Making the Leap of Faith: Migration to Micro-Packaging

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Schottky diodes can play several important roles inside battery powered handheld electronics equipment, such as cell phone handsets and portable gaming consoles. They are often incorporated into the DC-DC boost converters used to power the backlights for LCD displays and LED keypads. They can also be used for reverse current protection in battery charging circuits. With an ongoing trend to pack more functionality into increasingly smaller, more lightweight product enclosures, the need for all constituent components, including discretes, to have the smallest possible dimensions is greater than ever.

The footprint, lead pitch and overall height of traditional surface mount packaged Schottky diodes (such as the commonly used SOD-523 format) do not adequately address the space limitations being witnessed in the latest generations of portable electronic system designs. They are as a result constraining OEM development teams as they strive to create compelling new products. The advent of micro-packaging seems to offer the industry a solution to this problem, nevertheless widespread proliferation of such components is yet to be assured.

Despite the clear advantages that micro-packaged discretes can deliver there are a number of concerns that have arisen. In the following article we will discuss each of these, and look at how more forward-thinking semiconductor manufacturers are attempting to alleviate them.

Market drivers

We are now in what could be described as ‘the smartphone era’, with leading handset manufacturers releasing increasingly feature-rich models to compete for a share of this highly lucrative market. Figure 1 shows how shipments in smartphones are representing a growing proportion of the total cell phone market. The higher level of sophistication that these products possess has to still be squeezed into to the same (or certainly similar) form factors that consumers have become used to. The larger display sizes employed by smartphone models, needed to deliver high quality multimedia content, put further pressure on where to fit all the required components. Models also have to exhibit greater power efficiencies than early cell

phone generations in order to maximize battery life in spite of their added functionality.

