

Membrane Switch Substrates for the HP Indigo Press

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Abstract

Membrane switches are present in most modern appliances as well as many other devices. The current HP Indigo industrial presses allow the graphical overlays for membrane switches to be digitally printed on a wide range of materials. This paper presents the fundamental technical requirements for membrane switch materials, guidelines for selecting appropriate material for a project, plus the requirements for successful supply of those materials to the digital printer.

Membrane Switches: Background

Membrane switches consist of many layers of plastic film and adhesive. The typical construction is shown in figure 1, and laminating adhesive layers (not shown) bond the switch together.

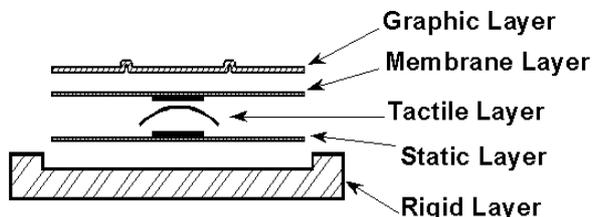


Figure 1. Membrane Switch Schematic

Membrane switches represent an important industrial market for printers of plastic films. Over the past 10 years, this market has enjoyed overall market growth rates of 8-10% per year. Traditionally the graphic layer for a membrane switch has been printed by screen print methods, due to the excellent ink adhesion and opacity provided by that method. In recent years, advances in the HP Indigo presses have made it possible for the digital printer to manufacture the graphic layer for membrane switches. As a high value market segment, membrane switches offer excellent financial rewards to the digital printer.

Application opportunities for digitally printed membrane switches include:

- Personalization
- Variable data: logo changes, color changes
- Language changes
- Short runs & prototypes
- Photographic images with no color limitations

Graphic Layer Technical Requirements

The graphic layer is the part of the switch that is exposed to the external environment - the part that is seen, touched and cleaned. Graphics are typically printed on the reverse side (2nd surface) and serve many purposes:

- to show location and function of switch keys
- to decorate and compliment the design of the device to which it is attached
- to protect other switch layers and internal electronics from contamination from the external environment, i.e. liquid spills, grease, dirt, cleaning chemicals, etc.
- to provide tactile feedback if embossed or selectively textured
- to provide windows for attached indicator lights or information displays, LCD displays, etc.

In order to perform the functions listed above, the film used for the graphic layer must:

- withstand the flexing that occurs during switch actuation for the life of the device
- resist scratching and abrasion
- resist chemicals present in device operation and cleaning
- provide and retain the appearance and processing characteristics required by the design of the switch.

Graphic Layer: Substrate Selection

There are three main types of film substrates that are useful for membrane switches: polyester (PET), polycarbonate (PC), and polycarbonate – polyester blended films (PC-PET). All of these film types are available with chemical primers to facilitate printing via the HP Indigo press. In addition, PET and PC films are available with various types of protective coatings (on the first surface) called hardcoats. Hardcoats are very thin polymer coatings that increase the scratch resistance and the chemical resistance of the film. These hardcoats are available in clear (glossy) versions as well as anti-glare / matte versions.

The best choice of film for the graphics layer is driven by the design and function of the device to which the switch will be attached. *In general, PET overlays are the most durable, with or without hardcoats applied. PC and PC-PET blended films are available in thicker gauges, and can be easier to die cut and emboss.*

The specific considerations for selecting the best substrate for a membrane switch are outlined below.

Flex Life (Actuation Life)

This property is used to describe how many switch actuations can be performed before an overlay will fail due to cracking or deformation. In almost all cases PET will out-perform PC by a wide margin, and PET will usually out-perform the design requirements of the device. In general, PC-PET blended films will have flex life intermediate to the life of PC and PET films.

Abrasion Resistance

PET is slightly harder to scratch than PC, but neither substrate is able to survive normal use without some sort of abrasion and scratch protection, usually in the form of a hardcoat. Hardcoats applied to PET or PC films greatly increase the abrasion resistance of the film, and can also produce a desired matte appearance. The availability of PC and PC-PET films with surface textures such as suede and velvet can give the film an apparent abrasion resistance that does not require a protective hardcoat.

Chemical Resistance

Hardcoated films exhibit much greater chemical resistance than uncoated films. PET has greater chemical resistance than PC. Blended films (PC-PET) are designed to improve the chemical resistance of PC but not to the level of non-hardcoated PET.

Appearance and Processing

Polycarbonate film is available in a wider range of gauges and textures than PET, and this breadth can make it more attractive to designers. PC is clearer than PET in heavier gauges, which makes color matching easier. PC die cuts easier without edge splitting. It embosses easier without the need for high temperatures to set the shape.

These many factors make choosing a film for a graphic overlay somewhat complicated. Long-term, high reliability applications favor PET, while low usage applications where appearance is most important point to PC. All the parameters of appearance, processing and reliability in the application must be weighed in order to make the optimal decision.

HP Indigo Printing Considerations

The advances in the HP Indigo platform have allowed industrial printers to combine the market opportunities of membrane switches with the power of digital printing. Since traditional (screen) printing processes have the traditional limitations (high setup costs driving longer runs), this combination of the application and digital printing can create a competitive advantage.

The plastic film substrate used must facilitate excellent adhesion with HP ElectroInk. Adhesion is important in all graphic applications, but even more so in membrane switches. During the flexing experienced in a switch's life, the graphic layer is exposed to physical stresses beyond those of normal applications. Superior ink adhesion separates films that excel from those that can cause device failure.

The majority of plastic substrates require a specific chemical coating applied to the film to facilitate good adhesion between the HP ElectroInk and the film itself. While some printers apply this type of coating in-house, the majority of industrial printers purchase films that are already coated and ready to print. A high quality coating leads to reliable initial image quality, durable images through excellent ink adhesion, vibrant color reproduction, and an elimination of "blanket memory" that can cause problems if less than 100% of the ElectroInk transfers onto a substrate.

Depending on switch construction, in particular if a hard dome is used for a tactile layer, tests show best results if the HP ElectroInk is backed up with a screened "flood coat", to provide extra opacity to the graphic. The flood coat ink also can act as an additional protective layer for the HP ElectroInk. A white laminating adhesive layer used to attach the graphic can also improve opacity.

Membrane switch overlays printed via HP ElectroInk have been tested to simulate heavy field use. The tests have indicated successful performance well beyond 5 million actuations with excellent appearance.

Supply Chain Considerations

To capitalize on the strengths of digital printing, the printer needs to develop a relationship with a supplier that has the following attributes:

- High quality, reliable coated plastic film products to prevent printing production problems.
- Inventory of standard product configurations to facilitate same-day or next day shipments.
- Capability to create custom products for specific project requirements. Combinations of film type and gauge create a wide variety of film needs.

Conclusion

Membrane switch overlay printing is an attractive market for the digital printer. The HP Indigo print platform makes this market area available to the digital printer, and a very wide array of high-quality substrates are needed to address the technical requirements of the application. Excellent quality print-receptive coatings are readily available on polyester, polycarbonate, blended polymer films, and hardcoated films to help the printer produce the best switch overlay possible.

Biography

Lloyd Brown earned a bachelors degree in Chemical Engineering from the University of Wisconsin and an MBA from Marquette University. He is the Vice President – Coated Products at Tekra Corporation (USA), co-manufacturer (with Hanita Coatings, Israel) of Dura-Go™ film substrates for the HP Indigo platform. Tekra has manufactured specialty coated films since 1984, including hardcoated polyester and polycarbonate films. E-mail: lwbrown@tekra.com.