precise termination method and safety protection in addition to that provided during battery manufacture.

Pulse current, with duty cycle of 5 to 1, is used until maximum voltage is reached. The pulse amplitude is dropped at this point until maximum voltage is reached one more time. This process is repeated until the value of a predetermined minimum current is reached. This procedure excludes staying too long with constant voltage and thereby decreasing the probability of electrolyte decomposition, without substantially sacrificing charging capacity and charging time. The rest period in the TBM charging profile is used for measuring open-circuit voltage (OCV), also ohmic and chemical polarization. Control of these parameters allows us to recognise hard, soft and chemical shunts as well and to make some adjustments to the charging profile.

The potential chemical shunt for example, which is specified as the reaction between electrolyte and metallic lithium, can be recognized from measurement of chemical polarization, which is inversely dependent on cell temperature. The battery response to an internal source of heat, from chemical polarization, is much faster than that of an external thermistor. Hard shunt identification is provided monitoring for a fast drop in the charging voltage, with the identification of soft shorts by monitoring the change in OCV. The conditions for creation of dendrites are monitored as a rise in chemical (concentration) polarization and the charging current is then tapered as necessary.

The cell equalization procedure includes measuring the OCV of individual cells, both at the beginning and end of charge, to identify any cell inbalance.

The rate of response during charging for a soft short is about one second, including conformation time, and less than 20 ms for a hard shunt. The measurement accuracy is ± 8 to 10 mV for full battery voltage.

The charge process provides a highly efficient transfer of energy from any power supply (linear or switching) to the battery terminals by the use of pulse width modulation.

The lithium charging algorithm can be used with regular microcontroller parameters: 8-bit word length, a frequency of at least 2 Mhz, four or more ADC inputs and at least one 8-bit parallel port.

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The morphology of microporous polyethylene separators and its significance for the performance of lithium batteries

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Solupor™ is a novel microporous (ultra) high molecular weight polyethylene membrane, fabricated in standard grades with base weights ranging from 7 to 16 g m^{-2} and mean pore sizes ranging from 0.1 to 2.0 μm and a porosity of 80 to 90%. The suitability of Solupor™ membranes as separator material in lithium batteries is demonstrated. These membranes have good wettability and thermal stability and pass voltage breakdown testing.

McMullin numbers are reported, ranging from 4 to 20 and tortuosities ranging from 1.8 to 4.1.

Electrical resistance is lowest for membranes with the highest pore size. Solupor™ membranes were tested in primary Li/MnO_2 cella and have load characteristics equal to or slightly better than commercial reference materials.

A special Solupor™ grade has been developed for an application in a battery production process for R6-size (''AA'') cells, in which the separator experiences high winding forces. At present, another special grade is under development, being a membrane with thermal shutdown capability and high permeability.

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Model of a powerful high-temperature primary battery

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The design of thermal chemical current sources (TCCS) for the solving of specific technological problems necessitates testing a large number of arrangements having various characteristics. One of the ways of reducing the volume of preliminary experimental work is computer simulation.

A mathematical model of thermal regimes of thermal batteries of filter-press design with cylindrical symmetry has been developed. This model is described by a heat balance equation in a region G with boundary S:

$$\iiint_G c(X,U).\rho(X,U)\{U(X.t_2) - U(X,t_1)\}\mathrm{d}V$$

$$= \int_{t,S}^{t2} \phi\{W(X,t,U).\mathrm{d}\sigma\} + \iiint_{G\ t}^{t2} f(X,t,U)\mathrm{d}t\mathrm{d}V$$

$$W_\alpha(X,t,U) = -\lambda(X,U).\frac{\partial U(X,t)}{\partial x_\alpha}$$

where:

$c\ (X,U)$	is the thermal capacity at point (x, y, z), having temperature U;
$\rho\ (X,U)$	is the density at point (x, y, z);
$U\ (X,t)$	is the temperature at point (x, y, z), at time t;
$W_\alpha\ (X,t,U)$	is the heat flow in the direction of Ox_a
$\lambda\ (X,U)$	is the thermal conductivity at point (x, y, z);