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AlphaCell® HP Series Batteries User Guide

Effective: September 2025



AlphaCell® HP Battery

User Guide

745-680-C5-002, Rev. B

Effective Date: September 2025

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Disclaimer

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

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

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

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Table of Contents

Safety Notes.....	5
Battery Maintenance Guidelines.....	6
Recycling and Disposal Instructions.....	6
Important Storage Practices.....	7
Electrical Safety	7
Chemical Hazards	8
1.0 Introduction.....	9
1.1 Description.....	9
1.2 Operating Conditions	11
1.3 Capacity	11
1.3.1 Ratings	12
2.0 Preparing for Maintenance.....	13
2.1 Required Tools and Equipment.....	13
3.0 Periodic Maintenance Tasks and Schedules	14
3.1 Monthly Remote Status Monitoring	14
4.0 Battery System Float Charging	15
4.1 Alpha Power Supply Charging Profile.....	16
5.0 Troubleshooting	17
6.0 Battery Parameters by Model Number	20
7.0 Battery Maintenance Report.....	21
7.1 Battery Maintenance Report for Return Authorizations	21

Figures

Fig. 0-1, Capacity vs. Storage Time	7
Fig. 1-1, Series String of Batteries	9
Fig. 1-2, Parallel String of Batteries	10
Fig. 1-3, Available Capacity vs. Ambient Temperature	11
Fig. 3-1, Flow Chart for Monthly Remote Status Monitoring	14
Fig. 4-1, Charger Modes	16

Tables

Table 1-1, AlphaCell® HP Battery Ratings	12
Table 5-1, Troubleshooting	17
Table 5-1, Troubleshooting, continued	18
Table 5-1, Troubleshooting, continued	19
Table 5-2, Battery Parameters, Current Models	20

Safety Notes

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

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



WARNING! GENERAL HAZARD

GENERAL HAZARD WARNING provides safety information to PREVENT INJURY OR DEATH to the technician or user.



WARNING! ELECTRICAL HAZARD

ELECTRICAL HAZARD WARNING provides electrical safety information to PREVENT INJURY OR DEATH to the technician or user.



WARNING! FUMES HAZARD

FUMES HAZARD WARNING provides fumes safety information to PREVENT INJURY OR DEATH to the technician or user.



WARNING! FIRE HAZARD

FIRE HAZARD WARNING provides flammability safety information to PREVENT INJURY OR DEATH to the technician or user.

There may be multiple warnings associated with the call out. Example:



WARNING! ELECTRICAL & FIRE HAZARD

This WARNING provides safety information for both Electrical AND Fire Hazards.



CAUTION!

CAUTION provides safety information intended to PREVENT DAMAGE to material or equipment.



NOTICE:

NOTICE provides additional information to help complete a specific task or procedure.

ATTENTION:

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

Battery Maintenance Guidelines



WARNING! ELECTRICAL HAZARD

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

- For optimal performance, inspect batteries every six months for:
 - **Signs of battery cracking, leaking or swelling.** The battery should be replaced immediately by authorized personnel using a battery of the identical type and rating (**match conductance, voltages, and date codes as specified in this document**).
 - **Signs of battery cable damage.** Battery cable should be replaced immediately by authorized personnel using replacement parts specified by vendor.
 - **Loose battery connection hardware.** Refer to documentation for the correct torque and connection hardware for the application.
- Do not attempt to remove the vents (valves) from the AlphaCell® HP battery or add water. This is a safety hazard and voids the warranty.
- Apply NO-OX® corrosion inhibitor on all exposed connections.
- When necessary, clean up any spilled electrolyte in accordance with all federal, state, and local regulations or codes.
- Follow approved storage instructions.
- Always replace batteries with those of an identical type and rating. Never install untested batteries.
- Do not charge batteries in a sealed container. Each individual battery should have at least ½ inch of space between it and all surrounding surfaces to allow for convection cooling.
- All battery compartments must have adequate ventilation to prevent an accumulation of potentially dangerous gas. **Never place batteries in a sealed enclosure.** Extreme caution should be used when maintaining and collecting data on the battery system.

Recycling and Disposal Instructions

- Spent or damaged batteries are considered environmentally unsafe as they contain lead and dilute sulfuric acid. They should not be "thrown away" with common refuse.
- Always recycle used batteries in accordance with federal, state, provincial, and local regulations. The Alpha Group provides recycling services. Call +1 800-863-3930 or contact your local Alpha representative.

Important Storage Practices

During storage please note:

- All lead acid batteries experience self-discharge while in open circuit storage. This causes circuit voltage and capacity to decrease.
- The self-discharge rate is related to ambient temperature. The lower the temperature, the less the discharge. Batteries should be stored in a clean, ventilated, and dry location with an ambient temperature of 32°F to 77°F (0°C to 25°C).
- It is important to track open circuit voltage which is related to the density of the electrolyte. If the open circuit voltage is lower than 12.6VDC or the batteries have been stored beyond the limits shown in **Fig. 0-1**, the batteries should be charged to avoid damage caused by self-discharge.
- All batteries should be fully charged before storage. Record the storage date and next supplemental charge date in a maintenance record and on the battery.
- Upon battery deployment, verify all batteries within each string measure in the range of $\pm 0.3\text{VDC}$ of the string average.



