Powering Embedded Systems with Artesyn Embedded Technologies

Interview with Stephen Dow, President

Watering Solar Cells to Improve Efficiency

Implementing a Cost Effective Solution for Automotive DC-DC Converter Testing
List of speakers (excerpt):

- Simon Fürst
  BMW Group for AUTOSAR
- Andreas Klage
  DRÄXLMAIER Group
- Dr. Ludger Laufenberg
  Kostal
- Wolfgang Lenders
  BMW Car IT
- Steve Nadig
  Daimler Trucks
- Dr. Reinhard Ploss
  Infineon Technologies
- Dr. Stefan Poledna
  TTTech
- Martin Schleicher
  Elektrobit
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November 7, 2016 | Messe München
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In this installment of Tech Lab, EEWeb engineer Nick Davis showcases ROHM’s BD7682FJ series of low noise quasi-resonant (QR) converters. QR converters are used to control silicon carbide (SiC) MOSFETs in DC-to-DC power converters. Now, you might be asking: Why use a QR converter? QR switching reduces turn-on losses at the power switch, which in turn increases efficiency and lowers the device temperature.

Both quasi-resonant and non-quasi-resonant converters can operate in discontinuous mode. However, during heavy loads quasi-resonant converters switch to boundary conduction mode. For very light loads the converter goes into burst-mode to improve efficiency.

Another benefit of using a QR converter is to reduce EMI. The EMI generated by QR operation is relatively low where the typical application for such a converter resides. As mentioned earlier, the BD7682FJ controls silicon carbide MOSFETs, which are different from traditional MOSFETs due to the higher gate drive voltage required. ROHM’s QR controllers have a window of operation centered around this higher gate drive voltage, making it possible to improve SiC MOSFET performance.

ROHM’s QR converter features a supply voltage range of 15V to 27.5V and requires just 19uA for operation. Other features include a soft-start function, per-cycle over-current limit protection, brownout protection, and current mask function. ROHM also guarantees long-term support for this device, which is very important for safety and EMI testing. After all, if a customer’s board has to be redesigned to accommodate a new controller then another series of expensive and time-consuming testing for EMI and safety will be required.

To view video, click on image.

For more information visit ROHM.com.
In this video, EEWeb engineer Nick goes over Infineon’s XMC1100 Boot Kit and their 24V Protected Switch Shield for Arduino. The XMC1100 Boot Kit is an Arduino compatible base board using Infineon’s XMC1100 ARM Cortex—M0 32-bit Microcontroller. The 24V Protected Switch Shield is an evaluation platform for testing Infineon’s BTT6020-1EKA and BTT6030-2EKA smart high-side switches. The 24V Protected Switch Shield comes fully assembled. However, due to cost reductions, the base board comes without pin headers assembled. But once you have selected and soldered these to the base board no other additional assembly is required. And, both the base board and the shield are Arduino compatible meaning they include pin headers and screw-holes in their PCBs allowing for easy mounting to custom motherboards.

The BTT6020-1EKA and BTT6030-2EKA PROFET +24V Smart Switches are ideal for home and building automation in addition to 24V applications for commercial, construction and agricultural vehicles. These PROFET switches are designed for controlling resistive, capacitive, and inductive loads. Both the BTT6020-1EKA and the BTT6030-2EKA are smart high-side power protected switches and behave similarly to MOSFETs. The term “high-side” simply means the switch is placed between the supply and the load, as opposed to a “low-side” switch, which is placed between the load and ground.

An advantage of using a high-side switch is when the switch is in the OFF state, the load is isolated from the supply. Because the wiring harness is also disconnected from the supply, there is no electrical galvanic corrosion, which results in a lower system cost due to reduced wiring repairs and replacements. The BTT6020-1EKA is a single-channel part capable of loads up to 7A while the BTT6030-2EKA is a dual-channel part and designed for 4A per channel, when both channels are active, or 6A for a single active channel. The switches are N-channel DMOS with integrated charge pumps, are PWM capable, and have inputs compatible with both CMOS and TTL. Keep in mind, however, the limited thermal performance of the 24V Protected Switch Shield limits the recommended maximum current to 5A.

Their integrated diagnostics include over-temperature, short-circuit and open-load detection, and an optional proportional current sensing of loads. Additionally, these switches have protections of current-limit and short-circuit shutdown, thermal shutdown, under- and over-voltage shutdown, loss of ground and loss of Vbb, and fast inductive energy demagnetization.

