EU Reg. 2023/1542

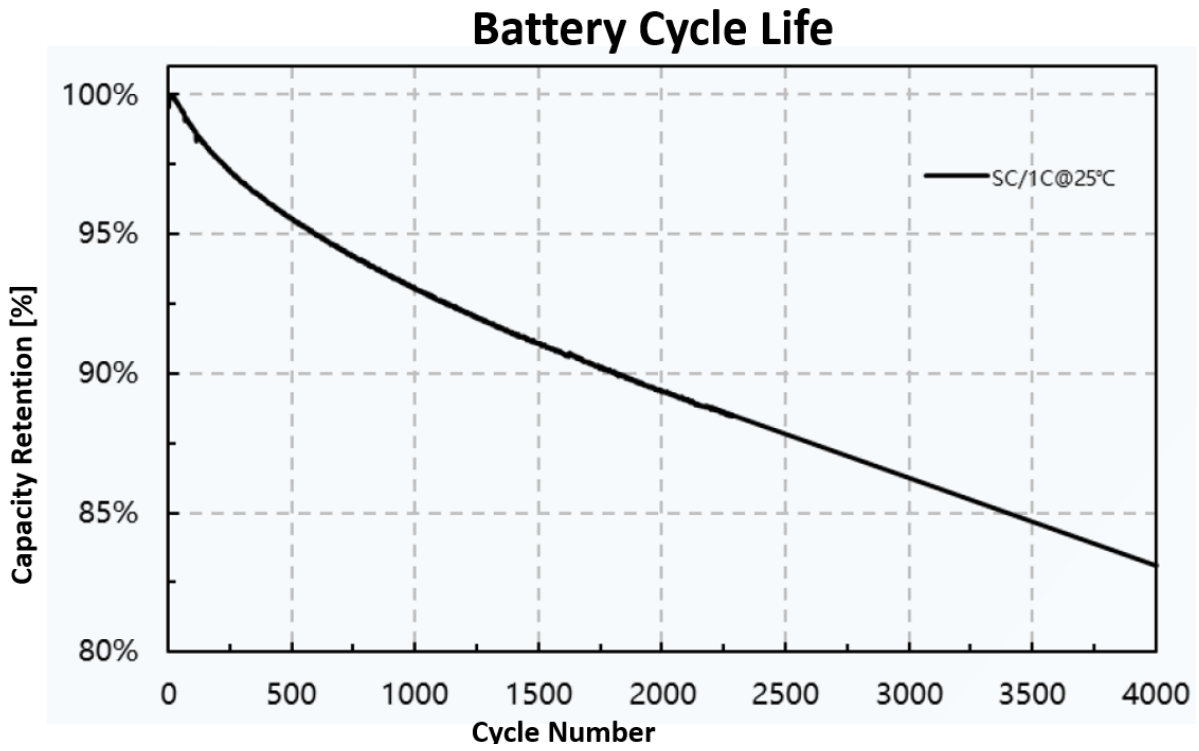
Electrochemical Performance and Durability Requirements of MLI Ultra 12/3000, 12/6000 and 24/6000 according to Article 10

Lifetime

The Mastervolt MLI Ultra 12/3000, 12/6000 and 24/6000 batteries have a lifetime of 3,000 cycles at an ambient temperature 25°C, with a charge rate of 1C, a discharge rate of 1C, and a Depth of Discharge (DoD) of 100%, before its capacity decreases to 80% of its initial value.

Rated Capacity Retention

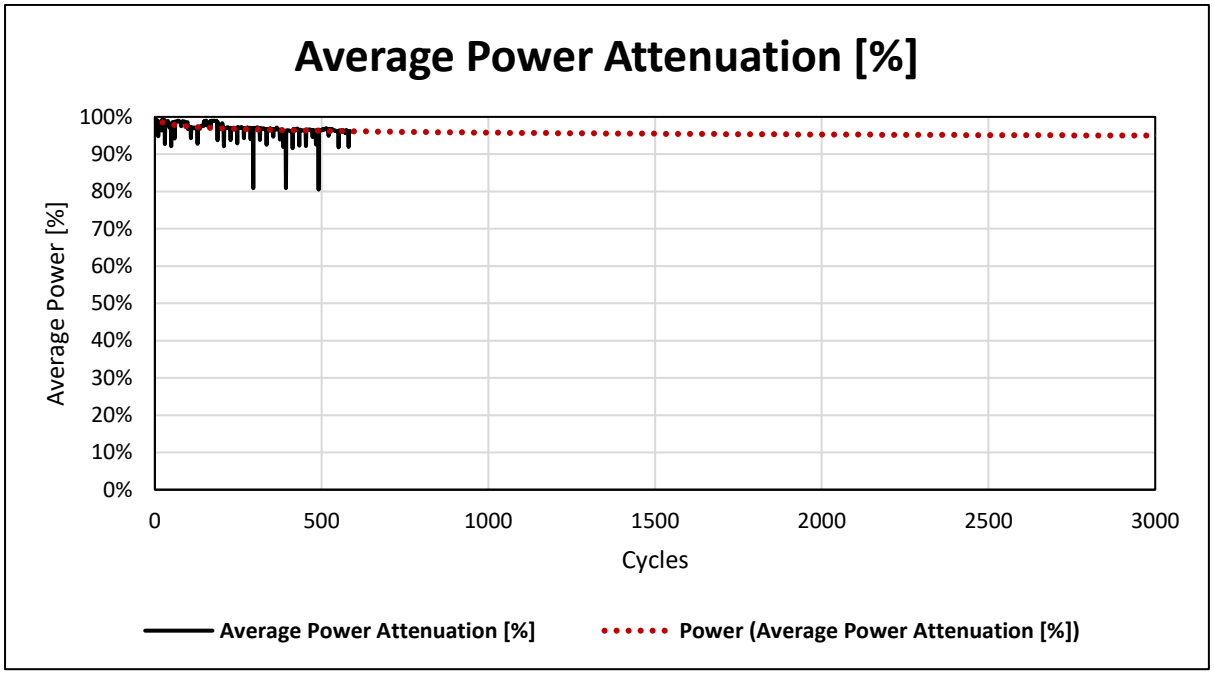
The graph below shows the capacity retention [%] when the battery is cycled with a 1C charge rate, a 1C discharge rate, and a DoD of 100% at ambient temperature of 25°C.