NOTICE:

The product warranty is void if the batteries are not stored and recharged in accordance with these guidelines.

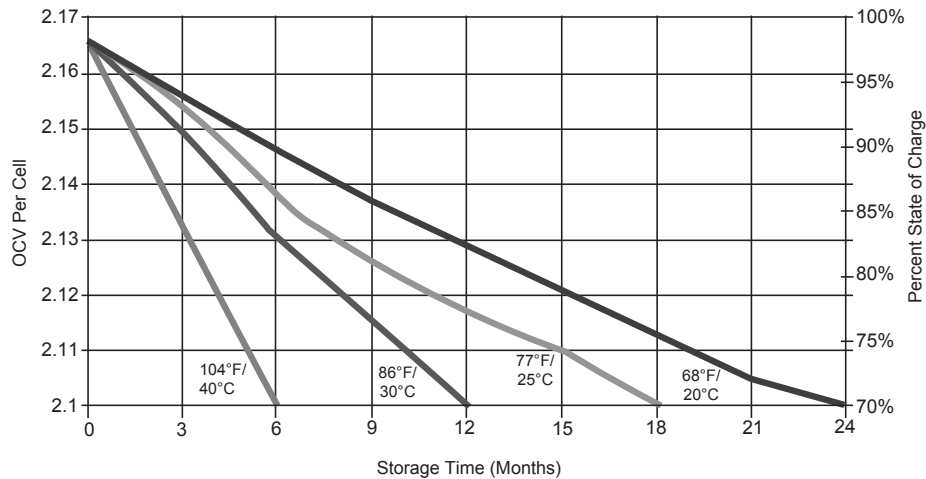


Fig. 0-1, Capacity vs. Storage Time

Electrical Safety

- Lethal voltages are present within the power supply and electrical enclosures. Never assume that an electrical connection or conductor is not energized. Check circuits with a volt meter prior to any installation or removal procedure.
- Observe circuit polarities.
- Always use the buddy system when working under hazardous conditions.
- Ensure no liquids or wet clothes contact internal components.
- Hazardous electrically live parts inside this unit are energized from batteries even when the AC input power is disconnected.
- Use an insulated blanket to cover exposed portions of the battery system when performing extended maintenance that could result in personal or equipment contact with the energized conductors.
- Certain types of rectifier circuits used in charging the battery may not include a line isolating transformer. In these cases extreme caution should be used when maintaining and collecting data on the battery system.

Chemical Hazards

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

To avoid injury:

- Servicing and connection of batteries shall be performed by, or under the direct supervision of, personnel knowledgeable of batteries and the required safety precautions.
- Always wear eye protection, rubber gloves, and a protective vest when working near batteries. To avoid battery contact, remove all metallic objects, (such as rings or watches), from your person.
- Batteries produce explosive gases. Keep all open flames and sparks away from batteries.
- Use tools with insulated handles, do not rest any tools on top of batteries.
- WARNING: Battery posts, terminals and related accessories can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer and birth defects or other reproductive harm. Wash hands after handling. For more information go to www.P65Warnings.ca.gov.
- If any battery emission contacts the skin, wash immediately and thoroughly with water. Follow your company's approved chemical exposure procedures.
- Neutralize any spilled battery emission with the special solution contained in an approved spill kit or with a solution of one pound (454 g) bicarbonate of soda to one gallon (3.8 liters) of water. Report a chemical spill using your company's spill reporting structure and seek medical attention if necessary.
- Always replace batteries with those of an identical type and rating (***match conductance, voltages, and date codes as specified in this document***).
- Never install old or untested batteries.
- Prior to handling the batteries, touch a grounded metal object to dissipate any static charge that may have developed on your body.
- Use special caution when connecting or adjusting battery cabling. An improperly or unconnected battery cable can make contact with an unintended surface that can result in arcing, fire, or a possible explosion.
- A battery showing signs of cracking, leaking, or swelling should be replaced immediately by authorized personnel using a battery of identical type and rating.

Mechanical Safety

- Keep hands and tools clear of fans.
- Fans are thermostatically controlled and will turn on automatically.
- Power supplies can reach extreme temperatures under load.
- Use caution around sheet metal components, especially sharp edges.
- Depending on the model, batteries can weigh anywhere from 25 to 100 pounds (11 kg to 45 kg). Exercise care when handling and moving batteries. Use proper handling equipment.

1.0 Introduction

The purpose of this guide is to provide the user with the necessary information to maintain batteries in storage and deploy batteries in Alpha® powering systems, as well as perform battery testing, install replacements and recycling.

