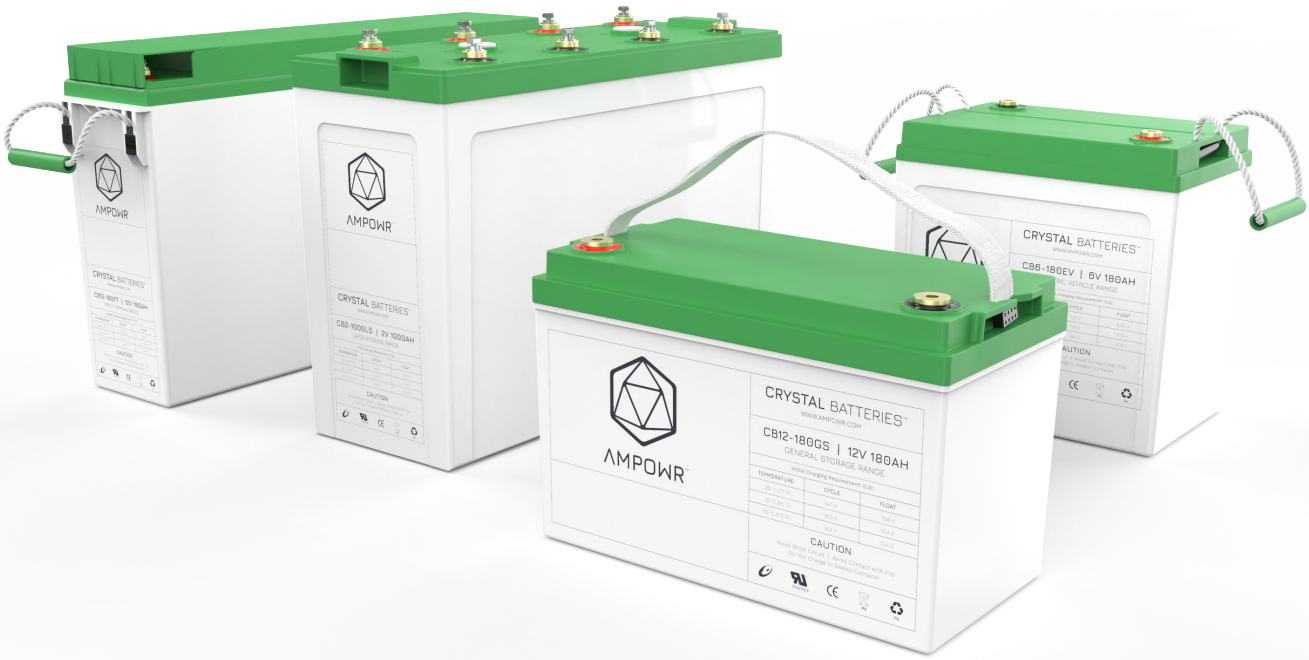
AMPOWR

USER MANUAL

CRYSTAL BATTERIES™

AMPOWR CRYSTAL BATTERY USER MANUAL

This manual provides full instructions regarding safety, storage, operation, and maintenance for Crystal Batteries™, as well as certain installation considerations. Failure to observe the precautions as presented may result in damage to equipment, injury, or loss of life.



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GENERAL SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS

Important! Please read this manual as it contains important instructions that should be followed during storage, installation, operation, and maintenance of Crystal Batteries™. Following the manual will help achieve the highest performance of your equipment and extend the lifetime of your product.

1. Battery handling and servicing should be performed or supervised by personnel who have professional knowledge about batteries and precautionary measures. Battery replacement by unauthorized personnel is prohibited. When replacing batteries, please use Crystal Batteries™ of the same capacity and size as originals used in equipment.

2. Do not misuse or disassemble / deconstruct Crystal Batteries™, this could result in human injury or cause damage to the batteries. In no event will Ampowr be responsible or liable for either indirect or consequential damage or injury that may result from misuse, abuse, or disassembly / deconstruction of batteries.

3. Crystal Batteries™ contain a small amount of sulphuric acid (< 3%). Sulphuric acid can be harmful to the skin and eyes if not handled with care. Take precautionary measures as described in this manual.

4. It is important to handle batteries correctly when returning batteries. As the batteries contain lead, any inappropriate handling of the batteries will have adverse effects on the environment and on persons. Please check local legislation to obtain approved handling procedures or return batteries to authorized service centers of the manufacturer for replacements and discarding.

5. Do not place batteries in or near a direct fire, open flame, or any source of heat.

6. Do not use an organic solvent to clean batteries.

7. Batteries may cause electric shock and burns when short-circuited. Always use tools with insulated handles when installing, changing, or maintaining Crystal Batteries™.

SYMBOLS FOR BATTERY USE AND OPERATION

Please read chapter 5 for further details on safety guidelines.

SAFETY WARNING

ELECTRICAL HAZARD

EYE PROTECTION

SHORT CIRCUIT PREVENTION

ADULT SUPERVISION REQUIRED

READ THE MANUAL

NO OPEN FLAMES OR SPARKS

Pb

RECYCLE

Pb

DO NOT DISPOSE OF BATTERIES INTO TRASH

THIS PRODUCT HAS PASSED UL SAFETY CERTIFICATION

THIS PRODUCT HAS PASSED CE CERTIFICATION

IEC

THIS PRODUCT HAS PASSED IEC/EN 60896-21/22

SHOCK HAZARD

RISK OF EXPLOSION

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1. GENERAL INFORMATION

1.1 INTRODUCTION

By its unique technology Crystal Batteries™ have a higher performance. To overcome the fundamental limitations of the lead-acid and gel batteries, Ampowr has successfully developed technological innovations that make Crystal Batteries™ ideal products to replace Lead Acid and Lead Gel batteries.

The safety properties of Crystal Batteries™ and the positive test results and case studies from multinational corporate clients have helped the Ampowr Crystal Batteries™ brand to successfully enter various global markets.

Crystal Batteries™ are widely used across a variety of dynamic applications. Our new type of environmentally friendly battery product is rapidly blending into the consumer lifestyles of many industries and is widely accepted by institutions and individuals.

The patented technology found in Crystal Batteries™ is a unique and advanced formula - a new type of composite SiO2 electrolyte developed to completely replace traditional sulphuric acid solutions. This secret recipe improves the product's application range and safety performance. When the composite electrolyte reacts with the plates during the charging. process, crystalline inorganic salts are formed, and the liquid electrolyte is converted into crystallized salt. The electrolyte is distributed evenly throughout the cell in a non-hierarchical manner, and there is no gradient concentration in the upper and/or lower electrode. This improvement gives complete cell saturation and assists Crystal Batteries™ in achieving an even charge distribution over the entire plate, improving the electrical properties of the battery and providing consistent and reliable performance. It effectively overcomes the disadvantages of plate sulphation, prevents active material loss, reduces water loss, has good temperature range resilience, overcharge/discharge performance, in addition to greatly improved battery life.

1.2 ADVANTAGES SUMMARIZED

Compared to mainstream rechargeable industrial batteries like Lead Acid, Lead Gel, and AGM batteries, Crystal Batteries™ have significant improvements:

- Crystal Batteries™ can charge faster
- Crystal Batteries™ can be discharged deeper (even to 0 Volts!)
- Crystal Batteries™ do not suffer thermal runaway.
- Crystal Batteries™ have an operating temperature range from -40˚C (-40˚F) to 65˚C (149˚F)
- Crystal Batteries™ can be charged in subzero conditions.
- Crystal Batteries™ can be cycled more often, even @ 80% DOD)
- Crystal Batteries™ have very low gassing (IEC 60896-21/22)
- Crystal Batteries™ can be used in a partial state of charge.
- Crystal Batteries™ can be stored for 2 years at 25˚C (77˚F)
- Crystal Batteries™ hold no cadmium, no antimony, and <3% sulphuric acid
- Crystal Batteries™ operate at higher temperatures with lower cycle loss

NOTE: Deep discharging, operating in a partial state of charge and operating above 25˚C (77˚F) will impact the number of battery cycles. Please refer to the product datasheets for more detailed information.

1.3 APPLICATIONS

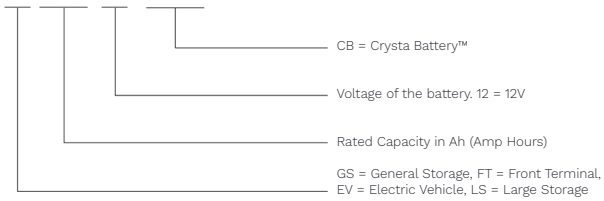
Crystal Batteries™ can be used in a wide range of applications where Lead Acid, Lead Gel, AGM or Lithium batteries are used today, including, but not limited to:

- Telecommunications, Communications Exchanges and Transmission Tower Systems;
- UPS (Uninterruptible Power Supply), PABX, Microwave Relay Stations and Data Centers;
- Radio and Broadcasting Stations;
- Hybrid systems, Power Plants, Substations and Transmission Systems;
- Emergency Lighting Systems;
- Railway Signal and Beacon Signaling System;
- Solar Energy and Wind Energy Storage Systems;
- Hotels, Auditoriums, Building Automation, and other Applications;
- Recreational and Off-Road Vehicle Applications;
- Motive and Electrical Vehicles;
- Marine (powered, sail and shipping);
- Security, Surveillance, Remote Monitoring, and Fire systems;
- Residential and commercial energy storage power systems.
- Military.

1.4 PRODUCT SPECIFICATION AND MODEL IDENTIFICATION

Model identification

CB - 12 - 100 - GS



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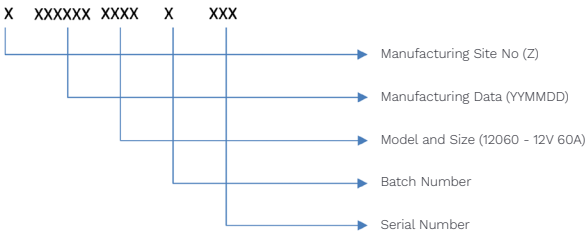


Battery Configurations

Our battery range consists of 2-volt cells, 6-volt blocks, 8-volt blocks, and 12-volt blocks. Blocks refer to a number of 2-volt cells in an enclosed case to complete a battery.

1 x 2V = 2 Volt Battery
3 x 2V = 6 Volt Battery
4 x 2V = 8 Volt Battery
6 x 2V = 12 Volt Battery

1.5 BATTERY FAMILIES

Crystal Batteries™ are grouped into 4 families, where each family addresses a different market and applications.

1

ELECTRIC VEHICLE RANGE

6V, 8V or **12V,** rated at **3h discharge**
From medium to high capacity
(27Ah to **265Ah)**

2

GENERAL STORAGE RANGE

6V or **12V,** rated at **10h discharge**
From small to high capacity
(7Ah to **200Ah)**

3

FRONT TERMINAL RANGE

12V, rated at **10h discharge**
Front terminal only
(55Ah to **180Ah)**

4

LARGE STORAGE RANGE

2V, rated at **10h discharge**
For high capacity banks
(100Ah to **3000Ah)**

1.6 PRODUCT STANDARDS

Crystal Batteries™ are manufactured to meet the following national and international standards and are manufactured under the ISO 9001, ISO 14001, and ISO45001 (OHS) system.

