Case study

Enabling a Major Leap in Power Density

Implementation of Trench Schottky diodes leads to compact, efficient AC/DC power supply design

The development of power supplies can often be a difficult process. They are expected to reach heightened levels of efficiency, whether that is for AC-powered or portable equipment, while still being as compact as possible. Cost is another important factor, and it also goes without saying that the power supplies must be reliable and safe.

One company facing and subsequently overcoming these design challenges is Recom — a highly successful European manufacturer of AC/DC power supplies and DC/DC converters headquartered in Gmunden, Austria. For a recent project, Recom wanted to develop an AC/DC power supply which was intended for medical and other applications. The goal was to create a solution which had double the power density of the company's previous model without sacrificing safety, reliability, efficiency, or performance. To get there, the development team had to use the latest advances in switching controllers, topologies and components — and turned to Nexperia for help.

Figure 1:
RACM1200-V, 1200 V AC power supply by Recom Power

Strict medical requirements set the bar

The new Recom RACM1200-V power supply had to meet the strict requirements of IEC60601-1, a series of technical standards for the safety and performance of medical electrical equipment. These requirements include maintaining safety with the appropriate creepage and clearance distances on the PCB, while also keeping power dissipation at a minimum.

The product parameters specified that the AC/DC power supply needed to deliver a peak output power of 1.2 kW. As well as the main output, it was necessary to have two auxiliary outputs: a 12 V/1 A supply to power an optional cooling fan, and an always-on 5 V/1 A output for control and monitoring purposes.

To minimize standby power consumption, the overall efficiency had to remain high even when the main output was switched off. It meant that the power supply needed to be efficient at both the 1.2 kW peak load and when delivering 5 W or less in active standby — this represented a difficult set of requirements to achieve in a single device.

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EFFICIENCY WINS.

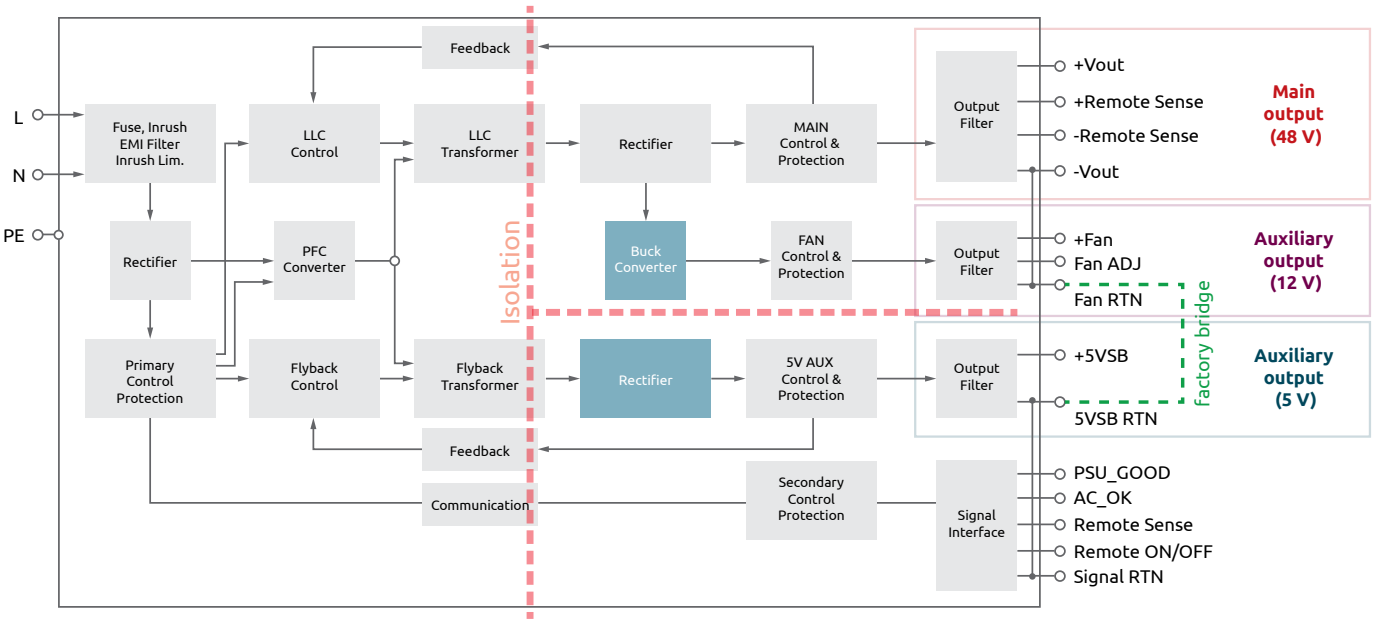

Figure 2: Block diagram of Recom's RACM1200-V AC/DC converter

As well as targeting medical usage, the power supply needed to be suitable for industrial, building automation, IT and home appliance deployments too. In terms of dimensions, it had to be compact and low profile, fitting inside a standard 19-inch rack mount enclosure.

