Tyco Electronics
Our commitment. Your advantage.

IEEE 1725-2006: Standard for Rechargeable Batteries in Cellular Telephones

As a result of consumer concern regarding battery safety, the Cellular Telecommunications and Internet Association (CTIA), in partnership with leading cellular network operators, has developed a program that helps cell / battery pack and handset manufacturers raise safety and quality levels. The CTIA has developed a certification program for validating compliance to the IEEE 1725-2006 standard via a combination of audits and testing. The standard establishes criteria for design analysis to ensure reliable user experience and operation of rechargeable lithium ion and lithium polymer batteries for cellular telephone applications.

Certification process & time frame

The CTIA battery certification program will be implemented in two stages. In the initial stage, which started in 2006, CTIA maintained a registry of systems declared to be complaint with IEEE 1725-2006. Compliance during this stage was established via independent evaluation of data and results supplied by the system vendor (e.g. manufacturer of cell, battery pack, host cellular product, power adapter or charging cradle).

In stage two, CTIA will introduce a program to certify systems for compliance with IEEE 1725-2006 via a combination of 3rd party testing and auditing. In January 2008, this certification requirement became mandatory in order to obtain PCS Type Certification Review Board (PTCRB) approval, with the cellular network operators giving preference to products that have been CTIA registered.

PTCRB was established in 1997 by North American operators, but now includes members from around the world whose purpose is to provide the framework within which GSM Mobile Equipment (ME) or UMTS User Equipment (UE) type certification can take place.

For more information on the CTIA battery registration program requirements, procedures, key reference documents and a listing of CTIA Authorized Testing Laboratories (CATLs) please refer to the web site: www.ctia.org (Search Term: Battery Registration Program).

IEEE 1725-2006 standard

IEEE 1725-2006 encompasses system integration, battery cell design process, manufacturing considerations, assembly precautions, leakage protection, component and thermal considerations, overcharge, overcurrent, mechanical considerations, connector & terminals, quality control, security and validation, as well as external influences such as the host and auxiliary devices including AC & DC adapters.

Since no industry wide standard currently exists, IEEE 1725-2006 is intended to standardize the evaluation of lithium-ion batteries for cell phone applications. Primary adopters will include manufacturers of battery cells, battery packs, cell phones, chargers/adapters, and carriers. Compliance is granted on a system basis so all system components (cell, battery pack, charger, or phone) must be compliant to this standard before the integrated system is certified.

For more information on how to obtain a complete copy of the IEEE 1725-2006 standard, please refer to the web site: http://grouper.ieee.org/groups/1725/

Events that could compromise battery safety

Rechargeable lithium chemistry-based battery cells and packs are particularly sensitive to overcurrent and/or overtemperature conditions caused by accidental shorting and abusive or runaway charging. These conditions can raise the battery temperature, resulting in cell damage, equipment failure or even venting, smoke or flame.

Short circuits during discharge

Accidental short circuits can occur when a metal object bridges the exposed terminals of the battery pack. These short circuits can raise temperatures high enough to damage or burn other components and surrounding materials.

Battery overcharge

Battery cell overcharge can result from an overcurrent or overvoltage condition or a combination of both. In both cases, if current or voltage is allowed to exceed the prescribed values, a significant rise in cell temperature may result, potentially resulting in venting, smoke or flame. Overcharge can occur, due to:

- A runaway charging condition, in which the charger fails to stop supplying current to the pack once fully charged. This is typically caused by a charger fault.
- Abusive charging can result in the pack being charged under the wrong conditions by an incorrect or faulty charger. This is likely to happen when aftermarket or non-compatible chargers are used.

Battery pack considerations & redundant protection

Section 6 of IEEE 1725-2006 covers the design analysis, manufacturing, and testing of rechargeable Li-ion and Li-ion Polymer battery packs to ensure reliable performance for the expected life of cellular phones. More specifically, sections 6.4 - 6.8 cover key battery pack safety considerations, such as:

- external short-circuits and limiting output current
- thermal protection design
- overcharge and overcurrent protection

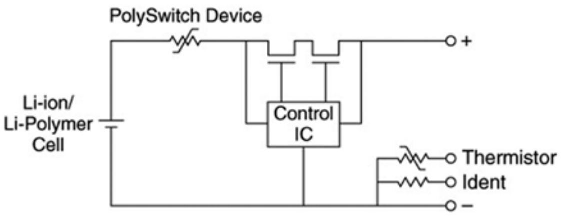
Requirements call for a minimum of one overcurrent protection function and two overcharge protection functions, where one of the overcharge protection functions must reside in the battery pack. These can be met with several design combinations between the battery cell, battery pack, host device (e.g. cellular phone) or charger and a broad combination of possible protection solutions such as "active circuit and/or devices such as a thermal fuse, PTC, or thermostat."

One solution would be to incorporate the primary protection function (active circuit) and redundant protection function, consisting of a polymeric positive temperature coefficient (PPTC) device, into the battery pack. In doing this, the PPTC device would provide resettability and close proximity to the cell for optimum temperature sensing as well as protection against damage from external short-circuits when the pack is removed from the host device. An example of this scenario could occur when a spare battery pack is carried in a briefcase or purse, where the terminals may come into contact with a metal object.