This manual guides you through periodic maintenance checks and troubleshooting of the AlphaCell® HP thin plate pure lead (TPPL) absorbent glass mat (AGM) battery.

Adherence to the procedures and practices detailed in this guide will not only insure the battery operates per specifications, but also provides the proper backup for the Alpha powering system in which it is installed.

To achieve these goals, this guide will address the following topics:

- The storage and maintenance of new battery inventory.
- Deployment of AlphaCell® HP batteries into Alpha® power systems.
- Proper preventive maintenance practices for AlphaCell® HP batteries.
- Replacement and recycling of AlphaCell® HP batteries.
- Warehousing, testing, and redeployment of reusable AlphaCell® HP batteries.
- How to keep proper maintenance records for troubleshooting and/or warranty claims.

1.1 Description

The AlphaCell® HP battery is a lead acid battery that facilitates an oxygen recombination cycle.

A 12V battery is made up of six 2V cells internally connected to provide 12 volts.

The battery system is a group of 12V batteries connected in a series string to provide a higher voltage system.

In **Fig. 1-1**, three of the nominal 12V batteries are connected in series to provide an 18 cell system with a nominal voltage of 36V.

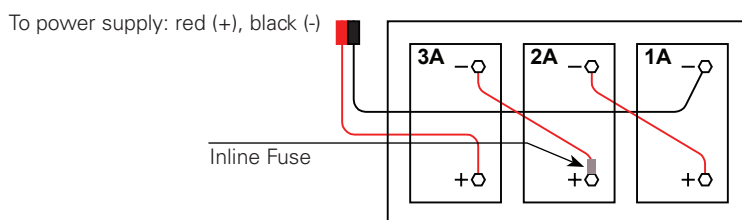


Fig. 1-1, Series String of Batteries

(For illustrative purposes, a 36 volt string is shown. 48 volt strings are also available.)

1.0 Introduction, continued

Multiple strings of batteries may be connected in parallel to create a system whose capacity equals the sum capacity of all the strings. For example in **Fig. 1-2**, two 36V, 90Ah capacity strings are connected in parallel to provide a nominal 36V at 180Ah.



WARNING! ELECTRICAL HAZARD

Alpha® highly recommends fusing in single and parallel string configurations.

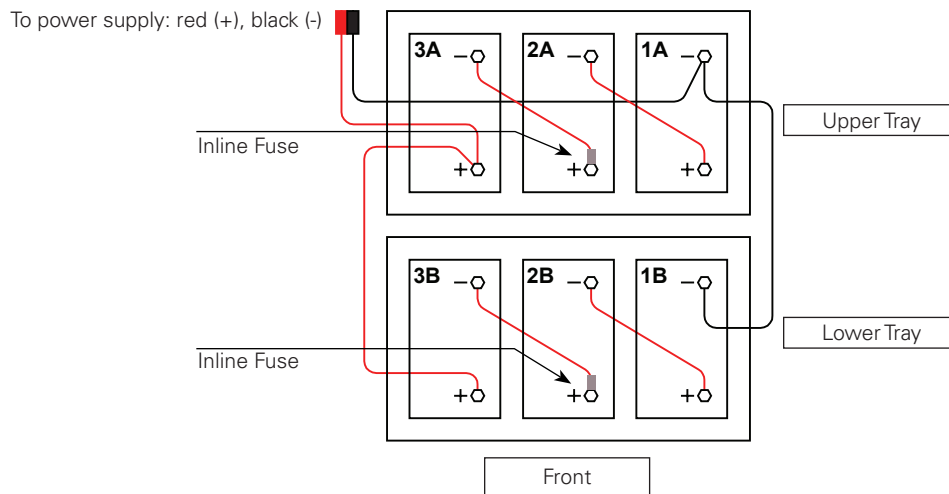


Fig. 1-2, Parallel String of Batteries

1.2 Operating Conditions

AlphaCell® HP batteries, which are valve regulated and virtually sealed, do not give off perceptible amounts of gas under normal operating conditions.

- Acceptable ambient operating temperature: -40°F to 131°F (-40°C to 55°C)
- Ideal ambient operating temperature: 68°F to 77°F (20°C to 25°C)
- Ambient humidity: ≤ 95%

1.3 Capacity

The actual capacity is related to the utilization ratio of the active positive and negative materials within the battery. The utilization ratio is influenced by the depth of discharge, the structure of the battery, and the manufacturing technology. During normal usage, the factors that influence the actual capacity are discharge rate, depth of discharge, end voltage, and temperature.

- The higher the discharge rate, the lower the available capacity.
- As batteries get colder, the available capacity is reduced. This is related to the kinetics of the electrochemical reactions and the resistivity of the electrolyte (see **Fig. 1-3**).

✓ NOTICE:

Although the battery can be operated at temperatures below -4°F (-20°C), the capacity and ability to discharge will be dramatically decreased. Similarly, temperatures approaching 122°F (50°C) will increase electrolyte loss and corrosion of the plates, resulting in a shorter battery life.

