ULTRALIFE®
BATTERY & ENERGY PRODUCTS

UB0032 (UBI-5390XC)

with Li-CFx/MnO_2 Hybrid Chemistry

There are several types of non-rechargeable full-size xx90 batteries in the market such as BA-5590 (Li-SO2) and BA-5390 (Li-MnO2). There are also several versions of rechargeable batteries commonly referred to as BB-2590. The full-size xx90 batteries provide two sections of power which can be used in 12V mode and 24V mode. The BB-2590 style battery, such as UBI-2590 made by Ultralife, is rechargeable battery with 7.2Ah of capacity under 24V mode (207Wh of energy) equating to 144 Wh/kg of energy density. This battery can cycle in excess of 300 cycles of cycle life. BA-5590 batteries and BA-5390 batteries are non-rechargeable. Generally, the BA-5590 has 7.5Ah of capacity under 24V mode (200Wh of energy) equating to 200Wh/kg of energy density. The Ultralife BA-5390 has 11.1Ah of capacity under 24V mode (300Wh of energy) equating to 225Wh/kg of energy density.

Ultralife has a complete family of rechargeable and non-rechargeable xx90 products. There is a white paper on the Ultralife website that explains features and typical use cases for each. Please refer to the link as below.

XX90 Family of Products White Paper
or http://ultralifecorporation.com/download/449/

The popular rechargeable BB-2590 battery needs a charger. It is very useful for training or non-frontline applications because of the cycle life. The non-rechargeable, or primary, xx90 batteries have high capacity, high energy density and very long shelf-life without requiring charge. They are attractive for special applications to lighten the load carrying during the mission.

In order to increase the capacity and energy density of the xx90 battery, Ultralife developed the UBI-5390XC (UB0032) full-size xx90 battery with Li-CFx/MnO2 chemistry. The UB0032 (UBI-5390XC) battery has more than 400Wh of energy, 16Ah of capacity under 24V mode and 32Ah under 12V mode. The battery has an average weight of 1300 grams, equating to 307 Wh/kg of energy density which is significantly higher than BA-5590 battery (50%) and the BA-5390 battery (36%). The following figures 1-4 show the discharge profiles of 250mA, 1A and 2A constant current at different temperatures. It indicates that the UBI-5390XC (UB0032) battery has an excellent low temperature performance.

