Automotive 4.0 – The new revolution?

Bus-fleet infotainment ready for "AUTOMOTIVE 4.0"
The automotive segment is often misunderstood quickly being solely associated with cars and related applications. It is however much bigger than that, including a broad range of applications such as buses, trucks, industrial vehicles, mobile machinery e.g. mining equipment, forklift, cleaning automated machines, emergency, service vehicles. Currently everyone in industry is talking about the increasingly famous INDUSTRY 4.0, which is often referred to as the fourth industrial revolution.

INDUSTRY 4.0 provides for what some call a "smart factory". Within the modular structured smart factories, cyber-physical systems monitor processes, creating virtual copies of the physical world enabling decentralized decisions. Over the Internet of Things, cyber-physical systems communicate and cooperate with each other and with humans in real time and, via the Internet of Services, both internal and pan-organizational services are offered and used by participants of the chain. The effects of applying INDUSTRY 4.0 upon the automotive industry can be translated into an AUTOMOTIVE 4.0 concept.

In 2016, more than 60% of cars are equipped with a color screen, part of the infotainment systems and the demand on the quality of the information delivered to the driver and passengers is very high. We all expect the same user experience from our cars as we get from our other personal devices, home entertainment and high speed connectivity. These increased expectations add complexities in interoperability and safety for the auto-manufacturers, especially when considering the promise of 5G and intelligent vehicles.

Whilst the screen is the obvious visible part of the 'iceberg', a lot of computing, sensors and other componentry make cars safer and more reliable. But collectively they are requiring increasingly efficient and robust power solutions. In the car industry power management is often achieved by a set of power-management integrated-circuits (PMIC), part of the centralized embedded computer system. Semiconductor manufacturers are offering a large range of PMIC's, with the latest generation including digital-control and advanced communication interfaces.

If the car industry represents the mass market for automotive infotainment systems, with the development of larger cities and growing demand for inter-city exchanges, existing train networks are often insufficient on their own and require complimentary fleets of buses to enable passengers to reach destinations effectively.

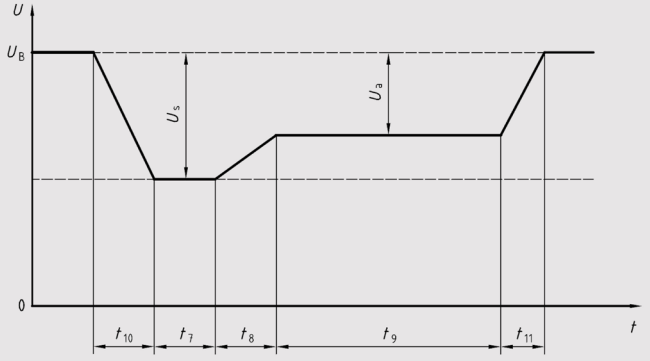
A recent study reported that the global demand for buses is projected to grow more than five percent per annum to 664,000 units in 2018, twice as fast as the 2008-2013 rate of increase. The number of buses in use worldwide is expected to exceed eight million units in that year and many of them will incorporate advanced infotainment and fleet monitoring equipment requiring stable and reliable power solutions.

Connected buses
As with airplanes and the new generations of high-speed trains, infotainment equipment is often installed in passenger seat, requiring local power sources immune from line disturbances, with low level of radio-emissions and able to work without forced air cooling. In addition, bus manufacturers are requiring seat-manufacturers to make seats simpler and easier to maintain (and upgrade), with less cabling and interconnections.

To satisfy these requirements seats will depend upon simplified connectivity, limited to only one power cable and an optical fiber for data-transmission, meaning that the power source powering the infotainment equipment must be installed within the seat, placing high demand on power supply manufacturers.

For decades power supplies for such equipment used to house underneath seats, utilizing free air convection cooling. The new generation of power modules however must operate without airflow thus they must be design-optimized for conduction cooling (e.g. baseplate

Figure 1 – New generation of DC/DC converters (Powerbox ENAR100/200) designed to meet "One package to fit all" integrating advanced thermal management and high efficiency topologies for automotive applications.



