Battery Simulator with Variable ESR Response

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In the course of developing new battery operated products a void of experience and hardware may exist. The battery life of a product can depend more on the ESR than the terminal voltage especially when modern low voltage switchers are used to boost battery voltage up to the required circuit voltages. In this case the switching regulator can act like a constant power sink which loads a battery even more as voltage decreases. The ESR of a real battery is not constant but reacts and "heals" after a load is removed and as ions are re-diffused.

Modern portable electronics power use varies widely and may include a low power or sleep mode. In this case a considerable percentage of the time the device may be taking short high power pulses from the battery. This is where the ESR response curve of this battery simulator excels. By placing different values in the feedback network various ESR curves can be obtained in response to load steps.

This circuit simulates most battery types from Lithium-Ion to Alkaline. It can supply 0.5 to 4.2V at several amperes to the device under test while simulating the ESR of a variety of batteries. In addition the feedback circuit allows for a delay to the final value of ESR as set by the ESR pot. This unique characteristic is seen in some types of batteries and has a large influence on the delivery of short digital pulsed loads.

FIG. 1

In *fig.1* U1 supplies a stable voltage which is used to set the unloaded output voltage. U2 provides the necessary inversions needed for the ESR function. U3/Q1 form a power output stage sourced here by 8V and limited by R8. U4 senses the output current thru R9 and provides 20X gain. This signal is presented to the ESR timing circuit which provides the ESR effect along with timing. Various combinations of values
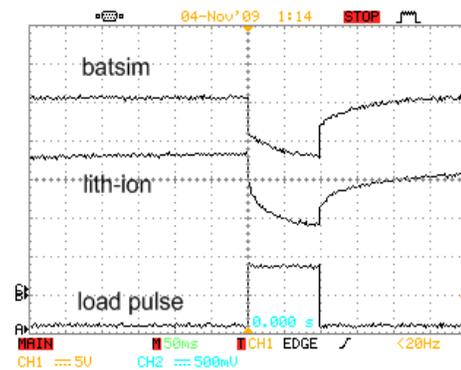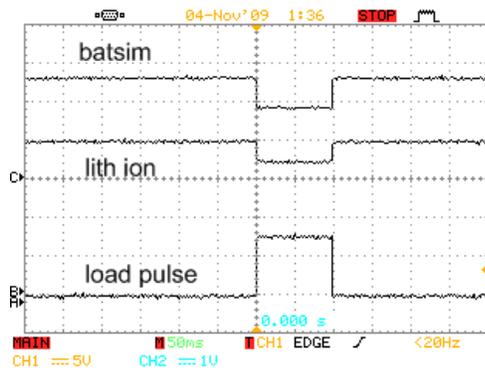
here can simulate different battery chemistries and sizes. By omitting C4 and replacing R-ESR 1-4 with (1) 100K resistor only the basic ESR function is provided.

Fig.2 shows a 1A load pulse applied without a capacitor in the feedback network simulating an 18650 style 2000mAHr battery. *Fig.3* shows the same load pulse applied to a small 200mAHr Lithium-Ion battery with the capacitor in the feedback network. The scope plots show good matching with the real world. With proper adjustment many curves can be realized. Additional information is available through http://www.graellc.net including LabView software and Voltage/ESR curves of select battery types.