‘F’ is for Flex

Behind the making of UL 796F, and what it means for fabricators and users.

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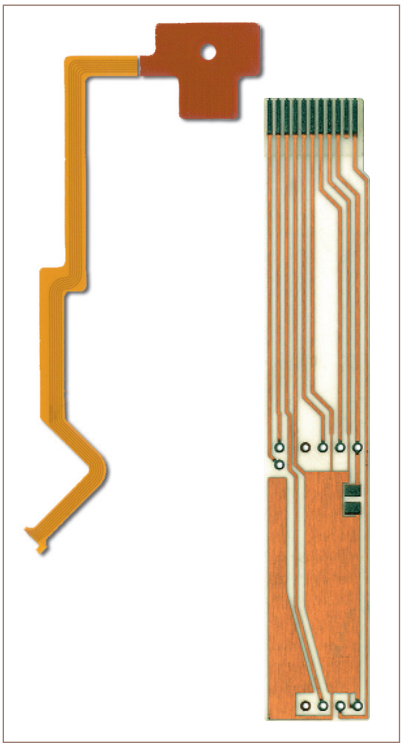
On Sept. 8, Underwriters Laboratories Inc. (UL) published a new standard,“UL 796F, Flexible Materials Interconnect Constructions,” and introduced a new category for flexible PCBs called ZPXK2. UL categories identify various product types; flexible PCBs have historically been recognized under the requirements of UL 796, but as their applications have diverged from that of rigid boards (also covered under UL 796), the need for a new standard and category arose.

Is UL 796F just the “F” revision of UL 796? Answer: No. Unlike IPC or the Department of Defense, UL does not designate specification revisions by means of a system of letters. UL 796 and UL 796F are different standards. Indeed, revisions to UL standards are noted by revision date rather than revision letter.

All currently recognized rigid and flexible PCBs have been tested to the requirements of “UL 796, Standard for Printed Wiring Boards,” and are recognized under the category ZPMV2. All currently recognized flexible PCBs under the ZPMV2 category can be given recognition in the new ZPXK2 category developed for UL 796F components. No testing is required to obtain UL recognition under ZPXK2 for products currently recognized under ZPMV2. Rather, a manufacturer can contact the UL representative it typically works with and identify the products recognized under ZPMV2 that it wants recognized under ZPXK2. In addition, the manufacturer will need to provide a new type designation for ZPXK2 components, as the type designations for ZPMV2 and ZPXK2 components must be different for the same UL file number or fabricator.

The OEM Squeeze

OEMs are demanding that fabricators of flexible PCBs perform certain types of assembly operations, including applying adhesive materials to the surface of finished, UL-recognized flexible PCBs. However, the addition of adhesive material could potentially jeopardize the V-0 flammability classification. UL PCB recognition under the ZPMV2 category only includes evaluation of the bare board itself and not “added” materials. This represents a dilemma for fabricators, as they cannot supply a UL-recognized board and still meet OEMs’ needs for new types of boards. This led OEMs and PCB manufacturers to petition UL for alternative approaches to meeting their needs.



Flexible PCB's like these from Parlex,

In order to address these changes, UL developed the ZPXK2 category. The new category accommodates changes in the finished boards made by flex manufacturers. It is intended to meet the current and anticipated needs of OEMs and flex manufacturers. ZPXK2 incorporates traditional UL bare board evaluation along with additional systems that go beyond the bare board.

Besides updating the specification, UL even adopted a new title to reflect the changing marketplace. The title – “Flexible Materials Interconnect Constructions” – is not intended to imply the complete interconnect construction itself is flexible and leaves open multiple possibilities as long as at least one of the base materials used to produce the interconnect construction possesses flexible characteristics. An FMIC can be produced from a buildup of materials intended for dynamic flexing (flexible), only

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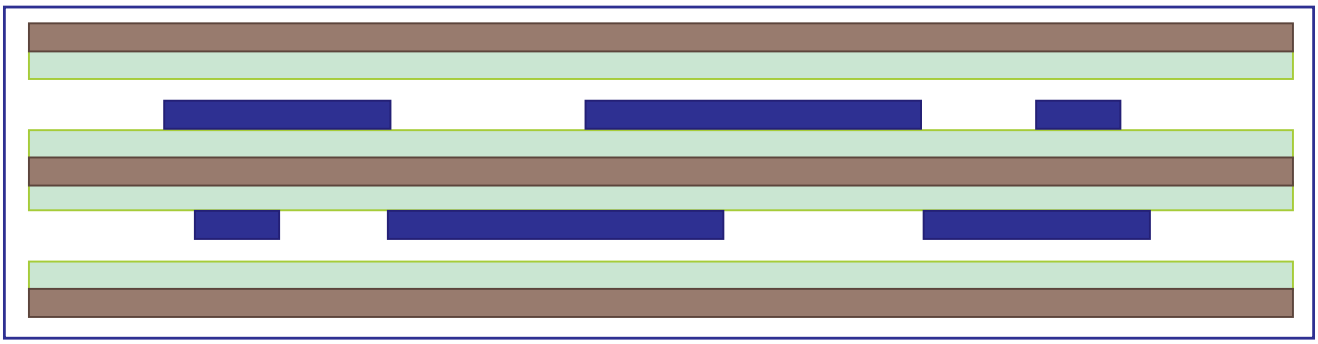

Figure 2. Example of a single layer, double-sided interconnect construction.

intended to be flexed for installation (flex-to-install), or not flexed at all (rigid). Additionally, a finished FMIC may include an integral combination of flexible, flex-to-install, and rigid interconnect constructions.