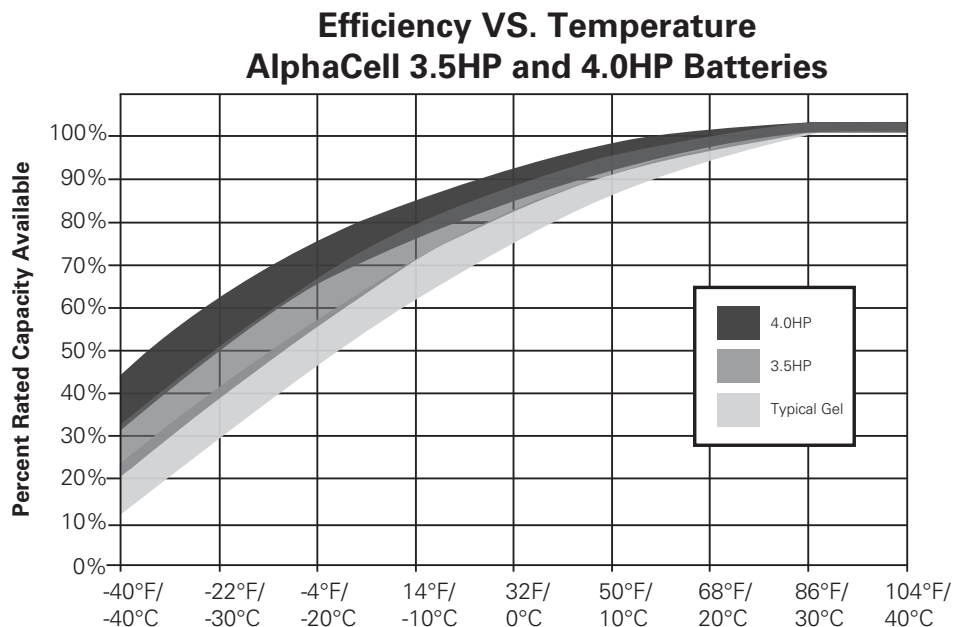


Fig. 1-3, Available Capacity vs. Ambient Temperature

1.3.1 Ratings

AlphaCell® 3.5HP Battery Ratings											
Amps											
End Voltage	15min	30min	45min	1hr	2hr	3hr	4hr	5hr	8hr	10hr	20hr
1.85	162.6	106.4	80.5	65.3	38	27.1	21.2	17.4	11.4	9.3	4.9
1.80	174.7	112.1	84.2	67.9	39.2	27.9	21.8	17.9	11.8	9.6	5.1
1.75	185.6	117.2	87.3	70.2	40.3	28.6	22.3	18.4	12.1	9.9	5.2
1.70	194.9	121.3	89.9	72	41.1	29.2	22.7	18.7	12.3	10	5.3

Power (Watts)											
End Voltage	15min	30min	45min	1hr	2hr	3hr	4hr	5hr	8hr	10hr	20hr
1.85	312.2	206	156.9	127.9	75.4	54.2	42.5	35.1	23.1	18.9	9.9
1.80	331	215.4	163.1	132.4	77.5	55.5	43.5	35.9	23.7	19.4	10.2
1.75	347.6	223.6	168.3	136.2	79.2	56.7	44.4	36.6	24.2	19.8	10.5
1.70	361.7	230.3	172.6	139.2	80.6	57.5	45	37.1	24.5	20.1	10.7

A/H Capacity											
End Voltage	15min	30min	45min	1hr	2hr	3hr	4hr	5hr	8hr	10hr	20hr
1.85	40.7	53.2	60.4	65.3	75.9	81.3	84.7	87.1	91.5	93.4	98.6
1.80	43.7	56.1	63.1	67.9	78.5	83.8	87.2	89.7	94.3	96.2	101.7
1.75	46.4	58.6	65.5	70.2	80.6	85.9	89.3	91.8	96.5	98.6	104.4
1.70	48.7	60.7	67.4	72	82.2	87.5	91	93.5	98.3	100.4	106.6

AlphaCell® 4.0HP Battery Ratings											
Amps											
End Voltage	15min	30min	45min	1hr	2hr	3hr	4hr	5hr	8hr	10hr	20hr
1.85	198.7	128.3	95.9	77	43.7	30.8	24	19.4	12.5	10.1	5.4
1.80	212.8	134.6	99.7	79.7	44.9	31.6	24.5	19.8	12.8	10.4	5.6
1.75	225.2	139.9	102.9	81.9	45.9	32.2	25	20.2	13.1	10.6	5.7
1.70	235.7	144.3	105.5	83.7	46.7	32.8	25.4	20.5	13.3	10.8	5.8

Power (Watts)											
End Voltage	15min	30min	45min	1hr	2hr	3hr	4hr	5hr	8hr	10hr	20hr
1.85	383.9	251.6	189.4	152.7	87.5	61.9	48.2	39	25.3	20.5	11
1.80	406.8	261.8	195.7	157.2	89.6	63.3	49.3	39.9	25.9	21	11.3
1.75	426.7	270.5	200.9	160.9	91.3	64.5	50.1	40.6	26.4	21.3	11.5
1.70	443.1	277.4	205.1	163.8	92.6	65.4	50.8	41.2	26.7	21.6	11.6