Trench Schottky diodes step up

The most challenging part of the design was the always-on 5 V output, as this meant a separate AC/DC power supply would need to be included, and that would take up valuable space. Due to the compact size of the design, the only option for placement of this extra circuitry was near the main output components, which would run hot when delivering the output current. This meant that overheating was a significant risk, so it therefore needed to be given careful consideration when the design was laid out.

At first, Recom tried fitting planar Schottky rectifiers for both the DC/DC and AC/DC auxiliary power converters, but overheating was still a problem (particularly under full load conditions).

To solve this problem, Recom selected Trench Schottky diodes from Nexperia. The Trench Schottky diode is a development on the original concept of a Schottky diode. The trench concept reduces leakage currents, thus increasing thermal stability. It also improves switching performance compared to planar Schottky diodes.

Nexperia's PMEG100T20ELR device is now being used in the buck converter of the RACM1200-V for its 12 W fan output (see Figure 2). Provided in a small and flat surface-mounted package, this Trench Schottky diode can handle a maximum forward current of 2 A, with a maximum reverse voltage of 100 V. Furthermore, it has a very low leakage current.

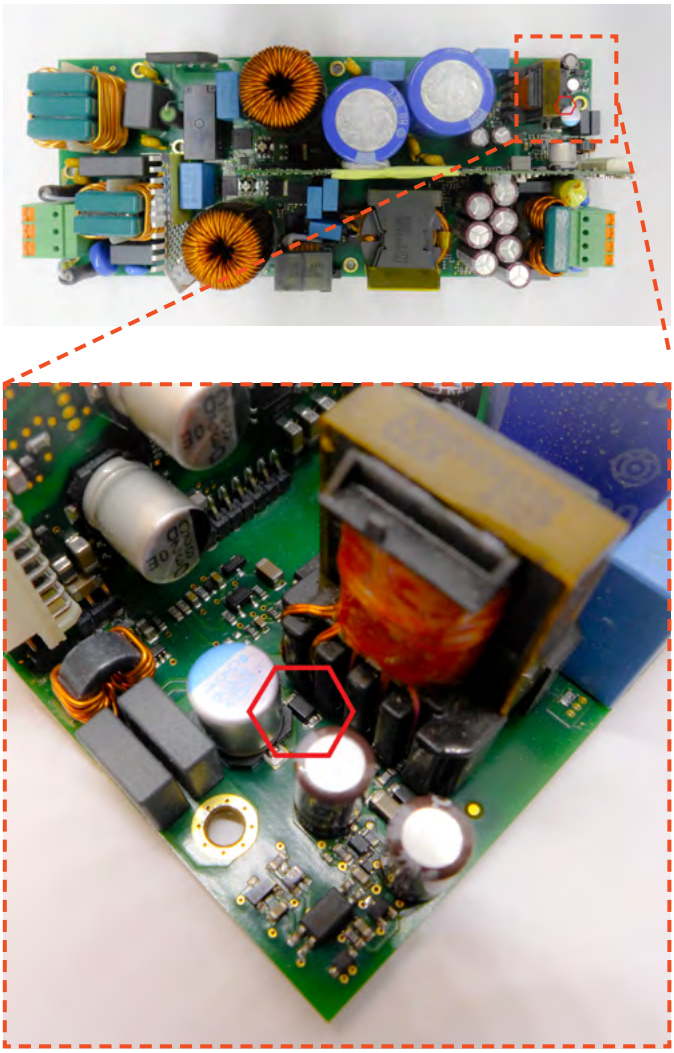

Figure 3: High density PCB of RACM1200-V including PMEG100T20ELR

Featuring low reverse recovery charge and high efficiency

The PMEG100T20ELR also features a low forward voltage drop. This is typically 705 mV and the maximum value is only 800 mV at room temperature (590 mV typ. / 660 mV max. at 125°C. It has a very low reverse recovery charge (Qrr) that is typically only 8.5 nC. These characteristics proved pivotal in minimizing the rectifier losses on each switching cycle of the converter (see Figure 4).