- IEC/EN 60896 -21/22 Battery Standards
- UL 1989 Standard for Battery Safety
- BS 6290-4 Lead Acid Stationary Cells and Batteries
- SR 4228 Battery String Safety and Performance
- GB/T22473-2008 lead-acid energy storage battery
- GB/T19638.2-2005 fixed type valve-controlled sealed battery
- Q/TDZG05-2010 fixed type valve control sealed Crystal Battery™

1.7 PRODUCT RANGE

ELECTRIC VEHICLE RANGE - EV

6 VOLT

BATTERY NAME	RATED VOLTAGE	RATED AH 3 HR RATE	RATED AH 20 HR RATE	WEIGHT	DIMENSIONS
1. CB6-180EV	6 V	180	248	33 kg / 72.8 lbs	**L** 260 mm (10.2") **W** 180 mm (7.1") **H** 275 mm (10.8")
2. CB6-210EV	6 V	210	280	36 kg / 79.4 lbs	**L** 260 mm (10.2") **W** 180 mm (7.1") **H** 275 mm (10.8")
3. CB6-265EV	6 V	265	330	46.5 kg / 102.5 lbs	**L** 295 mm (11.6") **W** 175 mm (6.9") **H** 350 mm (13.8")

8 VOLT

BATTERY NAME	RATED VOLTAGE	RATED AH 3 HR RATE	RATED AH 20 HR RATE	WEIGHT	DIMENSIONS
1. CB8-135EV	8 V	135	178	34 kg / 75 lbs	**L** 261 mm (10.3") **W** 182 mm (7.2") **H** 285 mm (11.2")

12 VOLT

BATTERY NAME	RATED VOLTAGE	RATED AH 3 HR RATE	RATED AH 20 HR RATE	WEIGHT	DIMENSIONS
1. CB12-27EV	12 V	27	34	9.5 kg / 20.9 lbs	**L** 175 mm (6.9") **W** 166 mm (6.5") **H** 125 mm (4.9")
2. CB12-40EV	12 V	40	49	12.5 kg / 27.6 lbs	**L** 222 mm (8.7") **W** 120 mm (4.7") **H** 175 mm (6.9")
3. CB12-60EV	12 V	60	77	22.3 kg / 49.2 lbs	**L** 260 mm (10.2") **W** 169 mm (6.7") **H** 215 mm (8.5")
4. CB12-70EV	12 V	70	86	25.5 kg / 56.2 lbs	**L** 260 mm (10.2") **W** 169 mm (6.7") **H** 215 mm (8.5")
5. CB12-100EV	12 V	100	124	34 kg / 75 lbs	**L** 331 mm (13") **W** 176 mm (6.9") **H** 219 mm (8.6")
6. CB12-120EV	12 V	120	151	40 kg / 88.2 lbs	**L** 330 mm (13") **W** 172 mm (6.8") **H** 255 mm (10")
7. CB12-150EV	12 V	150	183	49 kg / 108 lbs	**L** 484 mm (19.1") **W** 170 mm (6.7") **H** 241 mm (9.5")

GENERAL STORAGE RANGE - GS

6 VOLT

BATTERY NAME	RATED VOLTAGE	RATED AH 10 HR RATE	RATED AH 20 HR RATE	WEIGHT	DIMENSIONS
1. CB6-4GS	6 V	4	4,5	0.8 kg / 1.8 lbs	**L** 70 mm (2.8") **W** 47 mm (1.9") **H** 105 mm (4.1")
2. CB6-7.2GS	6 V	7,2	7,8	1.2 kg / 2.7 lbs	**L** 151 mm (5.9") **W** 35 mm (1.4") **H** 102 mm (4")
3. CB6-10GS	6 V	10	12	1.75 kg / 3.9 lbs	**L** 151 mm (5.9") **W** 50 mm (2") **H** 100 mm (3.9")
4. CB6-12GS	6 V	12	13,2	2.1 kg / 4.6 lbs	**L** 151 mm (5.9") **W** 50 mm (2") **H** 100 mm (3.9")
5. CB6-160GS	6 V	160	175	25.5 kg / 56.2 lbs	**L** 298 mm (11.7") **W** 172 mm (6.8") **H** 230 mm (9.1")
6. CB6-220GS	6 V	200	220	30.5 kg / 67.2 lbs	**L** 323 mm (12.7") **W** 178 mm (7") **H** 230 mm (9.1")

12 VOLT - HIGH RATE

BATTERY NAME	RATED VOLTAGE	RATED AH 10 HR RATE	RATED AH 20 HR RATE	WEIGHT	DIMENSIONS
1. CB12-7.2HGS	12 V (High Rate)	9	9.6	2.54 kg / 5.6 lbs	**L** 151 mm (5.9") **W** 65 mm (2.6") **H** 102 mm (4")

GENERAL STORAGE RANGE - GS

12 VOLT

BATTERY NAME	RATED VOLTAGE	RATED AH 10 HR RATE	RATED AH 20 HR RATE	WEIGHT	DIMENSIONS
1. CB12-7.2GS	12 V	7,2	7,8	2.2 kg / 4.6 lbs	**L** 151 mm (5.9") **W** 65 mm (2.6") **H** 102 mm (4")
2. CB12-10GS	12 V	10	12	3.5 kg / 7.7 lbs	**L** 151 mm (5.9") **W** 99 mm (3.9") **H** 102 mm (4")
3. CB12-12GS	12 V	12	13,2	4.1 kg / 9 lbs	**L** 151 mm (5.9") **W** 99 mm (3.9") **H** 102 mm (4")
4. CB12-14GS	12 V	14	15,5	4.25 kg / 9.4 lbs	**L** 151 mm (5.9") **W** 99 mm (3.9") **H** 105 mm (4.1")
5. CB12-18GS	12 V	18	20	5.9 kg / 13 lbs	**L** 181 mm (7.1") **W** 76 mm (3") **H** 170 mm (6.7")
6. CB12-22GS	12 V	22	24	6.9 kg / 15.2 lbs	**L** 181 mm (7.1") **W** 76 mm (3") **H** 170 mm (6.7")
7. CB12-24GS	12 V	24	27	7.8 kg / 17.2 lbs	**L** 175 mm (6.9") **W** 166 mm (6.5") **H** 125 mm (4.9")
8. CB12-26GS	12 V	26	29	7.8 kg / 17.2 lbs	**L** 175 mm (6.9") **W** 166 mm (6.5") **H** 125 mm (4.9")
9. CB12-28GS	12 V	28	32	8.5 kg / 18.7 lbs	**L** 175 mm (6.9") **W** 166 mm (6.5") **H** 125 mm (4.9")
10. CB12-35GS	12 V	35	40	12 kg / 26.5 lbs	**L** 194 mm (7.6") **W** 132 mm (5.2") **H** 176 mm (6.9")
11. CB12-40GS	12 V	40	44	13 kg / 28.7 lbs	**L** 196 mm (7.7") **W** 166 mm (6.5") **H** 176 mm (6.9")
12. CB12-55GS	12 V	55	60	16.9 kg / 37.3 lbs	**L** 229 mm (9") **W** 138 mm (5.4") **H** 215 mm (8.5")
13. CB12-65GS	12 V	65	72	21 kg / 46.3 lbs	**L** 350 mm (13.8") **W** 166 mm (6.5") **H** 175 mm (6.9")
14. CB12-70GS	12 V	70	78	22.3 kg / 49.2 lbs	**L** 260 mm (10.2") **W** 169 mm (6.7") **H** 215 mm (8.5")
15. CB12-90GS	12 V	90	100	27 kg / 59.5 lbs	**L** 307 mm (12.1") **W** 168 mm (6.6") **H** 216 mm (8.5")
16. CB12-100GS	12 V	100	110	31.5 kg / 69.5 lbs	**L** 327 mm (12.9") **W** 172 mm (6.8") **H** 220 mm (8.7")
17. CB12-120GS	12 V	120	132	36.5 kg / 80.5 lbs	**L** 407 mm (16") **W** 174 mm (6.9") **H** 237 mm (9.3")
18. CB12-150GS	12 V	150	162	46.5 kg / 102.5 lbs	**L** 484 mm (19.1") **W** 170 mm (6.7") **H** 241 mm (9.5")
19. CB12-180GS	12 V	180	190	59 kg / 130.1 lbs	**L** 522 mm (20.6") **W** 240 mm (9.5") **H** 224 mm (8.8")
20. CB12-200GS	12 V	200	220	62 kg / 136.7 lbs	**L** 522 mm (20.6") **W** 240 mm (9.5") **H** 224 mm (8.8")

FRONT TERMINAL RANGE - FT

12 VOLT					
BATTERY NAME	RATED VOLTAGE	RATED AH 10 HR RATE	RATED AH 20 HR RATE	WEIGHT	DIMENSIONS
1. CB12-55FT	12 V	55	60	16.3 kg / 35.9 lbs	**L** 277 mm (10.9") **W** 106 mm (4.2") **H** 228 mm (8.9")
2. CB12-90FT	12 V	90	100	31.5 kg / 69.5 lbs	**L** 396 mm (15.6") **W** 110 mm (4.3") **H** 286 mm (11.3")
3. CB12-100FT	12 V	100	108	34.5 kg / 76.1 lbs	**L** 560 mm (22.1") **W** 125 mm (4.9") **H** 228 mm (9")
4. CB12-155FT	12 V	155	170	48 kg / 105.8 lbs	**L** 558 mm (22") **W** 125 mm (4.9") **H** 283 mm (11.14")
5. CB12-170FT	12 V	170	190	50 kg / 110.2 lbs	**L** 546 mm (21.5") **W** 125 mm (4.9") **H** 320 mm (12.6")
6. CB12-180FT	12 V	180	194	50.5 kg / 111.3 lbs	**L** 546 mm (21.5") **W** 125 mm (4.9") **H** 320 mm (12.6")

LARGE STORAGE RANGE - LS

2 VOLT					
BATTERY NAME	RATED VOLTAGE	RATED AH 10 HR RATE	RATED AH 20 HR RATE	WEIGHT	DIMENSIONS
1. CB2-100LS	2 V	100	108	5.8 kg / 12.8 lbs	**L** 172 mm (6.8") **W** 72 mm (2.8") **H** 210 mm (8.3")
2. CB2-200LS	2 V	200	220	13.5 kg / 29.8 lbs	**L** 174 mm (6.9") **W** 112 mm (4.4") **H** 343 mm (13.5")
3. CB2-300LS	2 V	300	330	20.5 kg / 45.2 lbs	**L** 175 mm (6.9") **W** 155 mm (6.1") **H** 365 mm (13.4")
4. CB2-400LS	2 V	400	440	26 kg / 57.3 lbs	**L** 210 mm (8.3") **W** 175 mm (6.9") **H** 335 mm (13.2")
5. CB2-500LS	2 V	500	560	31 kg / 68.3 lbs	**L** 243 mm (9.6") **W** 175 mm (6.9") **H** 338 mm (13.3")
6. CB2-600LS	2 V	600	660	37.5 kg / 82.7 lbs	**L** 301 mm (11.9") **W** 175 mm (6.9") **H** 335 mm (13.2")
7. CB2-800LS	2 V	800	880	51 kg / 112.4 lbs	**L** 412 mm (16.2") **W** 175 mm (6.9") **H** 337 mm (13.3")
8. CB2-1000LS	2 V	1000	1100	61 kg / 134.5 lbs	**L** 480 mm (18.9") **W** 175 mm (6.9") **H** 340 mm (13.4")
9. CB2-1500LS	2 V	1500	1650	98.5 kg / 217.2 lbs	**L** 403 mm (15.9") **W** 354 mm (13.9") **H** 350 mm (13.8")
10 CB2-2000LS	2 V	2000	2200	124 kg / 273.4 lbs	**L** 491 mm (19.3") **W** 351 mm (13.8") **H** 364 mm (14.3")
11 CB2-2200LS	2 V	2200	2420	131.5 kg / 289.9 lbs	**L** 491 mm (19.3") **W** 351 mm (13.8") **H** 364 mm (14.3")
12 CB2-3000LS	2 V	3000	3300	192 kg / 423.3 lbs	**L** 712 mm (28") **W** 351 mm (13.8") **H** 360 mm (14.2")

2. TECHNICAL SPECIFICATIONS

Crystal Batteries™ are a unique range of batteries that were successfully developed by re-engineering existing batteries and incorporating new patented technologies. It has far better performance characteristics when compared to conventional batteries as a result of technological electro-chemical breakthroughs. The fundamental issues of Lead Acid battery like pollution, electrode sulphation, short life cycle, poor low/high temperature performance, and various other flaws have been significantly improved. Ampowr has set the highest standard for efficiency, safety, long shelf and cycle life, along with excellent product lifecycle and environmental credentials.

2.1 STRUCTURE CHARACTERISTICS

2.1.1 Special Electrolyte Composition

A unique and complex technology is used to synthesize a range of inorganic salts and various organic substances, thereby optimizing the reaction between the electrolyte and the active electrode material. These salts effectively convert the active substance into a Crystal that prevents it from becoming brittle and falling off the plates, thereby extending the service life. After sufficient cycles, the electrolyte within the battery crystallizes, leaving very little free-flowing electrolyte. This significantly reduces the chance of leakage which makes the battery safe for transport and use. The battery may be installed and used in a variety of orientations which simplifies system design and use. The wide range of installation applications is possible since the risk of electrolyte leakage is all but eliminated. The less corrosive chemical reaction improves product safety making it less harmful to installers and users alike.