Infineon’s XMC1100 Boot Kit and 24V Protected Switch Shield are great for home and building automation projects including HVAC systems, indoor or outdoor lighting, garden watering, and automatically opening or closing windows, doors and sun blinds. Or to take a different approach, you can control the internal electronics of machines such as elevators, refrigerators, sewing machines, lawn tractors, or robot lawn mowers.

The combination of the Infineon XMC1100 Boot Kit and 24V Protected Switch Shield is an easy-to-use platform for rapid development, evaluation, and testing of home and building automation applications for the Arduino user. For more information on these switches and other devices from Infineon, please visit www.infineon.com.
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Implementing a Cost-Effective Solution for Automotive DC-DC Converter Testing

A DC-DC converter is an electronic control unit (ECU) that converts a source voltage from one level to another. To ensure the DC-DC ECU operates seamlessly, manufacturers first have to put the ECU through rigorous functional tests while it is still in the manufacturing facility.

By Lok Teng Kee, Keysight Technologies
Functional testing of a DC-DC converter generally requires power input and load output simulations to measure the stability and integrity of voltage outputs, power efficiency, etc. Power levels may range from low to high. Automotive applications typically use higher power DC-DC converters, with ranges beyond 200 W.

DC-DC converters are used in start-stop systems of automobiles—these systems automatically shut off engine combustion during standstill, restarting the engine only when the driver engages the accelerator. These systems are seeing increased implementation, driven by the industry’s efforts to create “greener” environments with reduction of carbon emissions.

**DC-DC Converter Functional Testing**

A DC-DC converter is used to provide in-vehicle comfort—maintaining a 12 V supply to prevent any form of interruption to the vehicle’s infotainment and fan ventilation systems during engine startup. Figure 1 is a simplified block diagram that illustrates the function of a typical DC-DC converter ECU during activation. Whenever the battery voltage decreases to a level lower than 12 V due to impulse start-up, a trigger signal will be sent to the ECU, to boost the voltage and maintain it at a constant output level at around 12 V.

**Condition Simulations**

Functional testing of the DC-DC ECU requires a battery input emulator that is able to generate arbitrary waveform types of high power input to the ECU. Manufacturers typically create their defined impulse input pattern; figure 2 illustrates an example voltage impulse input emulated for testing purposes. A high power dynamic DC power supply is required to create an arbitrary voltage pattern with high inrush current to simulate the battery’s transient condition in the test process.

To achieve the right functional testing scenario, you will need dynamic DC power supplies capable of generating pulses from 12V to 6V at around 1-2 ms falling time, meeting the requirements of transient response emulations for most automotive batteries. It is also important to choose the appropriate power supply to minimize your initial set-up costs. There are instruments such as the Keysight N7951A/N7971A with 1 kW and 2 kW options rated at 20 V offering selections for lower (< 300 W) or higher power (> 300 W) types of ECUs in the market. This allows you to have greater flexibility to work with different power needs while leveraging the same equipment.

In addition to input emulation, electronic or passive loads are required to simulate the effects of on-board vehicular electronic networks. A load switching solution is needed to provide the flexibility of load disconnection and connection to establish open/close loop circuitries for functionality checking. The solution must also be able to tolerate handling of high current for...
automotive applications. Test engineers often need to develop custom switches for load connectivity, in consideration of safety and protective circuitry in the event that the ECU fails. Particularly in the high-mix automotive manufacturing industry, frequent re-design of custom switches is required to cater to different ECU applications—this incurs time and expenses. Therefore, a standard load switching solution usually provides better return on investment. Some solution providers such as Keysight offer standard load switching solutions—these off-the-shelf solutions are qualified for long hours of high current operations of up to 40 A per channel, which are typical requirements for automotive manufacturing test.

Measurement of Power Efficiency

Power efficiency is generally defined as “Power Efficiency = \( \frac{VI_{Output}}{VI_{Input}} \times 100\% \),” where \( VI_{Output} \) and \( VI_{Input} \) are the ECU output and input power consumption correspondingly; higher efficiency means less power loss during conversion. Power analyzers are very useful for engineers who want to quickly measure AC/DC power consumption, efficiency and quality. Multi-channel analyzers can simultaneously measure both input and output powers at very high accuracies. However, it may not be necessary to use a high precision instrument in the production line, since functionality checking does not need the accuracy and speed for analysis or characterization during the design phase. In addition, functional validations usually test operations at critical levels only. Figure 2 illustrates the typical levels tested in phases A, B and C of a battery input signal.

