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| UTC Project Information | |
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| Project Title | Electrical and Thermal Modeling of a Large-Format Lithium Titanate Oxide Battery System (Former title: Electrical and Thermal Management of a Lithium Titanate Prismatic Cell Battery System) |
| University | The Pennsylvania State University<br>Mineta National Transit Research Consortium |
| Principal Investigator | Timothy Cleary |
| PI Contact Information | Mineta Transportation Institute Research Associate<br>210 N. Fourth St., 4th Floor<br>San Jose, CA 95112<br>tcleary@engr.psu.edu<br>814-865-0500 |
| Funding Source(s) and Amounts Provided (by each agency or organization) | Research and Innovative Technology Administration University Transportation Centers Program ($120,792)<br><br>Larson Institute/Penn State ($23,052)<br><br>Industry Partner: Proterra ($100,175) |
| Total Project Cost | $244,019 |
| Agency ID or Contract Number | DTRT12-G-UTC21 |
| Start and End Dates | November 2012 – March 2015 |
| Brief Description of Research Project | The future of mass transportation is clearly moving towards the increased efficiency of hybrid and electric vehicles. Electrical energy storage is a key component in most of these advanced vehicles, with the system complexity and vehicle cost shifting from combustion engines to battery and electric drive systems.<br><br>To assist engineers and technicians in this transfer, the Battery Application Technology Testing and Energy Research Laboratory (BATTERY) of the Thomas D. Larson Pennsylvania Transportation Institute in the College of Engineering at The Pennsylvania State University partnered with an advanced bus manufacturer to study lithium titanate oxide battery chemistry for use in transit buses. The research team found, other than proprietary data/models, scant technical information or research on electrical and thermal modeling of this advanced chemistry.<br><br>The research team developed lithium titanate oxide modules to study their characteristic behaviors and produce state-of-charge estimators capable of running on the limited embedded processing power and memory of a typical battery management system. The team also investigated the thermal performance of this chemistry in the large format, producing a physics-based |

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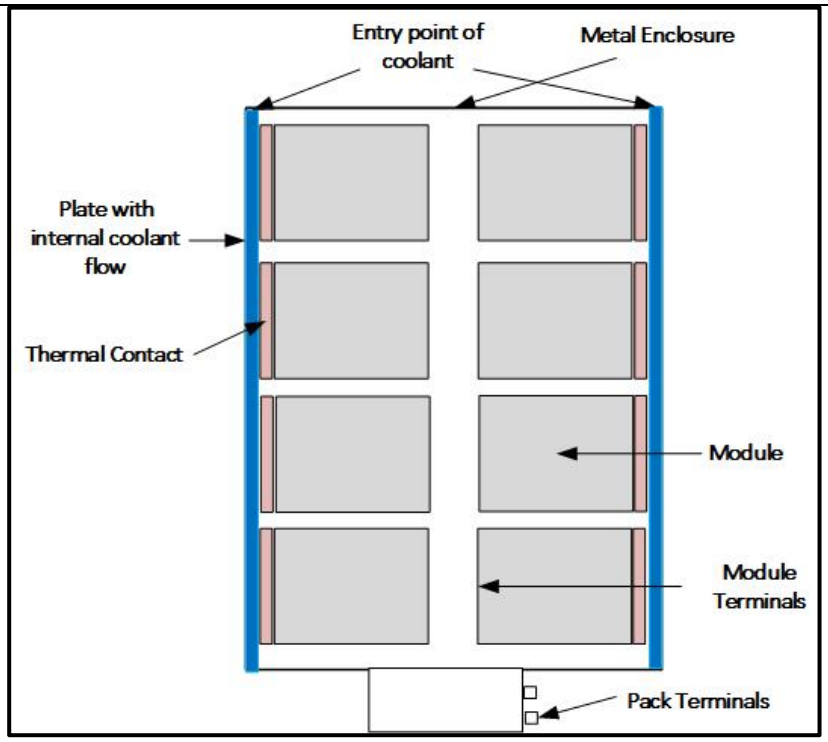
| | empirical thermal model for use in system-level simulations. This model predicts pack-level thermal behavior by reporting the minimum, maximum, and average temperatures within a system typically used for large automotive applications, as testing was concentrated on transit bus usage profiles.<br><br>This work supports battery system integration and management. The tools produced are intended to assist automotive engineers to achieve optimal system performance and ultimately a more efficient vehicle. |
| Describe Implementation of Research Outcomes (or why not implemented) | |
| Place Any Photos Here |  <br>Battery Pack Layout |
| Impacts/Benefits of Implementation (actual, not anticipated) | |

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| Web Links<br>• Reports<br>• Project Website | Final report (MNTRC Website):<br>http://transweb.sjsu.edu/project/1150.html<br><br>Final report (TRB Website):<br>http://trid.trb.org/view/2015/M/1349861 |