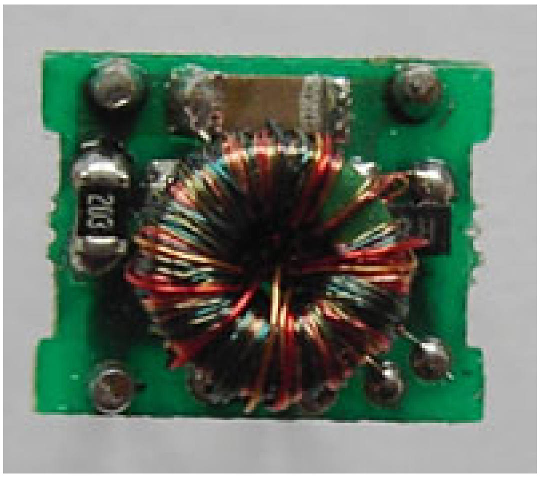
Converters Considerations

With the increasing trend of electronics making their way into more medical devices, it is critical that design engineers stay abreast of the technologies available to them. One component, isolated DC/DC converters, have gone through a variety of changes, enhancing their size and capabilities. This article reviews the benefits of the different types of converters and provides designers with the key considerations.

By Paul Cheesman
Paul Cheesman is the business development manager for Recom. With over fifteen years in the field of power supplies and DC/DC conversion, he is responsible for business development in UK and Scandinavia. Cheesman can be reached at +44-(0)7500-955240 or cheesman@recom-electronic.com.



Ring core transformer

Medical electronics in all forms have seen a dramatic upsurge during the last decade. By design, these devices (especially those that have patient connection) must have carefully selected components—those that have been independently assessed for safety. Without this, end product approval may be lengthy, expensive, and potentially impossible. In addition, there is a growing number of consumer and leisure products (e.g., those that offer heart rate monitoring) that are now considered medical devices and, therefore, need medical safety approvals before being distributed to the general public.

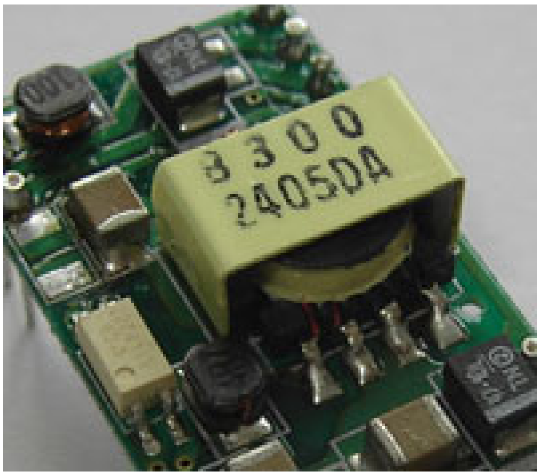
One result of the ever increasing market for electronic medical devices is the modifications and enhancements made to the components that are used within them. Isolated DC/DC converters have evolved considerably over the last few years, especially with increasing power densities, miniaturization, and isolation capabilities.

Transformer Construction

The challenge for these companies has been the ability to get reinforced isolation in such a small space. To understand the challenge, transformer construction must first be examined. There are five main classes of isolation:

- Operational or Functional- the output is isolated, but there is no shock protection
- Basic- the transformer offers one layer of basic shock protection
- Supplementary- the transformer has an independent layer of insulation in addition to basic insulation. However, this class has no relevance with regard to DC/DC converter construction
- Double- basic plus supplementary
- Reinforced- two layers of isolation that ensure single fault isolation

So how do these definitions translate into practical transformer construction?



Bobbin core

For operational or functional isolation, the input and output windings are wound directly over one another on a ring core, relying on the thickness of the wire lacquer for isolation (Figure 1). This method has the advantage of a very compact sized transformer that, despite the small size, can withstand 3.0 kVDC isolation testing. Most 1.0 W unregulated products use this construction.