A/H Capacity											
End Voltage	15min	30min	45min	1hr	2hr	3hr	4hr	5hr	8hr	10hr	20hr
1.85	49.7	64.2	72	77	87.5	92.5	95.8	96.9	100.3	101.3	108.8
1.80	53.2	67.3	74.8	79.7	89.8	94.8	98.1	99.2	102.7	103.8	111.7
1.75	56.3	70	77.2	81.9	91.8	96.7	100	101.1	104.7	105.9	114
1.70	58.9	72.1	79.1	83.7	93.3	98.2	101.5	102.6	106.3	107.5	115.8

Table 1-1, AlphaCell® HP Battery Ratings

2.0 Preparing for Maintenance

The battery system should be remotely monitored monthly and physically inspected quarterly. If the battery system has an automatic monitoring system to gather the electrical and environmental data, the monthly checks should consist of evaluating the recorded data and visiting any site that does not meet the specifications listed in the detailed procedures below. At a minimum each site needs to be physically inspected every three months.

You do not have to measure the electrolyte specific gravity or add water to the cells.

All batteries in the string should be numbered to facilitate recording and analysis of data unique to each unit.

Notify anyone affected by the intended maintenance or troubleshooting activity. This should include but not be limited to anyone responsible for the status monitoring equipment at the head-end or Network Operations Center (NOC).

2.1 Required Tools and Equipment

Prior to beginning maintenance, ensure that all required tools and equipment, including safety equipment, is available and functional.

The following is a list of the minimum equipment required to maintain and troubleshoot the AlphaCell® HP battery:

- Digital voltmeter
- Socket wrenches, insulated
- Box end wrenches, insulated
- Torque wrench calibrated in inch-lb
- Rubber gloves
- Full face shield
- Safety glasses
- Plastic apron
- Portable eyewash
- Spill kit, including sodium bicarbonate solution
- Fire extinguisher
- Optional equipment, depending on the type of maintenance being performed, includes:
 - AC/DC True-RMS clamp meter
 - Midtronics® conductance meter
 - 100 amp momentary load test set
 - System load bank (DC if to be performed at the battery and AC if to be performed by loading a power supply output— contact your Alpha Sales Representative for purchasing information).
 - NO-OX® corrosion inhibitor or other electrical contact paste
 - Paper Towels and/or rags

3.0 Periodic Maintenance Tasks and Schedules

The following tasks are to be performed on a monthly and quarterly schedule.

The following maintenance procedure requires a fully functional status monitoring system capable of remotely measuring and recording the following data on a periodic basis:

- Battery Temperature
- Individual Battery Voltage
- Total Battery String Voltage

Please note: If status monitoring is not available these checks need to be made during the quarterly on-site visit and any batteries not meeting the minimum requirement must be addressed at such time.

3.1 Monthly Remote Status Monitoring

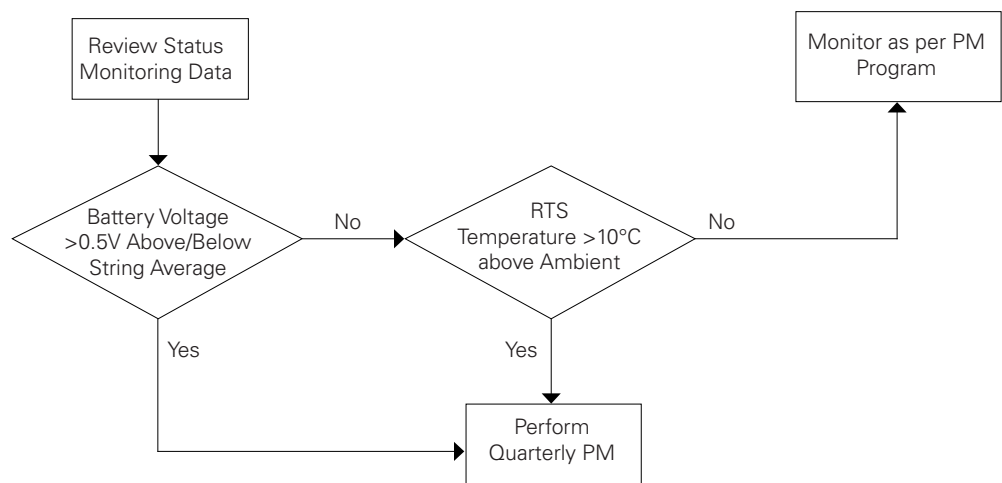


Fig. 3-1, Flow Chart for Monthly Remote Status Monitoring

Procedure

1. If any individual battery voltage varies more than 0.5V above or below the average for the string then a site visit is required.

