

Application Manual

Lithium Iron Disulfide (Li/FeS₂)

Introduction:

This manual contains general characteristics and guidelines for Lithium/FeS₂ L91 (AA) and L92 (AAA) batteries.

For additional battery information, please review the current datasheets at <http://data.energizer.com> , or contact us at <http://www.energizer.com> .

None of the information in this manual constitutes a representation or warranty by Energizer Holdings, Inc.

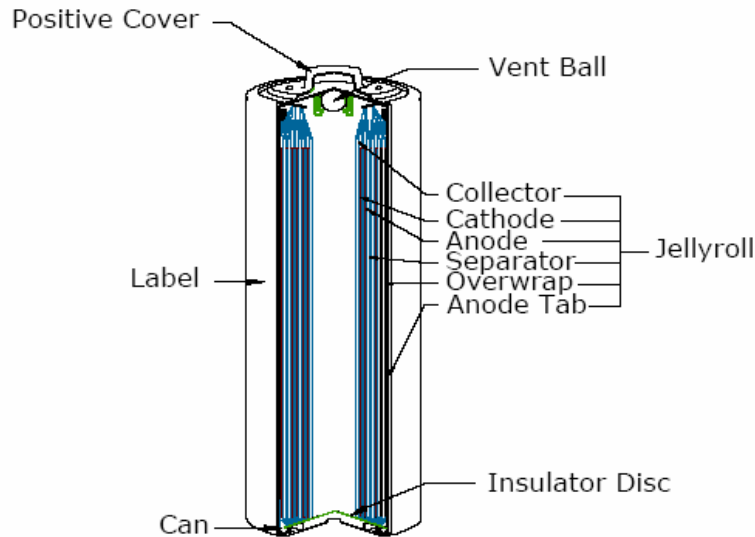
Advantages:

- Direct Compatibility - can be used in any application using primary 1.5 volt battery types AA and AAA.
- Longer service than other primary battery types, especially in moderate to heavy drain applications.
- Even greater service advantage over other primary battery types at low temperatures. Works at low temperature extremes where other types will not.
- Higher operating voltage and flatter discharge curve than other primary battery types.
- Superior leakage resistance compared to other primary battery types.
- Excellent performance even after 15 year storage at ambient conditions.
- Considerably lighter than other battery types.
- Good Service maintenance after high temperature storage.
- No added mercury, cadmium, or lead.

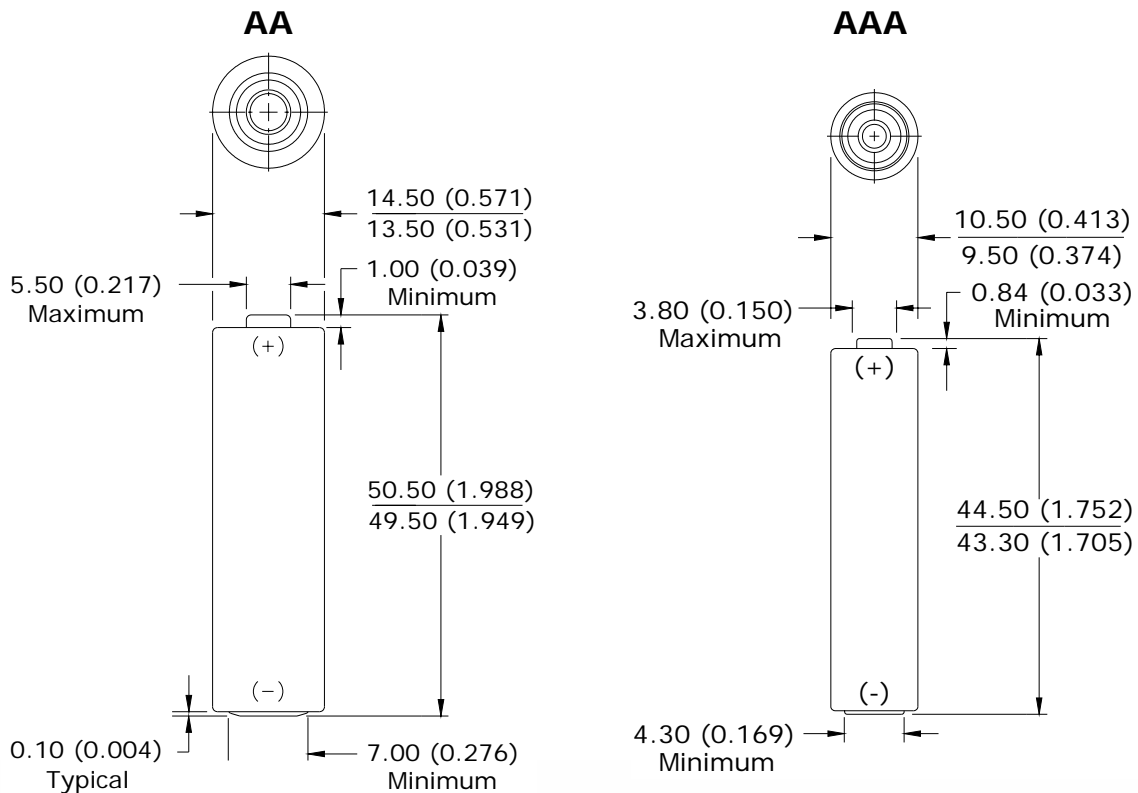
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Cutaway View:



Industry Standard Dimensions: mm (inches)



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Discharge Characteristics:

The discharge characteristics of batteries can vary, depending upon whether they are discharged at a constant resistance, constant current or constant power. Very few devices discharge batteries at a constant resistance. More often, they discharge batteries at closer to a constant current or constant power. However, because the test equipment for constant current and constant power testing is more complicated and expensive, constant resistance testing is frequently used where it will give a reasonably accurate estimate of duration.

Because of the significant differences in discharge characteristics for L91 and L92 batteries compared to AA and AAA alkaline batteries on constant resistance loads, constant resistance testing cannot be universally used to approximate relative L91 and L92 vs. alkaline battery duration, especially on heavier drains. On constant resistance discharge, L91 and L92 generally maintains a higher operating voltage during discharge. This removes capacity (amp-hours or watt-hours) at a faster rate for L91 and L92 than for alkaline batteries. This can result in understating the L91 and L92 duration for constant current and constant power applications.

To determine the battery duration for a particular application, it is most reliable to test the batteries in devices. When this is not practical, simulation testing can be done. If possible, determine whether the device is closest to a constant resistance, constant current or constant power load, and use the type of testing that best approximates the device.

Technical Advantages:

Safety Devices

Each L91 and L92 battery contains two safety devices. Positive Temperature Coefficient (PTC) Thermal Switch - Limits the current when the temperature reaches 85 to 95°C. On very high rates of discharge in devices where internal cell heat is not allowed to dissipate, the PTC will temporarily increase in resistance to reduce the flow of current. After cooling, it will automatically revert back to normal condition. Pressure Relief Vent – Activates with excessive internal pressure.

Storage

L91 and L92 batteries can be stored satisfactorily at room temperature and are stable at high temperatures. The maximum storage and operating temperatures are limited by label shrinkage. There are no problems at 60°C (140°F), and the batteries can tolerate 71°C (160°F) for at least 1 week.

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Technical Advantages: (cont.)

Containment

Avoid potting or encapsulation as this obstructs the pressure relief vent. This vent is required to prevent excessive pressure buildup if the battery is exposed to abusive conditions.

Charging

L91 and L92 are primary batteries and NOT designed to be recharged.

Connections

Use the same battery pressure contacts you would use for alkaline cells. Solder connections are not recommended. Welded connections are needed, they should be made to the nickel-plated positive cap and the nickel-plated cell bottom using a capacitor discharge welder (normal alkaline cell welding procedures).

Safety Warning

Fire, explosion and burn hazard. Do not open battery, dispose of in fire, heat above 100°C (212°F), expose contents to water, recharge, put in backwards, mix with used or other battery types - may explode or leak and cause personal injury.

Disposal

For small quantities, use the same procedures used for other Eveready and Energizer consumer products

Thermal Switch Characteristics and Considerations:

L91 and L92 batteries contains a re-settable thermal switch called a Positive Temperature Coefficient (PTC) device. This switch protects the battery from overheating if externally short circuited, charged or forced into deep discharge. This device is not a true switch since it does not have a completely off condition. Rather, it is a current limiter. When the PTC reaches the activation temperature, its resistance increases very rapidly. This reduces the flow of current, allowing the battery to cool. When the PTC cools to below the activation temperature, its resistance drops to a normal level. The PTC will continue to cycle from a low resistance state to a high resistance state for many cycles if the abusive condition continues or the battery is later exposed to other such conditions. Eventually the PTC may stop changing in resistance as its temperature changes, but if this does happen it will remain in a high resistance, safe condition.

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Thermal Switch Characteristics and Considerations:

There are two factors, which determine if or when the PTC will activate. One is the ambient temperature and the other is the internal heating that occurs as the result of discharge. The higher the rate of discharge (the heavier the drain or load on the battery), the more heat is generated. On light loads the heat dissipates and is not noticeable, but on heavy drains the battery may become noticeably warm to the touch (this is also true of alkaline batteries). If the load is too heavy, the PTC will heat up to the activation temperature. The higher the ambient temperature, the lower the load that the PTC will tolerate without activating.

All of the following can affect the ambient temperature or the internal heating during discharge:

- Surrounding air temperature
- Thermal insulating properties of the battery container
- Heat generated by equipment components
- Cumulative heating effects of many batteries
- Discharge rate(s) and duration(s)
- Frequency and length of rest periods

Because of the number of other variables involved, it is difficult to predict in advance whether the L91 and L92 batteries can operate under certain load conditions. The maximum continuous current drain is established at 2.0 amps for L91 and 1.5 amps for L92; however, higher pulses can be achieved.