2.1.2 Battery Enclosure

The battery enclosure is made from strong UL90 V2 flammability rated ABS plastic as a standard. It is also available in a V0 and V1 flammability rating for extreme temperature applications.

2.1.3 Grid and Plates

The grid is made with high-quality corrosion resistant pure lead alloy (99.97% Lead) to ensure excellent performance life of the positive and negative grids. This improves the overpotential of the anode and inhibits corrosion. Ampowr Crystal Batteries™ contain no Cadmium or Antimony further improving the batteries' eco-friendly status.

2.1.4 Separator - Super Absorbent Matt (SAM)

The patented separator is made of an ultra-fine organic fiber with enhanced saturation ability and extreme porosity. By using cathode absorption technology to create gas recombination, the SAM separator has extreme acid resistance and stability, which provides sufficient porosity and maintains the smooth passage of the gas while absorbing and storing sufficient volumes of electrolytes to ensure the batteries' high performance. The oxygen can rapidly distribute negative electrons to perform cathode absorption and oxygen combination cycle.

SAM vs AGM

Standard AGM (Absorbent Glass Mat) is a material used to function as a separator between plates that assists in electrolyte distribution and furthermore helps maintain the pasting oxide on the plates. As AGM is comprised of glass fibers, it tends to limit the electron flow since glass is also an insulator. Our advanced patented SAM is a super-absorbent mat made entirely from non-insulating highly porous organic fibers, thus SAM has better electrolyte absorption and has better retention compared to AGM.

2.1.5 Safety Valve

A safety exhaust valve is used that has high sensitivity and can open or close according to the internal pressure change of the battery. Safety valves are made of corrosion-resistant anti-aging fluorine rubber and functions over the life of the battery to retain the internal air pressure difference and retain the moisture within the battery. The internal pressure of the battery is maintained within an optimal safety range.

* Ampowr Crystal Batteries™ are extremely low gassing batteries. See section 6.3.2 for more information on gassing.

2.1.6 Sealing Performance

The battery compartment and covers are sealed with rubber rings and the terminals are dual-sealed. An epoxy resin sealing agent with low shrinkage is used to ensure that the terminals and lids seal properly.

2.1.7 Plate Performance

The positive and negative plates are the core electrochemical reaction region and the most important components of the battery second to the electrolyte. The grid is coated with lead paste and formed after curing, drying, and other processes. The active material of the positive and negative plates has the following composition:

Positive electrode plate: main component - Lead Dioxide (PbO_2);
Negative electrode plate: main component - Spongy Lead (Pb).

2.1.8 Special Manufacturing Process

Using negative pressure filling technology in combination with patented gravity filling containers to fill the batteries with electrolyte and the patented terminal connecting equipment, ensures an even distribution of electrolyte in each cell which further enhances the performance of the battery and increases efficiency.

2.2 GENERIC WORKING PRINCIPLE

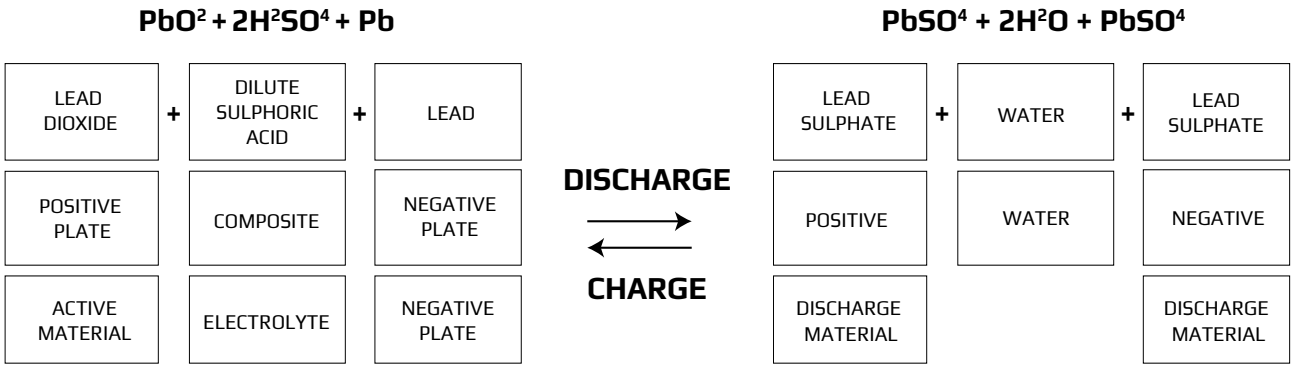


Figure 1. The main electrochemical reaction during charge / discharge.

The positive and negative active material reacts with the acidic element of the electrolyte and becomes lead sulphate and water when discharging, causing the acid density to decrease. When charging, the acid that concentrated in the positive oxide paste during discharge cycles is released back into the electrolyte. At this time, the lead sulphate in the positive and negative plate transforms into lead dioxide and a spongy type of lead which causes the acid density in the electrolyte to increase. The patented formulation acts to reduce the acidity of the solution and in turn, increases the hydrogen concentration that is required for ion exchange. None of the confidential chemical ingredients are indicated in Figure 1 due to the sensitive nature and to safeguard our intellectual property.

After charging or prior to charge completion, all the charging current is used for electrolysis of the moisture in the electrolyte with conventional lead-based batteries. The positive plates release oxygen and the negative plates release hydrogen gas. If the gas recombination efficiency of the battery is low, a large percentage of the gas will escape reducing moisture in the battery after every charge. This action causes the electrolyte content to decrease due to water loss which raises the acidity in the battery and shortens the life of the battery. This is known as late-charge fluid-loss phenomenon.

With Crystal Batteries™, the composite electrolyte has various additives that participate in the electrochemical reaction in addition to the regular chemical reaction. The additives inhibit the oxygen and hydrogen gas formation during the charging cycle increasing the batteries' recombination rate. This, in turn, reduces the water loss during and after charging. The lead sulphate can be totally transformed back into active material when discharging, prolonging the battery's useful life and making it resistant to sulphation.

Crystal Batteries™ use a new and patented advanced type of super absorbent matt (SAM) as a separator. The SAM has much higher electrical conductivity, heat resistance, and acid resistance abilities than standard commercial AGM separators.

The crystallized electrolyte in combination with the SAM effectively protects the plates and prevents the active material from falling off during regular use. The electrolyte is completely absorbed and stored in the SAM. Since the SAM is completely saturated with electrolyte when crystalized, no free liquid electrolyte will be present in the battery. The battery can now be used in various directional positions without leaking.

⚠ **CAUTIONARY NOTE**: Long-term storage with the plates horizontal to the ground may cause problems in the longer term as vibration or gravity may eventually reduce usage life.

3. CHARGE AND DISCHARGE SPECIFICATIONS

All batteries have different charge requirements due to the variations of lead and alloys used to make the plates, since the pasting density, composition, and the electrolyte solution are critical to the battery operation. Hence it is essential to be informed on the charging requirements specified in the user manual of the battery manufacturer.

In this chapter, the focus is on the minimum requirements to charge a Crystal Battery™, since it is the single most important part of the batteries' life and how it will perform in systems. Additional type and range specific charging and care information can be found in the datasheets on the www.ampowr.com website. Please take special care to comply with recommendations since the system performance and any warranty will be subject to correct charging procedures.

Battery system applications are usually defined into the following usage conditions:

- Cyclic - Regular Bulk/Absorption/Float
  Requires the battery to deliver all or most of its stored energy once per day over a long period of time.

  The batteries are discharged daily between 50% and 80% Depth of Discharge (DoD), followed by a full charge cycle. These charging cycles, as mentioned above, must occur at the recommended temperature-compensated voltage and current during the bulk or boost phase, followed by a reduced current absorption phase that is then ended with a float top-up phase at a highly reduced charging current to ensure the battery is fully charged and ready for the next long discharge cycle.

- Standby - Float with the occasional Bulk/Absorption/FloatRequires full capacity available for possible deep cycle with less frequent discharges.

  The batteries are less frequently discharged, 3 months or more between discharges, for example, followed by a full charge as per the cyclic use above. In most cases, this type of application requires less frequent purification as long as the charger is set to stop charging once the battery is full or with pre-set timers that stop the charging to prevent over-charging during standby times

- Float (UPS) - Float Only
  Requires full capacity discharge in a short period of time once or twice a year.

  The batteries are continuously in the float phase until required to discharge, in most cases a simple charger is designed to only supply a float voltage/current and not have multiple phase charge profiles that are required for effective battery charging. Float applications require a deep discharge purification cycle, or equalization cycle, at least every 3 months to ensure the battery chemistry remains active and to prolong the use life of the battery.

High Cyclic - Bulk/Absorption with no or infrequent float
Requires a cyclic charge profile and more frequent purification regime.

The batteries are frequently deeply discharged, in most cases daily or in extreme cases multiple times a day, in which charging consists of higher voltage and current during the boost phase followed by a reduced current absorption phase. In extreme cases, the battery charge profile seldom reaches the float or top-up phase, effectively forcing the battery to operate in a partial state of charge.

When the application requires a partial state of charge use, a purification charge MUST BE performed weekly and in less demanding applications, twice a month.

IMPORTANT NOTE: Float Applications
During float/trickle charge applications, the purpose is to replace the energy used by the internal self-discharge chemical reactions to maintain it at full charge. Generally, a power supply will deliver a constant voltage between 13.5 volts and 13.7 volts (typically 13.6 volts). This type of usage dictates that a periodical purification charge must be performed to maintain the batteries chemistry in a healthy state. See section 3 for details on purification charge.

Due to the wide variations in float charging systems, we have provided charge specifications in this manual that will deliver the best possible results.

All lead-based batteries need to be put through the three basic stages of charge BULK, ABSORPTION, and FLOAT. If these stages are not achieved the battery will NEVER be fully charged. If you intend to use Crystal Batteries™ in a float application, then we encourage you to contact the Ampowr technical team to discuss the application, ensuring you achieve the best results from the Crystal Batteries™.

3.1 CHARGE CHARACTERISTICS GS, HGS, FT AND LS

Charge voltages must be temperature compensated and Bulk/Boost times need to be adjusted according to the DOD to ensure optimal charge acceptance and enhance the recombination rate of the electrolyte.

This user manual should always be read in conjunction with the specific battery datasheet where further charging/discharging information can be found. Always check to ensure you have the most recent version of the datasheet and/or user manual by regularly visiting the Ampowr website: www.ampowr.com

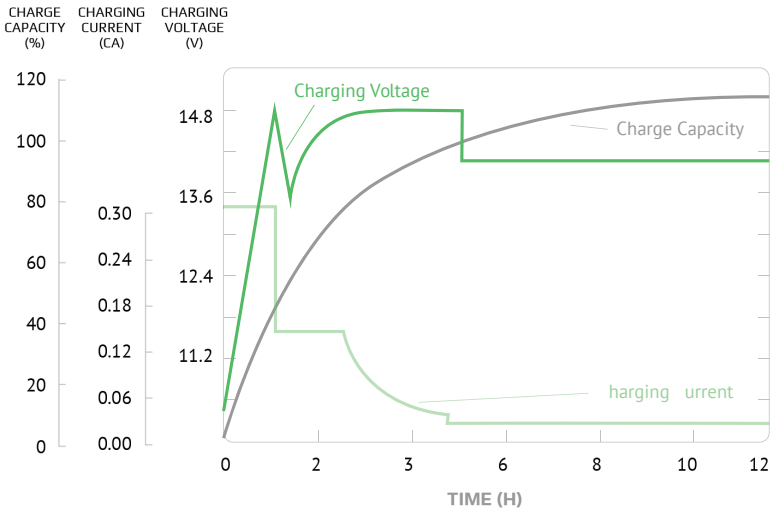
PLEASE OBSERVE THE FOLLOWING WHEN CHARGING CRYSTAL BATTERIES:

- The voltages quoted in ALL the charging information are the required terminal voltages. You may need to compensate your charger settings to overcome voltage drops over charging cables and other inline devices.
- When charging with a new charger always observe the battery during the first few charge cycles to ensure that the charger progresses through each stage of charge.
- Ampowr always recommends new batteries be given at least 3 additional discharge/charge cycles before putting new batteries into mission-critical applications.
- Crystal Batteries™ will typically increase by 5˚C (41˚F) to 10˚C (50˚F) during charging. If a battery is hot during charge, it is recommended to perform a purification charge cycle and then re-observe the next charge cycle. If the battery continues to get hot, consult the troubleshooting guide at the back of this manual or consult a Ampowr office.
- Always try and match the batteries from the sameproduction batch.
- Allow the batteries to cool down to room temperature after charging and prior to use for the best life and discharge performance.