- *The graph above is provided by the cell manufacturer.*

Power Fade

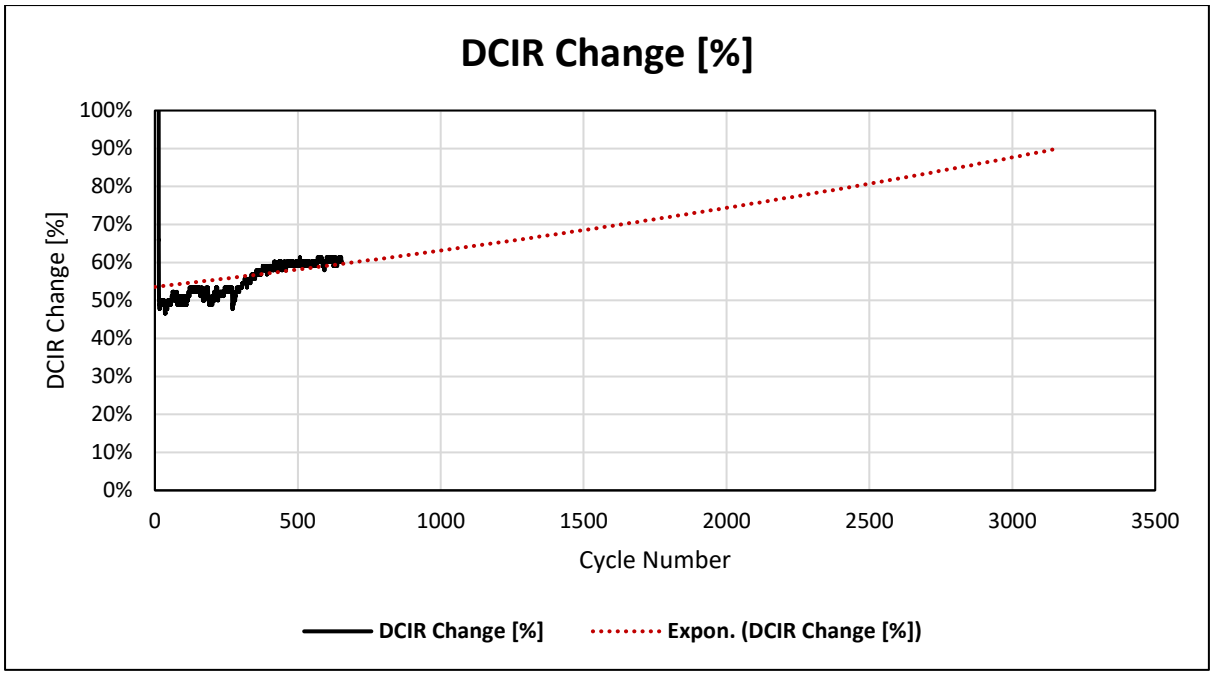
In the graph below the one cycle average power attenuation over lifetime is depicted. The average power [W] is calculated as the ratio of the energy [Wh] delivered by the battery during the discharge over the number of hours [h] the discharge process lasted. The graph below shows how the average power of the battery evolves over the lifetime of the battery if cycles with 1.5C charge, 1.5C discharge at 25°C with DoD=100%.