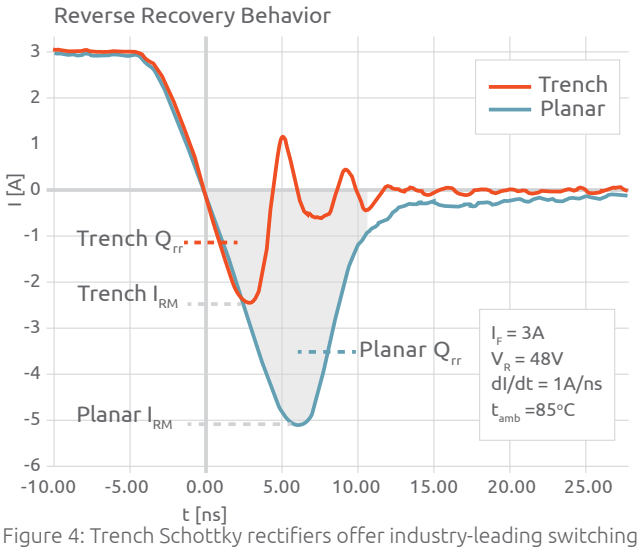

Figure 4: Trench Schottky rectifiers offer industry-leading switching behavior and low Qrr

Moreover, the selected Trench Schottky diode has a low reverse leakage current of typically only 60 nA (at 60 V reverse voltage). This was important from a DC/DC conversion perspective — with the input-to-output voltage ratio being low because the diode would be longer in its off-state, due to the high duty-cycle of the switching MOSFET. Without this one component, Recom would have had to change its power supply specifications to inferior figures, and this would have resulted in a significant compromise in performance.

Overall efficiency of Trench and Planar Schottky diodes is shown in Figure 5. This demonstrates how the benefits of using Trench diodes increase at higher switching frequencies.

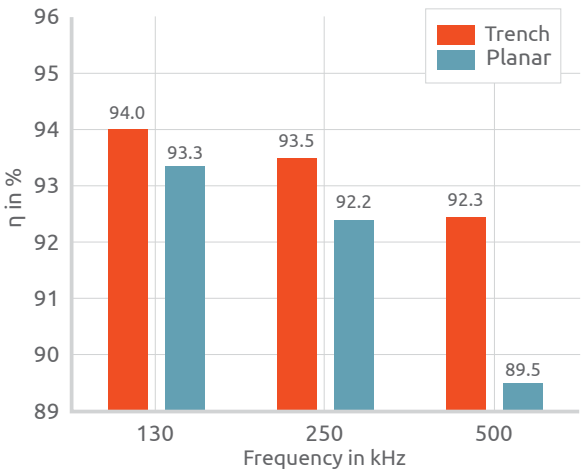

Figure 5: Efficiency compared of Trench and Planar Schottky diodes

However efficient a component might be, it will always dissipate some heat, so Recom engineers gave a lot of thought to how the parts would be cooled. The Nexperia Trench Schottky diodes use a copper clip-bonded FlatPower (CFP) technology to improve the heat conduction from the package to the board. This has a small, thin and light design format, and delivers superior thermal performance.

Improved thermal stability with a wide SOA

By leveraging Nexperia's CFP technology, Recom could design a PCB with low thermal impedance paths that would dissipate the heat generated, without needing to use gap pads or additional heat sinks for the power diodes. The Trench Schottky configuration also means that the thermal stability of the diodes is improved, with a wide safe operating area (SOA), as shown in Figure 6. This reduces the likelihood of thermal runaway in the rectifiers. Consequently, Recom engineers were able to design a power supply capable of delivering full auxiliary power and 800 W main power at 50 °C ambient temperature, without forced air cooling.