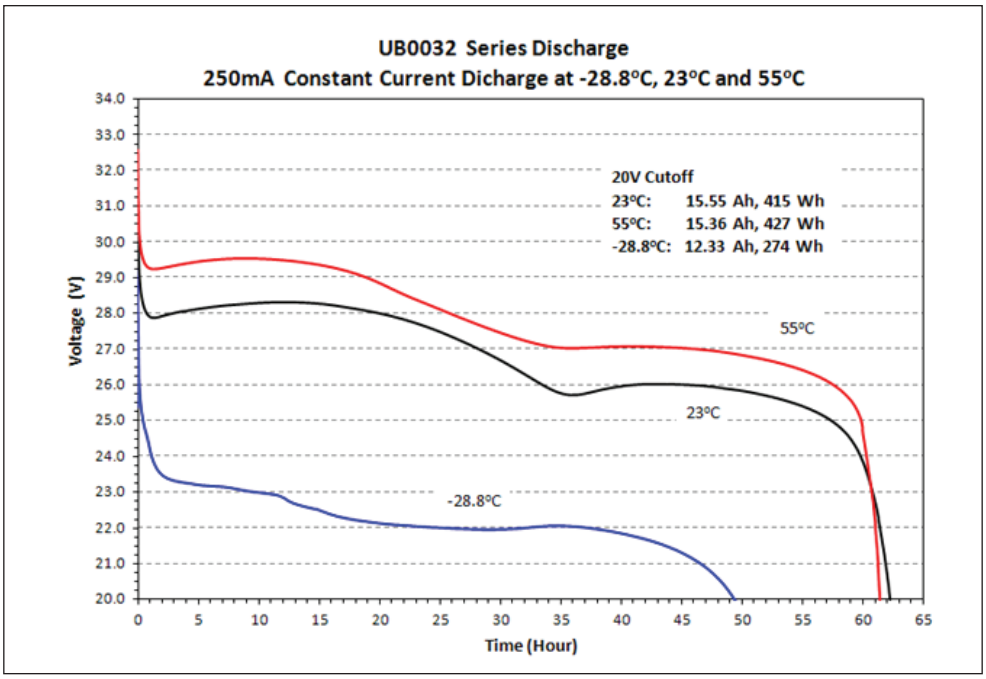

Figure 1

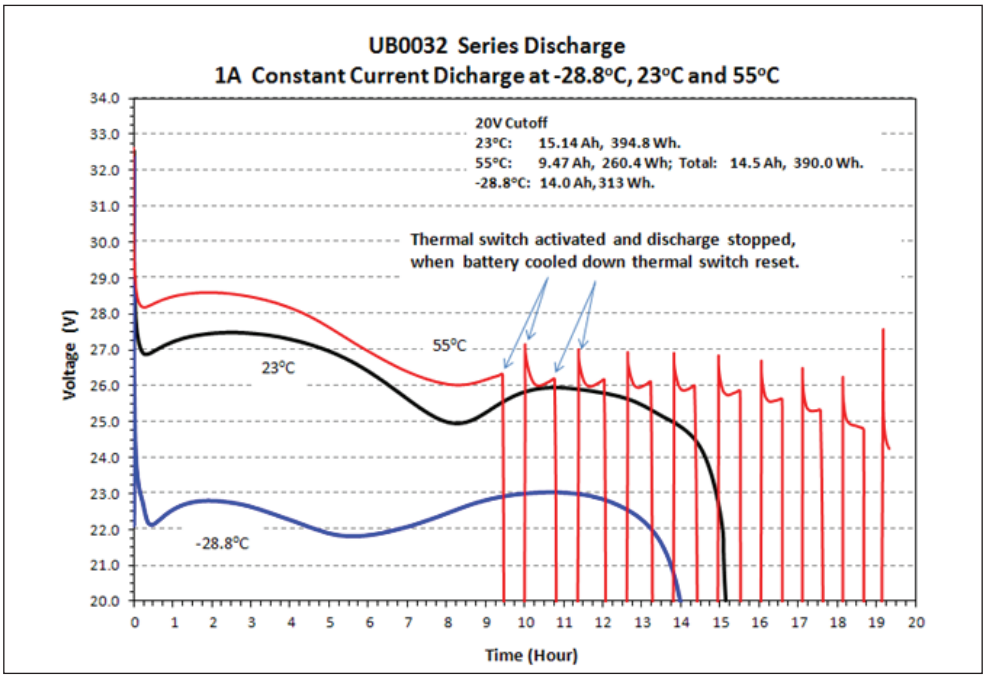

Figure 2

Newark, New York | 315-332-7100 | Fax: 315-331-7800

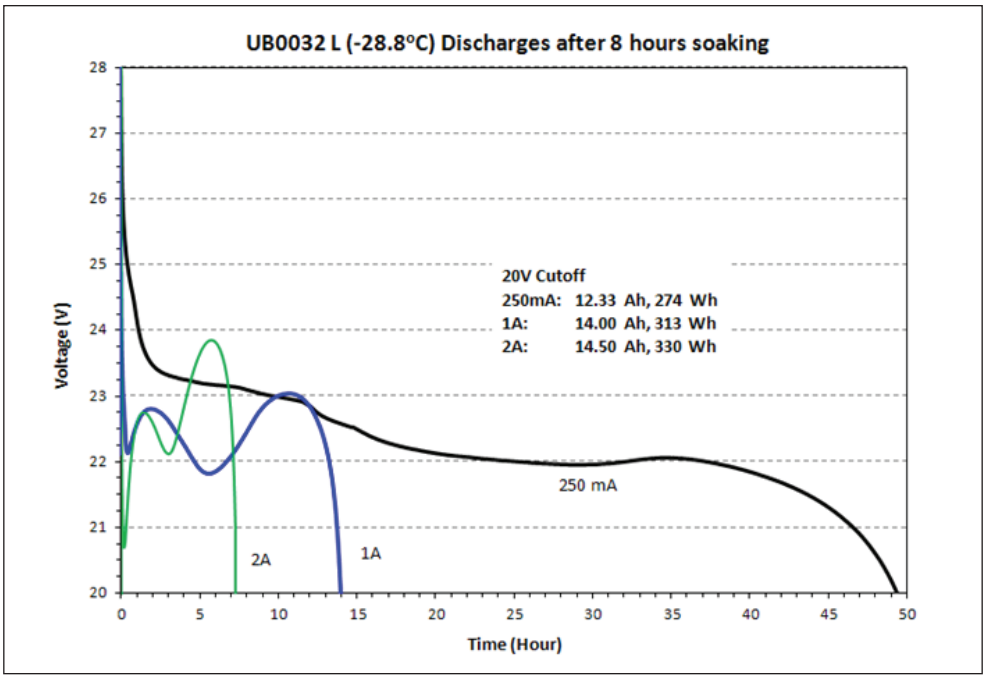

Figure 3

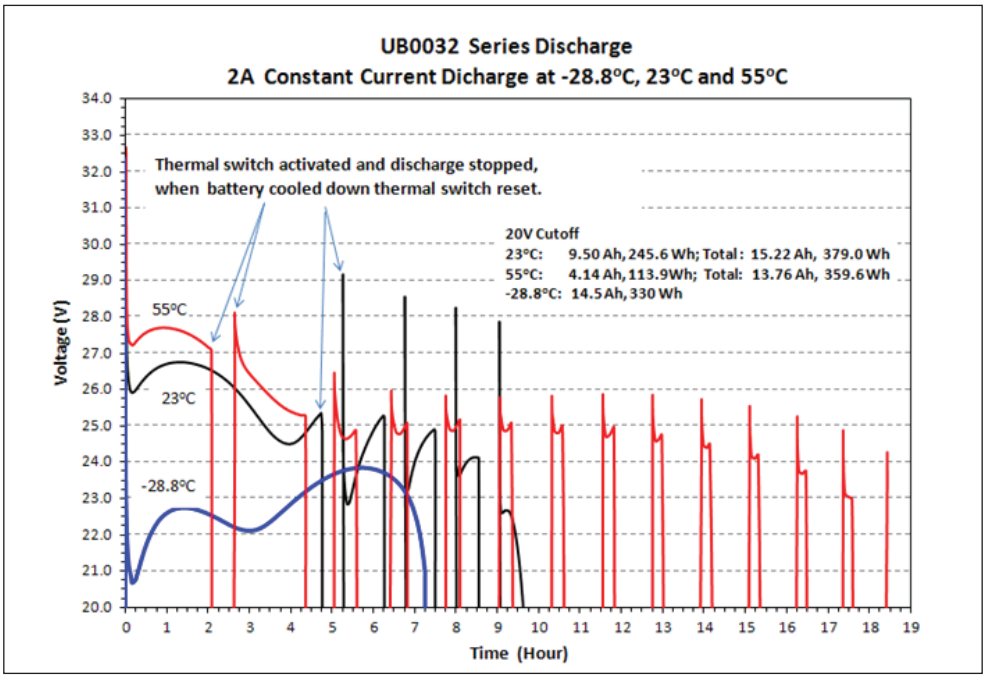

Figure 4

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In the figures 1-4, the profiles show that 2A constant current discharge at room-temperature, and 1A, 2A constant current discharge at 55°C the internal thermal protection switch opens after several hours of constant current discharge. This indicates that the thermal switch of UBI-5390XC (UB0032) battery has been activated and then resets after cooling down for a period of time. As well known, the CFx chemistry will generate heat when discharging under high constant current. The Li-CFx/MnO2 hybrid chemistry cell and battery produces some heat as well, although reduced when the Li-CFx part contributes to the discharge after Li-MnO2 part has completed.

