Membrane Switch Design Guide
ISO 9001: 2008 Certified
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Pannam Imaging
Pannam is an advanced interface solutions provider. We manufacture customized user interface membrane switches that demand the highest level of integration, execution and reliability. Our products serve many markets including medical, health and fitness, industrial controls, electronics and data communications. Pannam has focused its competitive expertise on the high quality, high value-added end of the product-need spectrum. With our advanced fabrication capabilities and overseas operations, Pannam has the flexibility to manage low-volume jobs, high-volume runs, and everything in between, providing the highest quality membrane switch to meet your specific job requirements.

The Design Process
This design guide will inform you of the various components for consideration in designing a user interface membrane switch. You will also be advised about available options for certain components. Pannam utilizes a project management system that guides the process from prototype to production. Once you have determined the product requirements and identified features and options, our engineers will design a new switch as well as produce the actual prototype, including a complete set of drawings and specifications.

Membrane Switch Design Concept

- Overlay
- Overlay Adhesive
- Opacity Layer
  - Blocks Out Unwanted EL Light
- EL Layer
- Circuit Pack
  - Dome Retainer/Circuit/Rear Adhesive
- Back Panel
Design

Production Drawings
During the design phase, Pannam consults with you to generate manufacturing drawings that meet your approval. These drawings accompany the job as it moves through production.

E-Files
Pannam supports files created in AutoCAD, SolidWorks, CorelDraw, Illustrator, and Inventor. To avoid font compatibility issues, we suggest converting all text to curves or outlines in your file before sending to Pannam. Also, no need to worry about complexity. We have worked with prints in all ranges of detail, including explicitly detailed prints, even sketches on napkins.
You can e-mail your file to sales@pannam.com.

Overlay

Achieving the Right Look
The overlay, the top layer of the membrane switch, is the graphic interface between user and machine. While the underlying layers house the electronic components, it is the overlay that most directly impresses your customer. To help create the desired look and feel of your overlay, we offer design assistance from simple color and overlay material selection, to complex design elements incorporating creative functionality. Pannam offers complete in-house graphics capabilities, enabling us to incorporate a wide variety of design elements such as CMYK process, color halftones and gradients, selective textures, transparent windows, screen tints, dead fronts and embossing.
During the design process, you will receive a color proof of your overlay to verify color placement. Exact color match swatches on the selected overlay material are available if required for approval. Pannam offers polyester and polycarbonate materials in many gloss and textured finishes.

Material Selection
Your overlay is what the user sees in the switch assembly. Its appearance and function are crucial to a successful switch solution. Contributing to overall function is overlay durability. It is essential to ensure that the overlay material chosen will last as long as your specific application requires. Polyester is the material of choice if your overlay is embossed, or for switches that require a large number of actuations (>25,000). Generally, life cycle tests show polyester keypads can be actuated over 1,000,000 times before showing any signs of wear. While polycarbonate offers more design options, it will not provide as many lifetime actuations as polyester. Please note that the actual switch, without an overlay in place, can last over 5,000,000 cycles.

Choosing Thickness
For excellent tactile feedback in a switch with stainless steel dome construction, choose an overlay thickness between .006” and .008”. This thickness range will be durable enough to hold up to numerous switch cycles. A thicker overlay will significantly decrease tactile feedback, giving a heavier feel.

Color Matching
Pannam calibrates colors within the acceptable standards of Delta-E measurements using a computer color matching system and archive recipes of colors already matched for specific customer applications. We can match colors from the Pantone Color Selection Guide, Federal Standard Guide, European Standard Guide or a customer-supplied swatch, providing it is a minimum 2” square size.

Printing Colors
All the colors on the overlay are printed on the second surface (the reverse) of the overlay material using either a digital or screen printing process, or a combination of both. Utilizing digital imaging can result in reduced cost and lead time if many colors, special logos, or gradient background shading is required. The thickness of the overlay material protects the graphics from damage or wear by the operator or environment. Selective textures and window clearing agents are the only inks printed on the first surface of the overlay and are UV cured to produce a durable finish.
**Finishes**
Polyester and polycarbonate overlays are available with a variety of textures and hardcoats. While a gloss overlay can offer a high-end appearance, it is very susceptible to scratches with use over time. To minimize scratches, a velvet-textured overlay is recommended for most applications, particularly for industrial environments. Conversely, extended-use keypads should not have printed texture on them. Alternatively, the switch can be designed with glossy keypads and a textured background so that the texture ink is printed only around the actual pad that functions. In this manner, potential keypad degradation is eliminated, and an attractive design element is introduced that more clearly differentiates the keypad from the surrounding switch area.

**LCD/LED Display Windows**
An overlay may include windows of varying shapes and sizes. Windows may be clear, or printed with transparent color to help conceal the underlying lighting element when not illuminated. Additionally, printed textures and clearing agents may be applied. Pannam recommends that smaller LED windows retain the same texture as the background.

