# Utilizing Laminates for Design Flexibility

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*Laminates offer flexible design opportunities for EMI control at the board, component and enclosure levels.*

## INTRODUCTION

As quickly as technology produces newer and smaller electronic devices, so it also brings problems associated with EMI. Design engineers are rapidly devising new and innovative ways to cope with EMI situations. Techniques most commonly utilized are to attack, reflect and absorb interference both at the circuit board level and at the enclosure itself. One shielding approach used to combat EMI, foil laminates, offers freedom to custom-design a ground or reflective shield utilizing today's modern materials. Laminates can also be used to reduce EMI emissions in existing designs.

## CONSTRUCTION

There are also a number of construction options for laminates. A "basic" flexible foil laminate shield consists of a thin foil laminated to a dielectric material. This simple laminate construction addresses the immediate need of requiring an EMI reflective surface on one side and an insulator on the opposite side.

These constructions are inexpensive to produce and can be prototyped in minutes. Material can be easily sampled and utilized at a testing facility or onsite by a skilled engineer. While testing designs on-site, these materials may be cut by hand and placed in various locations to ascertain the most effective results. Later, these parts can be manufactured in high-speed production volumes with the exacting tolerance of the original part. The constructions can be die cut, scored, slit or creased according to designers' specifications.

When these options are best utilized, laminates can become a multipurpose component which can significantly reduce the weight in a component. Options include adding self-adhesive mounting strips for a secure placement or using multiple constructions of more than one material for a multi-functional laminate. Other design options include using foams to create a combination shield /shock pad or utilizing surface cutouts on the top layer of a laminate to produce multiple grounding or solder points.

## COMPOSITION

### FOILS

Material selection to form a laminate is dependent on the application. There are a few thin, flexible foils and films that cover a wide variety of needs. Shielding effectiveness of the foils fall in the 20 dB to 60 dB range. This range is generally adequate for most shielding requirements. Usually foils are selected in thicknesses from 2 - 5 mils, but foil thickness is not selected based on shielding effectiveness. It is the flexibility that determines the thickness of the design. For example, a thin foil may be utilized for its ability to bend around a component, while a thicker choice may be required to keep the laminate stiff and prevent it from coming in contact with sensitive circuitry. Heavier materials also provide better puncture resistance. Items frequently used in the selection of laminates are listed in Table 1.

### DIELECTRIC MATERIALS

Materials that exhibit good electrical insulation and protection are a reasonable choice for the surface substrate of a laminate. Some laminates may offer UL listings such as UL94 - V-1 or V-0. The UL94 listing applies to the flammability of a material. A V-0,V-1 or V-2 classification depends upon total burn time; whether the material burns to the testing clamp; whether flaming drips from the material ignite cotton placed under the test burner; and the burn time of the material after the flame is removed. There are many types of burn tests, and generally speaking, the lower the V-rating the better the performance of the material. A rating of V-0 is the best performance level. Standard dielectric material selections vary in performance and cost from a standard PVC, or polyester, to a polyimide film. Again, these materials may be mixed and matched based upon the application.

The film layers, while performing the role of an insulator, provide a protective surface against scratches and punctures. These materials also provide an environmental improvement over plating or solvent-based painting processes, and allow recycling of plastic enclosures.

### ADHESIVES

Adhesives can be chosen for nearly every application. Understanding and utilizing the new methods of adhesive

| Thin Foils | Dielectrics | Adhesives / Pressure Sensitive | Foams |
|---|---|---|---|
| Copper | Teflon * (PTFE) | Conductive | Charester |
| Tinned Copper | Kapton * (Polyimide Film) | Nonconductive | Polyethylene |
| Aluminum | Nomex * (Aramid Paper) | Thermally Conductive | Polyurethane |
| Nickel | Fishpaper (Vulcanized Fiber) | Rubber Based | Vinyl |
| Steel | Mylar * (Polyester) | Acrylic Based | Neoprene |
| Stainless Steel | PVC | Silicone Based | Silicone Rubber |
| | Valox ¥ (PBT) | Thermoset | Urethane |
| | Lexan ¥(PC) | | Poron+ |
| | Ultem ¥(PEI) | | |

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***Table 1.*** *Options for Laminate Construction Materials.*

lamination can give a design engineer a whole series of low-cost flexible tools to produce smaller, more efficient components.

