# Turn to Embedded Passive Layers for Smaller, Lighter and More Efficient Devices

John Geissinger, Applications Engineer Senior Specialist, 3M Electronic Solutions Division

Nearly every electronic device – be it for a consumer, medical or military application – can benefit from a reduction in weight or form-factor size and increased efficiency, performance and functionality. Sounds too good to be true, but in fact, many applications could realize those benefits by using an embedded capacitive and/or resistive layer in their package or printed circuit board (PCB).

Embedded capacitance layers are not new, with patents extending back 40 years, but the rate of adoption has only recently shown a significant increase beyond the early adopters, which include military/avionics, high-performance computing and a few other niche products. Over the last several years, these materials have also undergone continuous improvement to meet new regulatory requirements and to become more cost effective, more manufacturing friendly and higher performing.

So, how does embedded capacitance material work?  Essentially, a parallel plate capacitor is created as a ply in a multi-layer PCB stack up. This ply consists of two copper planes (0.5 ounce or 1 ounce are typical) that are spaced very close together (<15 um) with a high dielectric constant material. This material can be designed into a system as very efficient power/ground planes or patterned for a specific capacitance value in order to perform functions such as low-pass filtering.

When used as a power/ground plane, the material has much lower inductance as compared to surface-mount technology (SMT) capacitors, which have higher inductance due to the traces and vias required to create the interconnect. With an embedded capacitance material, the charge is delivered to the integrated circuit (IC) much more quickly and efficiently than with discrete SMT capacitors, with a side benefit of improved electromagnetic interference (EMI) performance. The result is that the number of SMT-type capacitors used for decoupling or low-pass filtering can be reduced significantly, often by at least 75 percent for both a weight and space (X and Y axis) savings. In addition, these power/ground layers are 30-50

percent thinner than standard materials (i.e. FR4) for a savings in Z-axis height and weight as well.

Ready to test the benefits?  An easy approach for power/ground replacement exists without going through extensive redesign and simulation. Simply take an existing design and fabricate with embedded capacitive layers instead of the standard power/ground plane material set. Fully assemble the PCB with all SMT components and test. Remove a number of decoupling capacitors and retest. Continue removing capacitors and retesting until you have a good understanding of the performance versus caps removed for both the standard and the embedded capacitance board. This technique has been proven to be both quick and useful for developing the confidence in these “new” and increasingly popular high-performance embedded capacitive materials.

In many cases, incorporating a high-performance embedded capacitance material into your design can result in a smaller board, paving the way for a more compact, higher-performing device.