

# Lithium-ion / Lithium Polymer Battery Pack Protection



## Introduction:

We have seen a rapid growth in the number of portable devices available today. This emergence of technology has resulted in a demand for lightweight, high-capacity batteries. Lithium-ion and lithium-polymer battery packs have filled the demand.

## The Design Challenge:

Lithium packs are constantly charged and discharged over their life cycle. An overcharge or over-discharge results in the temperature of the battery increasing. As the electrolyte solution heats up, it may decompose. This will result in a gas being produced or metal lithium being precipitated. These events could cause either a fire or an explosion. This is why the discharging and charging of a lithium pack must be constantly monitored.

A typical protection circuit contains a protection IC that monitors the cell voltage. Two FETs, one to limit the charge current and one to monitor the discharge current. The majority of cells will also use a second level of protection to protect against failure of this

electronic circuitry. This can happen as a result of a number of events such as excessive heat, faulty components, or excessive electrostatic discharge. One method to protect against these events is to use a second circuit set slightly above the primary circuit. The secondary circuit is activated by failure of the primary circuit. This means that the number of components is doubled and of course, the price is doubled.

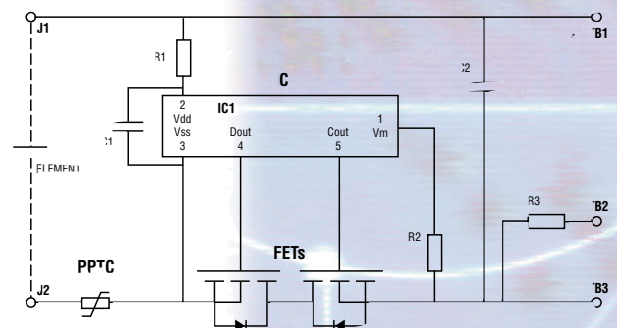


Figure 1. Typical Protection Circuit with a Multifuse device for Lithium-ion battery packs

## The Solution:

Bourns Multifuse® Polymer Positive Temperature Coefficient devices are ideal for the second level of protection inside a lithium pack. The circuit illustrated by Figure 1 shows how a PPTC device can be incorporated into a battery safety circuit.

The PPTC not only acts as a second level of protection, but also improves the overall safety of the pack.

**Benefits of Using the Bourns Multifuse® MF-VS Product Family:**

*Faster Charging Cycle*

The Bourns Multifuse® MF-VS product family has been specifically designed for this application. Manufacturers of cells recommend that during charging, cell temperatures must be kept below 100°C to avoid thermal cell runaway. The designer of the pack must limit the charge current to avoid the potential of reaching this temperature.

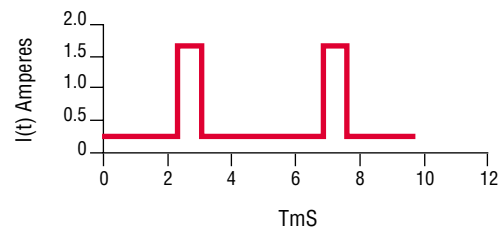
Bourns has developed a device that will trip at 85°C. The device will trip significantly faster because of the lower trip temperature. By using the MF-VS product, circuit designers can now design for higher/faster charging cycles.

*Longer Talk Times*

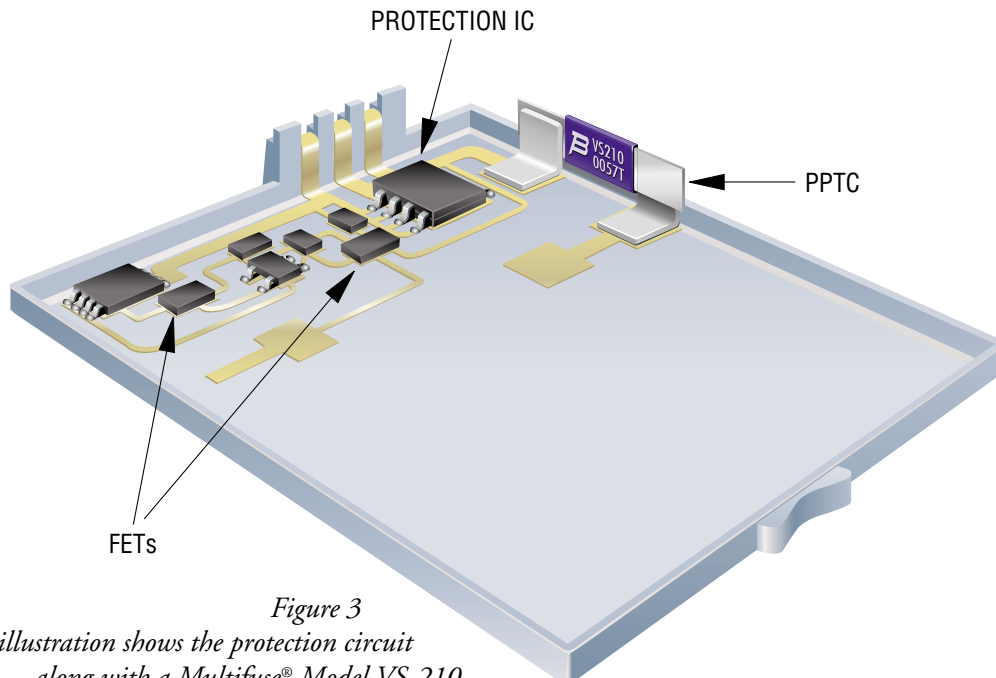
Digital phones need a pulse current up to 1.7 amps to continue transmitting during talk time. The ability of the battery to deliver short, heavy current spikes is a function of the remaining capacity and the internal resistance of the pack. The lower the resistance of the

pack, the longer it will be able to provide the necessary power to continue transmitting.

