J13	102	67.04	50.92	41.44	35.10	30.5	27.1	24.4	22.2	17.5	9.67	6.74	5.19	4.23	3.57	3.09	2.73	2.45	2.21	1.15
SBS J16	123	81.65	62.61	51.34	43.78	38.3	34.1	30.9	28.2	22.5	12.7	9.01	7.01	5.75	4.88	4.25	3.76	3.38	3.07	1.61
SBS J30	224	152	117	95.49	81.16	70.8	62.8	56.6	51.5	40.7	22.6	15.8	12.2	10.0	8.44	7.33	6.49	5.84	5.30	2.84
SBS J40	306	211	164	135	115	101	90.2	81.5	74.4	59.3	33.3	23.4	18.1	14.8	12.6	10.9	9.67	8.68	7.88	4.17
SBS J70	511	353	274	225	192	168	149	134	122	96.6	53.0	36.6	28.0	22.7	19.1	16.5	14.5	12.9	11.7	5.97
B8	277	168	125	101	85.6	75	66.5	60.1	54.9	43.9	25.2	17.9	14.0	11.5	9.72	8.44	7.67	6.87	6.20	3.24
B10	281	189	146	119	102	88	78.6	70.8	64.4	51.0	28.4	19.9	15.8	12.7	10.8	9.43	8.64	8.18	7.81	4.29
B14	421	306	243	204	176	155	139	126	115	92.5	52.4	36.9	28.6	23.4	19.9	17.3	15.3	13.7	12.5	6.60
C11	537	392	313	263	228	202	182	165	151	122.0	70.7	50.5	39.6	32.8	28.0	24.6	22.5	20.4	18.6	10.3

Note: SBSB10 discharge rates are preliminary data and subject to revision.

Constant Power Discharge (watts per cell) to 1.70Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	71.6	48.5	37.1	30.2	25.5	22.1	19.5	17.4	15.8	12.3	6.53	4.45	3.38	2.72	2.29	1.97	1.73	1.55	1.40	0.73
SBS15	126	80.3	60.6	49.3	41.8	36.5	33.0	29.3	26.7	21.3	12.0	8.52	6.64	5.45	4.63	4.03	3.57	3.21	2.92	1.53
SBS30	238	151	114	92.2	78.1	68.0	60.4	54.4	49.6	39.4	22.2	15.6	12.1	10.0	8.45	7.34	6.50	5.83	5.40	2.96
SBS40	305	202	155	128	109	95.4	85.1	76.9	70.3	56.1	31.8	22.4	17.4	14.3	12.1	10.5	9.46	8.30	7.76	4.17
SBS60	399	264	203	167	143	126	112	102	93.0	74.6	42.8	30.4	23.7	19.5	16.6	14.5	12.8	11.5	10.5	5.71
SBS110	677	485	386	324	281	249	225	205	189	154	90.6	65.4	51.6	42.8	36.7	32.1	28.7	25.9	23.6	12.8
SBS130	842	586	462	386	333	295	265	242	222	180	106	76.3	60.0	49.7	42.4	37.1	33.0	29.8	27.1	14.4
SBS300	1,645	1,314	1,081	914	793	698	618	562	516	412	245	173	134	114	94.8	83.5	74.3	67.6	61.8	33.3
SBS390	1,930	1,455	1,189	1,014	899	793	724	663	609	496	294	209	164	136	117	102	90.3	81.3	74.0	39.2
SBS J13	106	68.4	51.7	42.0	35.5	30.9	27.4	24.7	22.5	17.8	9.87	6.90	5.32	4.34	3.67	3.18	2.81	2.51	2.27	1.17
SBS J16	129	84.1	64.1	52.4	44.6	39.0	34.7	31.4	28.7	22.9	13.0	9.17	7.13	5.85	4.97	4.33	3.83	3.44	3.13	1.64
SBS J30	235	157	120	97.5	82.7	72.0	63.9	57.4	52.3	41.3	22.8	15.9	12.3	10.1	8.54	7.42	6.58	5.91	5.37	2.88
SBS J40	323	219	169	138	118	103	91.9	82.9	75.7	60.2	33.7	23.7	18.3	15.0	12.7	11.1	9.78	8.78	7.97	4.22
SBS J70	543	369	284	232	197	172	153	137	125	98.3	53.6	37.0	28.3	22.9	19.3	16.7	14.7	13.1	11.8	6.07
B8	277	170	127	103	87.5	76.2	67.9	61.3	55.9	44.7	25.5	18.1	14.1	11.5	9.78	8.49	7.72	6.92	6.25	3.30
B10	297	195	148	121	102	89.1	79.1	71.2	64.9	51.4	28.7	20.2	15.7	12.9	11.0	9.61	8.80	8.33	7.94	4.32
B14	448	320	253	210	181	159	142	129	118	93.9	52.8	37.1	28.7	23.5	19.9	17.3	15.3	13.8	12.5	6.65
C11	570	411	326	273	235	207	186	169	155	124	71.3	50.9	39.8	32.9	28.2	24.7	22.7	20.5	18.7	10.4