One can use a digital multimeter (DMM) to measure both input and output voltages and currents when they are static. Voltage measurement is relatively easy to capture by probing inputs/outputs reference to ground. For current measurement, instead of using the DMM as an “ammeter” that only works for low current measurements, a current shunt method is used. A current transducer or sensing resistor is placed in series at all inputs/outputs, and a DMM is used to measure its differential voltage that eventually will be converted to a current using Ohm’s Law \( V = I \times R \). Lastly, power efficiency can be calculated using obtained inputs/outputs voltage and current results.

Key sight’s TS-5000 load switching solution offers the capability of current sensing. The load cards are incorporated with either a sense resistor or current transducer on every single channel for current measurement purposes. The architecture of load cards and matrix switches allows interconnection to an inexpensive basic DMM, offering a much lower cost manufacturing solution for DC-DC power efficiency measurements.

Measurement of Stability

Stability validation is required to guarantee the health of the DC-DC converter during activation. A dynamic DC power supply is programmed to generate battery impulse patterns. A digitizer is then used to capture input impulse patterns for verification of desired falling and rising speeds. Besides input validation, the digitizer is also used for output stability measurements. Voltage output waveform is acquired during ECU activation. The full waveform illustrates the overall output stability—ripple, average, peak to peak and settling speed throughout boost mode. A digitizer with a minimal sampling rate of 0.1 us is recommended—this high resolution setting helps to capture any sudden glitch or spike.

Automotive batteries typically operate at around 12.6 V, so the digitizer must also be capable of detecting input signals at > 10 V. Higher-power type of DC-DC converters typically come with multiple inputs/outputs, and you will need a digitizer with more than two channels in order to measure all inputs and outputs simultaneously. Input and output waveform acquisitions need to be synchronized within the same time frame, displaying the correlation between all inputs/outputs, and also shortening the total test time.
Keysight’s M9217A/L453xA digitizer comes with two or four isolated input channel options for simultaneous measurement. The high input voltage at ±256 V also eliminates the need for input signal attenuation for typical data acquisition instrument with ±10 V dynamic range. For DC-DC converters with multiple inputs/outputs, the number of channels on the digitizer can be multiplied by configuring additional digitizers within the system, while synchronization can be achieved via its triggering capabilities. This scalability enables the user to upgrade the solution with the existing setup without migration needs to other instrumentation.

Conclusion
Cost of test is one of the key factors in the total cost of manufacturing an ECU. Automotive manufacturers often spend time on developing their own rack-and-stack test system, and may end up spending more on sourcing higher cost instrumentation. Overall cost can be greatly reduced by choosing the right instrument, or using the right test methodology. Choosing cost effective instrumentation and load switching solutions with commercial test-executive software as the foundation can help to increase manufacturers’ competitiveness in the automotive industry while keeping costs manageable.

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Why WATERING SOLAR CELLS Can Actually Improve the Technology’s Power Efficiency

Researchers make surprising discovery about renewable technology

While perovskite solar cells are a relatively new form of renewable energy technology, they are gaining considerable attention. That’s because they have doubled their efficiency to 22% since first being introduced less than a decade ago. Additionally, they are lighter, cheaper, and more flexible than the traditional crystalline silicon-based cells.
The term perovskite comes from the light-harvesting layer that differentiates them from other types of solar cells. During the manufacturing process, they are exposed to ambient air for a few hours after fabrication has been completed. This step improves the cells’ efficiency, though no one had a clear explanation as to why—manufacturers just know that it works.

Now, it appears as though it’s understood, and with this explanation, comes a recommendation for improvement. The recommendation comes from a team of researchers at the Okinawa Institute of Science and Technology (OIST) Graduate University, who were led by Professor Yabing Qui. Their results were published in the journal Advanced Materials Interfaces.

“It’s intriguing: why do we need ambient air to enhance the effectiveness of perovskite solar cells?” said Zafer Hawash, first author of the study and an OIST PhD student. “Which component of the ambient air is linked to this phenomenon?”

The team used these questions as the foundation for their study, and began by looking at the top layer of the solar cells—a logical choice given that perovskite solar cells have within them several layers. The top layer is the one that comes in contact with ambient air; as such, it’s the layer most likely to be affected by the external environment.