WARNING: FAILURE TO ADHERE TO RECOMMENDED CHARGE SPECIFICATIONS CAN REDUCE BATTERY PERFORMANCE AND VOID YOUR WARRANTY IF THE BATTERY OVERCHARGES OR UNDERCHARGES.

3.1.1 GS, HGS, FT 12-Volt Cyclic Charge Specifications

REGULAR CYCLE CHARGE CHARACTERISTICS 25˚C (77˚F).



The above graph represents the correct charge profile for the 12V GS, 12V HGS, and 12V FT batteries and indicates the minimum required charge curve for cyclic applications at an environmental temperature not exceeding 25°C (77˚F).

Bulk/Boost phase charge with a constant current of 0.30C @ C10 (30% of the battery's 10 hour rated capacity) for 1 to 1.50 hours with a constant current until the battery voltage reaches the threshold 14.7V @25C. Do not exceed 3 hours charge time in the bulk/boost phase.

Absorption phase charge with a constant current of 0.15C @C10 (15% of the battery's 10 hour rated capacity) for 3.5 hours with a constant current until the battery voltage reaches 14.7V @25C. Do not exceed 5 hours charge time in the absorption stage.

Float/Top up phase charge with a constant voltage of 13.6V @25C and a variable current of 0.05C to 0.01C @C10 (5% down to 1% of the batteries 10 hour rated capacity).

12-Volt Cyclic Charger Settings

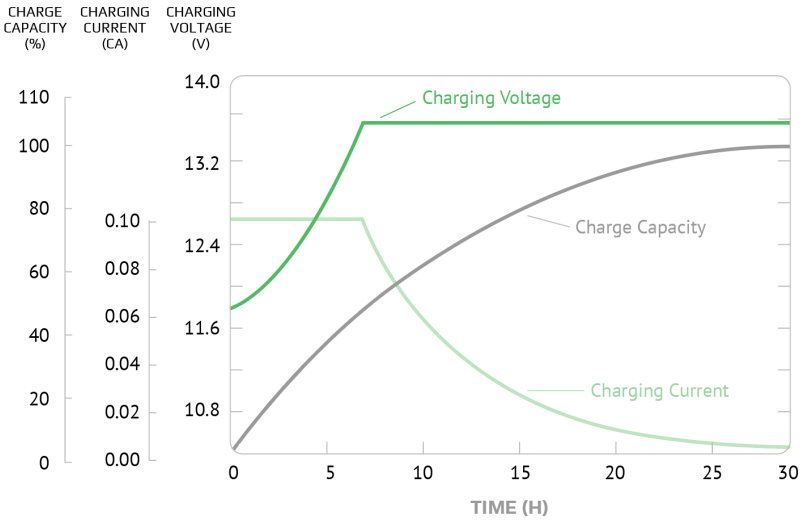
Crystal Batteries™ are high-end pure lead battery products that work best with good quality battery chargers that have the correct Crsytal Battery charge profile pre-loaded or that is custom programmable. See the below table and the datasheet for charger settings for the 12-volt blocks.

12 VOLT BATTERIES: GS, HGS, FT										
CYCLIC /DAILY CYCLING APPLICATIONS										
	BULK / BOOST			ABSORPTION				FLOAT		
Temperature	Constant Current Variable Voltage			Constant Current Variable Voltage				Variable Current Constant Voltage		
25˚C (77˚F)	14.7 Volts	0.3C Minimum (30% of C10 hour rated capacity)	Max. 3 hours	14.7 Volts	0.15C (15% of C10 hour rated capacity)	0.02C (2% of C10 hour rated capacity)	Max. 5 hours	13.6 Volts	0.02C (2% of C10 hour rated capacity)	Unlimited
35˚C (95˚F)	14.5 Volts			14.5 Volts				13.4 Volts		
45˚C (113˚F)	14.2 Volts			14.2 Volts				13.4 Volts		
* The above voltage set points are averages over indicated temperature ranges. Please refer to the technical datasheet for more specific voltage set points and temperature compensation for specific temperatures.										
* The above set points are for voltage regulated multi stage IUoU and adjustable switch mode chargers.										

WARNING: Discharging or charging a hot battery will reduce its life and increase the risk of overcharging.

3.1.2 GS, HGS, FT 12-Volt Float Charge Specifications

FLOATING CHARACTERISTICS 25˚C (77˚F).



The above graph represents the correct charge profile for the 12V GS, 12V HGS, and 12V FT batteries and indicates the minimum required charge curve for float or standby applications with a maximum DOD of 80% to 1.8 volts per cell at an environmental temperature not exceeding 25°C (77˚F).

Bulk/Boost phase charge with a constant current of 0.10C @ C10 (10% of the battery's 10 hour rated capacity) for 6 hours with a constant voltage until the battery voltage reaches 13.6V @25C. Do not exceed 7 hours charge time in the bulk/boost phase.

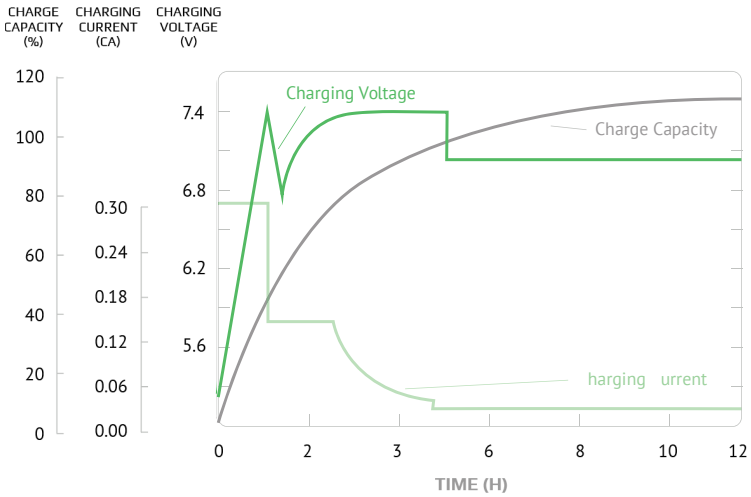
Absorption/Float phase charge with a constant voltage of 13.6V @25C and a variable current of 0.1C to 0.01C @C10 (10% down to 1% of the batteries 10 hour rated capacity).

Ampowr requires a periodical purification charge to be applied to the batteries when used in a FLOAT application. See Section 3 for details on purification charging.

See the previous table and the datasheet for float settings for the 12-volt blocks.

3.1.3 GS 6-Volt Cyclic Charge Specifications

REGULAR CYCLE CHARGE CHARACTERISTICS 25˚C (77˚F).



The above graph represents the correct charge profile for the 6V GS and batteries and indicates the minimum required charge curve for cyclic applications with a maximum DOD of 50% (down to 2 volts per cell) at an environmental temperature not exceeding 25°C (77˚C).

Bulk/Boost phase charge with a constant current of 0.30C @C10 (30% of the battery's 10 hour rated capacity) for 1 to 1.50 hours with a constant current until the battery voltage reaches 7.35V @25C. Do not exceed 3 hours of charge time in the bulk/boost phase.

Absorption phase charge with a constant current of 0.15C @C10 (15% of the battery's 10 hour rated capacity) for 3.5 hours with a constant current until the battery voltage reaches 7.35V @25C. Do not exceed 5 hours charge time in the absorption stage.

Float/Top up phase charge with a constant voltage of 6.8V @25C and a variable current of 0.05C to 0.01C @C10 (5% down to 1% of the batteries 10 hour rated capacity).

6-Volt Cyclic Charger Settings

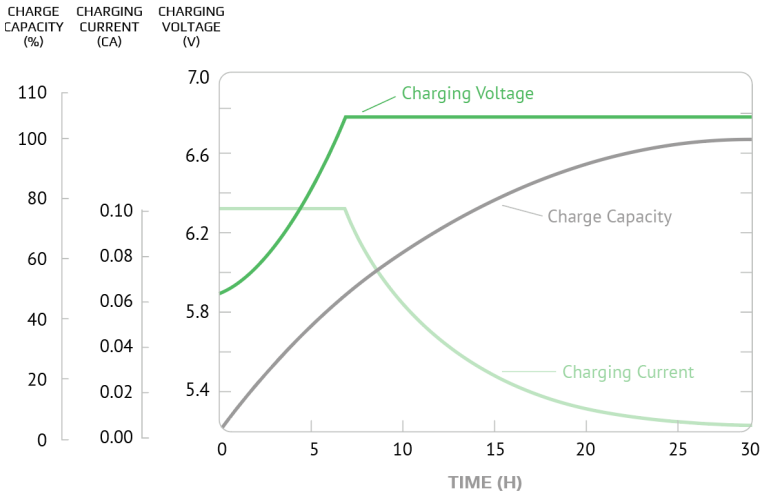
Crystal Batteries™ are high-end pure lead battery products that work best with good quality battery chargers that have the correct Crsytal Battery™ charge profile pre-loaded or that is custom programmable. See the below table and the datasheet for charger settings for the 6-volt blocks.

6 VOLT BATTERIES: GS										
CYCLIC /DAILY CYCLING APPLICATIONS										
	BULK / BOOST			ABSORPTION				FLOAT		
Temperature	Constant Current Variable Voltage			Constant Current Variable Voltage				Variable Current Constant Voltage		
25˚C (77˚F)	7.35 Volts	0.3C Minimum (30% of C10 hour rated capacity)	Max. 3 hours	7.35 Volts	0.15C (15% of C10 hour rated capacity)	0.02C (2% of C10 hour rated capacity)	Max. 5 hours	6.80 Volts	0.02C (2% of C10 hour rated capacity)	Unlimited
35˚C (95˚F)	7.25 Volts			7.25 Volts				6.70 Volts		
45˚C (113˚F)	7.10 Volts			7.10 Volts				6.70 Volts		
* The above voltage set points are averages over indicated temperature ranges. Please refer to the technical datasheet for more specific voltage set points and temperature compensation for specific temperatures.										
* The above set points are for voltage regulated multi stage IUotU and adjustable switch mode chargers.										

WARNING: Discharging or charging a hot battery will reduce its life and increase the risk of overcharging.

3.1.4 GS 6-Volt Float Charge Specifications

FLOATING CHARACTERISTICS 25˚C (77˚F).



The above graph represents the correct charge profile for the 6V GS batteries and indicates the minimum required charge curve for float or standby applications with a maximum DOD of 80% (to 1.833 volts per cell) at an environmental temperature not exceeding 25°C (77˚F).

Bulk/Boost phase charge with a constant current of 0.10C @C10 (10% of the battery's 10 hour rated capacity) for 6 hours with a constant voltage until the battery voltage reaches 6.8V @25C. Do not exceed 7 hours charge time in the bulk/boost phase.

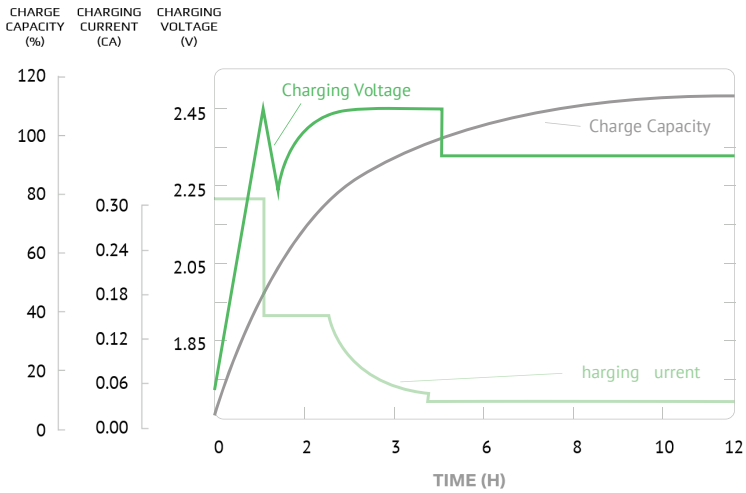
Absorption/Float phase charge with a constant voltage of 6.8V @25C and a variable current of 0.1C to 0.01C @C10 (10% down to 1% of the batteries 10 hour rated capacity).

