

Using the Battery Management System

Capabilities of the System

The Broadband Battery Management System (BMS) does the following:

- Monitors each battery in the system and optimizes the state of its charge.
- Identifies failing or failed batteries so that you can replace them before they cause damage to other batteries in the same string.
- Extends battery life and ensures that batteries are able to supply back-up power on demand.
- Integrates new replacement batteries with older existing batteries.
- Communicates with an APC Total System Power (TSP™) unit.
- Communicates with a transponder through the HMS-022 port.
- Connects up to eight Battery Management Systems and HMS-compatible devices.

Capacity

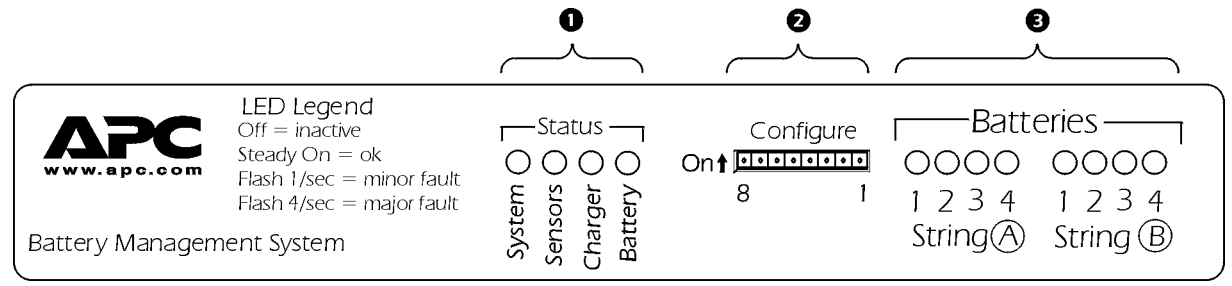
You can use a Broadband Battery Management System to manage one or two strings of three or four batteries each. The batteries must be six-cell batteries that have a nominal voltage of 12 VDC. The system can manage batteries of the same type and capacity that are manufactured by different vendors and show different voltages during charging.

Sensors

The Battery Management System monitors electrical current and ambient temperature through current and temperature sensors (probes).

- Each current probe measures the charge and discharge current of its battery string. The Battery Management System uses this measurement to assess the performance of individual batteries and to determine when the batteries are discharging. APC Field Service personnel can use the information about the current of the battery string for diagnostic purposes.
- The ambient temperature probe measures the temperature of the air inside the battery cabinet.
- The system uses the ambient temperature and proprietary algorithms to derive the internal battery temperature.

Front panel



1	Status LEDs
2	Configuration DIP switches
3	Battery LEDs

Adding or Removing Components

Adding or Removing a Battery String

Disconnect power to the system



When adding or removing a battery string, first disconnect power to the **Battery Management System** by unplugging the power input cable to avoid causing sparks that could cause a battery to explode.

Connect the new battery string



See also

See the Battery Management System *Installation and Quick-start Manual* (990-1244), which came with your system, for battery string connection instructions. It is also available on the APC Web site (www.apc.com).



Note

The Battery Management System detects the new battery string automatically. Verify that the polarities of the two strings match. If they do not, the Battery Management System will not be able to detect the second string.

Set the DIP switches

After disconnecting the input power, reset the DIP switches to configure the change in your system.



Note

The DIP Switches must be set to one of the following valid configurations. If the DIP switches are set incorrectly, your Battery Management System may not operate properly.

Condition	Switch Number							
	8	7	6	5	4	3	2	1
Gel Batteries*								Off
AGM Batteries								On
Four Batteries per string *							Off	
Three Batteries per string							On	
10 Volt Battery Sense for TSP*						Off		
10.5 Volt Battery Sense for TSP						On		
Not Used*					Off			
Not Used					On			
Size 100 Batteries*				Off				
Size 120 Batteries				On				
System Address # 1*	Off	Off	Off					
System Address # 2	Off	Off	On					
System Address # 3	Off	On	Off					
System Address # 4	Off	On	On					
System Address # 5	On	Off	Off					
System Address # 6	On	Off	On					
System Address # 7	On	On	Off					
System Address # 8	On	On	On					
*Default Setting								

Install a current sensor

If you add a second battery string to a system that had only one string, you must install a second current sensor. The system needs one sensor per string to measure the current throughout the string.