Constant Power Discharge (watts per cell) to 1.67Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	72.9	48.8	37.2	30.2	25.5	22.1	19.5	17.4	15.8	12.3	6.57	4.49	3.41	2.76	2.32	2.00	1.76	1.57	1.42	0.74
SBS15	128	80.9	60.9	49.5	42.0	36.6	32.6	29.4	26.8	21.3	12.1	8.54	6.65	5.46	4.65	4.05	3.58	3.22	2.92	1.53
SBS30	241	152	114	92.7	78.6	68.3	60.7	54.7	49.8	39.6	22.3	15.7	12.2	10.0	8.49	7.38	6.53	5.86	5.43	2.97
SBS40	311	205	157	128	110	95.9	85.6	77.4	70.6	56.4	31.9	22.6	17.5	14.3	12.1	10.5	9.50	8.34	7.79	4.17
SBS60	408	268	206	169	145	127	113	102	93.7	75.1	43.0	30.6	23.9	19.6	16.7	14.5	12.9	11.6	10.5	5.73
SBS110	699	498	395	331	287	255	229	209	193	156	91.9	66.2	52.2	43.2	37.0	32.4	28.9	26.1	23.8	12.9
SBS130	864	597	469	391	338	298	269	244	224	182	107	76.8	60.4	50.0	42.7	37.3	33.2	29.9	27.2	14.5
SBS300	1,679	1,325	1,093	930	798	705	623	566	521	417	248	174	135	114	95.6	84.1	74.8	68.0	62.3	33.3
SBS390	1,987	1,481	1,207	1,027	910	801	733	670	612	501	294	211	166	136	117	102	90.8	81.9	74.3	39.2
SBS J13	108	69.2	52.1	42.3	35.8	31.1	27.6	24.9	22.6	17.9	10.0	6.98	5.39	4.40	3.72	3.22	2.84	2.54	2.30	1.18
SBS J16	132	85.4	64.9	53.0	45.0	39.4	35.0	31.6	28.9	23.0	13.1	9.25	7.20	5.91	5.02	4.37	3.87	3.48	3.16	1.65
SBS J30	241	159	121	98.6	83.5	72.6	64.4	57.9	52.6	41.6	23.0	16.0	12.4	10.1	8.59	7.47	6.62	5.95	5.41	2.90
SBS J40	332	223	171	140	119	104	92.7	83.7	76.3	60.6	33.9	23.8	18.4	15.1	12.8	11.1	9.85	8.84	8.02	4.24
SBS J70	560	377	289	236	200	174	154	139	126	99.1	54.0	37.3	28.5	23.1	19.4	16.8	14.7	13.2	11.9	6.12
B8	278	171	128	104.0	88.4	77.0	68.6	61.9	56.4	45.0	25.6	18.1	14.1	11.6	9.81	8.52	7.74	6.96	6.27	3.33
B10	304	196	149	121	103	89.4	79.4	71.5	65.1	51.6	28.9	20.4	15.9	13.1	11.1	9.71	8.88	8.41	8.01	4.33
B14	461	327	257	214	184	161	144	130	119	94.6	53.0	37.2	28.8	23.5	20.0	17.3	15.4	13.8	12.5	6.67
C11	585	420	331	276	239	209	188	171	156	125	71.6	51.0	39.9	33.0	28.2	24.7	22.7	20.5	18.8	10.5

Constant Power Discharge (watts per cell) to 1.65Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	73.7	48.9	37.2	30.2	25.4	22.0	19.4	17.4	15.8	12.3	6.59	4.52	3.44	2.78	2.34	2.02	1.78	1.59	1.44	0.75
SBS15	129	81.5	61.3	49.8	42.2	36.7	32.7	29.5	26.9	21.4	12.1	8.58	6.68	5.49	4.66	4.06	3.60	3.23	2.93	1.53
SBS30	245	154	115	93.3	78.9	68.7	60.9	54.9	50.0	39.7	22.3	15.8	12.3	10.0	8.52	7.41	6.55	5.88	5.45	3.04
SBS40	316	207	158	129	110	96.4	85.9	77.6	70.9	56.6	32.1	22.6	17.6	14.4	12.2	10.6	9.54	8.36	7.82	4.17
SBS60	417	272	208	170	145	127	114	103	94.2	75.5	43.2	30.7	24.0	19.7	16.8	14.6	12.9	11.6	10.5	5.74
SBS110	718	507	401	336	290	257	231	211	194	157	92.3	66.5	52.4	43.4	37.2	32.5	29.0	26.2	23.9	12.9
SBS130	886	607	476	395	341	301	271	246	226	183	107	77.1	60.7	50.2	42.9	37.5	33.3	30.0	27.3	14.6
SBS300	1,745	1,344	1,111	946	810	709	629	567	523	419	252	176	137	115	95.9	84.2	74.8	68.0	62.3	33.3
SBS390	2,043	1,509	1,221	1,036	917	808	735	672	617	502	296	212	166	138	118	103	91.2	82.1	74.6	39.3
SBS J13	110	69.7	52.4	42.5	35.9	31.2	27.7	24.9	22.7	18.0	10.0	7.02	5.43	4.43	3.75	3.25	2.87	2.56	2.32	1.19
SBS J16	134	86.1	65.3	53.3	45.3	39.6	35.2	31.8	29.0	23.1	13.1	9.30	7.24	5.94	5.05	4.40	3.89	3.50	3.17	1.66
SBS J30	245	161	122	99.2	83.9	73.0	64.7	58.1	52.9	41.7	23.0	16.1	12.4	10.2	8.63	7.50	6.65	5.97	5.43	2.91
SBS J40	338	225	172	141	120	104.8	93.2	84.1	76.6	60.9	34.0	23.9	18.5	15.2	12.8	11.2	9.88	8.87	8.06	4.26
SBS J70	571	382	292	238	202	175	155	139	127	99.6	54.2	37.4	28.6	23.2	19.5	16.8	14.8	13.2	12.0	6.15
B8	278	173	129	105	89.0	77.6	69.0	62.3	56.8	45.3	25.7	18.2	14.2	11.6	9.84	8.54	7.77	6.96	6.29	3.35
B10	310	199	149	122	103	89.7	79.6	71.7	65.3	51.8	29.1	20.6	16.0	13.2	11.2	9.78	8.95	8.47	8.07	4.35
B14	473	333	261	216	185	162	145	131	120	95.1	53.2	37.3	28.8	23.6	20.0	17.4	15.4	13.8	12.5	6.69
C11	601	428	337	280	241	212	190	172	157	126	71.9	51.1	40.0	33.0	28.3	24.8	22.8	20.5	18.8	10.5

Note: SBSB10 discharge rates are preliminary data and subject to revision.