Parameter	12 V system	24 V system
U_s	– 6 V to – 7 V	– 12 V to – 16 V
U_a	– 2,5 V to – 6 V with $\lvert U_a \rvert \leqslant \lvert U_s \rvert$	– 5 V to – 12 V with $\lvert U_a \rvert \leqslant \lvert U_s \rvert$
R_i	0 Ω to 0,02 Ω	
t_7	15 ms to 40 ms [a]	50 ms to 100 ms [a]
t_8	⩽ 50 ms	
t_9	0,5 s to 20 s [a]	
t_{10}	5 ms	10 ms
t_{11}	5 ms to 100 ms [b]	10 ms to 100 ms [c]

Figure 2 – Example of ISO7367-2 pulse test, simulating supply voltage reduction by energizing the starter-motor circuit of internal combustion engines. The ISO7367 covers a broad range of electrical disturbances tests.

connected to the seat armature). To reduce power losses and optimize cooling, power converters require very high efficiency ratings with dissipative components connected directly to the baseplate (figure 01). Technologies used in high power density converters, in the telecommunication

industry, such as planar transformer, thermal via, thermal-drains and in some case heat-pumps are now being implemented throughout the automotive industry.

Powering infotainment in automotive applications demands that the power converters comply with international standards, such as ISO7637 specifying electrical disturbances for conducting and coupling test conditions for road vehicles using 12V or 24V batteries (figure 02), requiring the power supplies companies to work in very close cooperation with the equipment manufacturers ensuring the final products operate in full compliance with their environments.

Holistic fleet management

Appreciation is rarely given to the fact that modern buses are equipped with an impressive array of advanced electronics equipment requiring stable and sustainable power supplies (Figure 03). For reliability and optimization of fleet management, new generations of buses are equipped with real-time tracking capabilities connected to the navigation system, engine conditioning and safety equipment such as driving behavior analyzers. Monitoring systems are permanently reporting on the status of the vehicles, making it possible to also manage preventive maintenance and report the positioning of the fleet to a central coordinator.

For safety reasons, guarantying continuity of vital functionality, it is imperative in the event of main battery power failure, thus strategic systems include local batteries requiring micro-chargers. These micro-chargers share similarities with the infotainment power supplies, in that they are often installed in confined environments. Thus they share a need for high efficiency designs optimized around thermally managed conduction cooled mechanical formats. Designing to mitigate potential failures, caused by thermal stress, is vital and actively contributes towards high reliability units on the road.

Designers must also take into consideration specific demand for battery charging optimization e.g. measuring battery temperature, and in some cases communication between the battery charger and a central monitoring system. Such considerations need to be employed holistically in the overall design process, with suitable comparisons being made with the performances of previous generations of products, mainly based on analog control, the latest generation integrating micro-controllers and real time charging optimization. Some would argue that adding digital control in a micro-charger is an overkill

Figure 3 – Applications installed in modern buses, requiring stable power and some local battery for safety operation.

technology for such applications, whilst others would counter such arguments claiming that the technology has already proven benefits in terms of reliability and longer battery life-time.

But whatever the arguments, due consideration needs to be given to the number of power sources required to supply stable and reliable voltage to infotainment and other electronic equipment employed on buses. Bus manufacturers are increasingly requiring power supply manufacturers to develop standardized DC/DC converters, Chargers, Step down regulators that are easily installed, maintained and capable of higher powered demands, when upgrading equipment. The concept of “One package to fit all” is no longer a dream but has become reality, adding challenging mechanical constraints to the unit’s design parameters.

For power designers, bus-fleet modernization, and new generations of buses with modern infotainment and impressive array of advanced electronics equipment, there are opportunities to bring advanced power technology to a segment that has historically been very slow at adopting new technologies, taking big steps forward towards AUTOMOTIVE 4.0. Perhaps those early adopters are right to call this the fourth automotive revolution!

About Powerbox
Founded in 1974, with headquarters in Sweden and operations in 15 countries across four continents, Powerbox serves customers all around the globe. The company focuses on four major markets - industrial, medical, transportation/railway and defense - for which it designs and markets premium quality power conversion systems for demanding applications. Powerbox's mission is to use its expertise to increase customers' competitiveness by meeting all of their power needs. Every aspect of the company's business is focused on that goal, from the design of advanced components that go into products, through to high levels of customer service. Powerbox is recognized for technical innovations that reduce energy consumption and its ability to manage full product lifecycles while minimizing environmental impact.

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