1. Set the DIP switches on the new current sensor to identify its location correctly (the battery string it is monitoring).
2. Plug the ambient temperature sensor into the unused port on the current sensor to be located at the warmest area of the enclosure. Connect the two current sensors to each other with the supplied cable.
3. Use the remaining cable to connect the sensor string to the sensor port at the back of the Battery Management System. Unless at least one current sensor is connected to the sensor port, neither current sensor will be able to report information. If a current or temperature sensor is not functioning, always check this connection first.
4. Calibrate the new current sensor.



See also

See the *Installation and Quick-Start Manual* for detailed instructions on calibrating the current sensors.

5. Install the current sensor in the new string, ensuring that the current sensor is oriented correctly with a load-carrying conductor passing through it.



See also

For detailed instructions on how to install temperature and current sensors and to set the DIP switches correctly, see the *Installation and Quick-Start Manual*.

Restart the Battery Management System

After adding or removing a battery string, restart the Battery Management System by reconnecting the power input cable that you disconnected. At start-up, the Battery Management System integrates any new battery string and resets each battery's "current acceptance" (response) benchmark.



Note

The Battery Management System will not restart unless it detects 24 VDC through the CAN connection (TSP) or the HMS RS-485 connection.



Note

After the system restarts, check the **Batteries** LEDs. If the LED for each battery in the system is illuminated, you connected the batteries and set the battery DIP switches correctly. Once the start-up LED check and battery string discovery are complete, if any configured battery's LED turns off, recheck the connections and fuses for the associated battery.



See the [Troubleshooting](#) section for additional help.

Troubleshooting

LED Definitions

The twelve LEDs on the front panel of the Battery Management System indicate the status of the system. The Battery Management System does not require a computer to operate. The system notifies you of battery conditions and any system alarms through a set of LEDs and alarm relays.



See [LED states](#), and [Interpreting alarms](#).

As a test, all LEDs turn on for 3 seconds when the system starts up.



Note

Observe this test carefully at start-up. An LED could be off because it has failed rather than for the reasons cited in the following table.

LED states

The state of each LED indicates the following:

LED Action	Meaning
On	Function is active and normal
Flashing once per second (Slow)	Function has a Minor Fault
Flashing 4 times per second (Fast)	Function has a Major fault
Off	Function is inactive because of either a failure to detect it or non-configured batteries

Alarm indicators

Refer to the following table to determine the status of your system and follow the link for each event for more information.

Event	Status LEDs [‡]				Alarm Relays		Battery LEDs
	System	Sensor	Charger	Battery	Major	Minor	
Loss of System Power	Off	Off	Off	Off	Open	Open	All Off
Loss of Communication	Off	N/A	N/A	N/A	N/A	Closed	N/A
Normal Operation	On	On	On	On	Open	Open	Active batteries On
String Polarity Mismatch	On	On	On	On	Open	Open	All String B Off
Discharge or Charger Inactive	On	On	Off	On	N/A	Closed	N/A
Charger Voltage Low†	On	On	Slow	On	N/A	Closed	N/A
Charger Voltage High	On	On	Fast	On	N/A	Closed	N/A
Minor Battery Fault	On	On	N/A	Slow	N/A	Closed	Affected battery flashing slow
Major Battery Fault	On	On	N/A	Fast	Closed	N/A	Affected battery flashing fast
Sensor Address Fault	Slow	Off	Off	Off	N/A	Closed	N/A
N/A — LED or Relay not affected; see other criteria for indications.							
† A blown fuse or other open circuit in the battery string connectors may cause a Charger Voltage Low alarm.							
‡ LEDs: Fast = 4 Flashes per second. Slow = 1 Flash per second. If two states apply to an LED (both a major and a minor alarm occur) then highest priority state takes precedence, in order: Fast, Slow, Off.							

