Remotely Adjustable Magnet Bar Battery Lifetime Calculations

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SYSTEM CONFIGURATION

The RAM bar consists of two independent electronic control systems, the Control Module (CM) and the Motion Controller (MC). The CM is located outside the vacuum system and is controlled using a PC or the vacuum system's PLC via a RS-485 connection. The MC is located inside one of the battery boxes mounted to the magnet bar support structure. The MC has bi-directional communication with the CM via fiber optic cables and with each of the individual Motor Boards (MB) that are in the motor boxes via a wired RS-485 connection. The MC and all of the MBs are powered by 2 or more lithium ion battery packs. The CM battery box holds two 25 watt-hour batteries. Additional battery boxes without a CM can hold two 50 watt-hour batteries for 50 and 100 watt-hours of total power per box respectively.

To minimize the amount of power used in the system the MC disables the power bus that feeds each of the MBs and goes into a low energy sleep mode when not in use. The sleep mode is active for 95% of the idle time and the remaining 5% of the time the MC is actively listening for a command from the CM on the fiber optic communication

POWER USAGE

All of the functions that the MC preforms consume power. In order to determine how long a set of batteries would last each of those functions had to be identified and quantified. Moving the motors consumes 0.025 watt-hours per mm of movement. While active but not moving the motors, the system consumes 11 watt hours per week. Sleeping and listening for a command consumes 2.5 watt-hours per week. Lastly the lithium ion batteries lose roughly 4% of the total rated charge per month.

For a 3191mm long magnet bar there could be up to 11 motors, 1 MC with smaller batteries, and 3 battery boxes. This would provide a total power capacity of 350 watt-hours. If the system was configured to use the full 20mm of movement and was put through one homing procedure (11 watt-hours), calibrated the uniformity by moving each motor at least 2mm (0.55 watt-hours), and moved only 1mm per motor per week (0.275 watt-hours) then the system could in theory last up to 52 weeks before requiring the batteries to be recharged.

The system is not currently designed in a way that is conducive to estimating the remaining battery life but it will report the battery voltage which ranges from around 25 volts when fully charged to around 18 volts when nearing the end of the battery life.

BATTERY LIFE AS A FUNCTION OF LENGTH

Since the number of motors and the number of battery boxes is a function of the length of the bar then ultimately the practical battery life is also a function of the length of the magnet bar. Using the same assumptions as before the following graph provides a representation of estimated maximum battery life as a function of target tube length.

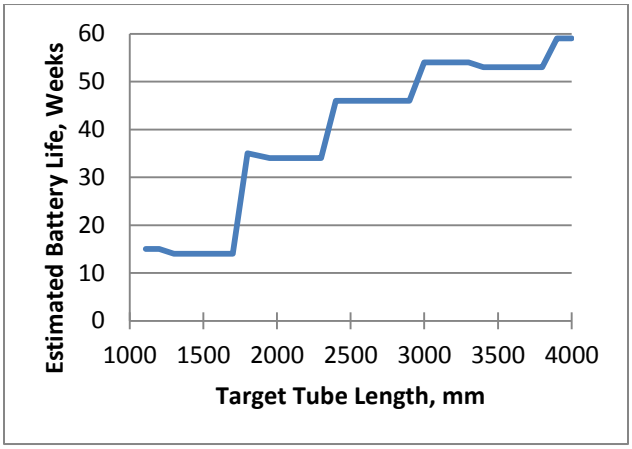

Figure 1: Estimated Battery Life as a Function of Target Length