Example: V1 = 13V, V2 = 13V, V3=14V
Average voltage = 13.3V
If V3 greater than average by 0.5V, then a site visit is required.

2. If the RTS temperature is greater than 10 degrees Celsius above the current regional ambient temperature then a site visit is required.
3. Prioritize site visits based on highest RTS temperatures and battery voltages.
4. Visit the site within 30 days and remedy the problem by replacing the bad battery or batteries and reset quarterly maintenance.

4.0 Battery System Float Charging

Battery System Float Charging Voltage

Encountering temperature extremes

In the instance of temperature extremes, temperature compensates the float charging voltage. The temperature compensation coefficient is -0.0022 V/C per °F (-0.004 V/C per °C).

For example, if the normal battery temperature is 90°F (13° above 77°F) you should reduce the average float charging voltage range by 0.028 V/C (13°F × -0.0022 V/C per °F) to 2.22 V/C.

If the battery operates at cold temperatures, (60°F, 17° below 77°F, for example), you can increase the charging voltage to improve recharging time.

For example, increase the charging voltage range by -17° × -0.0022 V/C per degree or 0.037 V/C.

Under or overcharging

If the battery is undercharged for a period of time during which there are multiple discharges, the battery does not fully recharge after each discharge and provides progressively lower capacity.

Excessive overcharging causes premature aging of the battery and loss of capacity, noted by excessive float current, corrosion of the plate grids, and gassing and drying of the limited amount of electrolyte.

Severe overcharging over extended periods of time can induce a thermal runaway condition. This requires replacing the battery system.



NOTICE:

The following set points are recommended for AlphaCell® HP batteries when used with the Alpha® XM series 2 or GMX power supply.

AlphaCell® HP Batteries*	
Accept	2.35 V/C
Float	2.25 V/C
Temp Comp	-4mV/C/C

* See: **Section 4.1 Alpha Power Supply Charging Profile on page 16**

4.1 Alpha Power Supply Charging Profile



NOTICE:

The following information specifically pertains to Alpha® XM series 2 and HP power supplies.

BULK charge is a “Constant Current” charge. This current is the maximum the charger is capable of delivering: 10A for 615, 906/915/915HV, and 922/922HV. As the charge is returned to the batteries, their voltage increases to a specific threshold (2.27VDC per cell). The BULK charger mode generally returns the battery charge state to 80 percent of rated battery capacity. Bulk mode is not temperature compensated. The charger then automatically switches to ACCEPT mode.

ACCEPT charge is a “Constant Voltage” charge. This voltage, 2.2 to 2.45VDC per cell, is manually adjustable if needed and temperature-compensated to ensure longer battery life and proper completion of the charge cycle.

This cycle is complete when the charging current into the batteries becomes less than 0.5A, or approximately six hours elapses from the time ACCEPT mode was entered. When the batteries are fully recharged the charger switches to the FLOAT mode of operation.

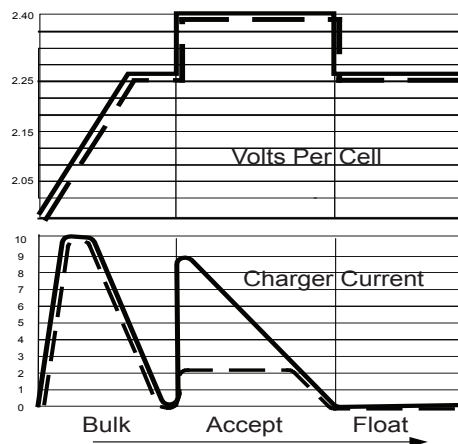
FLOAT charge is a temperature-compensated charge, averaging about 2.1 to 2.35VDC (adjustable) per cell. During FLOAT mode, the batteries are fully charged and ready to provide backup power.

During ACCEPT and FLOAT modes, the cell voltage is temperature-compensated at -0.004VDC per cell per degree Celsius (adjustable) to ensure a safe battery cell voltage and to maximize battery life.

For AlphaCell® HP batteries, the recommended battery system float charge voltage is equal to the number of cells in the system multiplied by the range of 2.1 to 2.35 volts per cell at 77°F (25°C).

For example, float charge a string of 3 each 12 volt (6 cell) batteries within a range of 37.8 to 42.3VDC (18 cells × 2.1 V/C minimum and 18 × 2.35 V/C maximum) at 77°F (25°C).

Severe overcharging over extended periods of time can induce a thermal runaway condition. This requires replacing the battery system.



(Dashed line indicates HV models.)