Event	Status LEDs [‡]				Alarm Relays		Battery LEDs
	System	Sensor	Charger	Battery	Major	Minor	
Battery String A Missing	Slow	On	Off	Off	N/A	Closed	All Off
Blown Fuse or Open Circuit on Battery String Connector	Slow	On	On/Slow [†]	On	N/A	Closed	Affected batteries Off
Sensor calibration	Slow	Slow	Slow	Slow	Open	Open	Affected strings flashing slow
Lowest Battery <= LVCO +0.5 V	Fast	N/A	Off	N/A	Closed	N/A	N/A
Blown Fuse or Open Circuit on Battery String Connector	Slow	N/A	Off	N/A	N/A	Closed	N/A
Standby Not Available	Fast	N/A	N/A	N/A	Closed	N/A	N/A
N/A — LED or Relay not affected; see other criteria for indications.							
† A blown fuse or other open circuit in the battery string connectors may cause a Charger Voltage Low alarm.							
‡ LEDs: Fast = 4 Flashes per second. Slow = 1 Flash per second. If two states apply to an LED (both a major and a minor alarm occur) then highest priority state takes precedence, in order: Fast, Slow, Off.							

Interpreting alarms

The Battery Management System can generate Major or Minor alarms.

- A *Major alarm* requires **immediate** action to ensure that the batteries are able to provide back-up power.
- A *Minor alarm* indicates a condition that is not likely to result in the batteries being unable to provide back-up power but could develop into a major alarm or could prevent the detection of a major alarm.

Each alarm type will close an associated normally-open alarm relay. The alarm relays can be connected to a device that monitors normally-open and normally-closed sensors.

Loss of System Power. The Battery Management System is not powered.

Possible Causes	Corrective Action
Power leads are connected to the wrong battery terminals	Switch each power lead to the opposite terminal of the battery string.
Power leads are not connected to a power source	Connect the Battery Management System to a power source.
Blown power lead fuse	<ul style="list-style-type: none">• Check the battery wire harness for pinched or frayed wires.• Replace the fuse. Monitor the Battery Management System for more blown power lead fuses. Blown fuses can be a sign of an internal problem with the Battery Management System.

Loss of Communication. The Battery Management System has lost communication with the TSP unit or the HMS device.

Possible Causes	Corrective Action
Communication cable not properly connected	Check the communication cable connections.
TSP or HMS device not operating properly	Check the TSP or connected HMS (RS-485) device.

String Polarity Mismatch. The second battery string's polarity is reversed from the polarity of the first battery string. The Battery Management System will not detect the second string if its polarity is reversed.

Possible Causes	Corrective Action
Second battery string's polarity does not match the first string's polarity	Reverse the order of the battery leads connected to one of the battery strings.

Sensor Input Fault. Minor Alarm. The number of sensors the BMS detects does not match the number of battery strings.

Possible Causes	Corrective Action
Current sensor is not installed on each battery string.	Install a current sensor for each battery string connected to the Battery Management System.
Ambient temperature sensor missing	Install an ambient temperature sensor in the open port on one of the current sensors.
Sensors not connected properly	Check current and ambient temperature sensor connections.

Discharge or Charger Inactive. Minor Alarm. The BMS detects 5 amps of continuous discharge current on either battery string for more than 5 seconds.

Possible Causes	Corrective Action
Loss of AC to power supply	Restore AC input before batteries are exhausted.
Power supply overloaded	<ul style="list-style-type: none"> • Check for short circuits on load. • Remove excess load on system.
Current sensor entered calibration mode during a battery charge	Re-calibrate each current sensor by performing calibration with no current flowing.
Current sensor installation reversed	If a discharge is indicated while the batteries are charging, verify orientation of the current sensor and reverse the orientation if the sensor is not installed correctly.

Charger Voltage Low. Minor Alarm. After a discharge or application of power, the Charger Voltage Low alarm condition is ignored for 60 minutes. After the 60-minute delay, the Charger Voltage Low alarm occurs if the string voltage value (the sum of all battery voltages in the string) is below the string voltage limits.

Possible Causes	Corrective Action
Power supply charger setting too low or charger temperature compensating circuit failed	<ul style="list-style-type: none"> • Check charging system. • Reset charger voltage or repair if required.
Incorrect temperature compensation selected	Verify that the configured temperature compensation method (ambient or battery) matches the power supply's compensation method.

Charger Voltage High. Minor Alarm. After a discharge or application of power, the Charger Voltage High alarm condition is ignored for 60 minutes. After the 60-minute delay, the Charger Voltage High alarm occurs if the string voltage value (the sum of all battery voltages in the string) is above the string voltage limits.