Constant Power Discharge (watts per cell) to 1.63Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	74.8	49.0	37.2	30.1	25.4	22.0	19.4	17.4	15.8	12.3	6.62	4.55	3.47	2.81	2.36	2.04	1.80	1.61	1.45	0.76
SBS15	130	81.7	61.4	49.8	42.3	36.8	32.7	29.5	26.9	21.4	12.1	8.58	6.68	5.49	4.68	4.07	3.60	3.24	2.93	1.54
SBS30	246	154	115	93.5	79.2	68.8	61.1	55.1	50.1	39.8	22.4	15.8	12.3	10.1	8.55	7.43	6.57	5.90	5.45	3.04
SBS40	318	207	158	130	111	96.7	86.2	77.9	71.1	56.8	32.1	22.7	17.6	14.4	12.2	10.6	9.54	8.38	7.82	4.21
SBS60	420	273	209	171	146	128	114	103	94.6	75.8	43.3	30.8	24.0	19.7	16.8	14.6	12.9	11.6	10.6	5.74
SBS110	728	514	406	340	293	260	233	213	196	159	93.2	67.0	52.7	43.7	37.3	32.7	29.1	26.2	23.9	12.9
SBS130	894	612	479	398	344	303	272	247	227	184	108	77.4	60.8	50.3	43.0	37.6	33.4	30.1	27.4	14.6
SBS300	1,753	1,352	1,116	951	817	714	634	572	527	424	254	177	137	115	96.0	84.4	74.9	68.2	62.3	33.3
SBS390	2,065	1,568	1,227	1,040	922	810	740	675	620	505	298	213	168	138	119	103.5	91.5	82.5	74.8	39.3
SBS J13	111	70.1	52.6	42.6	36.1	31.4	27.8	25.0	22.8	18.1	10.1	7.07	5.46	4.46	3.77	3.27	2.88	2.58	2.34	1.20
SBS J16	135	86.8	65.7	53.5	45.5	39.7	35.4	31.9	29.1	23.2	13.2	9.34	7.27	5.97	5.08	4.42	3.91	3.51	3.19	1.67
SBS J30	248	162	123	99.7	84.3	73.3	64.9	58.3	53.0	41.8	23.1	16.2	12.5	10.2	8.66	7.53	6.67	5.99	5.45	2.91
SBS J40	343	227	174	142	121	105	93.6	84.4	77.0	61.1	34.2	24.0	18.6	15.2	12.9	11.2	9.92	8.91	8.09	4.27
SBS J70	581	387	295	240	203	176	156	140	127	100	54.4	37.6	28.7	23.3	19.6	16.9	14.9	13.3	12.0	6.17
B8	279	173	129	105	90	77.9	69.4	62.6	57.1	45.5	25.8	18.2	14.2	11.6	9.89	8.58	7.78	6.97	6.30	3.36
B10	313	199	150	122	103	89.8	79.8	71.9	65.4	51.9	29.2	20.7	16.1	13.2	11.4	9.94	8.99	8.52	8.10	4.35
B14	478	336	263	218	187	163	146	132	120	95.5	53.3	37.3	28.9	23.6	20.0	17.4	15.4	13.8	12.5	6.69
C11	607	432	339	282	243	213	191	173	158	126	72.0	51.2	40.0	33.0	28.3	24.8	22.8	20.6	18.8	10.5

Constant Power Discharge (watts per cell) to 1.60Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	75.4	49.5	37.4	30.0	25.3	22.1	19.3	17.3	15.7	12.5	6.66	4.59	3.51	2.85	2.40	2.07	1.83	1.63	1.48	0.97
SBS15	132	82.4	61.8	50.1	42.4	37.0	32.8	29.6	27.0	21.5	12.2	8.62	6.72	5.52	4.69	4.08	3.62	3.25	2.95	1.54
SBS30	250	156	116	94.0	79.5	69.1	61.3	55.3	50.3	40.0	22.5	15.9	12.3	10.1	8.58	7.46	6.60	5.92	5.48	3.04
SBS40	325	210	160	130	111	97.1	86.5	78.2	71.4	57.0	32.3	22.8	17.7	14.5	12.3	10.6	9.59	8.40	7.85	4.25
SBS60	431	278	211	173	147	129	115	104	95.2	76.2	43.5	30.9	24.1	19.8	16.9	14.7	13.0	11.7	10.6	5.75
SBS110	753	525	413	344	297	263	236	215	198	160	93.7	67.4	53.0	43.9	37.5	32.8	29.2	26.4	24.0	12.9
SBS130	924	625	487	403	347	306	275	249	229	185	108	77.8	61.2	50.6	43.2	37.8	33.6	30.2	27.5	14.6
SBS300	1,790	1,370	1,129	953	821	717	647	580	527	426	255	177	138	115	96.4	84.6	75.1	68.4	62.4	33.3
SBS390	2,148	1,550	1,245	1,053	930	817	746	679	622	507	299	215	169	139	119	104	92.2	82.9	75.3	39.4
SBS J13	113	70.7	53.0	42.9	36.2	31.5	27.9	25.2	22.9	18.2	10.1	7.12	5.51	4.50	3.80	3.30	2.91	2.60	2.36	1.20
SBS J16	138	87.6	66.2	53.9	45.7	39.9	35.5	32.1	29.3	23.3	13.3	9.39	7.32	6.01	5.11	4.45	3.94	3.54	3.21	1.68
SBS J30	252	164	124	100	84.8	73.6	65.2	58.6	53.3	42.0	23.2	16.2	12.6	10.3	8.70	7.57	6.70	6.02	5.47	2.92
SBS J40	350	230	175	143	121	106	94.1	84.9	77.3	61.4	34.3	24.1	18.7	15.3	13.0	11.3	10.0	8.96	8.13	4.29
SBS J70	595	393	298	242	205	178	157	141	128	101	54.7	37.8	28.9	23.4	19.7	17.0	15.0	13.4	12.1	6.20
B8	280	175	131	106	90	79	69.9	63.1	57.5	45.8	25.9	18.3	14.2	11.7	9.89	8.58	7.81	6.96	6.32	3.38
B10	319	201	151	122	104	90	80.1	72.2	65.8	52.2	29.5	20.9	16.3	13.4	11.4	9.94	9.10	8.60	8.19	4.37
B14	495	344	268	221	189	165	147	133	121	96.1	53.5	37.5	28.9	23.7	20.0	17.4	15.4	13.9	12.6	6.72
C11	627	442	346	286	246	215	193	175	159	127	72.3	51.3	40.1	33.1	28.3	24.8	22.8	20.6	18.9	10.6

