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, transportation requirements, usage conditions, and charge/discharge specifications.

Battery 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 polyvinyl chloride 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 battery 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.

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 an 12 amp hour battery 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. Also, if you wan to run at 10 milliampere you will get less than the expected 1200 days, since self-discharge of the battery will limit your run time.

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. Work with the charger manufacturer to make sure that you have this problem solved.

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.