Fig. 4-1, Charger Modes

5.0 Troubleshooting

Problem	Symptom	Possible Causes	Possible Result	Corrective Actions
Capacity Test Results	Reduced operating time at 77°F (25°C) with smooth voltage decline	Normal life cycle	Eventual failure to support the load followed by potential for shorted cells	Replace battery system when at 70% of rated capacity or before
	Reduced operating time at 77°F (25°C) with steep voltage decline or voltage plateaus	Individual low capacity cells	Reversed cells during discharge Reversed cells will become very hot and will not fully recharge	Replace the isolated low capacity batteries
	Excessive initial voltage drop even to the point of dropping load in the first several seconds	<ul style="list-style-type: none"> Battery is extremely cold Cabling is too small gauge High resistance connections Battery is undersized Shorted cells 	<ul style="list-style-type: none"> Excessive voltage drop Cells will become hot, could develop thermal runaway; internal arcing could result in an explosion 	<ul style="list-style-type: none"> Heat the battery Run parallel cables or increase gauge of cables Clean and reassemble connections Add required parallel strings Replace isolated units with shorts and evaluate entire string
Visual Battery Checks	Cover or container crack	Handling or impact damage	Cell dry-out or ground fault. Potential internal gas ignition	Replace damaged unit
	Cover or container explosion	Ignition of cell internal gasses due to external source, fusing, or internal conductive path or internal spark due to shorting Potential exists for ill-maintained batteries or those left in service beyond useful life	<ul style="list-style-type: none"> Personal injury and equipment damage at time of explosion Failure to support load 	Replace damaged unit and evaluate balance of string
	Burned area on container	<ul style="list-style-type: none"> Crack in container leaking electrolyte to grounded rack Ground fault 	Could result in: <ul style="list-style-type: none"> Personal hazard due to conductive path to rack Smoke or battery fire Thermal runaway 	Clear the ground fault and replace defective unit; evaluate balance of string
	Permanently deformed (swollen) container	Thermal runaway possibly caused by high temp., environment, overcharging, excessively high recharge current, shorted cells, ground fault, or a combination	Could result in the emission of hydrogen sulfide, detectable as a rotten egg odor, battery fire, and inability to support the load	Replace the battery system and correct the items leading to the thermal runaway condition
	Rotten egg odor	Possible caused by high temperature environment, overcharging, excessively high recharge current, shorted cells, ground fault, or a combination of these.	Odor is a product of thermal runaway	Replace the battery system and correct items leading to thermal runaway condition
	Melted grease at terminals	Hot connections due to excessive resistance caused by loose connections, dirty contact surfaces or corrosion within connection	<ul style="list-style-type: none"> Excessive voltage drop perhaps leading to short operating time or damaged terminals In extreme case could lead to melted terminal and ignition of the battery cover 	<ul style="list-style-type: none"> Clean and reassemble connection if damaged Replace batteries with damaged terminals
	Corrosion at terminals	Possibly electrolyte leaking from battery terminal seal attacking the inter-unit container	Increased connection resistance and resulting increase in the connection heating and voltage drop at high rate discharge.	Disassemble connection, clean, coat connecting surfaces and terminal area, seal with anti-oxidation grease, reassemble the connection; if leakage about terminal area is obvious, the battery should be replaced

Table 5-1, Troubleshooting

5.0 Troubleshooting, continued

Problem	Symptom	Possible Causes	Possible Result	Corrective Actions
DC Voltage Checks	System float voltage > 2.3V/C average 77°F (25°C)	Charger output set incorrectly	Overcharging causes excessive gassing and drying out of electrolyte and contributes to potential thermal runaway	Reset the charger output voltage to recommended value
	System float voltage < 2.25V/C average 77°F (25°C)	Charger output set incorrectly	<ul style="list-style-type: none"> Undercharging results in gradual loss of operating time and capacity with successive discharge cycles. If persistent, an irreversible level of lead sulfate develops on the plates resulting in a permanent capacity loss 	<ul style="list-style-type: none"> Reset the charger output voltage to recommended value. Equalize battery system from 48 to 72 hours and perform capacity test. If capacity loss is permanent, replace the total battery system
	Individual battery float voltage > 13.3 VDC	<ul style="list-style-type: none"> Potentially the individual battery has shorted cell Verify with impedance or conductance check 	<ul style="list-style-type: none"> Reduced operating time under load Increased float current Heating of cell during discharge Contributes to potential thermal runaway 	Replace individual battery
	Individual battery float voltage 14.5 VDC for 6 cell	Potentially open cells in individual battery; confirm by checking for zero float current or check for very high impedance of the battery	<ul style="list-style-type: none"> Failure to support load Could result in an internal arc Could ignite gasses within the cell 	Replace individual battery
	DC voltage measured between battery system output terminals and ground (rack) or a ground fault indicated by automatic monitoring equipment	Damaged container allowing electrolyte to wick out to grounded surface (rack)	<ul style="list-style-type: none"> Personnel shock hazard resulting in serious injury or electrocution Potential burning of container at damaged area or battery fire 	Determine the source of ground fault and replace battery
Temperature Checks	Elevated room temperature	Lack of adequate air conditioning or ventilation	Reduced battery life	Cool room or accept reduced battery life
	Elevated battery temperature	<ul style="list-style-type: none"> Elevated room temp. Inadequate cabinet ventilation Discharge/charge cycle 	<ul style="list-style-type: none"> Reduced battery life Reduced life and potential thermal runaway Normal if not exceeding 18°F increase 	<ul style="list-style-type: none"> Improve room air conditioning Improve cabinet ventilation Limit recharge current
	High current recharge	<ul style="list-style-type: none"> High charging voltage Shorted cells 	Normal if not exceeding 18°F/10°C increase over ambient	<ul style="list-style-type: none"> Limit recharge current Reduce within specifications Replace shorted cells and evaluate total string