Constant Power Discharge (watts per cell) to 1.50Vpc at 20°C/68°F

	5 Min	10 Min	15 Min	20 Min	25 Min	30 Min	35 Min	40 Min	45 Min	1 Hr	2 Hrs	3 Hrs	4 Hrs	5 Hrs	6 Hrs	7 Hrs	8 Hrs	9 Hrs	10 Hrs	20 Hrs
SBS8	77.3	50.3	38.0	29.2	24.6	22.5	18.9	17.0	15.5	12.7	6.81	4.77	3.68	3.00	2.54	2.20	1.94	1.74	1.57	0.81
SBS15	133	82.9	62.2	50.4	42.7	37.2	33.1	29.8	27.2	21.7	12.3	8.69	6.76	5.55	4.71	4.10	3.63	3.26	2.96	1.53
SBS30	254	156	117	94.3	79.7	69.4	61.6	55.5	50.6	40.2	22.7	16.0	12.5	10.2	8.67	7.53	6.66	5.97	5.52	3.07
SBS40	332	212	161	131	112	97.7	87.0	78.7	71.9	57.4	32.6	23.0	17.8	14.6	12.3	10.7	9.60	8.40	7.84	4.26
SBS60	440	283	215	176	150	131	117	106	96.5	77.1	43.9	31.2	24.3	19.9	16.9	14.7	13.0	11.7	10.6	5.74
SBS110	795	544	426	353	304	269	241	219	201	163	95.0	68.3	53.7	44.4	37.9	33.2	29.5	26.6	24.2	13.0
SBS130	975	646	499	412	354	311	279	253	232	188	109	78.6	61.8	51.1	43.6	38.1	33.9	30.5	27.7	14.7
SBS300	1,846	1,392	1,129	956	826	721	651	583	532	428	257	178	138	116	97.4	85.2	75.2	68.6	62.8	33.4
SBS390	2,324	1,601	1,266	1,063	937	820	749	683	626	512	306	219	172	142	122	107	93.9	84.2	76.3	39.4
SBS J13	117	71.9	53.5	43.2	36.5	31.7	28.1	25.3	23.1	18.3	10.3	7.21	5.58	4.56	3.86	3.34	2.95	2.64	2.38	1.21
SBS J16	141	88.5	66.5	54.1	45.9	40.0	35.6	32.2	29.4	23.4	13.3	9.48	7.39	6.08	5.17	4.50	3.99	3.58	3.25	1.69
SBS J30	261	166	125	101	85.0	73.8	65.4	58.7	53.4	42.2	23.4	16.4	12.7	10.4	8.80	7.65	6.77	6.08	5.52	2.92
SBS J40	365	234	177	144	122	106	94.4	85.1	77.6	61.6	34.6	24.4	18.9	15.5	13.2	11.5	10.1	9.10	8.26	4.33
SBS J70	624	401	301	244	206	179	158	142	129	101	55.4	38.3	29.4	23.8	20.1	17.3	15.2	13.6	12.3	6.25
B8	284	177	132	108	90.2	79.7	69.9	63.1	58.4	46.5	26.3	18.6	14.4	11.8	9.89	8.58	7.86	7.04	6.36	3.37
B10	322	201	151	122	104	90.9	80.1	72.2	66.7	53.2	30.3	21.5	16.8	13.8	11.4	9.94	9.37	8.85	8.42	4.41
B14	524	355	274	225	192	167	149	134	122	97.0	54.0	37.8	29.2	23.9	20.22	17.56	15.5	14.0	12.7	6.74
C11	665	460	357	294	246	220	193	175	162	129	72.7	51.5	40.2	33.2	28.3	24.8	22.8	20.6	18.9	10.6

Note: SBSB10 discharge rates are preliminary data and subject to revision.

Temperature Correction

The following table shows the effect of battery temperature on the electrical discharge performance at different discharge rates. Performance is given as a factor of the performance at +20°C/68°F.

