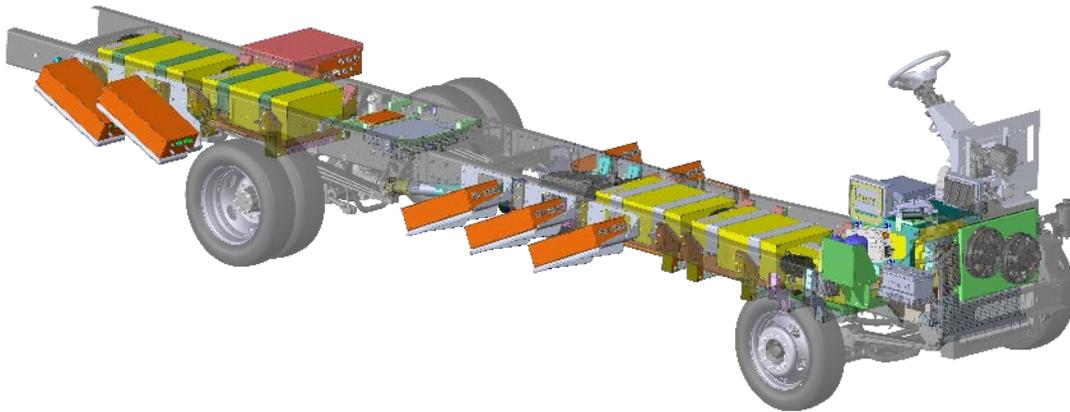

The Motiv Advantage: Technology

By Grayson Zulauf and Jim Castelaz. Copyright Motiv Power Systems, Inc. 2015

Motiv was founded on the understanding that the commercial vehicle market is ripe for all-electric vehicles, if only one could enable electrification across chassis, bodies, and end-users without starting from scratch each time. Electric vehicles have long been of interest to medium- and heavy-duty fleet owners, but technology advancements have been slow to arrive due to the diversity of needs, low production volumes, high power requirements, and lack of scalable solutions. Motiv's technology fundamentally changes the options available for fleets. Our patented system topology and deep expertise in dynamic controls, power electronics, and embedded software combine to form an unmatched technology platform on which to produce medium- and heavy-duty all-electric commercial vehicles.



The ePCS Topology

Motiv has succeeded at electrifying a true breadth of vehicles because of the “electric Powertrain Control System,” or ePCS, an all-electric powertrain that works no matter what chassis, battery or motor it is powered by or powering. The key innovation, and core intellectual property, is an architecture that abstracts battery characteristics – including chemistry, voltage, and power – from the operation of the rest of the system.

Dynamics Controls

To accomplish this abstraction, Motiv faced the challenge of building a traction inverter and motor power bus without the benefit of a direct battery connection to stabilize the voltage. The ePCS utilizes high-power, bidirectional 30 kW DC-DC converters (we call them APCs, or Adaptive Power Controllers) to convert between the battery voltage and the traction inverter voltage. Building a high-power, highly-flexible DC-DC converter is in itself a complex dynamic controls challenge, but paralleling up to 10 of these – like on our Refuse Truck – provides entirely new challenges with hundreds of amps flowing through the system at voltages over 700 volts. Motiv's propriety dynamic controls algorithms form the heart of a system that works independent of power or voltage, allowing us to quickly electrify both a 7-ton Type A school bus and a 33-ton refuse truck.

Power Electronics

All-electric commercial vehicles require power levels greater than standard consumer electric vehicles – an enormous challenge for building chargers, converters, and motor drives. Thermal interfaces must be robust and high performance, devices must be highly rugged and withstand high power and high voltage, and the magnetics must be precisely designed.

Like our competitors, Motiv had the option of buying off-the-shelf components for the power electronics – but we bet on doing it better ourselves. One example of how this bet has paid off is Motiv’s charger. Numerous on-board chargers exist in the industry, but none rival Motiv’s charger in performance, power density and functionality. Motiv’s charger supports power levels up to 60 kVA, is over 98% efficient, and allows our customers to charge from any standard grid power type. Our customers –with identical hardware and software – charge from J1772 Level 2 stations, 3-phase 208-V lines, and 3-phase 480 V lines. On top of this, the price is less than one-fifth of the closest off-the-shelf option.

You will find the same best-in-class performance inside every box marked “Motiv,” along with a promise to continue to invest in cost, weight, size, and performance improvements that our customers will see and feel.

Embedded Software

The software operating inside each of our boxes is what makes an all-electric vehicle run, literally. We conceptualize, design, write, validate, and ship our own software – with over 10 real-time operating environments on each vehicle – so we are improving it every single day. Our foundational software design includes innovative communications drivers on protocols like FlexRay – we aren’t just a CAN bus team – and features Motiv’s proprietary dynamic controls algorithms that enable the power systems. On top of these foundational and proven modules, we are implementing new features directly from customer requests and improving range, drive feel, and accessory performance, among other systems, through software improvements. New features are reviewed daily, scheduled weekly, and implemented expeditiously – all inside one building – so there is no passing the buck to “the 3rd party vehicle controller company” when software doesn’t perform up to snuff or drivers want a little more regenerative braking. One of Motiv’s newest features is secure, remote vehicle software updates which allow the new features that customers want to be installed on their vehicles without any down time or personnel intervention.

Results

Building our own technology, from the silicon to the software, is the only way we see to electrify a high-mix and high-volume of commercial vehicles. This approach takes Motiv well beyond the scope of “integrator” in expertise and practice as we build towards our vision of becoming the *Cummins of electric* – the premier electric powertrain provider for trucks and buses.

The results have validated this belief. In the four short years since winning our first vehicle grant, we have delivered North America’s first and only all-electric Refuse Truck, California’s first new all-electric school bus driving children to school every day, and five other end-user applications. We are the only company to have a powertrain in applications from refuse trucks to school buses to walk-in vans to work trucks to shuttle buses to...well, you get the idea. Beyond these “firsts,” we proudly boast repeat customer orders for both our E-450 and F-59 electrified chassis products.

We have big plans for the next four years, and beyond; we hope you will join us.