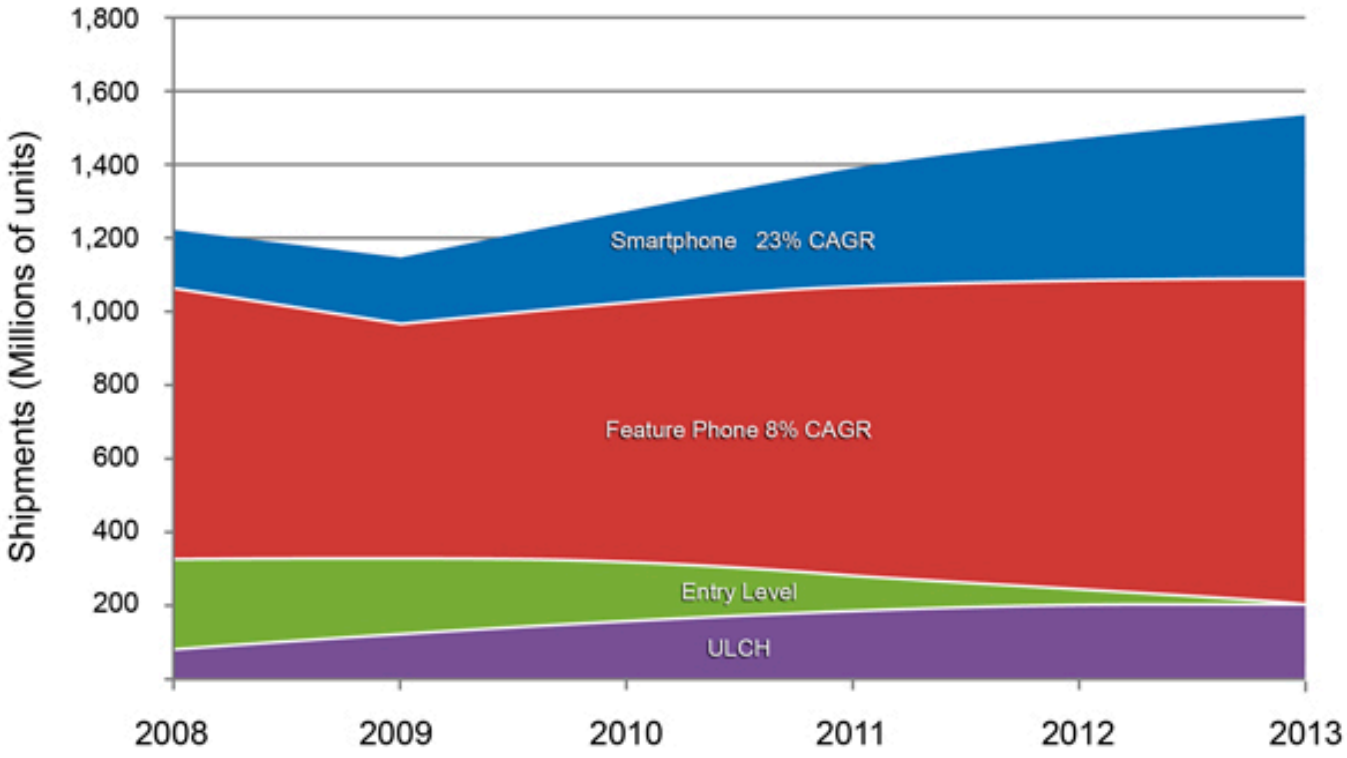

Figure 1: Cell phone handset shipments 2008-2013 [Source: iSuppli]

Changes to device packaging

In recent times much greater emphasis has been placed on the packaging employed by components, whereas in the past it was all about the process technology used. Semiconductor manufacturers have invested heavily in this area, introducing novel new approaches which support a considerable size reduction while still allowing a variety of performance metrics to be enhanced. Figure 2 shows how power semiconductor packaging has progressed over the years, with gull wing and flat lead packaged devices being superseded by ones in chipscale packages with considerably smaller footprints and lower profiles.