Possible Causes	Corrective Action
Power supply charger setting too high or charger temperature compensating circuit failed	<ul style="list-style-type: none"> • Check charging system. • Reset charger voltage or repair charger if required.
Incorrect temperature compensation selected	Verify that the configured temperature compensation method (ambient or battery) matches the power supply's compensation method.

Minor Battery Fault. A Minor battery alarm is an unfavorable condition that usually does not result in the loss of the critical load but could develop into a major alarm or would prevent the detection of a major alarm condition.

Possible Causes	Corrective Action
Blown fuse	Replace the blown battery lead fuse.
Open circuit in the battery wiring harness	Check the battery wiring harness connections.
Short circuit in the battery wiring harness	Check the battery wiring harness connections.

Major Battery Fault. Major battery alarms require immediate corrective action. They can result in the loss of the critical load during emergency battery operation.

Possible Causes	Corrective Action
Shorted cell	Replace affected battery.
Thermal runaway	Replace affected battery.
Dryout/sulfation/opens	Replace affected battery.
Very low capacity	Replace affected battery.

Sensor Address Fault. A current sensor is incorrectly addressed. The Battery Management System cannot gather data from the sensor if its address is incorrect.

Possible Causes	Corrective Action
Current sensors not correctly addressed.	Check DIP switch settings for each current sensor. String A's sensor should have DIP switch #1 set to On (all others Off), and String B's sensor should have DIP switch #2 set to On (all others Off).

Battery String A Missing. Minor Alarm. At start-up, the Battery Management System twice attempts to detect the polarity of Battery String A. If both attempts fail, the Battery Management System generates a **Battery String A missing** fault.

Possible Causes	Corrective Action
Single battery string is connected to the String B input	If you are using only one battery string, connect the battery string to the String A connector.
Blown battery lead fuse on String A, Battery #1	Replace the blown battery lead fuse.

Blown Fuse or Open Circuit on Battery String Connector. Minor Alarm. The Battery Management System detects an individual battery voltage of less than 3 VDC.

Possible Cause	Corrective Action
Blown battery lead fuse	Replace the blown battery lead fuse.
Open circuit in the battery wiring harness	Check the battery wiring harness connections.

Sensor calibration. The Battery Management System is in sensor calibration mode. You can set this mode by setting DIP switch #4 (on each sensor) to **On**. The Battery Management System will then obtain a new zero value. The LEDs will flash at a rate of once per second while the Battery Management System is in this mode. After five flashes, the sensor is calibrated.



Caution

Do not perform sensor calibration while there is current flowing through the sensor. Remove the sensor from the battery cable before performing a sensor calibration.

Possible Causes	Corrective Action
The Battery Management System is in sensor calibration mode.	Set the current sensor's DIP switch number four to Off .



See also

See the *Installation and Quick-Start Manual* for instructions on how to calibrate the sensors.

Lowest Battery \leq LVCO + 0.5 V. Major Alarm.

Possible Causes	Corrective Action
Batteries drained to near the low voltage cut off threshold and are nearing automatic shutdown.	Apply alternate utility power (such as a portable generator) to the TSP to prevent loss of power to the load.

AC Line Fail, Inverter On. Minor Alarm.

Possible Causes	Corrective Action
Utility power to the TSP has failed or is out of tolerance	Measure AC voltage and frequency to the TSP. Consult the TSP user manual for information on how to check utility power as measured by the unit.
Utility power removed from the TSP	Check connection.

Product Information

Specifications

Electrical

Item	Specification
Operating voltage range	22 – 54 VDC
Monitoring current	1.6 A
Maximum (Boost) current	3.5 A
Monitoring power	37 W
Maximum (Boost) power	75 W

Physical

Item	Specification
Dimensions (H × W × D)	1.75 × 10 × 4 in (4.45 × 25.4 × 10.16 cm)
Net weight	2.2 lb (1.0 kg)
Shipping dimensions (H × W × D)	5.3 × 11.5 × 8.3 in (13.46 × 29.21 × 21.08 cm)
Shipping weight	6 lb (2.7 kg)

Environmental

Item	Specification
Elevation (above MSL) <ul style="list-style-type: none">• Operating• Storage	10,000 ft (3000 m) 50,000 ft (15 000 m)
Temperature <ul style="list-style-type: none">• Operating• Storage	– 40 to 140° F (– 40 to 60° C) – 40 to 149° F (– 40 to 65° C)
Relative humidity: operating and storage	5 – 95% RH non-condensing.

