Making Isolation Safety Standards Work for You
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STANDARDS CAN BE AN ASSET—IF YOU UNDERSTAND THEM
In this article we will examine effective ways to use IEC (International Electrical Commission) safety standards to explore the limits of a design by figuring out what standards may apply to a problem amongst the hundreds available. The standards and supporting documents from the IEC are perceived as a burden to a designer, but they can actually be a huge asset if you have some understanding of what they contain, how to find and use them, and most importantly, where to start. We will show how to construct a map of the relationship between standards using freely available information from various safety agencies.

Design engineers are a creative bunch. There is every bit as much art in optimizing an electronic design within the constraints of size, cost, and performance as there is to paint a portrait with the constraints of available paint colors and canvas types. The design engineer’s pallet is the array of available components and the latest architectural ideas that can be combined with original contributions to make something never before built. The measure of success is the simplicity and elegance of the design.

Unfortunately, nothing breaks up the simplicity and elegance of a design like having to comply with a 300 page rulebook for safety, full of guidelines that do not always seem to have clear reasoning behind them. Engineers seem to deal with the safety standards on a continuum between two extremes.

ONE EXTREME
The first extreme is an engineer who knows a few rules about safety acquired through water cooler conversation. This engineer plunges ahead and makes the most elegant design allowing for these few rules of thumb and hopes for the best when the prototype is sent in for safety certification. This is great for innovation, but costly when designs must be reworked to make them comply with the appropriate standard. Or worse yet, something unsafe slips through the certification process and causes harm to an end customer.

The second extreme is from a design culture where product safety is so ingrained in the designs that it stifles innovation. Each design is based on the one before, and the proven safety techniques are pulled along unchanged from design to design. This approach usually yields safe products but closes designs off to new or improved ways of doing things and restricts creativity to small subsections of the project. This is safe but unsatisfying for the designer and creates barriers to making a breakthrough product that will differentiate itself from its competitors. For example, smaller form factors in isolation components can be achieved through application of the Comparative Tracking Index testing laid out in IEC 60112. Characterizing packaging material to higher CTI classes can reduce the creepage requirements of a package from 8 mm down to as little as 4 mm, shrinking component size by a factor of two or more. This can shrink the entire isolation boundary of the PCB and reduce the overall application size. This kind of optimization is available if the designers can find how to implement them through a little research into the standards.

In order to strike a balance between these extremes, it is necessary for the designer to navigate the safety standards and evaluate components and innovative techniques as they arise. But these standards can be inscrutable and overwhelming.

The most widely used set of standards is developed and maintained by the IEC, which offers hundreds of safety and compatibility standards that apply around the world. But how can a designer know what standards must be bought, read, and applied? None of these standards is available for free, and many companies do not have a dedicated employee to coordinate safety standards.

FINDING A SOLUTION
A simple way around this problem is for a design organization to identify the top level system standard for the application and industry, buy it, and try to make sense out of it. This isn’t always as simple as one might expect. A system level standard represents the distillation of years of experience with system safety applied to the product’s expected usage. These standards are updated every few years to reflect close to the state of the art in a particular field. The standards themselves are generated and maintained by committees of industry leaders, academics, and safety certification agencies. The system level standards are usually very large documents ranging up to 600 pages because they include enough detail to allow most design and testing decisions to be made without
having to purchase additional documents. However, there is a wealth of information behind each system level standard that can clarify the thought process behind the requirements and illuminate the underlying flexibility in the standards as well as the thinking behind them. A mapping of the interrelationships of IEC standards can reveal things that are not explicitly reflected in the system level standard. Consider an example of what can be gleaned from the document preview of a standard by referring to Figure 1. It is a map of the “normative references” for IEC 60950, the information technology system level standard. Normative references are standards or documents considered authoritative on a subject and considered indispensable to the application of the referencing standard. In order to keep the diagram simple enough that it did not require a fold out, we have restricted the scope to isolation related subjects. The documents are grouped into several categories by their main function and their rough position in the document hierarchy. These include:

1. System and piece part standards—represent the starting point for the exploration
2. Coordination documents—which address a specific type of safety issue so that it can be accessed by several system level standards
3. Test methods—codify how to evaluate some aspect of safety to assure consistent and comparable results
4. Instructional documents—explain analysis techniques and design guidelines
5. Classification documents—break materials and environments into groupings agreed upon by the industry

Figure 1. A Web of Documents Supporting IEC 60950 Concerning Insulation
Each of these document types has been color coded to highlight interrelationships. Examination of Figure 1 reveals a basic structure to the relationship between documents. System standards call coordination documents, which in turn call test methods, then informational documents, and finally classification documents. These relationships are not etched in stone, but generally this is the pattern that emerges. They can be stand alone documents called directly by a system level standard, or a web of linked references.

For this example, we started with IEC 60950—the information technology standard—which is one of the most commonly used across many application types. Note that this system standard calls other system and piece part standards because:

1. They share a common insulation requirement
2. A device can be used as a subsystem such as switch gear, IEC 60947
3. A commonly used safety component like an optocoupler has its own safety standard, IEC 60747-5

Each of these referenced subsystems or components can be certified independently under its own standard, allowing simple integration into larger systems without redundant analysis and testing. Another item to notice is that the IEC 60950 certification itself is used as part of the medical device certification, IEC 60601, so it feeds entirely into another system level standard. Each of the system level standards calls on its own web of supporting documents not shown here but indicated by the large arrows.

The insulation requirements of IEC 60950 are almost entirely derived from a coordination document IEC 60664 for insulation. As mentioned earlier, this allows the entire insulation analysis to be referenced together by many system level standards. Moving further up the tree we come to test methods, informational documents, and classification documents.

Let’s look at how knowledge of the available IEC recourse documents can be employed to dig into a common question. In the development of a safety system, it seems obvious that we would want to know how long our insulation system will last and what effects that lifetime will have. Looking at the IEC 60950 system standard does not yield much guidance on the subject. There are many requirements for thickness and distance, but it is not clear what is related to lifetime of the system and what is intended to handle transients. There is also no guidance on how to gauge system lifetime based on those requirements.

Examining the map in Figure 1 reveals an area in the upper left quadrant that deals with insulation breakdown and endurance. This is a few steps removed from the master system standard, which in many cases means that the guidance and background have been consolidated with other requirements by the time its information is reflected in the system standard.

To get back to the underlying test and analysis techniques requires acquiring one or two low level standards, in this case:

1. IEC 61251—electrical insulating materials—ac voltage endurance—introduction
2. IEC 62539—guide for statistical analysis of electrical insulation breakdown data

After working with these two documents, the insulation lifetime questions can be answered, or the proper tests to determine the lifetime of a new material can be determined. Having this information early in a design can guide the choice and use of materials, saving time and money in the long run. Exploring the web of IEC standards can allow quick access to this wealth of information.

Having this document map is very useful in tracking down appropriate resources within the IEC and even ISO systems (ISO documents are also referenced, but not shown here), but these maps are not easily found or created. In this case, we took the time to build it, but it did not require that we actually have any of these documents in order to construct Figure 1. The IEC website allows previews of nearly all of the IEC standards, which include the table of contents, scope of the document, and the normative references. This is enough to know what any particular standard covers and what other standards it references. This map was constructed using those free previews, and allows particular standards to be identified with confidence. The investment of time in constructing this type of map is well worthwhile.

RESOURCES
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