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Semiconductor technology helps break down the barriers to widespread electric vehicle adoption

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The anticipated penetration of the combustion engine powered passenger car market by vehicles with electrified powertrains – be they pure electric or hybrid - is not happening as quickly as perhaps many industry observers had anticipated just a few years ago. There are several reasons for this, not least that many automakers such as Ford and Volkswagen have been able to develop smaller capacity engines with direct gasoline injection and newer turbo technologies that develop the required power but with high efficiency, better economy and lower emissions. In addition, battery technology has still not made the giant step needed to enable the development of mass production electric vehicles that have a range between charges that sits comfortably with the car buying mass market segment and puts convenience on a par with combustion powered units.

However, semiconductor companies are making large strides in developing technologies and high efficient devices to control and manage electrified powertrains to help make them more viable as an alternative solution to combustion engines. For example, next generation Trench Field Stop IGBTs and Free Wheeling diodes that utilize state-of-the art silicon technology along with thin wafer implant and annealing technologies can support Electric vehicles applications such as On board battery charger, DC-DC converter and DC-AC inverter to drive main motor Intelligent power modules (IPMs) and power integrated modules (PIM) in highly efficient, small form factor packages that utilize direct-bond-copper (DBC) or insulated-metal-substrate-technologies (IMST) are also contributing to the ongoing innovation, as is the system-level optimization of IGBTs and fast recovery diodes aimed at hard-switching motor control applications to minimize power loss and improve overall system efficiency which has direct impact on the range. Sophisticated motor control techniques are now possible and being successfully implemented through the use of the latest digital signal processors (DSPs) and microcontrollers. Combined, this kind of technology from companies such as ON Semiconductor is enabling vehicle battery life to be managed and conserved and therefore providing an important area of support in stretching the achievable mileage between charging.

As well as lengthening the time between charging cycles, another clear objective is to shorten the length of the charging cycles themselves. The fast-paced lifestyle of consumers doesn’t always allow for protracted periods of time from when they return home in their car to when they next need to use the vehicle.

The charging time for the typical family electric vehicle available today is improving rapidly as new iterations of vehicles are launched by the big name vehicle manufacturers. In terms of home charging, the Nissan Leaf for example, can go from a 0% to 100% charge in approximately eight hours using the standard 16 A home charging configuration. An upgrade from the standard 3.3 kW on-board charger to a 6.6 kW version can shorten that charging time to just four hours. DC fast charger close to 50KW away from the home at dedicated charge points is claimed to allow the LEAF to charge from 0% to 80% in approximately 30 minutes.

One of the many factors that is facilitating the improvement of the charging speed of electrified vehicles is electrically robust components in the charging circuit that have high voltage, high current carrying capabilities with very high efficiency. Power switches developed from materials such as GaN and silicon carbide (SIC) enable faster switching which reduces the overall system weight and improve efficiency. IPMS and PIM’s integrated with these new WBG(wide band gap materials) enables achieving the levels of performance needed to help achieve significant improvements in charge times.

Additional areas that receive attention to further improve performance in terms of vehicle range are increased efficiency and reduced energy demands of the ever increasing amount of body electronics required to support passive and active passenger comfort, convenience and safety. For example, vehicle climate control functions are being improved to make them more energy efficient. When the cabin needs heating, thermal shutters can reduce the amount of cold air entering the engine compartment - thus making more heat available for the cabin. Solar panels on the roof can be used to drive small fans for removing hot air from the cabin when required. Integrating start-stop systems in vehicles enables cars to turn-off at red light and conserve energy during idling.

Regenerative circuits for braking, suspension and other vehicle systems can harvest valuable amounts of electrical energy during ordinary driving to charge the batteries and therefore extend range. The effectiveness of regenerative circuits is getting better all the time through the use of innovative control schemes and high efficiency power devices in power dense packaging.

Finally, in terms of presenting this information to the driver, the accuracy of battery monitoring systems is improving. Of course, just like a combustion engined car, if an electric vehicle is driven hard with aggressive acceleration and braking, then its range will be shortened versus a smoother more progressive style. The use of advanced software and algorithms means that prediction of range is becoming better and will not fluctuate wildly during a journey as there is a learning and predictive element to the way it makes calculations. This is reassuring for the driver and installs greater confidence that can help make or reinforce the decision to go electric!

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