Redundant protection, designed into the pack rather than into the charger, additionally protects against hazards that may occur from using third party chargers instead of the normal host charger.

Building redundant protection into the battery pack with PolySwitch devices

The figure below shows a schematic of a typical single-cell Li-ion battery pack for cellular phone applications, using a PolySwitch PPTC device.



In addition to an NTC thermistor, Li-ion packs typically include protection schemes where MOSFETs and a control IC provide overvoltage, undervoltage, and overcurrent protection while a PolySwitch device provides cell overtemperature protection on charge, discharge, and redundant overcurrent protection.

The PolySwitch device's low resistance overcomes the additional series resistance introduced by the MOSFETs and the low trip temperature can provide protection against thermal runaway in the case of an abusive overcharge.

Technology comparison

PPTC devices are often used to replace bimetal or thermal fuse protectors. Bimetals are often bulky, higher cost protectors which frequently do not latch in the protected position during a fault condition resulting in a cycling battery pack fault and battery cell damage.

Conventional thermal fuses are not resettable and are therefore limited in their ability to match the low temperature protection of PPTC devices. The selection of a low fusing temperature in conventional thermal fuses is limited by the need to avoid nuisance tripping in temporary high ambient temperature environments, such as car dashboards on a hot day or high storage temperatures.

Even thermal fuses with 94°C or higher fusing temperatures often nuisance trip during normal operation or pack assembly. Because the majority of fault conditions that a battery pack encounters are relatively infrequent or intermittent events, resettable protection is the preferred method.

How PPTC devices mitigate the effects of short circuit faults

During a short circuit fault, the PPTC device rapidly produces heat due to the excess current. As it nears trip temperature, the device increases in resistance by several orders of magnitude and limits the fault current to a low level. When the fault condition and power are removed, it cools and returns to a low resistance state. If the fault is not cleared and the power is not removed, the PPTC device will remain latched in the high resistance state.

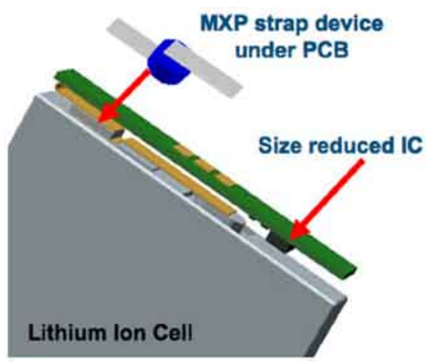
How PPTC devices provide overcharge protection

During a typical overcharge fault, cell temperature rises when excessive voltage across the fully charged cell causes chemical degradation of cell components. When a PPTC device is included in the circuit, as the cell temperature rises, the ambient temperature of the PPTC device increases accordingly and less current is required to trip the device.

Tyco Electronics' circuit protection solution

The popular PolySwitch device is available in a variety of product families, targeted at specific battery chemistries or usage profiles. The evolution of Tyco Electronics' circuit protection devices, shown below, continues in the direction of lower resistance, smaller form factors and better thermal protection.

The trend toward more space efficient packs requires smaller protection devices. Locating protection circuitry and connectors at the top of the cell eliminates the need for long metal interconnects, reduces weight and improves radio performance.

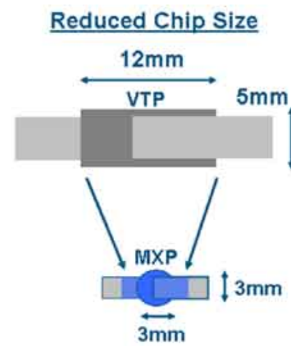


Tyco Electronics' PolySwitch MXP strap device was specifically designed for use under the PCB. The chart below shows that the MXP device provides low resistance (~10 mΩ), good thermal communication with the cell, and conforms to UL, CSA and TÜV standards.

	MXP190 (chip = 7 mm²)	VTP210 (chip = 60 mm²)
Initial Resistance (typ.)	10 mΩ	24 mΩ
Thermal cut-off @ 1A	85˚C	84˚C
Voltage rating	6V*	16V
Hold current at 60˚C	1.0A	1.0A
Typical Time-to-Trip @ 10A	1.5s	1.7s
Leakage Current @ 4V	150 mA	250 mA

* UL1434 rated voltage is 6V, but devices can withstand a higher voltage for a limited number of cycles.

This device incorporates conductive metal particles to achieve lower resistance than traditional carbon black filled PPTC devices. In comparison with the popular VTP strap device, having approximately the same hold current at 60˚C, it is 88% smaller in size (as shown in the drawing below) and 68% lower in resistance.



Dimensions are for the chip only, not a complete device with strap.

NOTE: All CTIA certification processes and time frames published in this Tech Note are considered accurate at the time of publication. For the latest updates, please refer to the CTIA.org website.

Raychem Circuit Protection Products
308 Constitution Drive, Building H
Menlo Park, CA USA 94025-1164
Tel : (800) 227-7040, (650) 361-6900
Fax : (650) 361-4600
www.circuitprotection.com
www.circuitprotection.com.hk (Chinese)
www.tycoelectronics.com/japan/raychem (Japanese)

Tyco Electronics
Our commitment. Your advantage.