Therefore, to maximize protection and safety, the UBI-5390XC (UB0032) battery has three layers of thermal protection. The first is a resettable thermal switch, the second a non-resettable thermal fuse and the final one is a thermal shut-down separator inside individual cells. The resettable thermal switch will shut down the battery circuit when the temperature of the cells inside the battery reaches the set-point (80°C) and will reset when the temperature reduces to below the set-point. The thermal fuse will be activated at higher temperature (90°C) than that of thermal switch and eventually permanently shut down the output during the event of quickly increasing temperature. The thermal shut-down separator will be activated when the temperature inside the cell reaches to shut-down point (approx. 130°C.) The UBI-5390XC (UB0032) battery also has other safety protection features such as charge protection and over-discharge protection. UBI-5390XC/SF (UB0031) battery has the same protection devices as UBI-5390XC (UB0032) battery.

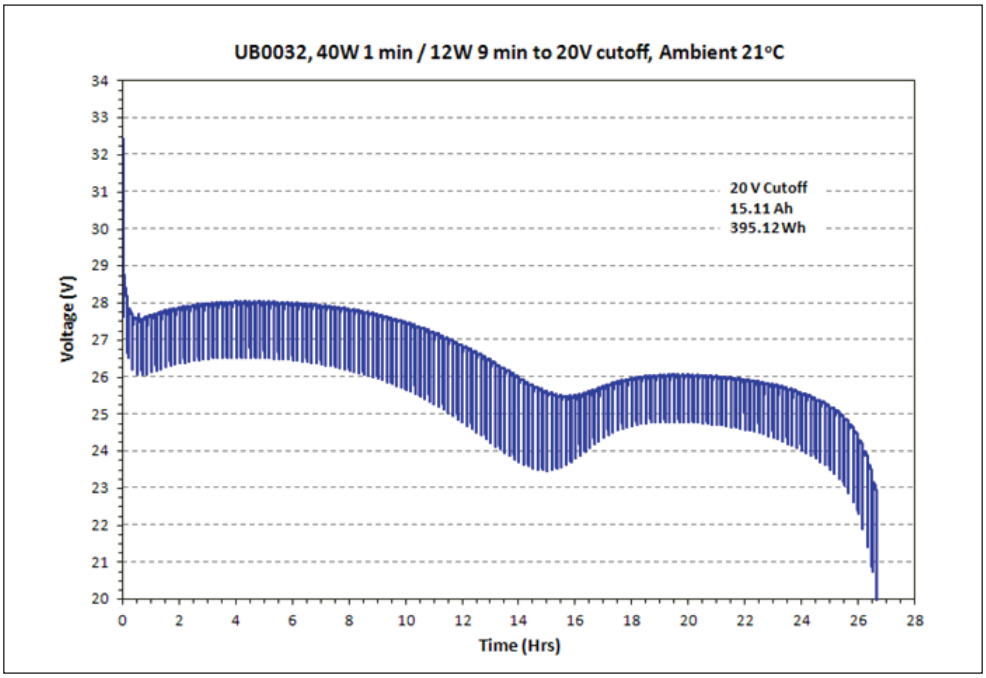

Figure 5

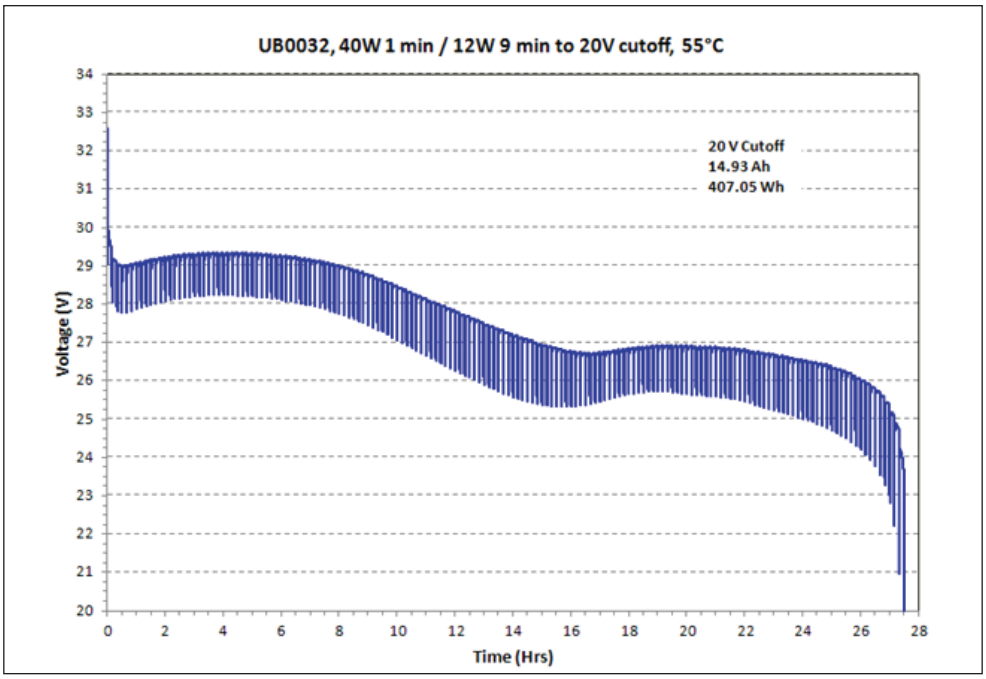

Figure 6

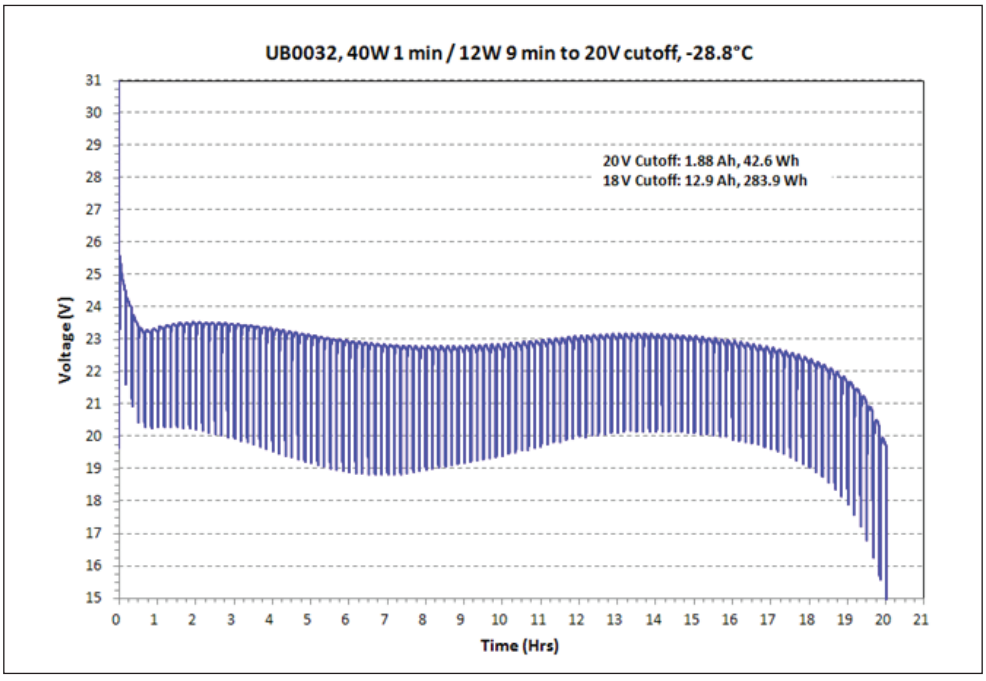

Figure 7

In the simulation of communication applications in the real world, figures 5-7 show that the discharge profile of high current pulse followed by low current, does not trigger the thermal switch. Therefore, the UBI-5390XC (UB0032) battery is expected to deliver the whole capacity uninterrupted when it is used for pulse discharge applications.