Ampowr requires a periodical purification charge to be applied to the batteries when used in a float application. See Section 3 for details on purification charging.

See the previous table and the datasheet for float settings for the 6-volt blocks.

3.1.5 LS 2-Volt Cyclic Charge Specifications

REGULAR CYCLE CHARGE CHARACTERISTICS 25˚C (77˚F).



The above graph represents the correct charge profile for the 2V LS batteries and indicates the minimum required charge curve for cyclic applications with a maximum DOD of 50% (down to 2 volts per cell) at an environmental temperature not exceeding 25°C.

Bulk/Boost phase charge with a constant current of 0.30C @C10 (30% of the battery's 10 hour rated capacity) for 1 to 1.50 hours with a constant current until the battery voltage reaches 2.45V @25C. Do not exceed 3 hours charge time in the bulk/boost phase.

Absorption phase charge with a constant current of 0.15C @C10 (15% of the battery's 10 hour rated capacity) for 3.5 hours with a constant current until the battery voltage reaches 2.45V @25C. Do not exceed 5 hours charge time in the absorption stage.

Float/Top up phase charge with a constant voltage of 2.27V @25C and a variable current of 0.05C to 0.01C @C10 (5% down to 1% of the batteries 10 hour rated capacity).

2-Volt Cyclic Charger Settings

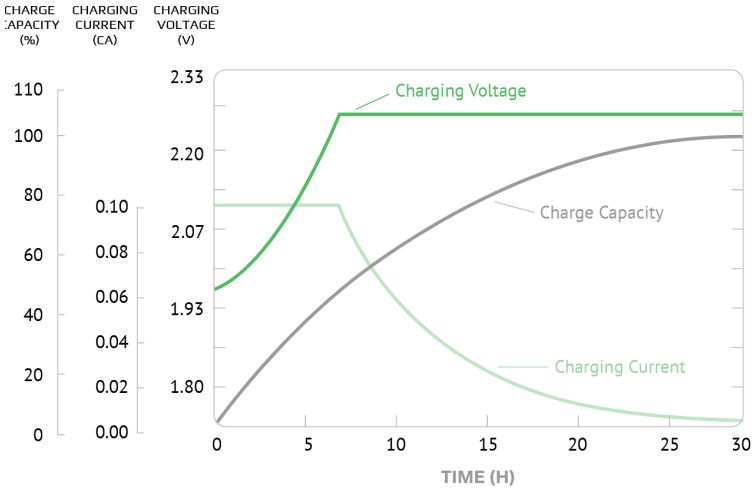
Crystal Batteries™ are high-end pure lead battery products that work best with good quality battery chargers that have the correct Crsytal Battery™ charge profile pre-loaded or that is custom programmable. See the below table and the datasheet for charger settings for the 2-volt blocks.

2 VOLT BATTERIES: LS										
CYCLIC /DAILY CYCLING APPLICATIONS										
	BULK / BOOST			ABSORPTION				FLOAT		
Temperature	Constant Current Variable Voltage			Constant Current Variable Voltage				Variable Current Constant Voltage		
25˚C (77˚F)	2.45 volts	0.3C Minimum (30% of C10 hour rated capacity)	Max. 3 hours	2.45 volts	0.15C (15% of C10 hour rated capacity)	0.02C (2% of C10 hour rated capacity)	Max. 5 hours	2.27 volts	0.02C (2% of C10 hour rated capacity)	Unlimited
35˚C (95˚F)	2.41 volts			2.41 volts				2.24 volts		
45˚C (113˚F)	2.37 volts			2.37 volts				2.23 volts		
* The above voltage set points are averages over indicated temperature ranges. Please refer to the technical datasheet for more specific voltage set points and temperature compensation for specific temperatures.										
* The above set points are for voltage regulated multi stage IUoU and adjustable switch mode chargers.										

WARNING: Discharging or charging a hot battery will reduce its life and increase the risk of overcharging.

3.1.6 LS 2-Volt Float Charge Specifications

FLOATING CHARACTERISTICS 25˚C (77˚F).



The above graph represents the correct charge profile for the 2V LS batteries and indicates the minimum required charge curve for float or standby applications with a maximum DOD of 80% (to 1.80 volts per cell at a C10 load, higher loads would imply a lower end voltage) at an environmental temperature not exceeding 25°C.

Bulk/Boost phase charge with a constant current of 0.10C @C10 (10% of the battery's 10 hour rated capacity) for 6 hours with a constant voltage until the battery voltage reaches 2.27V @25C. Do not exceed 7 hours charge time in the bulk/boost phase.

Absorption/Float phase charge with a constant voltage of 2.27V @25C and a variable current of 0.1C to 0.01C @C10 (10% down to 1% of the batteries 10 hour rated capacity).

A periodical purification charge must be applied to the batteries when used in a FLOAT application. See Section 3 for details on purification charging.

See the previous table and the datasheet for float settings for the 2-volt blocks.

3.2 CHARGE CHARACTERISTICS EV

Introduction to EV
The EV range is our electric vehicle range of batteries, specifically designed for demanding power needs like electric motors and vehicles, internal transport systems, industrial cleaning machines, golf carts, caravan, 4WD, and many more. The electric vehicle batteries have the same high outstanding characteristics as the GS range, however, there are a few differences to be noted.

- The EV range has a unique plate design to deliver faster discharge capability whilst retain the advantages of a deep cycle battery, however, the cycles of the battery are reduced.
- Has been designed to work specifically with electric motors;
- Has a much thicker busbar structure better suited for high-discharge high-cyclic applications and is capable of high power delivery more easily;
- Is ideal for motive applications.

The electric vehicle range includes 6V, 8V, and 12V batteries which vary from 27Ah to 265Ah capacity. The EV range share many similarities to the standard GS and FT range. The battery case, separator, terminals, safety valves, and top covers are all the same however the charging requirements are different.

Calculating the correct charging current for the electric vehicle range

The electric vehicle range has a different charge profile when compared to the regular GS or FT range. In addition, the capacity is measured on a 3-hour discharge rate instead of the 10-hour discharge for the regular GS and FT range.

The EV range is charged with less power than the regular range. To calculate the charging current, use the following formula:

Battery capacity at a 3-hour discharge rate (can be found in the datasheet) x 0.2C (or 20% of the C3 rate).

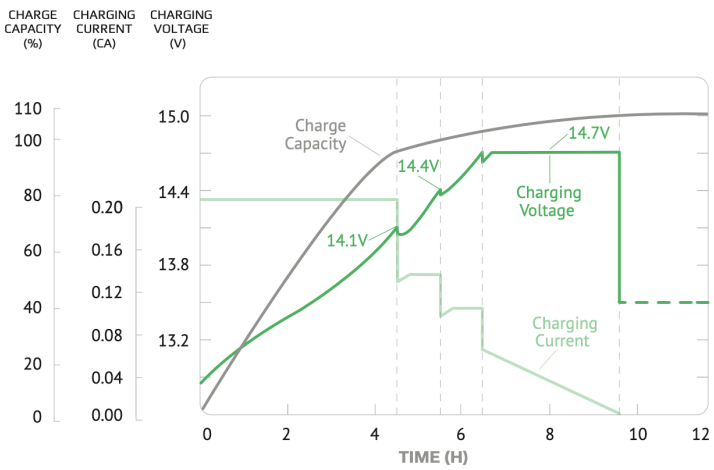
For example:
CB12-120EV delivers 120 Ah @C3 (on a 3h discharge) x 0.2C = 24A. The best choice here would be a 25A charger.

PLEASE OBSERVE THE FOLLOWING:
when charging Crystal Batteries™.

- The voltages quoted in ALL the charging information are the required terminal voltages. You may need to compensate your charger settings to overcome voltage drops over charging cables and other inline devices.
- When charging with a new charger always observe the battery during the first few charge cycles to ensure that the charger progresses through each stage of charge.
- Ampowr always recommends new batteries be given at least 3 additional discharge/charge cycles before putting new batteries into mission-critical applications.
- Crystal Batteries™ will typically increase by 5˚C (41˚F) to 10˚C (50˚F) during charging. If a battery is hot during charge, it is recommended to perform a purification charge cycle and then re-observe the next charge cycle. If the battery continues to get hot, consult the troubleshooting guide at the back of this manual or consult a Ampowr office.
- Always try and match the batteries from the sameproduction batch.
- Allow the batteries to cool down to room temperature after charging and prior to use for the best life and discharge performance.

3.2.1 EV 12-Volt Cyclic Charge Specifications

REGULAR CYCLE CHARGE CHARACTERISTICS 25˚C (77˚F).



The above graph represents the correct charge profile for the 12V EV batteries and indicates the minimum required charge curve for cyclic applications at an environmental temperature not exceeding 25°C (77˚F).

Bulk/Boost phase charge with a constant current of 0.20C @C3 (20% of the battery's 3 hour rated capacity) for 1 to 1.50 hours with a constant current until the battery voltage reaches 14.7V @25C. Do not exceed 3 hours charge time in the bulk/boost phase.

Absorption phase charge with a constant current of 0.10C @C3 (10% of the battery's 3 hour rated capacity) for 3.5 hours with a constant current until the battery voltage reaches 14.7V @25C. Then reduce the current again to 0.05C until the battery reaches 14.7V. Do not exceed 8 hours charge time in the absorption stage.

Float/Top up phase charge with a constant voltage of 13.6V @25C and a variable current of 0.05C to 0.01C @C10 (5% down to 1% of the batteries 10 hour rated capacity). Do not exceed 10 hours charge time in the float stage.

EV 12-Volt Cyclic Charger Settings

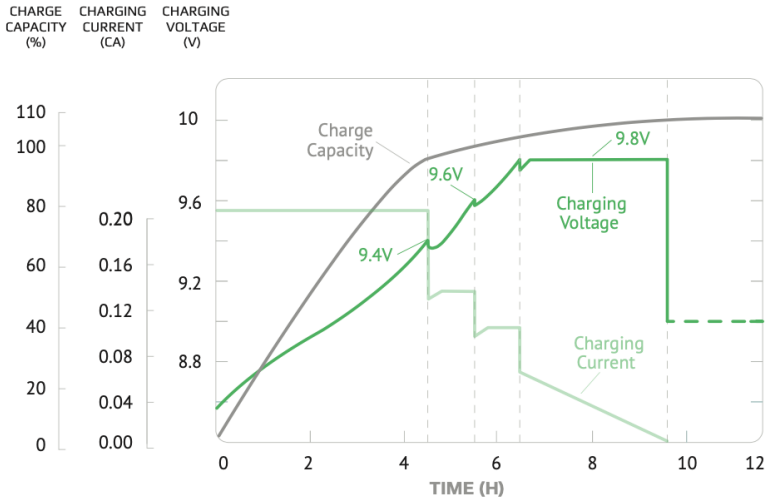
Crystal Batteries™ are high-end pure lead battery products that work best with good quality battery chargers that have the correct Crsytal Battery™ charge profile pre-loaded or that is custom programmable. See the below table and the datasheet for charger settings for the 12-volt blocks.

12 VOLT BATTERIES: EV										
CYCLIC /DAILY CYCLING APPLICATIONS										
	BULK / BOOST			ABSORPTION				FLOAT		
Temperature	Constant Current Variable Voltage			Constant Current Variable Voltage				Variable Current Constant Voltage		
20˚C - 30˚C	14.7 Volts	0.2C Minimum (20% of C3 hour rated capacity)	Max. 4 hours	14.7 Volts	0.10C (10% of C3 hour rated capacity)	0.05C (2% of C3 hour rated capacity)	Max. 4 hours	13.6 Volts	0.02C (2% of C3 hour rated capacity)	Max. 10 hours
31˚C - 40˚C	14.5 Volts			14.5 Volts				13.4 Volts		
41˚C - 45˚C	14.2 Volts			14.2 Volts				13.4 Volts		
* The above voltage set points are averages over indicated temperature ranges. Please refer to the technical datasheet for more specific voltage set points and temperature compensation for specific temperatures.										
* The above set points are for voltage regulated multi stage IUoU and adjustable switch mode chargers.										