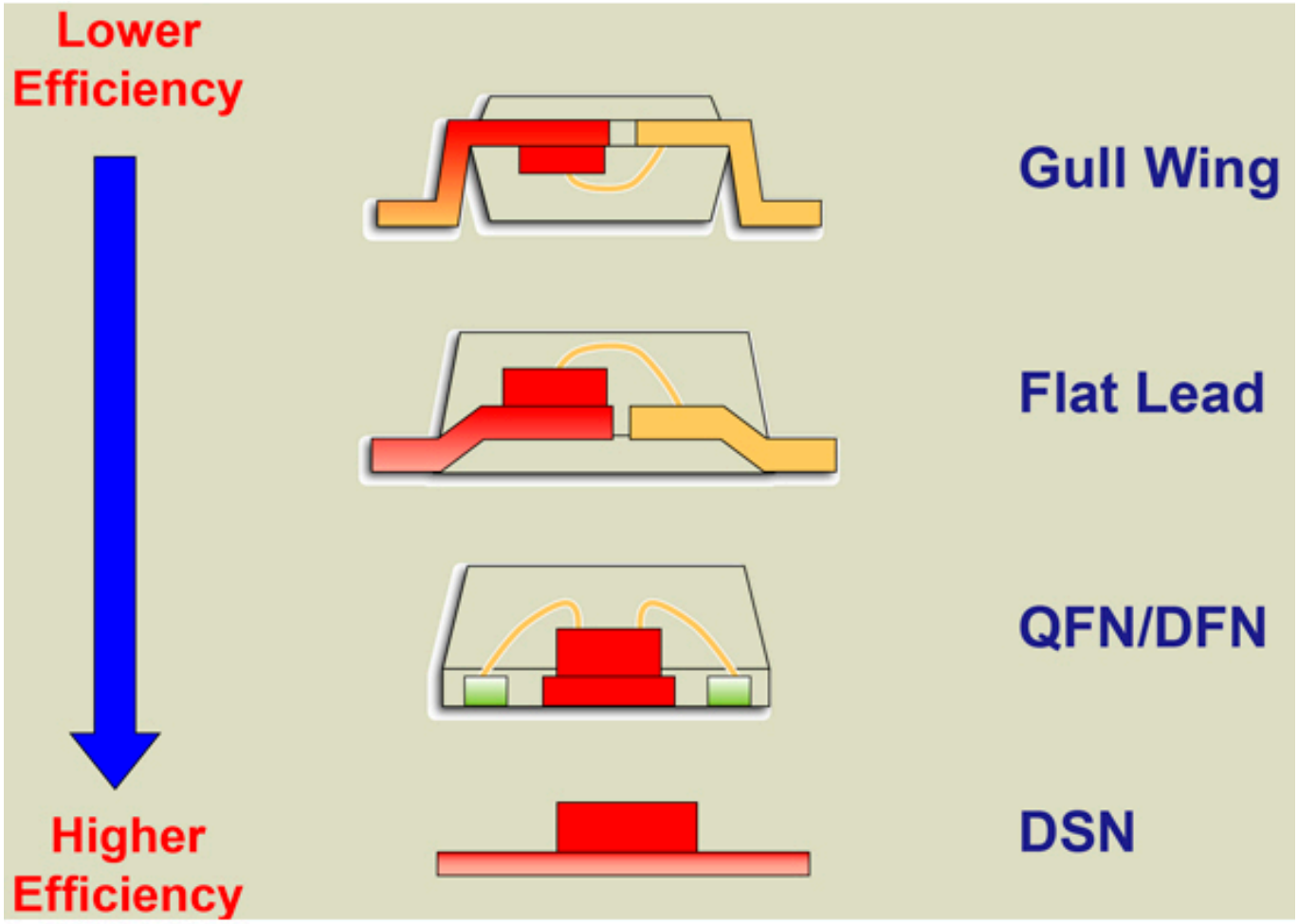

Figure 2: Evolution of discrete packaging technology

The Dual Silicon No-lead (DSN) format represents an 86% smaller solution, when comparing DSN2 0201 with SOD-523 (see Figure 3). This is a chipscale format that uses solderable metal contacts under the package similar in a style to Dual Flat No-lead (DFN) packages. As well as the space savings these micro devices offer, there is the far greater power density levels enabled that need to be taken into account. The DSN devices maximize utilization of the available silicon by providing larger active area than possible with similar size package devices. This delivers marked performance advantages for a given board space when compared to products in plastic molded packages (see Figure 4), with the forward voltage drop (Vf) being lowered, thus helping to increase circuit efficiency.

