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YOUR LEADING PROVIDER OF HIGH QUALITY CUSTOM BATTERY PACKS

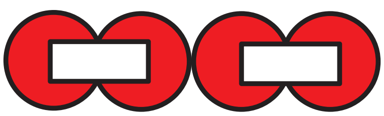
PURPOSE OF BATTERY PACKS?

Battery Cells come in fixed voltages and capacities. Capacities do vary, but voltages don't. In order to meet your power requirements a battery pack may need to be used. The type of battery, the number of cells, the shape of the pack, and the components of the pack will be determined by the voltage and load current of the device being powered.

Other considerations will be available space, operating temperature, usage conditions, transportation requirements, and charge/discharge specifications.

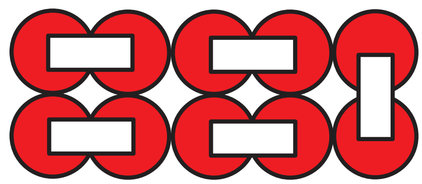
Configuration on Battery Packs

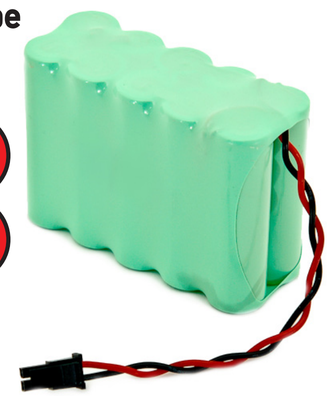
Linear or F Type



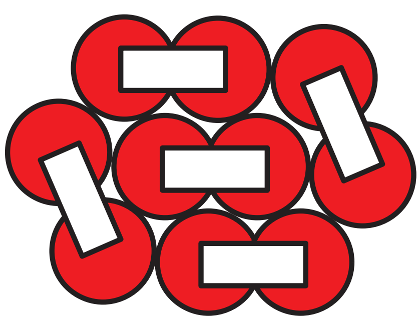
Multi-Row Cells

Cubic or Composite F Type





Nested Type Cells



Circular Type Cells

Linear or L-Type Cells

This is a stack of cells end to end.

These are usually constructed by standing two cells side-by-side, and welding a nickel strip across the terminals. The cells are positioned end to end by bending the nickel strip in a "U" shape. Allow a thickness increase of ½ to 1 mm per junction for this.

ELECTRICAL CONSIDERATIONS

How many amp-hours do I need?
Cell capacity is rated in amp-hours or milliamp hours. The symbol for capacity is C. This is amps times hours. Divide by hours and you get amps, divide by amps and you get hours. For example a 5 amp hour battery is the same as a 5000 milliamp-hour battery. If you want to discharge in 10 hours, you can get a current of 5/10 = 0.5 amps. If you need 100 milliamps current, then you can run for 5000/100 = 50 hours.

Often a discharge or charge rate is given proportional to C. So a discharge rate of C/5 means C/(5 hours), or the constant current to fully discharge the battery in 5 hours.

The calculation of run time versus current is a rough estimate, but is accurate under the right conditions. The faster you discharge, the lower the capacity of a battery. This trade-off depends on the battery chemistry and construction. Usually the capacity of a battery is quoted at a C/20 discharge rate. So a 12 amp hour sealed lead acid battery will actually put out a steady 0.6 amps for 20 hours. However, if you discharge the same battery at 12 amps, you would expect to run an hour, but you will only last for 22 minutes.

VOLTAGE REQUIREMENTS

The first question to answer is “how much voltage do I need?” The second is “how many cells in series do I need?” The voltage of any cell is a moving target. The following table shows the range of the various chemistries:

Chemistry	Type	Nominal Voltage	Fully Charged Voltage	Fully Discharged Voltage	Minimum Charge Voltage
NiMH	Secondary	1.2 V	1.4 V	1.0 V	1.55 V
NiCad	Secondary	1.2 V	1.4 V	1.0 V	1.50 V
Lead Acid	Secondary	2.0 V	2.1 V	1.75 V	2.3 - 2.35 V

So a 10 cell pack of NiMH cells would have 14 Volts when fully charged, and run down to 10 volts when fully discharged. Your system must be able to tolerate this voltage range. Furthermore, if you want to be able to charge while your system is running, the system must be able to accept the charging voltage, which is always higher than the nominal or the fully charged voltage.