Before getting into the team’s findings, it is worth explaining that this layer is referred to as the “hole transport layer” because it has a dopant, or a substance added to enhance the electrical conductivity of the material. Researchers have gotten as far as understanding that the dopant of the hole transport layer plays an important role in improving the solar cells’ performance, but not why.

What the team ended up doing is exposing the layer to a variety of environmental gases—specifically focusing on oxygen, nitrogen, and moisture (water in a gas state). After each exposure, they checked the electrical properties of the layer to determine if and how the inside of the transport layer changed.

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“TFSI—a salt: This is the eureka moment—you see, given that it is a salt, it has a hygroscopic nature or, in layman’s terms, it absorbs water. So, when the solar cells are exposed to moisture, the water that is absorbed by the transport layer causes the dopant to redistribute, thus improving the cell’s overall performance and efficiency.

Worth noting—overexposure can have a negative impact on the solar cells, so time exposed to moisture needs to be monitored.

The team also documented the role of oxygen within the solar cells, and how it impacted the technology’s performance. “Oxygen enhances the electrical conductivity of the transport layer as
well, but this effect does not last long," Hawash commented. "But with the right amount of exposure to moisture, the electric proprieties are irreversibly enhanced."

So, in conclusion, exposing perovskite solar cells to moisture after fabrication is the most effective way to improve the technology's performance, but not too much moisture.

To explore the discovery a bit more, check out the team's published paper, entitled "Moisture and Oxygen Enhance Conductivity of LiTFSI-Doped Spiro-MeOTAD Hole Transport Layer in Perovskite Solar Cells".
Powering Embedded Systems with Artesyn Embedded Technologies

Artesyn Embedded Technologies designs and manufactures power conversion and embedded computing solutions for a wide range of industries including communications, computing, healthcare, military, aerospace and industrial automation. With a long standing reputation spanning over 40 years, Artesyn continues to work on creating well-tested, reliable products for its customers. EEWeb met with Artesyn’s president, Stephen Dow, to discuss Artesyn's current and future proprietary technologies and the production and testing of their products.
How did Artesyn Embedded Technologies begin?

Artesyn Embedded Technologies was formed as a result of the divestiture of Emerson Network Power’s embedded power business. The company encompasses the former Artesyn Technologies and Astec, both of which were well-recognized, global power conversion brands prior to being bought by Emerson. Today, with its extensive ac-dc and dc-dc product portfolios, Artesyn is one of the most successful power supply companies in the world.

While you design embedded systems, it seems that your focus is more on powering embedded systems. What is it about your products that make them ideal specifically for embedded systems versus other applications?

Artesyn has vast experience and long relationships with OEMs who require technologically-advanced solutions to power their systems. Our power supplies are, except for our consumer products, designed to be located inside the customer’s equipment. And beyond the product itself, we understand how our customers use our power supplies and how our power supplies interact with the rest of their embedded system requirements. This is why our customers view us as a trusted advisor on all aspects of embedded power.

We have also built a significant business that serves the consumer electronics industry. Artesyn designs and manufactures chargers and adapters that are not embedded but are external power supplies primarily used to power mobile electronic devices. We have earned the trust of many well-known consumer technology brands and have shipped over a billion products to these customers.

What does Artesyn view as the most important aspect of a power supply?

There really isn’t a one-size-fits-all answer to this question. We know this from direct interaction with our customers and from industry roadmaps, such as the Power Sources Manufacturers Association (PSMA) Power Technology Roadmap. If there is one aspect that most agree is important, it is efficiency and energy usage. This is evident in a range of platforms such our DS3000TE which exceeds Titanium level efficiency requirements in the computing segment and our CPS250-M which draws less than 0.5W no-load power while serving medical applications.

Beyond that, key specifications are usually application dependent. In critical infrastructure applications, reliability, availability, and redundancy are key specifications. In test, measurement, and medical imaging applications, electrical noise is always a key specification.

What are the proprietary technologies that differentiate you from other power conversion companies?

The success of our leading edge power supplies depends on a number of key technologies. Two key areas of technology differentiation for us are digital control and electromechanical packaging. Early leadership positions in understanding the importance of both, and then implementing these in a high volume production environment has helped Artesyn maintain a leadership position in the highly-competitive embedded power space.