Rate	Temperature ¹									
	0°C 32°F	5°C 41°F	10°C 50°F	15°C 59°F	20°C 68°F	25°C 77°F	30°C 86°F	35°C 95°F	40°C 104°F	REPV ²
5 m	0.688	0.763	0.840	0.919	1	1.082	1.164	1.247	1.330	1.63Vpc
10 m	0.726	0.795	0.864	0.933	1	1.066	1.129	1.191	1.249	1.65Vpc
15 m	0.746	0.812	0.877	0.940	1	1.057	1.112	1.163	1.210	1.65Vpc
20 m	0.760	0.824	0.886	0.944	1	1.052	1.100	1.145	1.185	1.67Vpc
25 m	0.771	0.833	0.892	0.948	1	1.048	1.092	1.132	1.167	1.67Vpc
30 m	0.779	0.840	0.897	0.950	1	1.045	1.086	1.122	1.154	1.70Vpc
35 m	0.786	0.845	0.901	0.953	1	1.043	1.081	1.115	1.143	1.70Vpc
40 m	0.792	0.850	0.904	0.954	1	1.041	1.077	1.108	1.135	1.70Vpc
45 m	0.797	0.854	0.907	0.956	1	1.039	1.074	1.103	1.127	1.70Vpc
60 m	0.809	0.863	0.914	0.959	1	1.035	1.066	1.091	1.111	1.75Vpc
2 hrs	0.834	0.884	0.928	0.967	1	1.028	1.050	1.068	1.080	1.80Vpc
3 hrs	0.847	0.893	0.934	0.970	1	1.024	1.044	1.058	1.067	1.80Vpc
4 hrs	0.855	0.900	0.939	0.972	1	1.023	1.040	1.052	1.060	1.80Vpc
5 hrs	0.861	0.904	0.941	0.973	1	1.021	1.037	1.049	1.056	1.80Vpc
8 hrs	0.871	0.911	0.946	0.975	1	1.019	1.034	1.044	1.050	1.80Vpc
10 hrs	0.875	0.914	0.948	0.976	1	1.019	1.033	1.043	1.049	1.80Vpc

¹ Figures apply to all products

² REPV = Recommended End Point Voltage (the on-load voltage at which it is recommended to disconnect the battery from any load)

Short Circuit Currents

Short Circuit Current and Internal Resistance – BS 6290 Method

Model	Internal Resistance (mΩ)	Short Circuit Current (Amps)
SBS8	27.1	455
SBS15	13.5	891
SBS30	7.9	1,556
SBS40	5.6	2,184
SBS60	4.4	2,618
SBS110	1.7	3,804
SBS130	1.4	4,111
SBS300	0.23	8,700
SBS390	0.18	11,101
SBS J13	13	957
SBS J16	11	1,111
SBS J30	7	1,766
SBS J40	5.2	2,400
SBS J70	3.5	3,500
SBSB8	7.7	1,584
SBSB10	6.2	1,968
SBSB14	3.8	3,210
SBSC11	3.3	3,696



Performance Information

End of Discharge Voltage

The voltage point to which a battery can be discharged is a function of the discharge rate. The recommended end voltage point (REVP) is the voltage at which a battery should be disconnected from the load.

Discharging the battery below the REVP or leaving the battery connected to a load in a discharged state will “overdischarge” the battery and may impair its ability to accept charge. In “overdischarge” conditions the sulphuric acid electrolyte can be depleted of sulphate ions and become essentially water. A lack of sulphate ions as charge conductors will cause the cell impedance to appear high and little charge current to flow. Longer charge time or alteration of the charge voltage may be required before normal charging can be resumed.

In a severe “overdischarge” condition, the lead sulphate present on the plate surfaces can go into solution in the electrolyte. Upon recharge, the water and sulphate ion in the lead sulphate convert to sulphuric acid. This can result in dendritic shorts between plates leading to cell failure.

Disconnecting the battery from the load when the REVP is reached will eliminate the risk of overdischarge. The battery must be re-connected and put on charge as soon as mains power is restored.

Note: When the load is removed from the battery, its voltage will increase, up to approximately 12V. Because of this phenomenon some hysteresis must be designed into the battery disconnect circuitry so that the load is not continuously reapplied to the battery as the battery voltage recovers.

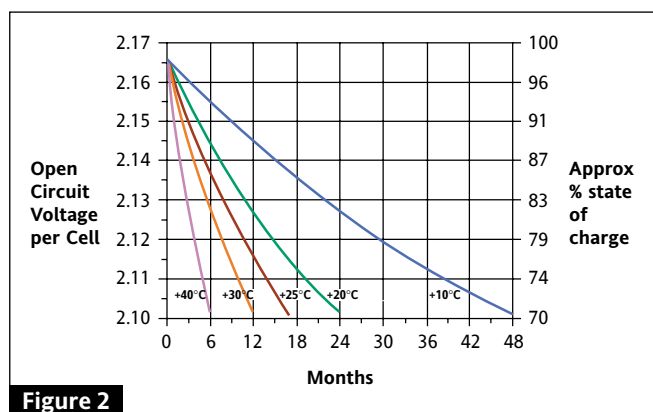
The battery disconnect circuitry must not itself impose any residual load on the battery after disconnection.

Storage

Batteries lose capacity when standing on open-circuit because of parasitic chemical reactions. SBS self-discharge rate is very low because of the high purity of the grid lead and electrolyte.

Batteries should be stored in a cool, dry area. High temperature increases the rate of self-discharge and reduces storage life.

Figure 2 shows the relationship between open-circuit voltage and storage time at five temperatures.



The maximum storage times before a freshening charge is required and recommended open circuit voltage (OCV) audit intervals are:

Temperature °C	Storage (Months)	OCV Audit (months)
10	48	6
15	34	6
20	24	4
25	17	4
30	12	3
35	8.5	2
40	6	2

Monoblocs must be given a freshening charge when bloc voltages approach the equivalent of 2.10 Volts per cell or when the maximum storage time is reached, whichever occurs first.

