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Chip my Ride – Silicon and Vehicle Efficiency

By Oleg Khaykin, President and CEO of International Rectifier

Semiconductor technology is absolutely essential in delivering efficiency improvements for conventional, hybrid and electric vehicle designs.

With the first 'electric carriage' invented at some point between 1832 and 1839 by Scottish pioneer Robert Anderson, the electric car has a significantly longer history than that of the internal combustion engine (which didn't make its debut until 1883). Powered by non-rechargeable cells Anderson's crude vehicle may have had limited commercial potential, but it was the start of over 170 years of interest in the viability of battery-powered vehicles. Since then, many electric vehicles have come and gone - including International Rectifier's own prototype, which was developed in 1958 for the purpose of demonstrating the viability of silicon controlled rectifiers (SCRs) in electric vehicle drives and which can be seen on display at IR's Temecula, US facility.

Fast forward to today and the electric vehicle has come a long way, as demonstrated by the recent launch of the Tesla Roadster. A true sports car (with a price tag to match), this fully electrical vehicle is capable of 0 to 100kph in four seconds and claims a top speed of over 200kph. At the same time, there has been tremendous investment and progress in the development of hybrid vehicles, illustrated by the popularity of the Toyota Prius - many of which can be found gliding around the same Los Angeles streets that IR's electric vehicle travelled forty years previously.

Right now, interest in hybrid and electric vehicles is at a peak thanks to the pressure to cut carbon emissions and concerns regarding the stability of supply and the cost of oil. These same concerns are also fuelling demands to make conventional petrol-, diesel- and (increasingly bio-fuel-) powered automobiles more efficient. And, while we may have moved on from the SCRs of the 1960s, semiconductor technology remains at the heart of this search for automotive efficiency.

Semiconductor content

According to a recent report from industry analyst iSuppli, the semiconductor content of the conventional automobile will double in the five years from 2007. Some of this growth will come from replacing heavy mechanical systems with lighter and more efficient electronic/electrical technologies such as power steering systems and brake-by-wire designs. Power semiconductors are a vital element of such systems and almost all other vehicle electronics - from control of pumps, fans and blowers to driving HID and LED headlamps and powering MCUs, peripherals and other silicon in safety, security, comfort and infotainment applications.

According to iSuppli, a mid-sized petrol engine car uses around 430 semiconductor devices, split between MCUs, memory, ASICs, power ICs, analogue ICs, LEDs and CCDs (with the MCU making up the greatest proportion of the semiconductor cost). In the case of a similarly sized hybrid, however, there is likely to be around 730 semiconductor devices, with the majority of this total being dedicated to the power transistors and power discretes related to inverter and battery circuits.

Finally, it is reasonable to suggest that the semiconductor content of fully electric vehicles is going to be even higher than that of their hybrid counterparts. Critical to the performance of the Tesla Roadster mentioned earlier, for instance, is the Power Electronics Module (PEM) which contains high voltage electronics and performs functions such as motor torque control, regenerative braking control, and charging. Then there is the ESS (Energy Storage System) that uses the same lithium ion cells commonly used in laptops. Tesla has built its battery pack with 11 individual sheets of 621 cells, with each sheet requiring a semiconductor device to evaluate and monitor the cells for charge balancing, cooling, and safety.

Powering the future of automotive design

What is clear is that, as we move forwards, semiconductors will play a key role in the development of ever-more efficient vehicles. It is for this reason that companies such as International Rectifier are investing considerable resources in developing new technologies – including mixed-signal processes that meet automotive reliability requirements and allow high voltage analogue electronics to be integrated onto the same IC as digital control - that will meet the rapidly evolving needs of designers, irrespective of the underlying power train architecture.

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