For common laminates, an acrylic-based pressure sensitive adhesive fits most application requirements. Conductive adhesives are also available and can be designed to send current in either the X, Y, or Z axis or in a combination. For extremes of above 250°F, silicone adhesives are best chosen for their reliability at high temperatures. Most general laminate needs tend to remain in the -40°F to 150°F range, in which a good acrylic-based adhesive system will be expected to perform aggressive bonding functions. Average specifications on an acrylic pressure sensitive adhesive are peel adhesion of 61 oz/inch width, tensile strength of 30 lbs/inch width, and elongation of 7 percent. Adhesives from various manufacturers will vary slightly in their performance levels. It is always suggested to test the adhesive selected in the specific application if possible.

If "zone laminating' is exploited, a laminate can perform some unique functions. Zone laminating is the process where a designer can specify the areas on which adhesive placement on a laminate is to be located. Designers can, for instance choose a conductive adhesive and zone the placement of the adhesive to flow only on the outer area of a laminate. By selecting where the placement of adhesive will run, a directed energy flow results. Thus, the designer creates a path of either thermal or electrical conductivity within a thin flexible laminate. Selection of a type of adhesive and choosing a selected zone for lamination or leaving an area to remain exposed are just a few of the options available to the designer.

## FOAMS

Additional problem-solving abilities are introduced when foams are added to a laminate. Using a foam-based laminate, a designer can co-produce a shield/ insulator/shock pad. These are very useful parts when incorporated into small mobile devices such as a pager or a cellular phone. Foams come in a variety of thicknesses, compression sets and durabilities. Types of foam can be classified as charester, polyethylene, polyurethane, vinyl, neoprene, urethane and poron.

For the purpose of utilizing foams in laminates, it is assumed that temperature/ flame resistance is desirable. Selections should therefore be made in accordance with the particular specification of the foam. Price can vary greatly between types of foam. Care should be taken not to over-specify a material.

## APPLICATIONS

Although laminates are ideally suited for internal shielding of printed circuit boards and suppression of EMI at the source, laminates are also utilized in the shielding of plastic enclosures from external sources of EMI. Typical applications include: ground planes, keyboard and monitor shields, anti-static vinyl laminates for instrument cases, electronic component shields, disc drives and communication equipment shields.

## VARIATIONS

What aids designers in the construction of a laminate is their own imagination and innovation. Laminates can perform a number of roles and be twisted, flexed, and folded into numerous shapes. Tabs can be exposed as grounding points or layers can be removed to provide solder points. If edge shorting is of concern, the foil can be encapsulated between two film layers which extend beyond the foil edge. If a circuit needs to be surrounded with protection, there are even methods to produce Faraday cages out of lightweight laminates to provide 360° of shielding around an EMI source (Figure 1).

## CONCLUSION

As EMI issues continue to come to the forefront of component development, engineers will pursue new materials and designs to protect their devices from this modern problem. They will continue to seek ways to produce smaller and faster devices. There are many resources available to guide engineers in understanding the newest shielding aids. There are also many trade organizations devoted to solving EMI problems. It is imperative that engineers, designers and manufacturers keep their minds open to new ideas and materials. Too often, it becomes easy to over-specify a material or a process to achieve proper shielding.

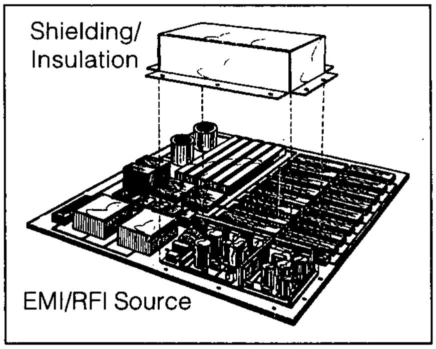


***Figure 1.*** *Use of Laminates to Construct Faraday Cage.*

Companies can no longer tolerate this luxury as the competition in the marketplace continues to demand that more is accomplished with less. Laminates can be a great saving on the overall production cost of a design. If designers are knowledgeable about laminates and the materials they comprise, many new design opportunities will be at their disposal.

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