Another type of transformer construction is winding the input and output windings over one another on a bobbin core (Figure 2). This method still relies on the thickness of the lacquer for isolation, but permits less flexible triple-coated wires to be used. It offers the advantage of a very compact sized transformer that can deliver more power and offers isolations of up to 6.0 kVDC.

With basic insulation, the input and output windings are not wound directly over one another, but are separated with a physical barrier, such as an insulating film (Figure 3). This method can be used in larger sized transformers where there is enough room to add layers of tape between the windings.

With double or reinforced insulation, the input and output windings are not wound directly over one another but are separated by a physical barrier. Figure 4 shows the transformer used in products with 5.2 kVDC isolation which uses a separation bridge to physically separate the windings. In addition, the ring core is plastic coated, so it is also independently isolated from the windings.

There is also a more compact way of making a reinforced insulated transformer—the potted core (Figure 5). With this method of construction, the core and primary winding are placed in a plastic pot which is filled with epoxy. A lid is fitted and then the secondary winding is wound around the whole construction through a hole in the middle. This method offers 5.2 kV isolation, but is physically smaller than the bridge system. Both reinforced transformer construction methods offer substantially reduced coupling capacitance between input and output (a parasitic feature of all transformers) to typically 4.0 pF—an exceptionally low value that helps increase performance, especially when used to isolated high voltage AC where leakage currents have to be kept within defined parameters.

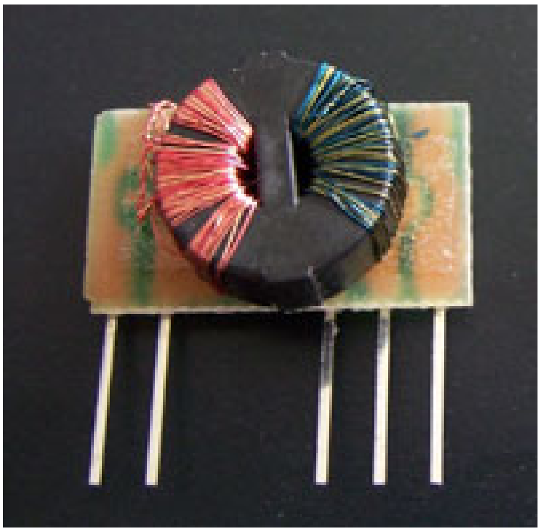
Clearance and Creepage Distances

Transformer construction is a major factor in insulation capabilities, but clearance and creepage distances in converter design must also be considered. Clearance is the shortest distance between two points measured point to point (arcing distance); creepage is the shortest distance between two points measured by following the surface (tracking distance).

Bobbin transformer with basic insulation

The clearance and creepage within the transformer depend on the construction. Operational/functional have creepage and clearance equal only to the thickness of the lacquer, approximately 0.016 mm. The bridge transformer construction has a creepage and clearance equal to the thickness of the separation bridge (2.0 mm). The pot core construction has a clearance equal to the wall thickness of the plastic pot (0.3 mm) but a creepage of a minimum of 3.0 mm.

As products are fully potted or injection molded, care must be taken in interpreting the values given in many safety standards that define creepage and clearance in air. The epoxy or injection molding compound used in the converters has a dielectric strength of at least 15 kV/mm, so very often the converter can be treated as a homogenous unit and the creepage and clearances can be measured externally between the converter pins.



Bridge transformer

Nevertheless, the creepage between input and output tracks on the converter PCB is fundamental. This separation is dependent on the converter size, but varies from typically 1.1 to 11.1 mm.

Conclusion

With an ever widening gamut of medical electronics on the market (both professional and consumer), the demand for isolated off-the-shelf DC/DC converters has never been higher. A good component supplier understands this market position and will ensure that his products are assessed to EN-60601-1. Medical device manufacturers should seek out component suppliers who are not only able to provide a quality product, but also willing to work with them as a manufacturing partner, keeping them informed of the latest advancements and technologies for their devices. Surrounding itself with these types of suppliers and manufacturing partners will allow the OEM to focus on its core competences while being certain that it is using the latest and greatest available technologies in its devices.

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