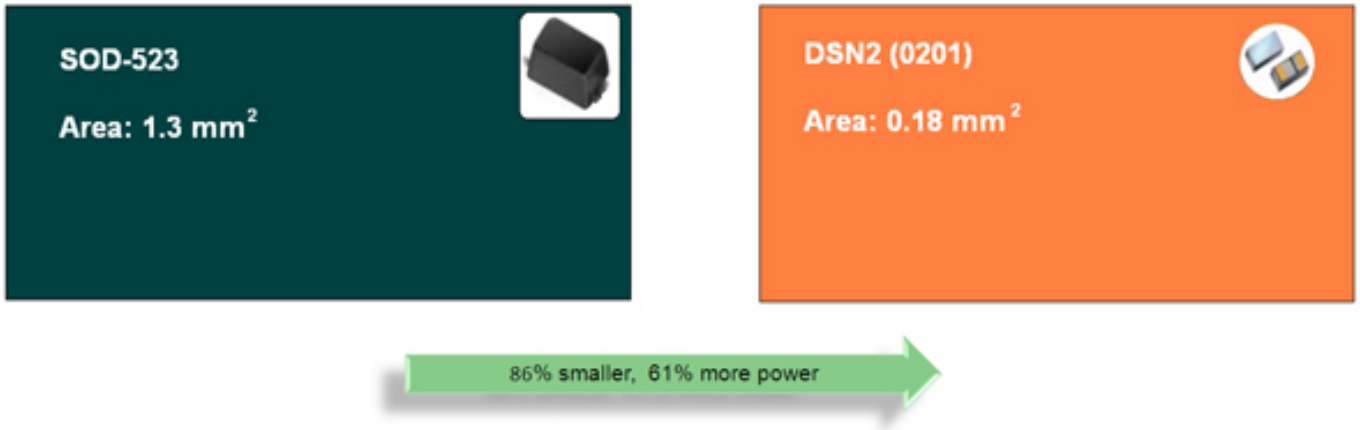

Figure 3: Comparison between DSN2 0201 and SOD-523 package types

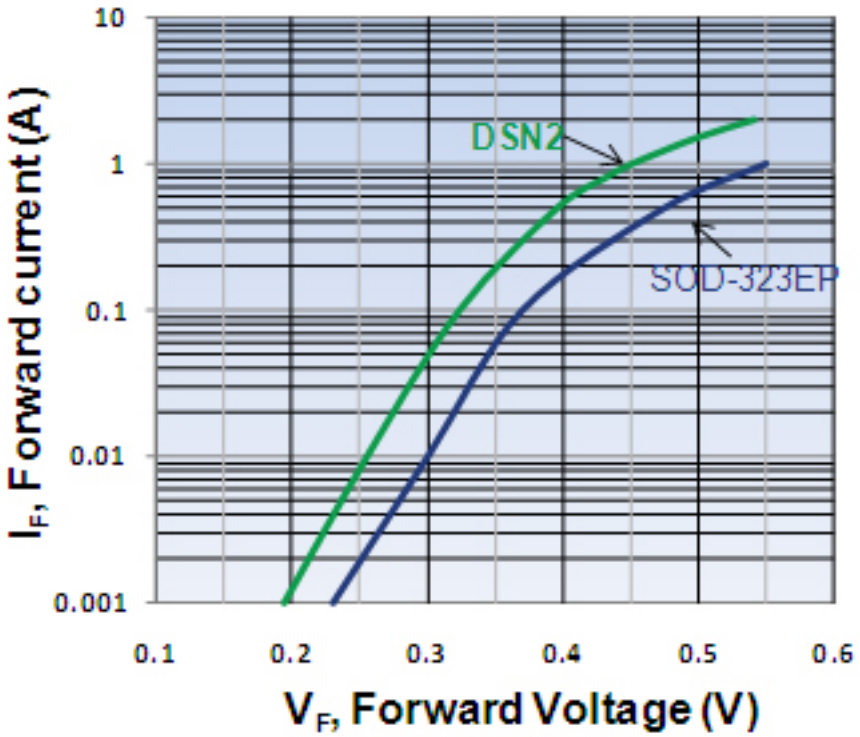

Figure 4: Performance advantages of DSN packages

The Non Solder Masked Defined (NSMD) pads recommended for the DSN components are preferable to traditional SMD pads, as it is easier to define and control the location and size of copper pad verses the solder mask opening. This is due to copper etch processes having tighter tolerances than solder mask processes. NSMD pads also allow for easier visual inspection of the solder fillet. In addition, the shorter thermal path from the die to the PCB in DSN devices supports greater dissipation of heat, reducing power losses and helping extend the battery lifespan of the product. Finally, even with the now well established RoHS guidelines in place, it is still permitted for electronics components to contain lead for the die attach, however the move to chipscale devices, such as DSN, has meant that there is no lead material involved whatsoever, resulting in more environmentally-friendly products entering the market.