Almost all of our new platforms above a few-hundred watts are digitally controlled. This, and our proprietary packaging knowledge, helps us to minimize parts count, packaging parasitics, and drive the required efficiency, density and overall performance levels. The barriers to entry in both of these areas can be high and our continued levels of investment maintains our leadership position.

Having an Embedded Computing group within Artesyn, with its wealth of firmware and software experience, is unique to the power industry. We are able to leverage these years of experience in software and firmware as we migrate our power products from the analog world to the digital world.

Do you make bespoke power converters for customers? Or perhaps in-house integration between your products and those of your clients?

Bespoke power supplies and converters are a large part of Artesyn’s business and complement our standard product portfolio. We offer many levels of customization. For very high volume opportunities, ground-up custom designs can be worthwhile for both our customers and for our business.

At lower volumes, we encourage the use of standard products from our extensive catalog. However, even in some of these cases, we do recognize that customization or modifications may still be needed to optimize a customer’s application. Our Modified-Standard and Value-Add programs allow us to do these customizations in a cost effective, short time-to-market manner by leveraging our standard product portfolio.

In critical infrastructure applications, reliability, availability, and redundancy are key specifications. In test, measurement, and medical imaging applications, electrical noise is always a key specification.
Comprehensive test regimens are built into all stages of our development process, our production processes and even post-production.

In addition, to best serve our customers’ needs, last year we developed an online configurator tool, called ConfigPro, which calculates over 3 million configurable power supply combinations for our modular platforms, such as the 2nd Generation of uMP products. This powerful algorithm tool optimizes cost and finds the ideal solution for our customers’ requirements.

And, our channel partners are an important part of the customization ecosystem. In every geographical region, we have Value-Add Resellers (VARs) who can take our standard products and adapt them to the specific needs of our customer’s applications.

What type of testing do you perform on your different power supplies?

Comprehensive test regimens are built into all stages of our development process, our production processes and even post-production. This ranges from testing against detailed performance specifications, through stress testing and rigorous environmental testing, and on to safety and compliance testing. In a production and post-production environment, similar tests and additional reliability testing are often performed. And as the control of power supplies migrates from the analog realm to the digital realm, we have implemented comprehensive software and firmware testing. Investment in capital equipment, state of the art labs and employee training means that most of this capability resides in-house.

How do you approach the design and testing of your low-power, 3-10 watt devices versus your 1,000+ watt devices?

We have a common development framework within Artesyn to ensure best-in-class design results. Flexibility is built into these frameworks to optimize the development process for different types of products and their different applications. The adaptation and optimization is related more to design and test for specific applications than it is for power level. For example, a 250W open-frame power supply intended for application in an enterprise switch would have more in common with a 1200W power supply for an enterprise application than it would when compared with a 250W sealed power supply intended for a wet or dirty outdoor application. The approach to design and testing would align, or differ, accordingly. We have shipped over a billion mobile charging power supplies, something that would not be possible without these proven design and test processes.

If you can share, what are your next technological steps to make sure that you’re still a leader in the power industry?

The market will continue to expect improvements in efficiency, reliability and cost. In close consultation with our customers and suppliers, we will continue to lead the industry in addressing those challenges with the innovative new products we are currently developing.

Increased levels of integration will be key as we continue to drive efficiency and density improvements while maintaining the needed levels or reliability and a cost-competitive position. Integration will encompass active devices, passive device and interconnects. And thermal management of these integrated devices will be of high importance. Digital configuration and control will help maintain the flexibility of these technologies and leverage them across different platforms and applications.

Through these technology advances and innovations, we will continue to deliver performance-driven and cost-effective solutions to meet, or exceed, our customer needs.

Related, do you see any large leaps in power conversion technology in the next ten years or continuous incremental improvements?

The power supply industry is looking closely at the technical and commercial viability of wide-band gap switching technologies, including gallium nitride (GaN) and silicon-carbide (SiC). These technologies are being used in niche applications, but are not yet cost-effective in more mainstream applications. The adoption of these technologies will result in additional efficiency and density gains. Only time will tell whether these changes will be significant or incremental. Regardless, Artesyn will be in a position to take advantage of these advances in technology.

If you could boil it down to one thing, what would you attribute your success to?

Artesyn is a global company with well-respected engineering centers of excellence backed by world-class manufacturing. We know our customers and their applications, and we can deliver on their needs.

For more information, visit www.artesyn.com/power.