The most reliable method to determine this is to test the batteries in the device of interest under worst case conditions. While the PTC does impose some limitations on applications for which the L91 and L92 batteries are suitable, it is a critical element in ensuring that the battery is safe, protecting the battery, the equipment and the user.

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Transportation of Li/FeS₂ Cell and Batteries:

Effective December 29, 2004, the US DOT, Federal Aviation Administration has banned the cargo shipments of non-rechargeable Lithium batteries aboard passenger flights. (This new directive does not apply to Lithium rechargeable batteries, only primary batteries such as Lithium photo, Lithium miniatures, and L91/L92). Cargo shipments of non-rechargeable lithium batteries will be permitted on all-cargo flights. Airline passengers will still be allowed to carry on board and use, or pack in checked bags, personal computers and other consumer products that contain lithium batteries.

In addition to the changes to air freight rules, the DOT also requires that the following phrase be on all packages containing primary lithium : "PRIMARY LITHIUM BATTERIES – FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT" regardless of transportation method.

Energizer complies with IATA (International Air Transport Association) regulations concerning the shipment of lithium batteries. The IATA regulations require Lithium batteries to be packaged in a safe and reasonable manner that prevents short circuits and be contained in "strong outer packaging" that prevents spillage of contents for all forms of transportation (ground, air, or ocean). All Energizer® lithium batteries are manufactured, packaged, and labeled to comply with these IATA regulations.

Energizer is committed to not only meeting but *exceeding* product safety guidelines. Energizer policy is to minimize air shipment for all Primary lithium and lithium ion batteries as follows:

- All *Energizer Lithium* products purchased or manufactured, all samples, and all customer returns need to be transported by overland truck or ocean freight
- Lithium batteries may be shipped by air cargo only on an urgent and as-needed basis.
- Customers may not return product to Energizer via air shipment
- Energizer employees may carry 12 batteries in personal carry-on luggage, packaged to prevent short shorting, if sales samples are needed.
- Master Shippers and necessary shipping paperwork must contain the Lithium Battery Warning label "Primary Lithium Batteries – Forbidden For Transport Aboard Passenger Aircraft".

The above represents Energizer's official policy and we expect that our distributors and our customers will follow our guidelines.

Energizer lithium batteries are safe for consumer use and we are complying with US DOT regulations to further ensure the safe transportation of these products. We understand that issues may arise as a result of these restrictions and we will take all appropriate and reasonable steps to ensure product availability needs are met.

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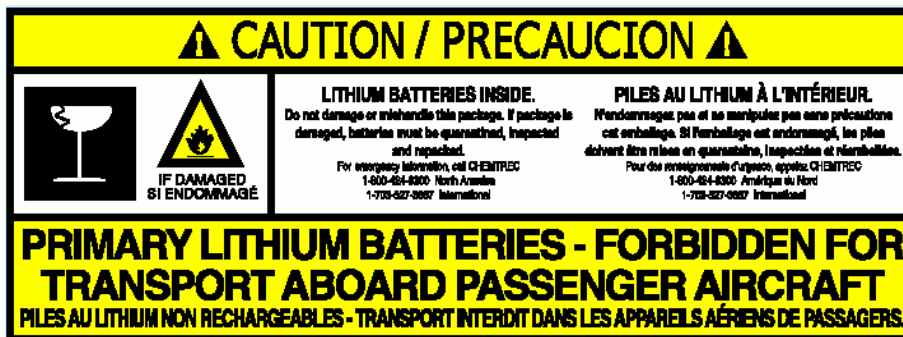
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Transportation of Li/FeS₂ Cell and Batteries: (cont.)

MARKING - The following must appear on the packaging:

- Shippers name and address
- Name and address or company or person receiving the batteries

LABEL - Caution Lithium Batteries sticker must be on package.



SHIPPING DOCUMENTS - The following must be included on a "NOT RESTRICTED" shipping document.

- Number of packages
- Article and description
- Net quantity per package
- Name and full address of shipper
- Name and title of authorized employee signing
- Date
- Signature of shipper
- Shipper shall be a trained and qualified in DOT and/or IATA/ICAO regulations

Information in this document represents performance and transportation information for lithium batteries at the time of draft. Because batteries can be modified, those considering the use of a lithium battery should contact the nearest Energizer Sales office for the latest information. The contents of this document contain general background information and do not represent an applied warranty by Eveready Battery Company, Inc for any batteries. While great effort was taken to preserve accuracy, Energizer cannot guarantee the accuracy or completeness and shall not be held liable for any errors and/or outdated information. The information does not constitute legal advice on transportation regulations, should not be considered legal advice, and should not substitute for obtaining legal advice from competent transportation regulatory authorities and experts.