One example of the, well, flexibility built into ZPXK2 is the system component symbol (SCS) and the size class number (SCN), used for the addition of adhesive and stiffener materials not subject to evaluation per UL 796 or UL 796F. Adding the SCS/SCN marking permits a fabricator to apply adhesive and stiffener materials of unknown flammability characteristics (of limited size) to a recognized FMIC.

The SCS/SCN marking is intended to indicate the presence of an unevaluated material on the FMIC. The volume and size of the unevaluated material in question is identified by the SCN marking applied and is defined in UL 796F. Many UL end-product compliance standards include what are sometimes referred to as a "small part exceptions."For applications in which the location of a small part of material with unknown flammability characteristics does not impose hazardous conditions, a volume and size limitation is identified for the material in question. If the small part of material does not exceed the volume and size limitation, the small part of material can be used for the application without being subject to flammability tests or bearing a flammability classification. The UL end-product standard (e.g., UL 1950) dictates the acceptable SCN for the specific application being considered.

From a practical standpoint, a UL services field representatives will compare the SCN marking applied to the FMIC to the SCN indicated in UL's follow-up services procedure for the end-product being evaluated. The volume and size of the small part of unevaluated material is then checked against the volume and size corresponding to the SCN.

Other systems using the recognized marking are under consideration for inclusion in future revisions of UL 796F. One example takes into consideration the trend to add passive components to the FMIC during the FMIC fabrication process. In this case, an additional character in the marking could provide critical component information to the OEM.

What's a 'Layer?'

There has been some misinterpretation of the word "layer" by users of both UL 796 and UL 796F. While many PCB manufacturers use the word to denote a conductive plane, UL defines "layer" to mean an insulative (non-conductive) material plane. This is because the properties and integrity of the dielectric materials are considered during safety evaluations. The build up of materials in an interconnect construction may include one plane of conductors (single-sided), two planes of conductors (double-sided), or three or more planes of conductors (multilayer). Interconnect constructions with one or two conductor planes are referred to in UL's specifications as single-layer interconnect constructions, and UL multilayer interconnect constructions are those including three or more conductor planes. A finished FMIC may also include an integral combination of single-sided, double-sided, and multilayer interconnect constructions (Figure 2).

A finished FMIC with different integral interconnect constructions (e.g., single-layer and multilayer) is referred to as a multilayer rigid-flex composite FMIC. Multilayer rigid-flex composite FMICs often include a single-layer (i.e., single-sided or double-sided) flexible interconnect construction laminated between a multilayer rigid interconnect construction, with integral electrical connections; the rigid section often includes an industrial laminate material, such as FR-4. Each different cross-sectional area (i.e., single-layer, multilayer, flexible, flex-to-install, etc.) of the multilayer rigid-flex composite FMIC is subject to the appropriate evaluation as defined in UL 796F. Recognition for the different combinations of cross sections has been simplified in the ZPXK2 category so different interconnect constructions can be used like "building blocks" and intermixed to produce various multilayer rigid-flex composite FMICs.

An increase in the number and

type of materials used by fabricators and the variety of interconnect constructions produced have prompted UL to review current tests and test methods. Historically, flexible PCBs submitted to UL consisted of 0.001″ base material, 0.001″ cover film, and 0.001″ adhesive in all the appropriate places. Today, films and adhesives include thickness ranges from 0.0002″ [DOUBLE CHECK THIS DIMENSION] to 0.005″; therefore, a variety of material buildups are inevitable. Some of these same ranges of film thickness are being used without adhesive, and new materials and buildups are constantly being developed and released to the market.

An ad hoc group for test methods, consisting of industry representatives and UL staff was formed to review and comment on UL 796 test methods applicable to flex PCBs. In addition to the mechanical and flammability tests applicable to flexible PCBs, electrical tests applicable to the materials used to produce flexible boards were evaluated. The test methods in UL 796F incorporate the input received from the group.

Current "flex tests" such as the (ambient) bend test (formerly the flexibility test), cold bend test, and repeated flexing test, call for wrapping test samples around a single size of mandrel. Some test samples built-up with heavier base materials cannot comply with current tests, yet the FMICs are intended to flex in a much larger diameter during final use. The single-mandrel size used as a test fixture does not accurately reflect the intended application in many cases, yet the finished FMIC may possess the level of integrity needed for the intended application. The new materials, buildups, and applications suggest additional mandrel sizes should be considered. UL is following suit and is currently considering additional mandrel sizes and new test methods with the intent of developing test methods reflecting the applications of the FMICs in additional types of end-products.

The ad hoc group was so successful UL is hopeful more industry representatives will consider participating and contributing in future group meetings to address future development initiatives. To get involved, contact one of the authors for further details. **PC FAB**

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