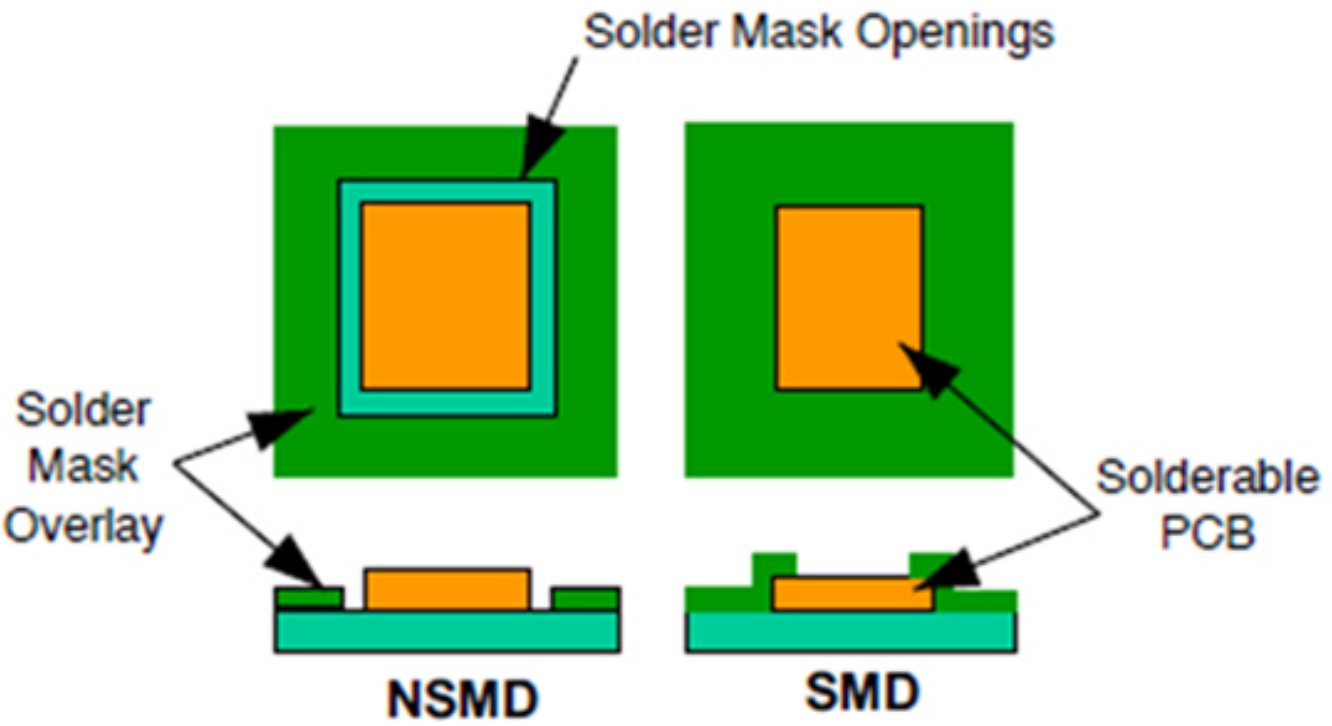

Figure 5: Comparison between NSMD and SMD pads

By moving to micro-packaged discretes OEMs will be able to overcome the space constraint issues they are facing and produce sleek and attractive portable devices which have expansive feature sets. The arguments for adopting micro-packaged Schottky diodes into portable designs appear to be strong. This can only take place though if the drawbacks that chipscale devices are perceived to have can be dealt with.

