ULTRACAPACITOR TECHNOLOGY FOR UTILITY APPLICATIONS

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There are a number of utility applications requiring high-power energy storage devices like lithium batteries and ultracapacitors. In this paper, recent test data for the performance of new commercially available devices from Ioxus and Nesscap are presented along with data for advanced prototype devices from Yunasko (Ukraine) and Skeleton Technologies (Estonia). All these devices utilize carbon/carbon electrodes and an organic electrolyte with rated voltages of 2.7 to 2.85 volts (V). The capacitances of the devices are 350 to 3000 F. The devices were tested at high currents (up to 400 amperes) and high powers (up to 2200 watts/kilogram [W/kg]) in both the constant and pulse power modes. The usable energy densities are 4 to 6 Wh/kg and the 95% efficient power densities are 1000 to 2700 W/kg. All these devices are suitable for high-power, DC utility applications.

Some utility applications require pulsing at 60 cycle AC. Some of the new devices tested have RC time constants significantly less than 1 second and can be pulsed with times in the millisecond (msec) range. Test data are presented for 5 msec pulses and cycling periods of 15 msec with no loss of capacitance and very low resistance. This indicates the device could be used to provide load leveling for 60 cycle AC loads.

Data for the Skeleton Technology 350 F device are shown in Table 1.

Table 1. Constant Power Discharge Data.

Power W	W/kg (1)	Time sec	Wh	Wh/kg	Wh/l
17	247	59.1	.284	4.06	7.67
24	339	43.5	.286	4.09	7.73
41	590	23.9	.274	3.92	7.39
60	858	16.0	.267	3.81	7.2
80	1142	11.7	.26	3.71	7.01
109	1554	8.5	.257	3.67	6.94
155	2214	4.9	.211	3.01	5.69

Discharge 2.85 V to 1.42 V

(1) All characteristics based on packaged weight and volume.

Pulse Power Calculation at 95% Efficiency

$P=9/16 \times (1- \text{eff}) V_0^2/R = 9/16 \times (.05) (2.85^2/.0012 = 190W$

$(W/kg)_{packaged} = 170/.070 = 2714$

Matched impedance power $V^2/4R = (2.85)^2/(4*.0012) = 1692$, 24 kW/kg packaged