EMI Control for a Multi-cell Battery

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***Abstract*— Electromagnetic emissions from multi-cell batteries were previously observed to cause electromagnetic interference (EMI) that can cause nearby electronic safety and health devices to malfunction. While shielding and filtering are the two most common EMI mitigation methods, both have pros and cons and are not applicable in all situations. In this paper, we propose an innovative approach for mitigating EMI emissions from a multi-cell battery. The new approach takes advantage of the coherent nature of the currents in battery cells, and their structural symmetry found in certain battery packs, and then rearranges them into magnetic mutual cancellation loops so that the magnetic fields produced from the battery cells are cancelling each other. Using an electronic device typically used in underground coal mines as an example, the proposed approach can effectively reduce the EMI from the device by 25dB by simply rearranging the position of the battery cells.**

I. Introduction

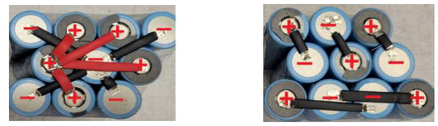
To meet the increasing demand of power and energy, manufacturers are now packing more cells into battery packs. As a result, the electromagnetic field (EMF) emission from the battery becomes more eminent. To address the problem, Maleki et al. [1] studied the EMF of a single battery cell and revealed that the tab locations of cathode and anode and their length played important roles. Li et al. [2] investigated various shielding materials for reducing the EMF from the battery of a personal dust monitor (PDM) which is an electronic device mandated in US underground coal mines for monitoring dust concentrations. In this paper, we propose a different approach for mitigating the EMF from a multi-cell battery. The concept in some ways is similar to the magnetic field cancellation technique discussed in [3]. The idea is to create a counter magnetic field so that the magnetic fields in the desired areas are annihilated. The challenge of these techniques is the complexity and cost of designing a compensating circuit system that produces the counter magnetic field. Our approach, however, is different in that no external compensation circuit is needed. In this study, the authors make use of the coherent nature of the currents in battery cells and the symmetric feature found in many battery packs and re-arrange the cells in such a way that the magnetic fields produced from the cells can cancel each other out.

II. Methodology

The original battery pack of the PDM is shown on Fig. 1. It is a 2S/5P structure where there are two cells connected in series and five parallel connections for higher power output.

(a) Top view (b) Bottom view

Fig. 1. The original multi-cell battery pack extracted from a PDM



(a) Top view (b) Bottom view

Fig. 2. Modified battery pack for the PDM for reduced EMF

The modified battery packing is presented in Fig. 2. It is still a 2S/5P structure so that the capacity and voltage of the battery pack is not changed. However, the battery cells are re-arranged. The cell pairs are interleaved such that the neighboring cell pairs will have opposite current flow directions to cancel EMF generated by those battery cells.

III. Results and Conclusions

To characterize the effectiveness of the proposed approach for EMF reduction, we used the RE101 protocol defined in MIL-STD-461 [4] to measure the magnetic fields emitted from the six sides of the two versions of the battery pack, while the battery is powering a PDM circuit through a long shielded cable. The magnetic field reduction at 100KHz is presented in Fig. 3. It was found that the new battery design can effectively decrease the EMF by 10dB to 25dB, depending on the measured side.

Note that not all battery packs have such a symmetric feature, and there is added complexity in the new battery jointing. However, the approach presented in this paper gives battery designers and manufactures a new perspective and/or solution in designing batteries for electromagnetic compatibility (EMC).

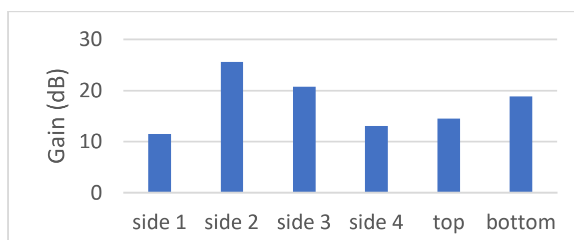


Fig. 3. EMF reduction gain of new battery design at 100KHz

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