WARNING: Discharging or charging a hot battery will reduce its life and increase the risk of overcharging.

3.2.2 EV 8-Volt Cyclic Charge Specifications

REGULAR CYCLE CHARGE CHARACTERISTICS 25˚C (77˚F).



The above graph represents the correct charge profile for the 12V EV batteries and indicates the minimum required charge curve for cyclic applications at an environmental temperature not exceeding 25°C (77˚F).

Bulk/Boost phase charge with a constant current of 0.20C @C3 (20% of the battery's 3 hour rated capacity) for 1 to 1.50 hours with a constant current until the battery voltage reaches 9.8V @25C. Do not exceed 3 hours charge time in the bulk/boost phase.

Absorption phase charge with a constant current of 0.10C @C3 (10% of the battery's 3 hour rated capacity) for 3.5 hours with a constant current until the battery voltage reaches 9.8V @25C. Then reduce the current again to 0.05C until the battery reaches 9.8V. Do not exceed 8 hours charge time in the absorption stage.

Float/Top up phase charge with a constant voltage of 9.1V @25C and a variable current of 0.05C to 0.01C @C10 (5% down to 1% of the batteries 10 hour rated capacity). Do not exceed 10 hours charge time in the float stage.

EV 8-Volt Cyclic Charger Settings

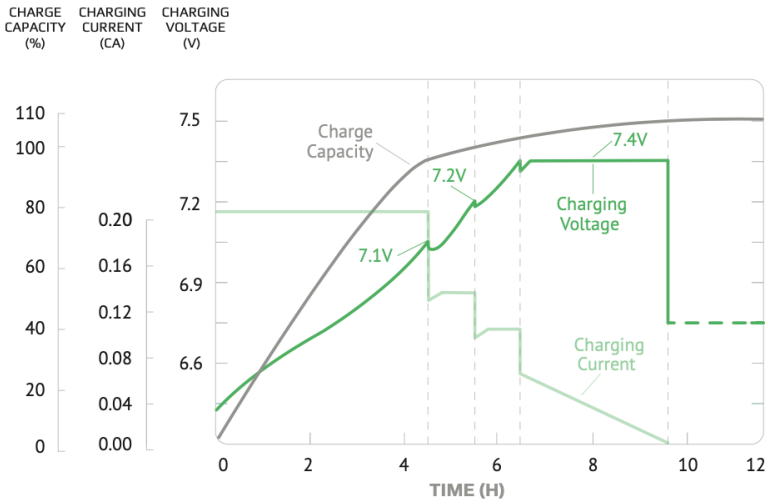
Crystal Batteries™ are high-end pure lead battery products that work best with good quality battery chargers that have the correct Crsytal Battery™ charge profile pre-loaded or that is custom programmable. See the below table and the datasheet for charger settings for the 8-volt blocks.

8 VOLT BATTERIES 8-GREV										
CYCLIC /DAILY CYCLING APPLICATIONS										
	BULK / BOOST			ABSORPTION				FLOAT		
Temperature	Constant Current Variable Voltage			Constant Current Variable Voltage				Variable Current Constant Voltage		
20˚C - 30˚C	9.80 Volts	0.2C Minimum (20% of C3 hour rated capacity)	Max. 4 hours	9.80 Volts	0.10C (10% of C3 hour rated capacity)	0.05C (2% of C3 hour rated capacity)	Max. 4 hours	9.07 Volts	0.02C (2% of C3 hour rated capacity)	Max. 10 hours
31˚C - 40˚C	9.67 Volts			9.67 Volts				8.93 Volts		
41˚C - 45˚C	9.47 Volts			9.47 Volts				8.93 Volts		
* The above voltage set points are averages over indicated temperature ranges. Please refer to the technical datasheet for more specific voltage set points and temperature compensation for specific temperatures.										
* The above set points are for voltage regulated multi stage IUoU and adjustable switch mode chargers.										

WARNING: Discharging or charging a hot battery will reduce its life and increase the risk of overcharging.

3.2.3 EV 6-Volt Cyclic Charge Specifications

REGULAR CYCLE CHARGE CHARACTERISTICS 25˚C (77˚F).



The above graph represents the correct charge profile for the 12V EV batteries and indicates the minimum required charge curve for cyclic applications at an environmental temperature not exceeding 25°C (77˚F).

Bulk/Boost phase charge with a constant current of 0.20C @C3 (20% of the battery's 3 hour rated capacity) for 1 to 1.50 hours with a constant current until the battery voltage reaches 7.4V @25C. Do not exceed 3 hours charge time in the bulk/boost phase.

Absorption phase charge with a constant current of 0.10C @C3 (10% of the battery's 3 hour rated capacity) for 3.5 hours with a constant current until the battery voltage reaches 7.4V @25C. Then reduce the current again to 0.05C until the battery reaches 7.4V. Do not exceed 8 hours charge time in the absorption stage.

Float/Top up phase charge with a constant voltage of 6.85V @25C and a variable current of 0.05C to 0.01C @C10 (5% down to 1% of the batteries 10 hour rated capacity). Do not exceed 10 hours charge time in the float stage.

EV 6-Volt Cyclic Charger Settings

Crystal Batteries™ are high-end pure lead battery products that work best with good quality battery chargers that have the correct Crsytal Battery™ charge profile pre-loaded or that is custom programmable. See the below table and the datasheet for charger settings for the 6-volt blocks.

6 VOLT BATTERIES 6-GREV										
CYCLIC /DAILY CYCLING APPLICATIONS										
	BULK / BOOST			ABSORPTION				FLOAT		
Temperature	Constant Current Variable Voltage			Constant Current Variable Voltage				Variable Current Constant Voltage		
20˚C - 30˚C	7.35 Volts	0.2C Minimum (20% of C3 hour rated capacity)	Max. 4 hours	7.35 Volts	0.10C (10% of C3 hour rated capacity)	0.05C (2% of C3 hour rated capacity)	Max. 4 hours	6.80 Volts	0.02C (2% of C3 hour rated capacity)	Max. 10 hours
31˚C - 40˚C	7.25 Volts			7.25 Volts				6.70 Volts		
41˚C - 45˚C	7.10 Volts			7.10 Volts				6.70 Volts		
* The above voltage set points are averages over indicated temperature ranges. Please refer to the technical datasheet for more specific voltage set points and temperature compensation for specific temperatures.										
* The above set points are for voltage regulated multi stage IUoU and adjustable switch mode chargers.										

WARNING: Discharging or charging a hot battery will reduce its life and increase the risk of overcharging.

3.3 PURIFICATION CHARGING

Ampowr Crystal Batteries™ are a very resilient battery that can operate at wider temperature ranges, from a partial state of charge and at very low depths of discharge. Occasionally the battery will require a purification charge to:

- Redistribute the electrolyte internally within the battery;
- Recombine the battery;
- Equalize the internal cell voltages;
- Soak the lead (Saturation charge);
- To ultimately recover voltage and capacity.

Purification charging is achieved by the following process:

1. Use at least half the rated Ah of the battery irrespective of discharge rate, for example, running the battery for 30 minutes at 1C, or 60 minutes at 0.5C, or 300 minutes at 0.1C.
2. Recharge the battery using the cycle charge characteristics and with the correct recharge current which is 0.25C to 0.35C of the 10-hour rate for the LS, GS, FT range and 0.15C to 0.25C of the 3-hour rate for the EV range.
3. Let the battery float for a minimum of 10 hours for the LS, GS, FT, and the EV.

Floating and infrequent use of the battery requires more purification charging than general cyclic use. Please see Section 3 for the correct purification charge frequency depending on the application.

3.4 BATTERY LIFE AND TEMPERATURE

By far one of the most critical aspects of a battery are the effects of temperature. A battery is a chemical reactor and in the natural course of charging and discharging battery heat will be generated. Additionally, ambient temperature has an effect on a battery both in terms of its capacity and the way in which a battery needs to be charged.

Traditional batteries tend to de-rate quickly at higher temperatures and the reason for this is simple chemistry. At 50˚C (122˚F) very acidic electrolytes start to break down. Due to the extremely low levels of acid (<3%) in Crystal Batteries™, our battery can withstand the heat longer and de-rate at a slower rate than traditional lead acid batteries. Note: The batteries cycle life will still be shortened in extreme temperatures.

3.4.1 Minimum and Maximum Temperatures

The best application temperature for Crystal Batteries™ is 15°C (59˚F) to 25°C (77˚F). Every 10°C (50˚F) additional increase in temperature, means an additional 13% reduction (vs. 50% on competing batteries) in cycle life. When the ambient temperature is at a constant 40°C (104˚F) the battery cycle life decreases at 23%.

Therefore, the ambient temperature of battery, must be controlled when it is in use. If the temperature is too high and is not effectively controlled, the heat that is built-up to a certain level will damage the battery. lifetime

Although Crystal Batteries™ can withstand operation in extreme temperatures, the battery room/area should preferably be air-conditioned and/or properly ventilated to improve the ambient temperature. The gap in between batteries should not be less than 6mm, while the float voltage and cycle charging voltage should be adjusted according to the requirements listed in this manual.

When charged at the recommended settings we typically see a temperature variation of 5˚C (41˚F) to 10˚C (50˚F) from ambient. If the batteries temperature exceeds 20˚C (68˚F) above ambient whilst charging or discharging you should stop immediately and contact a Ampowr office for technical support.

STATUS	OPERATING TEMPERATURE	OPTIMUM OPERATING TEMPERATURE
DISCHARGE	-40˚C (-40˚F) to 65˚C (149˚F)	15˚C (59˚F) to 25˚C (77˚F)
CHARGE	-40˚C (-40˚F) to 65˚C (149˚F)	15˚C (59˚F) to 25˚C (77˚F)
STORAGE	-20˚C (-4˚F) to 40˚C (104˚F)	15˚C (59˚F) to 25˚C (77˚F)

Table 1 Operating temperatures Crystal Batteries™.

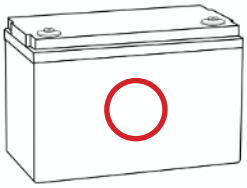
3.4.2 Temperature Compensation When Charging

The charge voltage must be adjusted according to the change in ambient temperature shown in the table below. Always use temperature compensated charging equipment when charging Crystal Batteries™. The recommended temperature correction factor is -3mV per degree Celsius (from 25°C / 77˚F) per cell. Temperature corrected chargers need to be set up and or changed to this value.

CELL CHARGE VOLTAGE VS. TEMPERATURE CHART

Temperature (˚C)	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70
Temperature (˚F)	-40	-31	-22	-13	-4	5	14	23	32	41	50	59	68	77	86	95	104	113	122	131	140	149	158
Cycle Charge	2.66	2.64	2.62	2.60	2.58	2.56	2.54	2.52	2.50	2.48	2.47	2.47	2.45	2.45	2.43	2.41	2.39	2.37	2.35	2.33	2.31	2.29	2.27
Float Charge	2.46	2.44	2.42	2.42	2.38	2.36	2.34	2.32	2.31	2.30	2.29	2.29	2.29	2.27	2.26	2.24	2.23	2.23	2.23	2.23	2.23	2.23	2.23

Table 2 Battery voltage setting for different temperatures.



Ampowr recommends that temperature sensors be placed on the side in the middle of a battery to best monitor the charging and discharging temperatures. Placing temperature sensors on the terminal can give a false reading as the terminal may get hot under certain discharge loads.

3.5 DISCHARGE CHARACTERISTICS

3.5.1 Battery Capacity

Batteries under certain discharge conditions will release a certain amount of current. The cumulative amount of current released is called the capacity and the most common unit of measure for a battery's capacity is Amp Hours (Ah).

A battery's capacity can be defined in two parts, namely the rated capacity and actual capacity. The actual capacity of the battery under certain discharge conditions is calculated by the current (A) multiplied by the discharge time (h). The resulting unit is Ah. As an example, a 100Ah battery can be discharged all the way down to zero volts and deliver an actual rated capacity of 130 Ah.

Whilst Crystal Batteries™ do have the ability to discharge all the way down to zero volts, a battery's rated capacity is measured over a period of time to a specific depth of discharge. This is when we apply a "C" rating for a battery. For example, a battery may be 100Ah @ C10 which tells us that the battery will deliver 10 Amps for 10 Hours until it reaches 10.5 volts (the international standard for dead flat).