The internal resistance of the protection circuitry, therefore, has a direct relationship to the talk time capacity of the phone. Bourns Multifuse® offers the MF-VS product family as the ideal solution to help designers increase talk time capacity. The initial resistance of the Model MF-VS210 is specified between 18-30 mohms. And Bourns can now offer customized solutions with initial resistances considerably below this value.

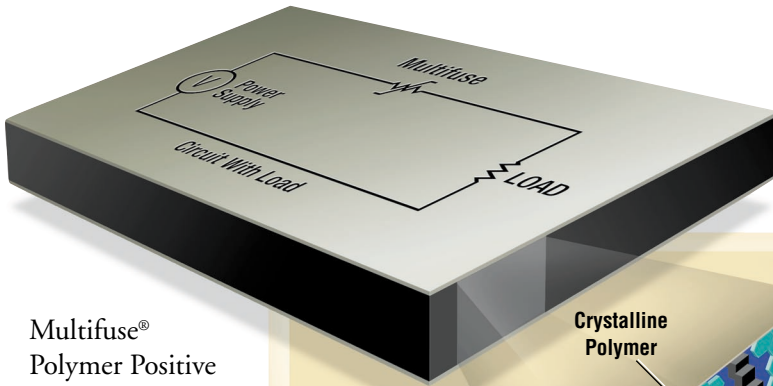


*Figure 2*  
The GSM Wave standard transmits voice data in packets of 567  $\mu$ S at a period of 4.61 mS. The current peaks vary according to signal strength and reach 1.7 amperes in fringe areas.



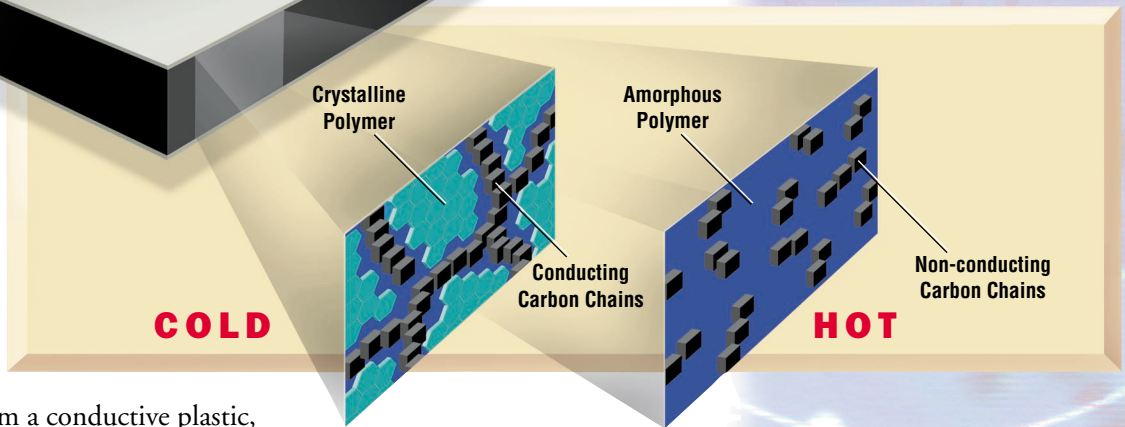
*Figure 3*  
The above illustration shows the protection circuit along with a Multifuse® Model VS-210 integrated into a lithium-ion pack using Bourns Idacon® technology. The total resistance of the package can be reduced to levels below 100 mohms.

## The Solution



Multifuse® Polymer Positive Temperature Coefficients (PPTCs) are the perfect solution for this circuit protection challenge. MULTIFUSE

PPTCs are made from a conductive plastic, formed into thin sheets with electrodes attached to either side. The conductive plastic is manufactured from a non-conductive semi-crystalline polymer and a highly conductive carbon black. The conductive carbon black filler material in the MULTIFUSE PPTC device is extruded into the polymer. The carbon particles are packed close enough together to allow current to follow through the polymer insulator.



During fault conditions, excessive current flows through the MULTIFUSE PPTC device.  $I^2R$  heating causes the material's temperature to rise. Thermal derating of fuses is necessary for high or low ambient temperatures. As this self-heating continues, the material's temperature continues to rise until the conductive particles move apart and the resistance of the device increases exponentially.

The device remains in the high resistive current blocking state until the over fault condition is removed and the circuit is reset to its original parameters. This allows the carbon particles to rebond to one another and current to flow through the fuse.