Freshening Charge

Charge the monoblocs, or strings at a constant voltage equivalent to 2.27 to 2.4 Volts per cell with 10% of C₁₀ current available, for 24 hours.

Warning

SBS monoblocs are supplied in a charged condition, and are capable of extremely high short circuit currents. Take care to avoid short-circuiting terminals of opposite polarity.

Unpacking

Open the shipping containers and check the contents for damage and against the packing list. Immediately inform the Enersys sales department of any damaged or missing items.

Battery Location

Batteries can be installed on racks, shelves or in cabinets. The floor must be capable of supporting the combined weight of the battery, housing, accessories and cables.

Monobloc Connection

Each battery is supplied with an instruction sheet or manual.

The positive terminal on each monobloc is identified by a “+” sign and/or a red collar round the terminal. Install the monoblocs in accordance with the instructions and layout drawing. Check that the correct terminal orientation and positive/negative polarity sequence is maintained throughout the battery string.

Connect the blocs together with the connectors and fasteners provided. The fastener torque values are:

Model(s)	Fastener	Torque
SBS8	M4	1.0 Nm / 9 in lbs
SBS15–60	M6	3.9 Nm / 35 in lbs
SBS110–390	M8	5.0 Nm / 44 in lbs
SBS J13–70	M6	6.8 Nm / 60 in lbs
SBSB8–14	M8	5 Nm / 44 in lbs
SBSC11	M8	5 Nm / 44 in lbs

Place the insulating covers in position immediately after tightening the fasteners.

The main battery cables are now ready to be connected to the system.

Site Acceptance Tests

Before conducting a capacity discharge or fully loaded duty cycle test the battery must be given a commissioning charge. The commissioning charge shall consist of 7 continuous days of float charge at the recommended float voltage with no load connected to the battery, see Charging, page 19.

Ventilation

During normal charging conditions the volume of hydrogen emitted from a SBS battery is virtually negligible, and will normally dissipate rapidly into the atmosphere. To comply with the requirements of EN 50272, Part 2, the battery room, or cabinet must have sufficient air circulation to limit the accumulation of hydrogen gas to a maximum of 1% by volume, when the battery is being charged at the equivalent of 2.40 volts per cell.

Optional remote venting systems are available to vent gases outside the battery compartment.

SBS typical hydrogen evolution rates on stabilised float at 25°C/77°F are:

Volts/Cell	Hydrogen Evolution = ml/hour/bloc		
	2.27 Vpc	2.40 Vpc	2.45 Vpc
SBS8	0.7	3.6	6.9
SBS15	1.4	7.3	14
SBS30	2.4	13	24
SBS40	3.3	18	33
SBS60	4.2	22	43
SBS110	2.7	15	28
SBS130	3.3	18	33
SBS300	1.1	12	23
SBS390	2.2	15	29
SBS J13	1.1	5.8	11.1
SBS J16	1.4	7.2	14.1
SBS J30	2.6	13.3	26.3
SBS J40	3.8	20.1	38.4
SBS J70	5.9	31.3	59.6
SBSB8	2.4	12.8	24.3
SBSB10	3.0	15.9	30.3
SBSB14	4.9	25.6	49.3
SBSC11	5.6	29.6	56.2

Battery Housings

Battery housings should provide at least 150mm / 6 inches of free space above top terminal batteries for installation and maintenance access.

Telecom Batteries

SBS batteries usually are installed on shelves or in cabinets supplied by the equipment manufacturer.

If the equipment does not include the battery housing, Enersys can provide a variety of shelves and racks. Consult a Enersys representative for details.

Racks

For higher voltage battery strings, a variety of stepped and tiered racks are available. Rack length can be customised for specific battery layouts. Consult a Enersys representative for details.

- *Non-seismic* - Racks, shelves and cabinets must be assembled and installed in accordance with the instructions provided with the equipment.
- *Seismic* - Because of the variations in building design and construction materials and methods, it is the responsibility of the battery installer to ensure seismic battery housings are anchored to the floor with the appropriate type and size of anchor bolts and in accordance with applicable building codes.

The completed battery and housing assembly and anchoring method must provide for a self supporting structure that can withstand overturning moments caused by earthquakes without auxiliary support or bracing.

Earthing

Batteries and housings can be earthed or isolated. The earthing or isolation materials and methods will depend on the application, voltage, location and type of battery housing.

The system specification should include the most appropriate combination of earthing and isolation methods for the safety of the installation, operation and maintenance personnel, system integrity and compliance with applicable building and safety codes.

It is the responsibility of the battery installer to ensure that the battery and housing is earthed or isolated in compliance with the system specification.



Voltage Setting

SBS are designed for continuous float operation on constant voltage chargers. Constant voltage charging is the safest, most efficient and recommended method of charging VRLA batteries.

The recommended float voltage setting is 2.27 volts per cell at 25°C/77°F. Therefore the system voltage setting equals the number of cells in series x 2.27Vpc.

Battery life and charging characteristics are affected by temperature. Optimum battery life will be achieved when the battery is operating between 20°C/68°F to 25°C/77°F. Battery life is reduced by 50% for every 10°C/18°F increase in temperature. Float voltage compensation reduces the charging current as battery temperature increases, and partially negates the adverse effect of high temperature.