Matching Cells in a Pack
Be careful to match the cells in a battery pack. When a battery pack is near zero volts under load the weaker cells will go into reversal, and suffer damage and perhaps venting.

SMART BATTERY PACK

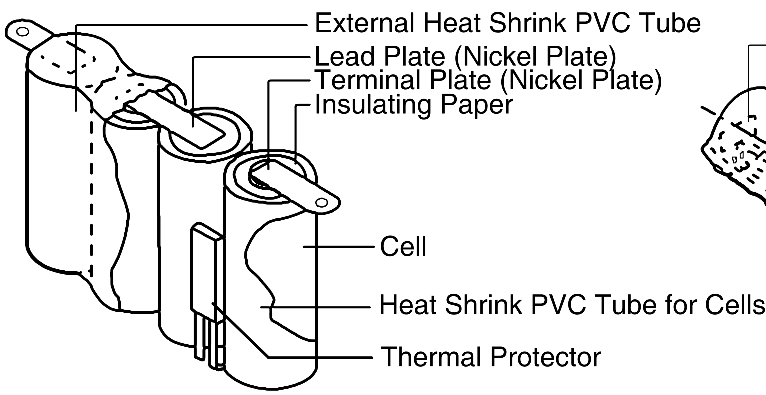
A new type of battery pack, a smart battery pack, provides the device with information about its power status so that the device can conserve power intelligently. Smart battery packs can include many additional features and functionality such as fuel gauge integration, SMBus communication protocol, cell balancing and protection circuitry.

The SMBus protocol architecture provides a means for keeping hardware costs low while also providing flexible functionality in a modular way. SMBus is a protocol that allows multiple nodes to respond to unique addresses. Details and specifications for SMBus can be found at www.smbus.org.

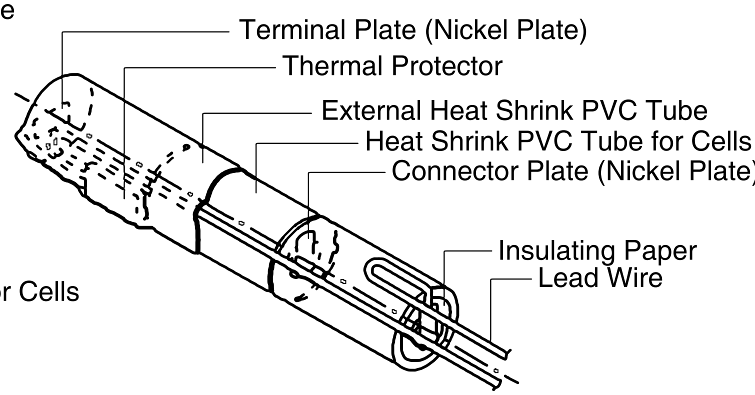
A smart battery can manage its own charging, report errors, inform the device of low-charge conditions, predict remaining run-time, provide temperate, voltage and current information and continuously self-correct to maintain prediction accuracy.