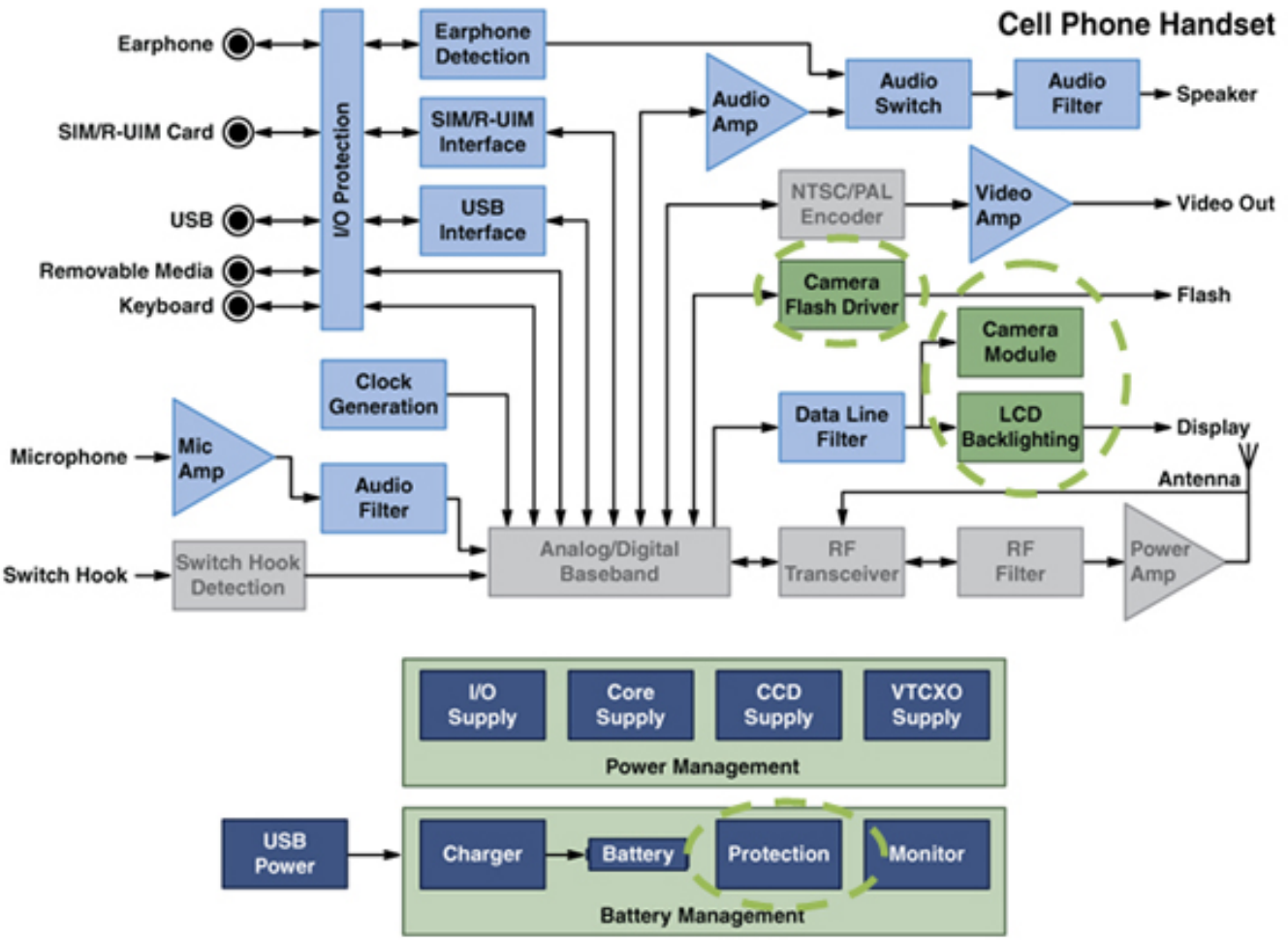

Figure 6: Use of micro-packaged discrete in modern mobile handsets

Question marks about DSN micro-packaging

So why is there unease about DSN? Well, there are a number of reasons. In the past doubts have been raised about the robustness of this technology. The limited number of companies currently able to offer DSN solutions means that OEMs are reluctant to commit to it, as they are worried about not having enough possible supply channels and being tied in too closely with a particular semiconductor manufacturer. This is something that OEMs in the consumer space are always very keen to avoid, in case there is a sudden rise in demand for their end product and their ability to fulfill orders is held back by the available stock of a single constituent component. Lastly, Schottky diodes are in general prone to electrostatic discharge (ESD), and the use of chipscale packaging will normally accentuate this.

Manufacturers, such as ON Semiconductor, have invested heavily in the development of micro-packaging, in order to offer DSN-based discrete components that have all the advantageous attributes already listed without OEMs having to make compromises elsewhere. It has meant that it can offer Schottky diode devices such as the DSN2 0201 Schottky series that are only 0.6 mm x 0.3 mm x 0.3 mm in size, available with low forward voltage (Vf) or low leakage current (Ir) in 100mA and 200mA continuous current (Ic) specification. An operating temperature range of –40 °C to +125 °C, a thermal resistance of 400 °C/W and a total power dissipation (at 25 °C ambient temperature) of 312 mW. Use of proprietary technology has

meant that OEMs concerns about the fragility of these packages and their vulnerability to ESD can be allayed. ON Semiconductor has subjected its DSN Schottky devices to over 1000 thermal cycles (-40 °C to 125 °C) without failure, indicating they can be used in even the harshest of environments. These devices have also undergone rigorous die and board level shear strength testing to assure they are capable of handling unexpected mechanical stresses that may occur in the customer's production line. In addition these devices are Moisture Sensitivity Level (MSL) 1 tested, indicating no sensitivity to atmospheric moisture. The diodes' ESD characteristics exceed Human Body Model (HBM) Class 3B and Machine Model Class C, which are the highest standards defined by the industry. As the DSN has full footprint compatibility with DFN packaging, OEMs are not at risk of being tied in to one supplier either. It effectively gives them the second source option they value so highly.

In conclusion, DSN presents the industry with a route by which innovative portable design can continue long into the future. DSN permits improvement in thermal performance, due to closer contact between the device and the PCB, and boosted overall efficiency, thanks to utilization of the silicon to a greater degree. Its small footprint outline and increased power density means that discrete components have only minimal affect on the overall PCB area budget, and do not impact heavily on layout in space constrained product enclosures. Furthermore, as long as board real estate is being reduced, the thinness and small footprint of these devices is highly suited to lower profile slim-line consumer electronics designs such as smartphones. Advances being made by certain semiconductor manufacturers have made DSN a compelling proposition and devices based on this form factor are now far more likely to be specified in portable electronics products.