**Embossing**
Depending on design creativity, embossing can dramatically enhance the look of the overlay.

- **Pad**: The entire shape of the keypad is raised.
- **Rail (Perimeter)**: A rim around the perimeter of the keypad is raised.
- **Dome**: The entire keypad is raised to a spherical shape *(normally used in poly-dome constructions)*.

Embossing can also be a great design enhancement to the function of a switch. For example, rail (perimeter) embossing can be used as a finger locator for a switch with many keypads, or a Braille pattern can be added to the overlay for the visually impaired. Depending on size and shape, custom logos and multi-level shapes can be embossed, as well.

There are certain limitations to be aware of:

- **Height**: Typically, emboss height on polyester overlay should measure 1.5x the thickness of the base material. It is possible to emboss beyond 1.5x material thickness, but only at a cost to durability. Heavily used keypads that have been embossed will most certainly degrade more rapidly due to a thinner wall thickness at the point of stress.

- **Width**: Recommended minimum emboss width is 8x the base material thickness. This will maintain strength and form of the overlay.

- **Radius**: Recommended minimum corner radius is .032”. Completely square corners are not possible because they will crack the overlay material.

- **Spacing**: Typical minimum space between embossed areas is .125”. Minimum recommended spacing from embossing to edge of overlay is .250”.

**Tolerances for Overlays and Circuits**

Imaging: +/- .015” copy to edge. Die-cutting (Hole and perimeter size): +/- .010” hole to edge

**Circuits**

**Production**
There are numerous methods for producing circuit layers depending on durability, power and system integration requirements. Pannam offers screen printed silver conductive ink circuits as its standard construction. We also supply copper-etched and PCB circuits depending on your design requirements.

The silver conductive ink circuit layer is typically printed on .005” thick polyester and is designed to minimize overall resistance. After printing, the circuit layer is fabricated to the proper shape to fit in the switch stack-up. A typical switch stack-up will range in thickness from .025” to .050”.

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*Image of circuit board and overlay.*
Electrical Schematics
It is more cost-effective to allow Pannam to do the circuit design (unless you have done this before, specifically for membrane switches). Depending on the size and shape of the part, the complexity of the electrical schematic and keypad configuration, it is sometimes more difficult to fit all of the circuitry on a single layer. It may be necessary to use bridging, through-hole printing, or multiple circuit layers to accommodate the functionality required. Our experienced engineering team can make electrical schematic suggestions to limit the number of printed circuit passes, which will reduce the cost of the switch with no loss of performance.

Circuit Tail Length
The circuit tail is part of the circuit layer. The length of the circuit tail can be as long as required to terminate to other functioning parts of the system. The longer the circuit tail, the more base material and conductive ink will be used, which will increase the cost of the switch and the resistance. Pannam can also supply extension cables with or without connectors.

Circuit Tail Connectors
- Berg ®/FCI ® (Standard)
- Molex ®
- CrimpFlex ® (Standard)
- Solder tabs
- Amp ®
- ZIF ®
- Male or female connector pins

Lighting Options

Optical Fibers
Optical fibers are an ideal choice for backlighting, as they offer uniform lighting over a large area with less power consumption. In addition to their low profile, optical fibers are immune to EMI and RFI, offer long life (10,000 to 100,000 hours), and operate in a wide range of temperatures, moisture and humidity levels.

Electroluminescent (EL) Lamps
EL lamps provide even light distribution and are used frequently as a backlighting option. Their compactness offers additional design flexibility and may be more economical than optical fibers. EL lamps do not produce heat and have a half-life of approximately 3,000 to 8,000 hours. An important consideration is that once they reach their half-life, the brightness starts to fade rapidly.

Light Emitting Diodes (LEDs)
LEDs are considered the standard for indicator lamps in user interface membrane switches due to their brightness and robustness. Additional benefits include long life and low energy consumption. LEDs create bright spots. For this reason, Pannam discourages the use of LEDs as a backlighting option. LEDs may be surface-mounted to the circuit layer or placed on a separate LED layer.

Electrical Specifications

Switch Contact Rating
28V DC/30mA max

Loop Resistance
100 Ohms max (may be dependent on design)

Switch Configuration
SPST normally open

Surface-Mounted LED Specifications
Available upon request

Contact Bounce
<200 milli-seconds on break, <10 on make

Actuation Force/Design

Examples of actuation choices for specific applications:
Light Force (3-6 oz.) High-speed data entry
Medium Force (10-14 oz.) Most applications fall in this range (medical devices, test equipment, etc.)
Heavy Force (16-20 oz.) Manufacturing plant, where a machine operator may be wearing protective gloves; ensures activation is deliberate

Non-Tactile
Non-tactile switches can be designed with a broad range of actuation forces starting at 3 oz. Overall non-tactile switch thickness starts at .030”.