Approvals/Standards

Approvals	CE, EN55024, FCC part 15, ICES-003, CISPR22, VCCI, C-Tick
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Warranty and Service

Limited warranty

APC warrants the Battery Management System to be free from defects in materials and workmanship for a period of two years from the date of purchase. Its obligation under this warranty is limited to repairing or replacing, at its own sole option, any such defective products. This warranty does not apply to equipment that has been damaged by accident, negligence, or misapplication or has been altered or modified in any way. This warranty applies only to the original purchaser.

Warranty limitations

Except as provided herein, APC makes no warranties, express or implied, including warranties of merchantability and fitness for a particular purpose. Some jurisdictions do not permit limitation or exclusion of implied warranties; therefore, the aforesaid limitation(s) or exclusion(s) may not apply to the purchaser.

Except as provided above, in no event will APC be liable for direct, indirect, special, incidental, or consequential damages arising out of the use of this product, even if advised of the possibility of such damage.

Specifically, APC is not liable for any costs, such as lost profits or revenue, loss of equipment, loss of use of equipment, loss of software, loss of data, costs of substitutes, claims by third parties, or otherwise. This warranty gives you specific legal rights and you may also have other rights, which vary according to jurisdiction.

Obtaining service

To obtain support for problems with your Battery Management System:

1. Note the serial number and date of purchase. The serial number is located on the top of the unit.
2. Contact Customer Support at a phone number at the end of this user's guide. A technician will try to help you solve the problem by phone.
3. If you must return the product, the technician will give you a return material authorization (RMA) number. If the warranty expired, you will be charged for repair or replacement.
4. Pack the unit carefully. The warranty does not cover damage sustained in transit. Enclose a letter with your name, address, RMA number and daytime phone number; a copy of the sales receipt; and a check as payment, if applicable.
5. Mark the RMA number clearly on the outside of the shipping carton.
6. Ship by insured, prepaid carrier to the address provided by the Customer Support technician.

Life-Support Policy

General policy

American Power Conversion (APC) does not recommend the use of any of its products in the following situations:

- In life-support applications where failure or malfunction of the APC product can be reasonably expected to cause failure of the life-support device or to affect significantly its safety or effectiveness.
- In direct patient care.

APC will not knowingly sell its products for use in such applications unless it receives in writing assurances satisfactory to APC that (a) the risks of injury or damage have been minimized, (b) the customer assumes all such risks, and (c) the liability of American Power Conversion is adequately protected under the circumstances.

Examples of life-support devices

The term *life-support device* includes but is not limited to neonatal oxygen analyzers, nerve stimulators (whether used for anesthesia, pain relief, or other purposes), autotransfusion devices, blood pumps, defibrillators, arrhythmia detectors and alarms, pacemakers, hemodialysis systems, peritoneal dialysis systems, neonatal ventilator incubators, ventilators (for adults and infants), anesthesia ventilators, infusion pumps, and any other devices designated as “critical” by the U.S. FDA.

Hospital-grade wiring devices and leakage current protection may be ordered as options on many APC UPS systems. APC does not claim that units with these modifications are certified or listed as hospital-grade by APC or any other organization. Therefore these units do not meet the requirements for use in direct patient care.

APC Worldwide Customer Support

Customer support for this or any other APC product is available at no charge in any of the following ways:

- Visit the APC Web site to find answers to frequently asked questions (FAQs), to access documents in the APC Knowledge Base, and to submit customer support requests.
 - **www.apc.com** (Corporate Headquarters)
Connect to localized APC Web sites for specific countries, each of which provides customer support information.
 - **www.apc.com/support/**
Global support with FAQs, knowledge base, and e-support.
- Contact an APC Customer Support center by telephone or e-mail.
 - Regional centers:

APC headquarters U.S., Canada	(1)(800)800-4272 (toll free)
Latin America	(1)(401)789-5735 (USA)
Europe, Middle East, Africa	(353)(91)702020 (Ireland)
Japan	(0) 35434-2021

- Local, country-specific centers: go to **www.apc.com/support/contact** for contact information.

Contact the APC representative or other distributor from whom you purchased your APC product for information on how to obtain local customer support.

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