The UBI-5390XC (UB0032) battery has a discharge profile with significant two plateaus in above figures. The first plateau with higher running voltage belongs to the Li-MnO2 chemistry discharge behavior and the second plateau is mostly contributed by the Li-CFx chemistry discharge. In order to know whether the UBI-5390XC (UB0032) battery can handle the discharge after being partially discharged, the batteries are first discharged at 11.2Ah which is 70% of nominal capacity of 16Ah, rested for 24 hours and then discharged again. The following figures 8 and 9 indicate that at room temperature the UBI-5390XC (UB0032) battery with 30% capacity remaining can deliver more than 3.5Ah of capacity under 2A constant current discharge or a simulated communication discharge profile. The following figures 10 and 11 indicate that at 0°C the UBI-5390XC (UB0032) battery with 30% capacity remaining can still deliver more than 3.0Ah of capacity under 2A constant current discharge or a simulated communication discharge profile.

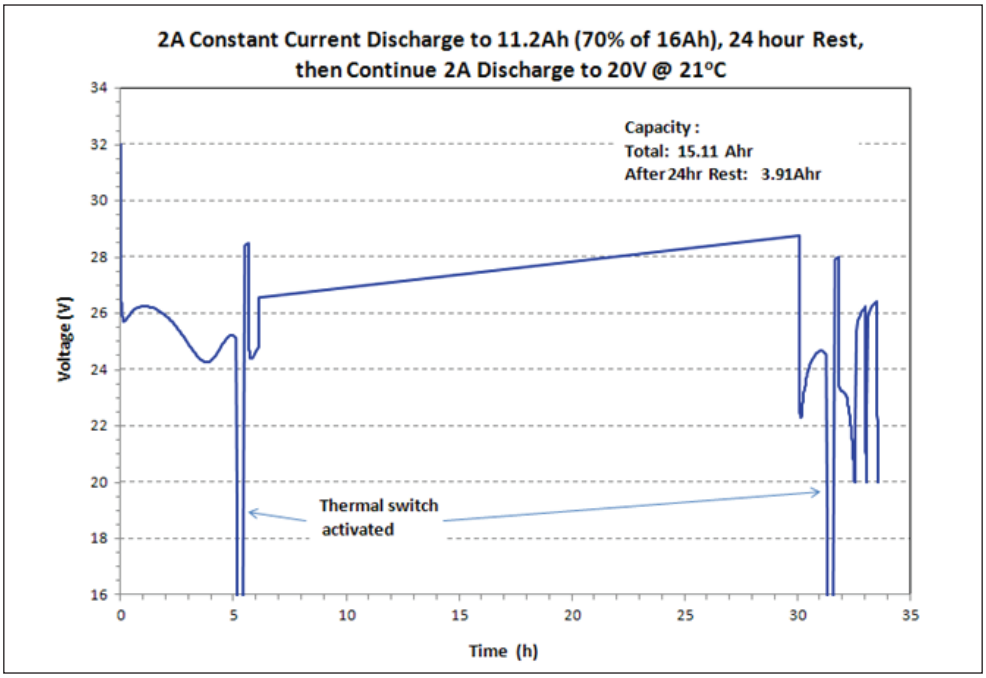

Figure 8

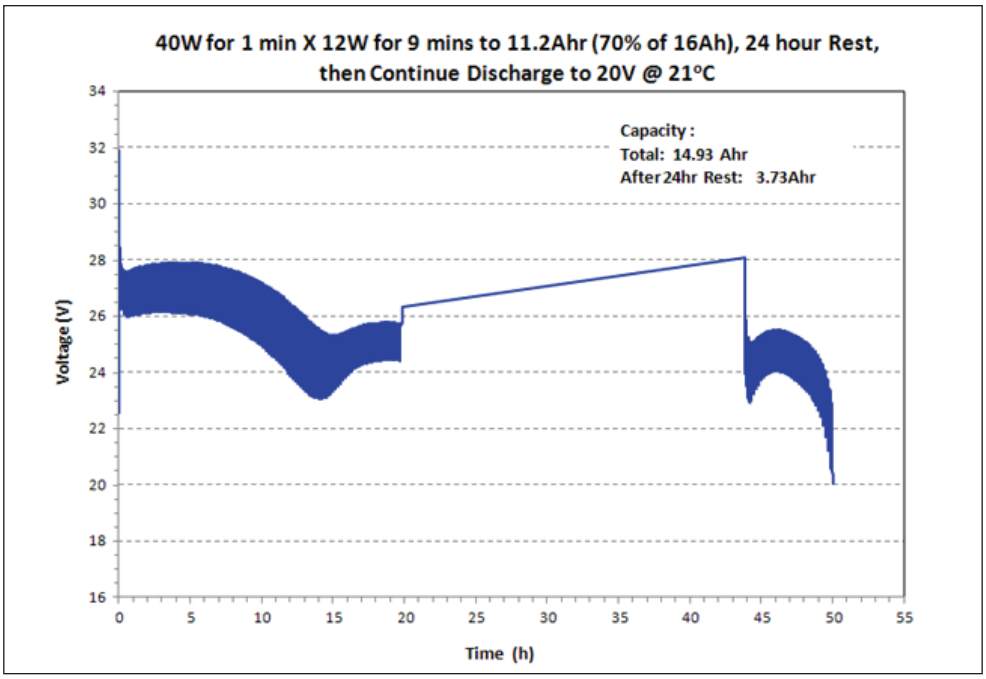

Figure 9

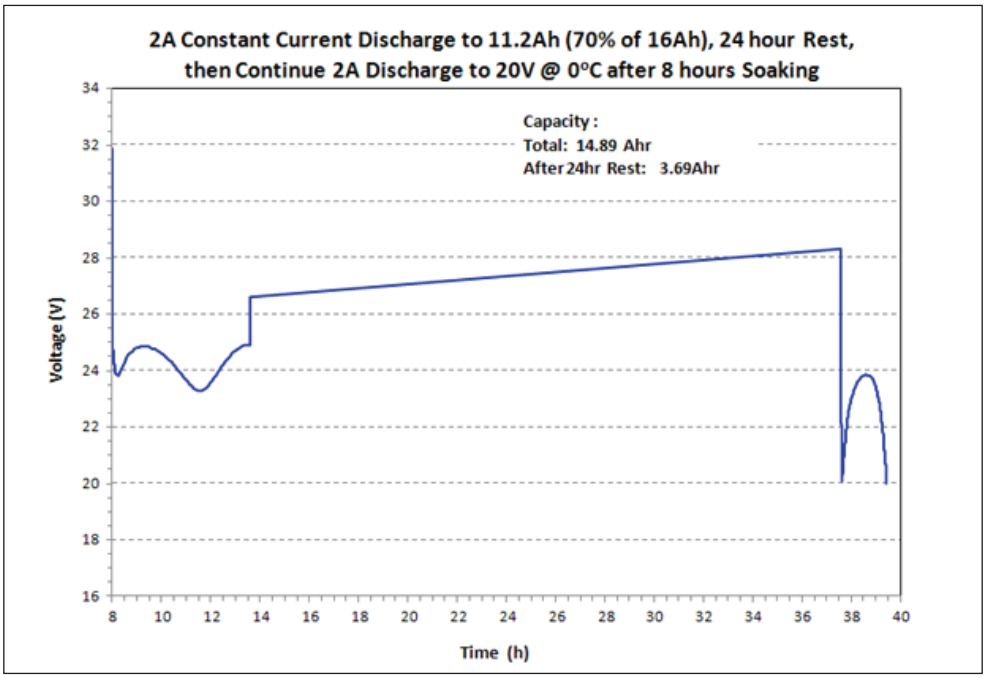

Figure 10

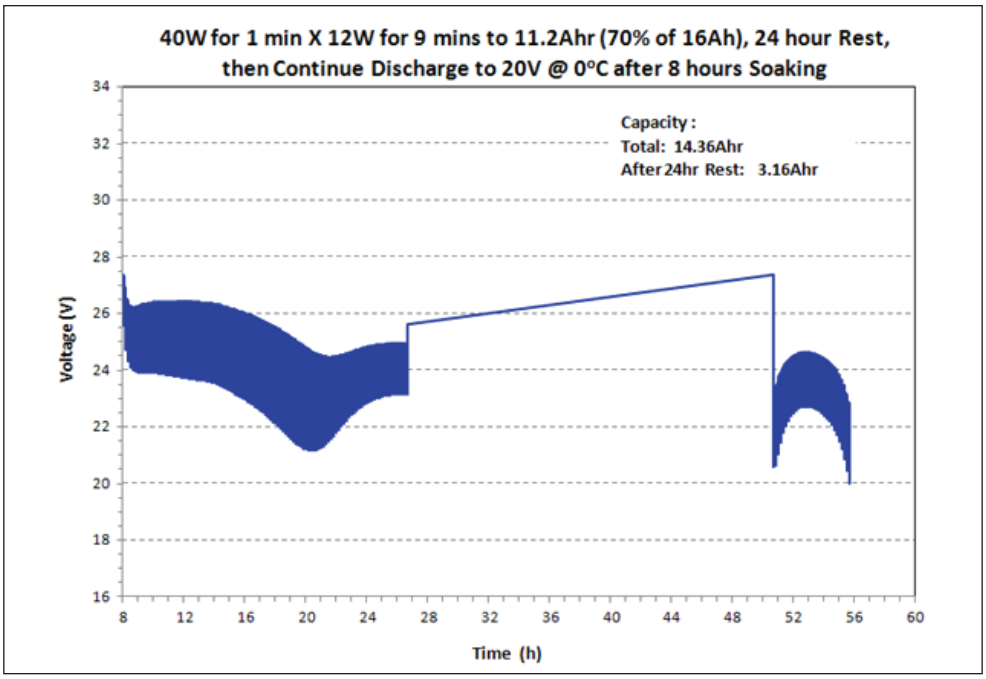

Figure 9

In summary and comparison, the following table lists several non-rechargeable xx90 batteries available in the market with chemistry, voltage mode, capacity, energy and energy density. It indicates that the UBI-5390XC (UB0032) battery has the highest energy and the highest energy density.

Battery	BA-5590	BA-5390A/U (UB0023)	UBI-5390XC (UB0032)	UBI-5390XC/SF (UB0031)
Cells	10 D-cells	10 D-cells	10 D-cells	5 D-cells
Chemistry	Li-SO_2	Li-MnO_2	Li-CF_x/MnO_2	Li-CF_x/MnO_2
Voltage Mode	12V & 24V	12V & 24V	12V & 24V	12V
Capacity	15 Ah @ 12V 7.5 Ah @ 24V	22.2 Ah @ 12V 11.1 Ah@24V	32 Ah @ 12V 16 Ah@24V	16 Ah@12V
Energy	200 Wh	300 Wh	400 Wh	200 Wh
Weight	1000 g	1330 g	1300 g	680 g
Energy Density	200 Wh/kg	225 Wh/kg	307 Wh/kg	294 Wh/kg

Table 1: Summary of Several Types of Non-Rechargeable BA-xx90 Batteries