Overlay
Adhesive
Top Circuit
Spacer
Bottom Circuit
Rear Adhesive

Actuation force is determined by the spacer thickness (layer between the top and bottom circuit layers) and the diameter of the spacer hole. For example, a switch with a thin spacer and large diameter spacer hole will have a light actuation force.
Tactile
Overlay
Dome/Dome Retainer
Circuit
Rear Adhesive

Actuation force in a switch designed with tactile feedback does not have as much feel flexibility as a non-tactile switch. Using different sizes of stainless steel domes will vary the force to meet most requirements.

Choosing a Dome
Typically, Pannam makes a proper dome recommendation based on the size of the keypad. The 12.2mm dome is the most common and cost-effective choice for most applications.

Stainless Steel dome specifications:

<table>
<thead>
<tr>
<th>Size</th>
<th>Force</th>
<th>Travel</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.5mm</td>
<td>9-11oz.</td>
<td>.015&quot; - .019&quot;</td>
</tr>
<tr>
<td>12.2mm</td>
<td>11-18 oz.</td>
<td>.020&quot; - .024&quot;</td>
</tr>
<tr>
<td>20mm</td>
<td>17-23 oz.</td>
<td>.047&quot; - .055&quot;</td>
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Force is for the stainless dome itself. Other aspects of construction design will affect actuation force or feel.

Shielding
Shielding is used to protect the switches from electrostatic discharge (ESD) and electromagnetic interference (EMI). Pannam can design a switch that incorporates the proper shielding layer for your specific application needs.

Types of Shields
Pannam uses three different basic shielding methods to protect switches:
- Foil: Laminated aluminum foil and polyester.
- Transparent Film: Shielding required over windows (more costly).
- Printed: Screen printed with silver conductive ink in a grid, bus-bar or full-coating format. Typically, the grid format is chosen because it is very reliable and does not use as much silver conductive ink as does the full-coating format.

Shield Termination Methods
- Tab: The preferred method for reliability. Can be attached to a stud or stand-off on a back panel or metal enclosure.
- Connector: Shield layer can be terminated into a pin or pins on the circuit tail connector.
- Wrap-Around: Shield layer can wrap completely around the membrane on all four sides to ground to a chassis. Although this method is very reliable, it is more costly than the other two methods due to the added labor and material necessary to execute.

User Interface Membrane Switch Backings
User interface membrane switches are typically flexible with a mounting adhesive or have a rigid aluminum backing. Pannam can recommend a mounting adhesive appropriate for the intended application surface. A smooth surface will readily accept an adhesive while a powder-coated or rough surface will require a thicker, more aggressive adhesive. Ideally, the mating surface for a flexible switch should be as flat as possible. A curved or convex surface may require stronger adhesive to prevent delamination of the membrane from the backer. Tactile switches are not recommended on concave surfaces, as the domes can be pushed past parallel, causing them to invert and fail prematurely.

Additionally, it is important to understand the durability and environmental requirements of the switch after it will be applied in a system to ensure the proper adhesive choice. Sample materials can be provided to the customer for testing in their environment, or a bezel may be sent to Pannam to allow for hands-on testing and recommendations by our engineers.

Pannam has full capabilities for shearing, bending, milling, punching and installing PEM inserts in aluminum back panels. Typical thicknesses range from .032” to .125”. They may be alodined to create a non-corrosive surface; or anodized to create a non-conductive, non-corrosive surface that can be colored. Although alodining is usually less expensive, anodizing is more durable.
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Product Offering
• Membrane Switches
  - SimTouch™
  - SimScroll®
  - SimSlide™
• Elastomer Keypads
• Overlays

• Integrated Assemblies
• Printed Circuit Boards
• Touch Screens
• Flexible Circuits
• Plastic Consoles & Metal Back Panels
• Medical Electrodes
• Labels/Nameplates

Full-Service Facilities
• Artwork Generation
  - AutoCad
  - Adobe Illustrator
  - Autodesk Inventor
  - CorelDraw
• Electrical Testing
• Screen Manufacturing
• Laminating
• High-Speed State-of-the-Art Cutting Lasers
• SMT Placement
• Dome Placement
• Connector Assembly
• Color Matching
• Digital UV Flatbed Printing
• Assembly
• Die Cutting/Fabricating/Slitting
• Punch Out – Weeding

Engineering Capability
• Electronic circuit design development
• Keypad designs
• Mechanical designs (sheet metal, brackets, etc.)
• Test Hardware Development (functional and parametric testing)
• Manufacturing tooling designs

Quality System & Certifications
• Facility certification is to ISO 9001:2008
• Each employee is trained and certified to specific processes, and records are maintained for all activities