3.5.2 Battery Discharge Rate

The battery discharge rate uses rated hours to determine the discharge time. This time is influenced by the amount of current drawn from the battery. If the discharge current increases, the discharge time will decrease, and also affect the rated capacity.

Hour rated discharge:
C3 = 3 hour rated capacity (Ah)
C10 = 10 hour rated capacity (Ah)
C20 = 20 hour rated capacity (Ah)
C120 = 120 hour rated capacity (Ah)

The "C" rating of a battery tells us a lot about how a battery has been designed to operate. A 100Ah @ C20 battery would discharge 5 amps for 20 hours until the battery was 10.5 volts. This not only tells us the discharge times of the battery but also the types of loads that this battery has been designed for. Note that Ampowr GS & FT range of batteries have a C10 rating which means it can handle higher discharge loads. The EV has an amazing C3 rate which means that it can handle very heavy discharge loads. Ideal for electric motors and heavy load applications.

Whilst Crystal Batteries™ have been used successfully as cranking or starting batteries, Ampowr does not recommend this. Our batteries are simply not designed as a crank battery.

Rate of Discharge

1C = 1 multiplied by the 10-hour rated capacity used for the discharge current (A)
0.10C = 0.1 multiplied by the 10-hour rated capacity used for the discharge current (A)
0.01C = 0.01 multiplied by the 10-hour rated capacity used for the discharge current (A)

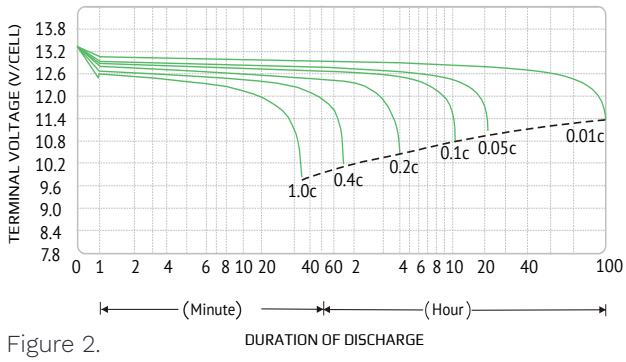


Figure 2.
Generic curve of different discharge rates of Crystal Batteries™ at 25°C (77˚F). For discharge values of a specific battery, model revert to the constant current discharge tables in the models specific datasheets.

3.5.3 Influence of Temperature on Capacity

The discharge characteristics and temperature of batteries are closely related. When the temperature is low, the
discharge capacity of the battery will be reduced. For example, when the temperature is dropped from 25°C (77˚F) to 0°C (32˚F), the capacity of the battery will drop to about 95% of its rated capacity.

As the ambient temperature rises, the battery capacity will increase within a certain range, for example, the battery capacity will rise to about 105% of the rated capacity when the temperature rises from 25°C (77˚F) to 40°C (104˚F), however if the temperature continues to rise, the capacity increase will slow down, and not increase further.

In Figure 3 you will see the effect of temperature on the capacity of the GS, FT, and LS series Crystal Batteries™.

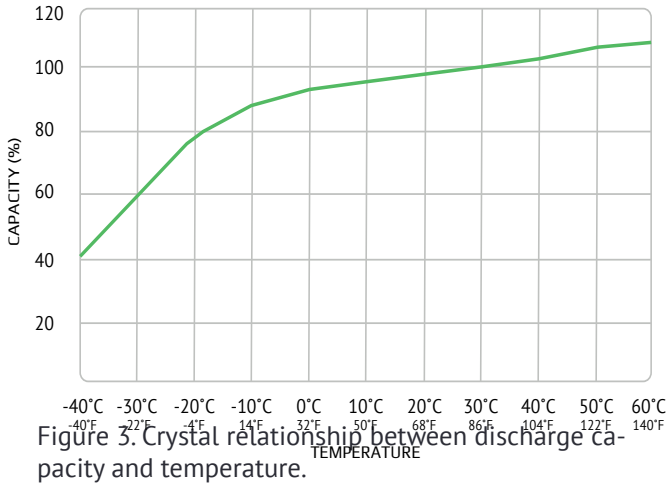


Figure 3. Crystal relationship between discharge capacity and temperature.

3.5.4 Discharge Voltage

The termination voltage refers to the battery voltage dropping during discharge to the minimum working voltage required for operation. The termination voltage and the discharge current are closely related. Generally, during high current discharge, the termination voltage of the battery should be set lower. Please refer to the batteries' data sheet for model-specific information on low voltage disconnect points.

Over discharging below the termination voltage should be avoided since the over discharging could only gain a small amount of additional capacity, but drastically reduce the battery's service life.

DISCHARGE CURRENT (A)	DISCHARGE VOLTAGE (V/P/CELL)
0.05C or less than the discharge gap	1.9
0.05C or similar to this value	1.85
0.1C or similar to this value	1.8
0.2C or similar to this value	1.75
0.2C - 0.5C	1.7
0.5C - 1C	1.6
1C - 3C	1.5
3C	1.3

Table 3 Termination voltage of Crystal Batteries™ when discharged at different current.

4. TRANSPORT, STORAGE AND INSTALLATION

4.1 BATTERY TRANSPORT

Crystal Batteries™ are considered NON-HAZARDOUS normal goods for airfreight and shipping. Crystal Batteries™ are not restricted to IATA Dangerous Goods Regulation (special provision A67) and not restricted to IMO International Maritime Dangerous Goods code (special provision 238). Note: Still requires an IATA certificate before shipping via air or sea freight.

4.2 BATTERY STORAGE

On arrival
All Crystal Batteries™ have been charged prior to shipping to activate the crystallization of the electrolyte in the batteries. Precautions have been taken to pack the battery units, individual cells or cabinets containing batteries for shipment to ensure their safe arrival.

However, upon receipt, you should inspect for evidence of damage that may have occurred during transit. If damage is noted, make a descriptive notation, and file a damage report. If you have any questions concerning potential damages, contact your nearest Ampowr office or an authorized distributor.

Ampowr recommends you perform 3 purification cycles prior to the batteries being put into mission-critical or solar installations.

WARNING: During Inspections take Precautions Against Shock

STORAGE: Crystal Batteries™ should be stored in a clean, well ventilated and dry environment

WARNING: Avoid direct exposure of Crystal Batteries™ to the sun.

WARNING: The optimum storage temperature of Crystal Batteries™ is 15°C to 25°C. The minimum storage temperature is -20°C (-4˚F), the maximum storage temperature is +40°C (104˚F). Storage at higher temperatures will result in accelerated rates of self-discharge and possible deterioration of battery performance and lifetime.

WARNING: The maximum relative humidity for storage of Crystal Batteries™ is 95%.

WARNING: The highest elevation for storage of Crystal Batteries™ is 6000m above sea level

Self-Discharge
The self-discharge characteristics of a battery changes with environmental temperatures, the higher the temperature the higher the self-discharge, so the batteries should not be stored in an environment that is subjected to extremely high-temperature conditions for long durations of time.

Due to the use of our unique Crystal composite electrolyte and alloy grid plate technology, the self-discharge rate of Crystal Batteries™ is significantly reduced. At a constant 25°C (77˚F) environmental temperature Crystal Batteries™ can be kept on a shelf for up to two years without constant top up charging. The batteries will maintain over 80% of their rated capacity after 12 months.

STORAGE CAPACITY 25˚C (77˚F)	3 months storage	95%
	6 months storage	85%
	1 year storage	80%

Table 4 Self-discharge characteristics of Crystal Batteries™.

4.3 BATTERY INSTALLATION

BEFORE INSTALLATION READ THIS SECTION THOROUGHLY. TO ENSURE CORRECT INSTALLATION ACCORDING TO REQUIRED APPLICATION AND EQUIPMENT SETTINGS

Prior to Installation:
Ensure that the batteries remain in the shipping packaging until it arrives on the installation site. After the batteries are unpacked, check for any visible damage to the product. Batteries should be handled with great care during transportation and installation to avoid risk of electrical shock, high voltage, short-circuit and reverse connection. You are dealing with a live battery.

Electrically insulated equipment and clothing should be used when working with or connecting batteries.

DO NOT lift any cell by the terminal posts as this will void the warranty. Always lift the batteries by the supplied handles or from the bottom of the batteries, in the event that the battery is not designed or supplied with the required lifting handles.

WARNING: Please note that the batteries need to be lifted evenly as the handles are not designed to carry the full weight of the battery on a single handle

DO NOT attempt to remove the pressure relief valves or vent covers as this will void the warranty. Attempted removal may also damage the vent and prevent proper functioning of the battery.

When there are multiple batteries connected together in a group (series or parallel), ensure that the voltage of the batteries in the group match prior to connecting.

Before connecting the equipment to the batteries, use a piece of fine grit sandpaper to sand the contact area of the terminal and the connecting lug. This will ensure good contact between battery and lug and reduce the risk of oxidation.

Before connecting the load, charge the batteries to a state of full charge to ensure all the batteries are on the same level.

Batteries should be installed away from direct sunlight, heat sources (1 meter and above), organic solvents, corrosive gas and locations where sparks may occur, such as transformers, power switch and fuses. **At this point it is safe to connect the batteries.**

Installation and Connection

- Wrap metal installation tools (such as wrenches) with insulating tape, to create insulation.
- Ensure that all heating and cooling ducts are directed away from the batteries. The installation site should be kept clean, dry and well ventilated, at all times.
- To prevent a temperature rise of the batteries when used in the equipment, the batteries should preferably be stored at the lowest section of the equipment. In addition, avoid contact between the batteries and with the inner walls of the machine.
- First establish connection between the batteries, then connect the battery pack with a charger or with connections loading.
- Smudgy, oily and loosely connected connections could cause contact problems and lead to faults on the equipment. Ensure that all contacts are clean from oil and grease and that all connections are securely fastened.
- Terminals should be torqued to individual battery specifications, but not exceed 10 N.m. Excessive tightening will cause damage to the thread on or inside the battery terminal. Terminal connections should be checked periodically during the life of the battery to ensure that there are no loose connections.

TERMINAL	TORQUE
M5 (F5)	-2.5Nm
M6 (F3)	3.8 - 5.4Nm
M8 (F4)	7.8 - 9.8Nm

Table 5 Torque Settings of Crystal Batteries™.

- When making parallel connections with multiple batteries, connect the batteries in series first and then in parallel. To ensure good heat distributing conditions, maintain 10mm or more space between batteries; and 35mm and above space between each row and column of battery series;
- Ensure that the batteries are connected in the correct way. Ensure that reverse polarity is eliminated by connecting positive to positive and negative to negative on the equipment. Also ensure that the correct size of wire diameter is used according to current drawn requirement. If incorrect wires are used, it will heat rapidly and cause damage to both the battery and the equipment that it is connected to.
- After connection, coat the battery terminal with anti-rust coating;
- When the battery is installed in place, check that the total voltage measuring system and the positive and negative polarity of the battery is connected correctly. Load charge only when connections are verified.
- To achieve optimum battery life, please use quality automatic current limiting voltage charging equipment that has overvoltage, under voltage, overcurrent protection devices and alert settings. Equipment charge should reach regulation accuracy ± 1%, ripple ≤ 1%, steady flow accuracy ≤ 1%.

5. OPERATIONS AND MAINTENANCE

5.1 BATTERY MAINTENANCE

WARNING: During maintenance take precautions against electrical shock.

WARNING: Crystal Batteries™ contains sulphuric acid (< 3%). Sulphuric acid can be harmful to the skin and eyes. Take precautionary measures as described in this manual.

WARNING: When batteries are discharged, the termination voltage should be set according to the discharging current requirement. The over discharge protection should be set to be ±0.05V lower than the termination voltage to ensure good operation and long life of the batteries and equipment.

After the battery is discharged, it should be immediately be charged again.

WARNING: When abnormalities or damage is noticed, the problem should be investigated immediately. If the battery was the cause it should be replaced immediately to prevent further damage.

WARNING: When charging the battery, the con trollers charge voltage accuracy should be less than ±1% to prolong battery service life.

WARNING: All display instrumentation should be regularly checked and calibrated to ensure accurate reading of measurements. If the equipment can't read an error the equipment could cause damage to the batteries.

The following maintenance process by Crystal Batteries™ series is required.

