Topic A
Universal Adapting Battery Charger

The objective of this topic is to develop an efficient battery charger power supply capable of adapting to a range of applications. The requirement is a small plug-in power supply capable of automatically charging a wide range of battery configurations. This would reduce the needs for battery-charging devices in a typical home or office from several to as few as one.

Minimum requirements:

- Devices must operate without degradation or derating for input supplies ranging from 48 Hz to 440 Hz and 95 V to 270 V RMS.
- Devices must adapt and successfully charge any of the following battery combinations without external settings, switches, or other user intervention. (The listed combinations represent nominal voltages of 2 V to 18 V.) During final testing events, readily available commercial cells will be used to test these configurations.
  - Lead-acid cells, single or series combinations up to nine cells.
  - Nickel-cadmium cells, series combinations of two to fifteen cells.
  - Nickel-metal-hydride cells, series combination of two to fifteen cells.
  - Lithium-ion cells, single or series combinations up to five cells.
- Charging currents up to 1 A must be possible at all voltages.
- Batteries are to be charged *in situ*: it is assumed that the individual product to be recharged by this device has a barrel-type dc jack that provides access to the battery terminals. Teams should plan on a configuration that permits multiple jack adapters for maximum flexibility. Typical examples of existing power supplies with multiple jack adapters are the "itips" and "iGo" adapter family from Radio Shack, adapters from Targus, and those from many other vendors.
- The charger must address the specific needs of each battery configuration, including but not limited to: no overcharge of lithium cells, appropriate end-of-charge action for each chemistry, safe charging methods to minimize thermal runaway possibilities.
- External indication of "charging" and "charge complete" conditions.
- Polarity-insensitive design. Batteries can be charged without trouble regardless of their connection polarity to the charger.
- Protection against open-circuit and short-circuit conditions.
- Device draws no more than 0.25 W when no battery is connected.
- After battery charge is complete, devices draws no more than 0.25 W plus twice any power required for maintaining battery "float charge" if needed for a given chemistry.
- Power drawn during charging not to exceed 0.5 W plus twice the power delivered to the battery terminals.
- Input power factor not less than 0.7 under any circumstances, and not less than 0.8 during any battery charging condition under which the charging current exceeds 0.5 A.
- Details of power factor and power quality requirements will be posted on the web site. The device should never exceed power quality limits listed in standard IEC-61000-3-2.
- The charging methods should meet manufacturers' recommendations for each cell type.

- Batteries can be connected whether or not power is available without damage (i.e. fully hot pluggable with no requirements for a particular connection sequence).
- The device has no exposed live parts and is suitable for safe use indoors.
- A prototype device prepared by the team should be suitable for common-carrier shipment to the competition event site.
- Manufacturing cost in high-volume production (>1 M units/year) not to exceed US$10, including the cost of at least one output adapter.

Optional (bonus points are awarded for any of these, provided minimum requirements listed above are met):

- Operation from a vehicle dc outlet (12-15 V typical)
- Minimum power factor 0.9 for charging currents of 0.5 A and higher and power factor no less than 0.8 under all circumstances.
- Device draws no more than 0.1 W when no battery is connected.
- Charging currents up to 2 A are supported.
- Operation supports nominal battery voltages from 2 V to 24 V (up to 12 lead-acid cells, 20 nickel cells, 6 lithium cells)
- Ability to support rechargeable alkaline cell combinations of two to four or more cells in series.
- Size less than 15 cm x 6 cm x 3 cm, not including cords. Mass less than 0.4 kg.
- Switch setting or push button converts the unit into a fixed 12 V power supply that can deliver up to 1 A. The device reverts to charging mode automatically when batteries are then connected.
- Display indicates battery configuration and state of charge.
- Efficiency above 75%, not including up to 0.1 W quiescent power.

Entries are judged based on meeting the required specifications, based on lowest energy consumption during a specific test sequence to be defined in the rules, lowest cost for all aspects of the solution, smallest size and weight, most innovative design approaches, optional aspects met by the team, and other factors. Each team is also expected to deliver timely progress reports and final reports, and be prepared to present their design and operating results during final test events. The final report should include analysis of manufacturing cost, of safety, and of reliability as well as a complete discussion of the design and discussion of operating data to confirm that requirements are met.

Teams are not constrained to any particular form factor or configuration. They may choose whether to integrate an ac plug into the unit or use a separate ac line cord. It is understood that final units delivered to the competition are prototypes and may not reflect the actual packaging design for high-volume production. Teams should provide a clear discussion of how their prototype represents and is different from a final product version.