- *The graph above is based on data from internal testing conducted by Navico Group on a same series, manufacturer, chemistry, and type cell but of different capacity.*

Internal Resistance Increase

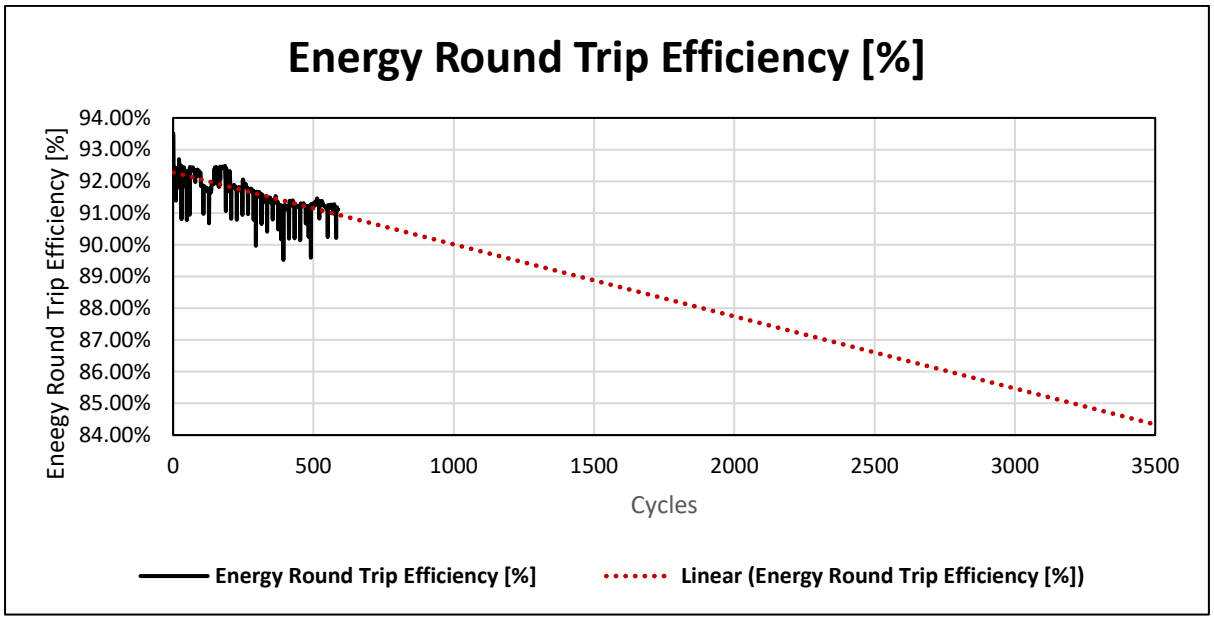
The graph below shows the increase of the internal resistance as percentage of its initial value [%] when the battery is cycled with a 1.5C charge rate, a 1.5C discharge rate, and a DoD of 100% at an ambient temperature of 25°C.



- *The graph above is based on data from internal testing conducted by Navico Group on a same series, manufacturer, chemistry, and type cell but of different capacity.*

Energy Round Trip Efficiency

The graph below shows the Energy Round Trip Efficiency [%] when the battery is cycled with a 1.5C charge rate, a 1.5C discharge rate, and a DoD of 100% at ambient temperature of 25°C.



- *The graph above is based on data from internal testing conducted by Navico Group on a same series, manufacturer, chemistry, and type cell but of different capacity.*

Battery Power Capability

The nominal power per battery along with other parameters are stated in the table below.

Battery Model	Nominal Voltage	Cont. Discharge Current	Nominal Capacity	Battery Energy	Nominal Power	Nominal Power / Battery Energy	Initial Internal Resistance
MLI Ultra 12/3000	12.8V	200A	230Ah	2,944Wh	2,560W	0.87	3.52mΩ
MLI Ultra 12/6000	12.8	300	460Ah	5,888Wh	3,840W	0.65	1.76mΩ
MLI Ultra 24/6000	29.2V	200	230Ah	5,888Wh	5,840W	0.87	7.04mΩ

- *The battery can maintain the nominal power over the whole SoC range, but its duration for which is different based on the SoC.*

Formulas & Definitions

The internal resistance of the battery presented above is the equivalent DCIR [Ω] of the battery as measured during the cell cycling and calculated as follows:

$$DCIR[m\Omega] = \frac{\Delta V[Volt]}{\Delta I[Ampere]} = \frac{V_{discharge}[Volt] - V_{rest}[Volt]}{I_{discharge}}$$

The round-trip efficiency is defined as shown in the following equation:

$$Energy\ Round\ Trip\ Efficiency[\%] = \left(\frac{Energy_{Discharge}[Wh]}{Energy_{Charge}[Wh]}\right) * 100\%$$

- *The losses and resistance due to BMS and connections are ignored as they remain constant and are considerably smaller.*

The nominal power definition can be seen in the equation below:

$$Nominal\ Power[W] = Nominal\ Voltage[V] *\ Discharge\ Current^{maximum}_{Continuous}[A]$$

Battery energy is defined as follows:

$$Battery\ Energy[Wh] = Nominal\ Voltage[V] * Battery\ Capacity[Ah]$$