CONSTRUCTION OF BATTERY PACKS

“F” Type Construction



“L” Type Construction



BATTERY CHEMISTRIES

Chemistry	Nominal Cell Voltage	Energy Density (Wh/kg)	Energy Density (Wh/L)	Cycle Life @ 20C (see note below)	Comments
Li-Ion	3.6-3.7	100-250	250-360	300-500	Can be very expensive depending on form factor. Very high energy density. Very common in laptop computers, moderate to high-end digital cameras and camcorders, and cell phones. Very low rate of self-discharge. Special cells within the Li-Ion family are capable of high-discharge rates. More volatile than other chemistries if not manufactured with rigorous quality standards. Additional DOT and/or IATA testing regulations will apply.
Li-Polymer	3.6-3.7	130-200	300	300-1000	This type has technologically evolved from lithium-ion batteries. The primary difference is that the lithium-salt electrolyte is not held in an organic solvent but in a solid polymer composite such as polyethylene oxide or polyacr lonitrile. The advantages of Li-ion polymer over the lithium-ion design include potentially lower cost of manufacture, adaptability to a wide variety of packaging shapes, and ruggedness. Additional DOT and/or IATA testing regulations will apply.
LiFePO4	3.2-3.3	90-110	220	1000 and up	Very expensive. High energy density. Very common in power tools and medical devices. Very low rate of self-discharge. Capable of very-high discharge rates. More volatile than other chemistries if not manufactured with rigorous quality standards. Additional DOT and/or IATA testing regulations will apply.
NiMH	1.2	30-80	140-300	500-1000	Inexpensive. Traditional chemistry has high energy density, but also a high rate of self-discharge. Newer chemistry has low self-discharge rate, but also a ~25% lower energy density. Very heavy. Used in some cars.
NiCd	1.2	40-60	50-150	1000-2000	Inexpensive. High/low drain, moderate energy density. Can withstand very high discharge rates with virtually no loss of capacity. Moderate rate of self-discharge. Reputed to suffer from memory effect (which is alleged to cause early failure). Environmental hazard due to Cadmium - use now virtually prohibited in Europe.
Lead Acid	2.1	30-40	60-75	500-800	Moderately expensive. Moderate energy density. Moderate rate of self-discharge. Higher discharge rates result in considerable loss of capacity. Does not suffer from memory effect. Environmental hazard due to Lead. Common use - Automobile batteries.
Alkaline	1.5	163	398	1	Moderate energy density. Good for high and low drain uses.
Zinc-air	1.65	470	1480-9780	1	Mostly used in hearing aids.

PACK ASSEMBLY

Heat Shrink Tubing

The most common way to hold the pack together is to use heat shrink tubing. Heat shrink tubing is typically made of polyvinylchloride and varies in thickness based upon battery type and configuration.

Lead Wires

To connect the pack to a device, vinyl clad electrical wire that conforms to UL requirements is typically used. Red for the positive and black for the negative are the standard colors.

Thermal/Thermostat Components

Thermal protectors (thermistors) are typically used to prevent overcharge and overheat. These components are connected in a direct line circuit to the battery.

Connectors

The ends of the lead wires are usually connected to connectors specified by the customer to match their requirement for connection to the device.

Adhesive

There are several standard adhesives that are used to connect the batteries inside the pack that are standard in the industry. Some customers specify which adhesive is to be used that they believe will improve the performance for their specific application.

Nickel Strips

Nickel foil is used to spot weld packs together. Nickel is fairly low resistance, yet has enough resistivity to be spot welded. It is strong, has very good corrosion resistance, and will not oxidize easily.

This table gives examples of the resistance of nickel spot weld strips.

Cell Size (cm)	Foil Thickness (cm)	Strip Width (cm)	Strip Length (cm)	Resistance (milliOhms)
AA	0.018	0.5	1.4	1.0
AA	0.025	0.5	1.4	0.76
Sub C	0.025	0.05	2.3	1.2
Sub C	0.025	1.0	2.3	0.6
Sub C	0.018	0.5	2.3	1.7
D	0.018	1.0	3.3	1.2
D	0.025	1.0	3.3	0.9
D	0.025	2.0	3.3	0.4

Protective Cases

The most typical type of protective cases are injected molded plastic or steel cases. These can be custom designed for every application.

Over the course of life most batteries release hydrogen, and sometimes oxygen. Take this into account if you are designing a closed system, such as waterproof lights, weatherproof installations, etc. Some method of releasing or absorbing the hydrogen, flooding with air or inert gas should be used. In closed cabinets some provision for ventilation is necessary to prevent hydrogen gas from accumulating.

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