5.1.1 Quarterly Maintenance

- Keep the battery room clean.
- Measure and record the ambient temperature of the battery room.
- Check the cleanliness, terminal damage and signs of overheating, or signs of damage or overheating on the case and covers of each battery.
- Check if there are any loose connections and tighten according to specification.
- Measure and record float voltage of each battery line. If there are two or more batteries with voltage falling below 2.18V/cell after temperature correction, a purification charge must be conducted to the battery series. See section 3 purification charge Specifications.
- Conduct an actual load discharge test of the battery series at least twice a year and release 70% - 80% of the rated capacity of the battery and record the individual cell voltages with 30 min intervals at C10 loads and 10 min interval with larger loads.
- A purification charge must be conducted to the battery series. See section 3 purification charge specifications.

5.1.2 Annual Maintenance

- Repeat all quarterly maintenance inspections.
- Check for loose connecting screws annually and tighten them if they are loose.
- Conduct an actual load discharge test of the battery series at least twice a year and release 70% - 80% of the rated capacity DOD of the battery.
- A purification charge must be conducted to the battery series. See section 3 purification charge specifications.

6. SAFETY GUIDE

6.1 GENERAL SAFETY

CAUTION: YOU SHOULD BE TRAINED IN HANDLING, INSTALLING, OPERATING AND MAINTAINING BATTERIES BEFORE YOU WORK ON ANY BATTERY SYSTEM.

You must understand the risk of working with batteries and be prepared and equipped to take the necessary safety precaution. If not, contact your nearest Crystal Batteries™ authorized distributor or dealer to clarify any of the noted safety precautions.

6.2 SAFETY EQUIPMENT AND CLOTHING

When working with a Crystal Battery™ system, be sure you have the necessary tools and safety equipment, including but not limited to:

- Insulated tools
- Rubber gloves
- Fire extinguisher
- Rubber apron
- Safety goggles

ALWAYS

- Remove all jewelry (i.e. rings, watches, chains, etc.)
- Keep sparks and flames away from the battery

NEVER

- Lay tools or metallic objects on the battery modules.

Using the correct tools and wearing proper safety equipment will help prevent injury should an accident occur.

6.3 SAFETY PRECAUTIONS

6.3.1 Sulphuric Acid Burns

Crystal Batteries™ are sealed batteries with an electrolyte that solidifies into a non-dangerous white crystalline powder. Although there is no direct acid danger, Crystal Batteries™ do contain <3% sulphuric acid. Since sulphuric acid can cause burns and other serious injuries, below guidelines must be observed.

In case of SKIN CONTACT with sulphuric acid, IMMEDIATELY:

1. REMOVE contaminated CLOTHING
2. FLUSH the area THOROUGHLY with WATER
3. SEEK MEDICAL ATTENTION, if required

In case of eye contact with sulphuric acid, IMMEDIATELY:

1. FLUSH THOROUGHLY for at least 15 minutes with large amounts of WATER
2. SEEK MEDICAL ATTENTION

In case of sulphuric acid contact with clothing or material, IMMEDIATELY:

1. Remove contaminated clothing
2. Apply a solution of sodium bicarbonate solution (0.5kg/ 5.0L 1.0lb/1.0 gal liters of water on the clothing or material
3. Apply the solution until bubbling stops, then rinse with clean water

6.3.2 Explosive Gasses

According to IEC 60896-21/22 Crystal Batteries™ have very low gassing compared to conventional lead-based batteries. Only after extended and severe over-charging gas is observed. For safety purposes below, guidelines must be observed.

Batteries can generate gases, which when released and introduced to a spark sourcecan explode, causing blindness and other serious personal injury. Always wear protective clothing and use the correct safety tools. Eliminate any potential of sparks, flames or arcing.

In case of fire:

To extinguish a fire in a battery room containing Crystal Batteries™, use a CO2, foam or dry-chemical extinguishing medium. Do NOT discharge the extinguisher directly onto the battery. The resulting thermal shock may cause cracking of the battery case/cover.

Special procedures:

If batteries are on charge, shut off power. Use positive-pressure, self-contained breathing apparatus.

Toxic fumes:

Burning plastic may cause toxic fumes. Leave area as soon as possible if toxic fumes are present. Wear breathing apparatus if required to remain in the area.

6.3.3 Electrical Shocks and Burns

Multi-cell battery systems can attain high voltage and/or currents. Do NOT touch uninsulated batteries, connectors or terminals. To prevent serious electrical burns and shock, use EXTREME CAUTION when working with the system.

Always wear protective clothing and use nonconductive or insulated safety tools when working with ANY battery system.

Remove all jewelry that could produce a short circuit. BEFORE working on the system:

1. Disconnect ALL loads and power sources to the battery. Use appropriate lockout/tag out procedures.

2. If working on an assembled battery system, sectionalize (interrupt the battery sections) into safe working voltage levels.

3. Check the battery system grounding. Grounding of the battery system is NOT recommended. However, grounding of the rack is recommended.

IF THE BATTERY SYSTEM IS GROUNDED: (system is intentionally grounded by connecting a battery terminal to ground).

1. An increased shock hazard exists between the terminal of opposite polarity and ground (i.e. dirt and acid accumulated on top of the battery cell touching the rack).

2. If an unintentional ground develops within the already grounded system, a short circuit may occur and cause explosion or fire.

IF BATTERY SYSTEM IS ACCIDENTALY GROUNDED:

1.If an unintentional ground develops within the system, an increased shock hazard exists between the terminal of opposite polarity and ground.

2.If a second unintentional ground develops within the already unintentionally grounded system, a short circuit may occur and cause explosion or fire.

Therefore, should you be required to work on a grounded battery system, please be certain you are using the correct safety precautions, equipment, and clothing.

IMPORTANT If you have any questions concerning safety when working with the battery system, contact your nearest Crystal Batteries™ authorized distributor or dealer to clarify any of the noted safety precautions.

7. TROUBLESHOOTING

Batteries are often blamed first as they are the device that provides the power, however in most cases it is often something else in the charging system that has gone wrong OR the way in which the batteries are being used. Whilst the trouble shooting guide doesn't cover every possible scenario it will be a good starting point to try an eliminate and ultimately determine the root cause. If you don't find your solution here, we encourage you to contact your reseller who can assist you further.

SYMPTOM	POSSIBLE CAUSES	ACTION / REMEDY
Battery gets hot during CHARGE or has swollen the case Note: 5˚C (41˚F) to 10˚C (50˚F) from ambient is normal. If the battery exceeds 20˚C (68˚F) from ambient or exceeds 65˚C (149˚F), then STOP charging. Minor swelling or bowing in the sides of a battery is normal.	- Lose terminals or poor crimps - Shorted cells within the battery - Excessive charge Voltage or Amperage - Cable size or configuration - Physical damage	- Check and clean terminals and all crimps and connections - Check the batteries resting voltage. Each cell is at least 2V. If a cell is shorted the resting voltage will reflect this i.e. a 12 Volt battery with a resting voltage around 10V could indicate a shorted cell. Shorted cells can become heating elements when charging - Check that your charger settings are set according to the charge specifications AND the battery data sheet. - Ensure your chargers timers are working and that the charger progresses through the various stages and ultimately stops charging. - Check that no loads are holding the battery voltage down whilst charging causing the charger to stay in Bulk or Absorption. - Ensure any solar regulators are charging at the correct voltage Note: Solar regulators commonly bypass when they fail putting the full cell voltage on a battery. - Check that the cables between batteries are the correct size AND that each link cable is exactly the same length. Also ensure that the cables (positive & negative) to and from battery chargers, loads or busbars are exactly the same length. Cable imbalance can cause a battery to fail prematurely - Check the battery for any signs of impact. Batteries are heavy and can be damaged in transport. Always check the underside and exterior for damage or impacts.

SYMPTOM	POSSIBLE CAUSES	ACTION / REMEDY
Battery gets hot during CHARGE or has swollen the case **Cont.**	- Excessive Temperature Common in automotive under bonnet DC to DC charging. Extreme heat, high loads i.e. two fridges and long journeys can put batteries under excessive strain. - Temperature compensation	- relocate or cool the batteries. - Is the swelling a result of the charger NOT temperature compensating the charge voltages at higher temperatures.
Battery gets hot during DIS-CHARGE or has swollen the case Note: 5˚C (41˚F) to 10˚C (51˚F) from ambient is normal. If the battery exceeds 20˚C (68˚F) from ambient or exceeds 65˚C (149˚F), then STOP charging. Minor swelling or bowing in the sides of a battery is normal.	- Excessive amperage draw. - Cable sizes and configurations	- Please apply ohms law remembering that a 1000W load at 12V = 83 Amps but at 9 volts it = 111 Amps. Refer to the battery data sheet for discharge specifications. -Please note the C Rating of the battery relevant to the discharge load. Refer to the data sheet for specifications. - Check that the cables between batteries are the correct size AND that each link cable is exactly the same length. Also ensure that the cables (positive & negative) to and from battery chargers, loads or busbars are exactly the same length. Cable imbalance can cause a battery to fail prematurely.
Battery capacity is low and the charger rushes through bulk & absorption stages.	- The batteries may have been undercharged Never assume a charger is delivering the correct charge current. Always measure the actual current and voltage being delivered at the terminal. - Shorted cell	- Check that the charge current and voltages are in accordance with this user manual and the batteries data sheet. Pay particular attention to the charge current requirements of the battery. 0.3C or 30% of the C10 rate for GS,HGS & FT Range 0.2C or 20% pf the C10 rate for the GREV Range. - Perform a purification charge according to the charge specifications. Check the batteries resting voltage. Each cell is at least 2V. If a cell is shorted the resting voltage will reflect this i.e. a 12 volt battery with a resting voltage around 10V could indicate a shorted cell. Shorted cells become heating elements when charging.

SYMPTOM	POSSIBLE CAUSES	ACTION / REMEDY
Battery capacity is low. The battery accepts charge and does not get hot but will not hold more than 80% capacity	- The battery is aging and has lost capacity through the normal process of loss of electrolyte	Perform a purification charge according to the charge specifications. OR Replace the battery.
No or very low terminal voltage	- Undercharged, shorted cell of broken bus bar internally.	- Apply the correct charge to the battery AND observe the battery temperature. IF: 1. The battery takes charge and stays cool – typical undercharged condition - perform 2 or 3 more discharge and charge cycles and then recheck the battery capacity 2. The battery takes charge AND gets hot (more than 5˚C (41˚F) to 15˚C (59˚F) above ambient) – STOP Charging and contact your reseller for further assistance
	- Broken battery post or bus bar from overtightening or physical abuse. Can happen if the battery is carried by the terminals, dropped or impacted. (Common causes of battery failure)	3. No charge acceptance – potentially a broken busbar - Check handling procedures or transport methods - Check if the resin around the battery post is cracked. - Check battery terminal tensions - if the battery does not take charge and/or has a low or NO resting voltage (terminal voltage with no load at least an hour after charge) there is a good chance the bus bar is broken, OR the terminal has been overtightened and torn the post from the busbar.

8. CUSTOMER SERVICE

Ampowr abides to the “endless pursuit of perfect quality and meeting our customer’s demand meticulously” mission to provide our customers with quality services through fast, satisfied pre-sale and after-sales service. We are committed to provide you with the follow
service:

- Our company is committed to a standard 3-year warranty (repair, replacement and return) on product design, manufacturing, material deficiencies caused by quality
problems, and lifelong maintenance within the design life, when the product is used according to its purpose.

- Respond to user complaints within
twenty-four hours and resolve the problem in a timely manner.

- Free technical guidance according to our customer’s requirements.

- Conduct regular training courses in battery use and technical maintenance.

- Establish comprehensive user data files and pay regular visits to customers.

- Please do not dispose used and old batteries casually. Battery disposal should be referred to local certified environmental processing organization or our company.

8.1 CRYSTAL BATTERIES™ AUTHORIZED DISTRIBUTORS AND DEALERS

Should you require installation supervision, service, parts, accessories or maintenance; Crystal Batteries™ has a service organization by means of the authorized distributors and dealer network to assist with your questions. Please call your nearest Crystal Batteries™ authorized distributor for more information.

Please contact us through the following methods in the event of application issues:

AMPOWR B.V.

Boteyken 363
3454 PD Utrecht
The Netherlands

E info@ampowr.com

www.ampowr.com

AMPOWR

AMPOWR B.V.

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W www.ampowr.com