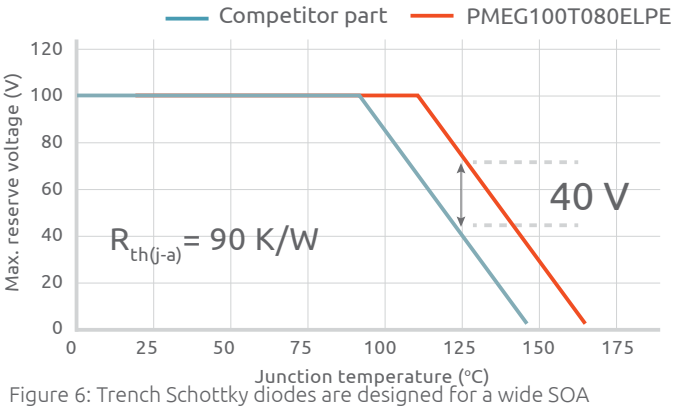

Figure 6: Trench Schottky diodes are designed for a wide SOA

To make the design fit into a standard 19" rack mount enclosure, the maximum height had to be 40 mm or less. The Nexperia Trench Schottky diodes have very low profiles and require around half the PCB space of most competing devices. This gave Recom more flexibility in terms of the other components placed on the board.

Figure 7: Nexperia Trench Schottky diode in CFP packaging requires only half the PCB space of alternative solutions

In total, the Recom power supply design comprises over 70 Nexperia products — mostly diodes, transistors and logic components, as well as three further Trench Schottky diodes (part number PMEG40T20ER). During the project, Nexperia power experts were available to support Recom with technical advice, helping its engineers to make the best design and component selection decisions.

Power supply offers high-power density and fan-less operation

Through working with Nexperia on this project, Recom was able to launch a highly efficient, baseplate-cooled power supply measuring just 228 x 96.2 x 40 mm in size. Now available on the market, the RACM1200-V can deliver a continuous power output of 1 kW with the baseplate held to 80 °C. Peak output of up to 1.2 kW is available for up to 10 s, or continuously with airflow. It achieves a peak efficiency of typically 95 %. Besides its wide range of programmable functions, the high-power density and fan-less operation of this unit makes it highly suitable for use in a variety of high-availability applications.

To meet all the design specifications envisaged for this product, Recom found that Trench Schottky diodes were the best route to take. These provided the required combination of efficiency, switching performance and thermal stability, all in compact space-saving packages.

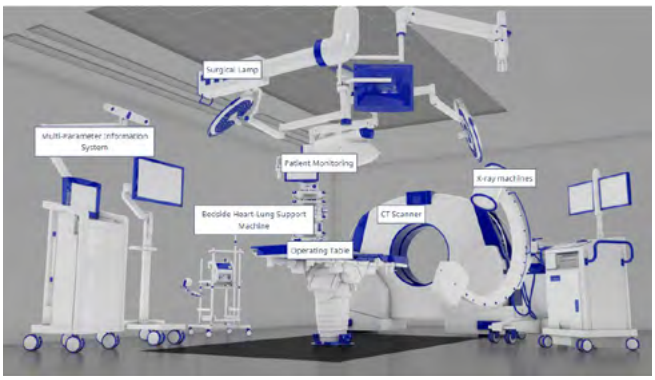

Figure 8: Medical application landscape for Recom power supplies

Steve Roberts, Innovation Manager at Recom explains:

"We looked at products from different Trench Schottky diode suppliers, and after giving each of them considerable scrutiny, came to the conclusion that Nexperia's components were the best choice. These offered enhanced thermal performance and a larger SOA, which would both be critical features if we were to meet the standards relating to medical applications. Additionally, the low profile of these products was another key advantage."

About RECOM Power

The RECOM group is a power supply manufacturer headquartered in Austria with over four decades of experience in developing and manufacturing the latest standard and custom power converter technology, from sub-1W to tens of kW. Customers worldwide have access to our vast selection of DC/DC converters and AC/DC power supplies along with a broad range of switching regulators and LED drivers, all of which comply with international safety standards and carry the latest certifications.

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About Nexperia

Nexperia is a leading expert in the high-volume production of essential semiconductors that are required by every electronic design in the world. The company's portfolio includes diodes, bipolar transistors, ESD protection devices, MOSFETs, GaN FETs and analog & logic ICs. Headquartered in Nijmegen, the Netherlands, Nexperia annually ships more than 100 billion products, meeting automotive standards. These products are recognized as benchmarks in efficiency – in process, size, power and performance — with industry-leading small packages that save valuable energy and space. Nexperia has over 12,000 employees across Asia, Europe and the US.

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