The recommended float voltage temperature compensation is:

- 2.27Vpc + 0.004 mV per cell per °C/1.8°F below 25°C/77°F
- 2.27Vpc – 0.004 mV per cell per °C/1.8°F above 25°C/77°F

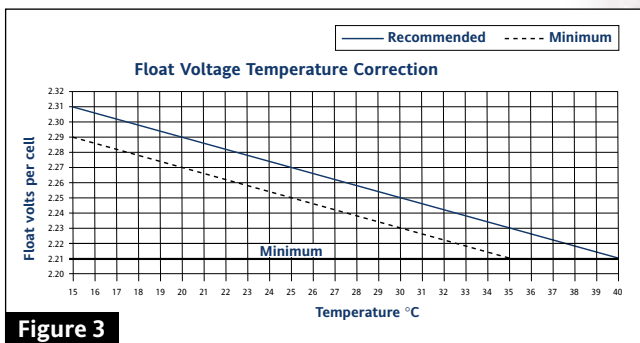


Figure 3

The battery and ambient temperatures can be significantly different. Batteries have a large thermal mass, and there is a substantial time lag between changes in ambient and battery temperature.

Thermal sensors must register battery temperature, not ambient temperature. As a rule, sensors should be placed in the following positions:

- Front terminal models - in the centre of the side wall of a bloc, in the middle of the string
- Top terminal models - attached by a ring terminal to the terminal of a bloc in the middle of a string

Sensors on the side of blocs should be insulated from ambient temperature.

Temperature compensation is capped at 40°C/104°F, at higher temperature the compensated voltage approaches the battery open circuit voltage and there would be insufficient over voltage to keep the battery in a fully charged condition.

Charging Current

There is no limit on the charging current provided the float voltage is set at the recommended value as the battery itself will regulate the current, accepting only as much as is required to reach float voltage.

Recharge time is a function of the charging current.

To recharge in an acceptable time it is recommended that the current output of the charger should be equal to the standing load plus 0.1C₈ to 0.4C₈.

Typical recharge times are shown in Figure 4.

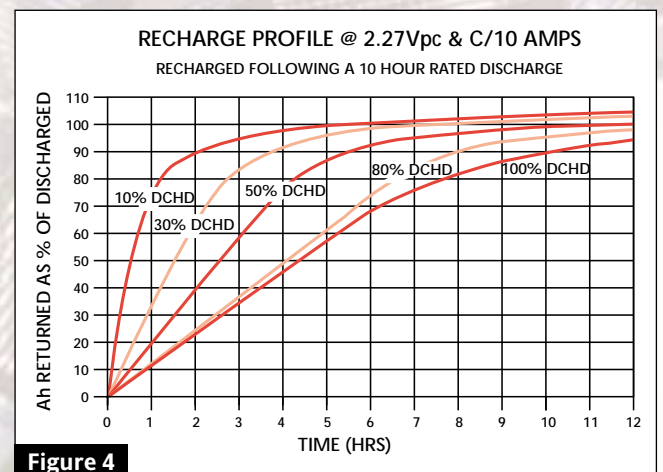


Figure 4

Charging

Fast Charging

“Fast” charge techniques are best suited for frequent discharge or cyclic applications.

For applications requiring a faster recharge, a potential of 2.38 volts per cell at 25°C/77°F can be applied to the battery. This will achieve a faster recharge. However, it is recommended that this higher potential only be applied until the charging current remains constant for a period of two hours. The voltage should then be set at the recommended float voltage.

Charging at a high potential for extended periods may warm the battery, increase grid corrosion and reduce the life of the battery.

Voltage temperature compensation is applicable to “fast” charging.

Constant Current Charging

Only constant voltage charging is recommended. However, constant current charging is an acceptable method of charging SBS batteries provided safeguards are taken to avoid overcharge.

- The maximum recommended charging current is $0.05C_8$.
- It is important to know how many ampere-hours (Amps x hours) are removed from the battery on discharge.
- The duration of a constant current recharge should be set to return 105% of the capacity removed during the discharge.

For example: an SBS60 is rated at 51 Ah/ C_8 /1.75Vpc/25°C
Maximum charging current = $51 \times 0.05 = 2.55$ amps
If the battery is fully discharged, the recharge time = $51 \text{ Ah} \times 1.05 / 2.55 = 21$ hours.
Therefore, the battery should be at 2.55 amps for 21 hours to bring it to a fully charged condition.

- Continuing the charge for an extended period will overcharge the battery.

Ripple

Voltage Ripple

Is normally seen as a cyclic variation of the DC charging voltage, usually at twice the mains supply frequency, i.e. 100 Hz for a 50 Hz supply, or twice the switching frequency with switch mode rectifiers.

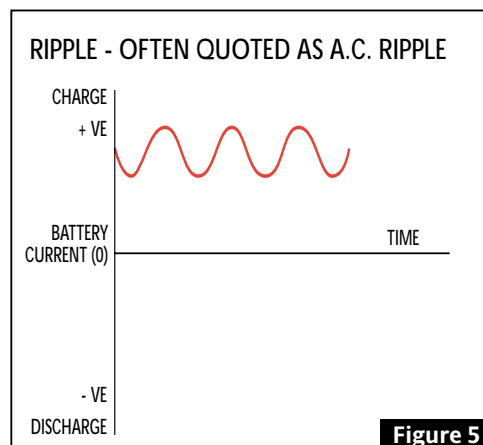
Under steady state conditions the charger output voltage, with the load, but not the battery connected, should not vary by more than $\pm 1\%$ over the range of 5 to 100% of the charger’s rated output current.

With the battery disconnected, the voltage ripple, the summation of the effects of load and input supply variations, on the DC charging voltage should not vary by more than 2% of the nominal value.