Table 5-1, Troubleshooting, continued

5.0 Troubleshooting, continued

Type	Symptom	Possible Cause	Possible Result	Corrective Actions
Float Charging Current Checks	Float current to string is zero	A battery or connection in series string is open. Verify via the float voltage check or AC ripple voltage or impedance check of individual batteries	<ul style="list-style-type: none"> Failure to support load; if an internal arc occurs during discharge, it can ignite gasses internal to cell If there is an open/loose connection in external conductive path, can damage termination under load 	Replace battery with open cell or repair open/loose external connection
	Float current exceeds 3.0 milliamperes per ampere hour of rated capacity at 77°F (25°C) at float voltage	<ul style="list-style-type: none"> Batteries not fully recharged. Batteries above 77°F (25°C) Potentially shorted cells in battery Depending on degree, battery entering or in thermal runaway 	<ul style="list-style-type: none"> Not at 100% capacity Conductive to thermal runaway Thermal runaway results in eventual meltdown of battery and potential of hydrogen sulfide emissions and fire 	Determine specific cause; take corrective action
High Rate 10 Second Load Test	Terminal voltage marginally below minimum voltage specified for 10 second point.	Battery perhaps not fully charged or is older, in service battery and has somewhat lower capacity	Perhaps reduced operating time	Fully recharge battery
	Terminal voltage significantly below minimum voltage specified for 10 second point	<ul style="list-style-type: none"> Battery discharged of battery conductive path, plate grid, or active material or electrolyte volume deterioration Shorted Open cells 	<ul style="list-style-type: none"> Reduced operating time. Conductive to thermal runaway Will not support load 	Charge, retest battery or replace as required
Battery Impedance/ Conductance Test	Impedance / resistance increase by 50% from original values or conductance decline to 50% of the value when new	<ul style="list-style-type: none"> Battery discharged or battery conductive path, plate grid or active material, or electrolyte volume deterioration Shorted cells Open cells 	<ul style="list-style-type: none"> Reduced operating time Conductive to thermal runaway Will not support load 	Charge and retest battery or replace as required
Connection Hardware Resistance / Tightness Check	Connection resistance increase 20% or more from original value	<ul style="list-style-type: none"> Repetitive cycles results in heating and cooling of connection, resulting in relaxation of torque, increase in connection resistance. Contamination within the connection results in corrosion and high terminal resistance 	<ul style="list-style-type: none"> Loose connections result in heat damaged or melted terminals during high rate discharge. Excessive voltage drop during high rate discharge and resulting reduced operating time 	<ul style="list-style-type: none"> Re-torque connection as required Correct source of contamination, clean contact surface areas, grease contact surfaces with anti-oxidant grease, reassemble
	Connection hardware tightness is less than the specified "re-torque" value	Repetitive cycles results in heating and cooling of connection resulting in relaxation of torque and increase in connection resistance	Loose connections result in heat damaged or melted terminals during high rate discharge	Re-torque the connection as required
AC Ripple Voltage Checks	AC ripple (p-p) voltage on system <4% of the value of the DC float voltage	Poor filtering of charger output	Excessive AC ripple could cause the battery to cycle at the ripple frequency and result in heating and deterioration of the plate active material	Improve the charger output filtering
	Individual battery in string exhibits AC ripple voltage twice that of other typical batteries in string	Battery with high AC ripple voltage has proportionately higher impedance; evaluate for performance; subject battery could have deteriorating conductive path or dry, shorted or open cell	<ul style="list-style-type: none"> Reduced operating time. Potential conditions could be conducive to thermal runaway 	Verify battery condition; replace as required

Table 5-1, Troubleshooting, continued

6.0 Battery Parameters by Model Number

Parameter	Model Number	
	3.5 HP	4.0 HP
Terminal Type	Threaded Insert	Threaded Insert
Bolt Size	1/4"-20 UNC Bolt	1/4"-20 UNC Bolt
Annual Re-torque Inch-Pounds / Nm	110 in-lb / 12.4 Nm	110 in-lb / 12.4 Nm
Open Circuit Voltage	12.80	12.80
Average Float Voltage Range (volts/unit)	12.6 to 14.1	12.6 to 14.1
Typical Impedance @ 60Hz ohms	2.7	2.2
Typical Conductance 7Hz mohms	1400 to 1850	1700 to 2500

Table 5-2, Battery Parameters, Current Models

7.1 Battery Maintenance Report for Return Authorizations

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[illegible][illegible]



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745-680-C5-002, Rev. B (09/2025)