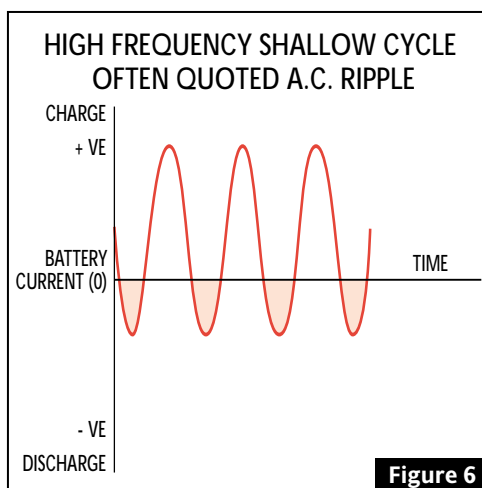
AC Current Ripple

All AC ripple currents cause internal heating of the battery due to the $I_{rms}^2 \times R_{internal \text{ losses}}$. The heat generated causes an increase in the battery’s self-discharge rate resulting in increased float currents and can in marginal - high ambient temperature - situations lead to thermal runaway.

During recharge or float charge the AC current into a battery should have a positive value as shown in the following graph (Figure 5). Ripple current must not exceed 10% RMS of the batteries nominal C_8 capacity and must never be a negative value.



The output of some UPS inverter systems can produce the type of wave form shown in Figure 6. This will subject the battery to high frequency discharge, and the battery will slowly lose capacity and may sustain irreparable damage.



Cycling

SBS are designed to meet or exceed the cyclic requirements of telecommunications standards, and can be cycled at charge voltages between 2.27 and 2.40 Volts per cell.

SBS cyclic performance and life in an application will be affected by the following factors:

- Discharge rate
- Depth of discharge
- Recharge voltage, current and time
- Operating temperature

There are too many variables to be taken into consideration to make non-specific claims for cyclic life. For advice on the most suitable SBS cyclic battery please provide details of the application to Enersys.

Maintenance

SBS batteries are low maintenance items compared with flooded batteries. Nevertheless, some maintenance is necessary to ensure the battery is in good condition.

Installation and Maintenance activities should be recorded. Record sheets are included in the Operating and maintenance manual provided with the battery. A sample record sheet is at the end of this section.

Below is a suggested maintenance routine. However, the frequency of inspection and maintenance procedures may vary depending on the criticality, number and location of installations, equipment and commercial considerations.

Records

It is important to keep a written record of a battery's service life. The record is an aid in fault diagnosis and predicting end of life. The record sheet should be kept with the battery so its operating characteristics and service history is available to anyone that works on it. Enersys may require the record if a warranty claim is made.

Record sheets should be designed so that "trends" and "sudden deviations" are easily noticeable.

Trend Data - can be helpful in predicting end of battery life so that battery replacement can be scheduled and sudden or catastrophic failures can be avoided.

Sudden Deviations - in bloc or string readings should be investigated, it may be indicative of a cell or charger defect.

Readings

Every three months measure and record:

- String voltage
- Bloc voltage
- Charger voltage
- Charging current
- Battery and ambient temperatures

String Voltage Readings

String voltage must be measured at the battery's terminal. If applicable, float voltage temperature compensation must be taken into consideration.

- String voltage = Number of Cells in Series x Float Voltage Per Cell
- Correct float voltage will maintain the battery in a fully charged condition, recharge in an acceptable time and achieve optimum life.
- High float voltage will increase the rate of positive grid corrosion, gassing, risk of thermal runaway and reduce battery life.
- Low float voltage will extend recharge time, not replace internal losses and may cause degradation of the negative plate leading to gradual permanent loss of capacity.

A discrepancy between the voltage measured at the battery terminals and the charger voltmeter must be investigated.

If necessary, adjust the float voltage to the correct value.

Bloc Voltage Readings

Bloc voltages may vary within a string, but individual stabilised bloc voltages should be reasonably constant. The individual blocs should be within $\pm 5\%$ of the mean.

A sudden significant, or a small but continuous, deviation from the bloc's stabilised voltage should be investigated.

Inspection

Inspect the blocs for dust, damage, leaks, loose or corroded connectors. If a bloc or battery needs cleaning it should be isolated and cleaned with a damp soft cloth.

Disposal

SBS batteries are recyclable. Scrap batteries must be sent to a licensed recycling facility for disposal.

Scrap batteries must be packaged, transported and recycled in accordance with local and national regulations.

A list of licensed recyclers and additional information on battery disposal can be found on the web site: www.recycle.net/battery.

Battery Installation and Maintenance Record Sheet

Installed by: _____ Date: _____ Battery Type: _____ Site: _____

Float voltage readings to be taken at the battery terminals, not at charger output terminals.

Date:													
Float Voltage:													
Current:													
Amb.Temp:													
Readings:	Volts	*mhos	Volts	mhos	Volts	mhos	Volts	mhos	Volts	mhos	Volts	mhos	
String 1 Bloc 1													
2													
3													
4													
String 2 Bloc 1													
2													
3													
4													
String 3 Bloc 1													
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String 6 Bloc 1													
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String 7 Bloc 1													
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Notes: _____

*mhos = unit of conductance (equivalent to Siemens)

Global Headquarters
P.O. Box 14145 Reading,
PA 196212-4145
USA
Tel: +1-610-208-1991
+1-800-538-3627
Fax: +1-610-372-8613

EnerSys EMEA
Houtweg 26
1140 Brussels
Belgium
Tel: +32 (0)2 247 94 47
Fax: +32 (0)2 247 94 49

EnerSys Asia
No. 49, Yanshan Road
Shekou, Shenzhen
518066, China
Tel: +86-755-2689 3639
Fax: +86-755-2689 8013



www.enersysinc.com

Contact: