SSI ELECTRONICS, INC.

MEMBRANE SWITCHES: Design Guide

SSI TECHNICAL RESOURCE

Since membrane switches are custom designed to meet specific applications, each product will have its own criteria to meet. SSI has used its' more than 20 years of membrane switch experience to compile some of the most critical guidelines to designing and specifying our products. The use of these guidelines will help ensure that all aspects of product design are considered as to maximize the aesthetic quality, reliability, and efficiency of the final product.

GENERAL CONSIDERATIONS

ENVIRONMENTAL

- What temperature and humidity range will this product experience?
- What types of contaminants or chemicals will come into contact with this product?
- Will this product be subjected to moisture and/or U.V. exposure?

MECHANICAL

- Will tactile response be required?
- To what material will the switch be laminated?
- What number of actuations will this product receive?
- Will actuation force be a factor?

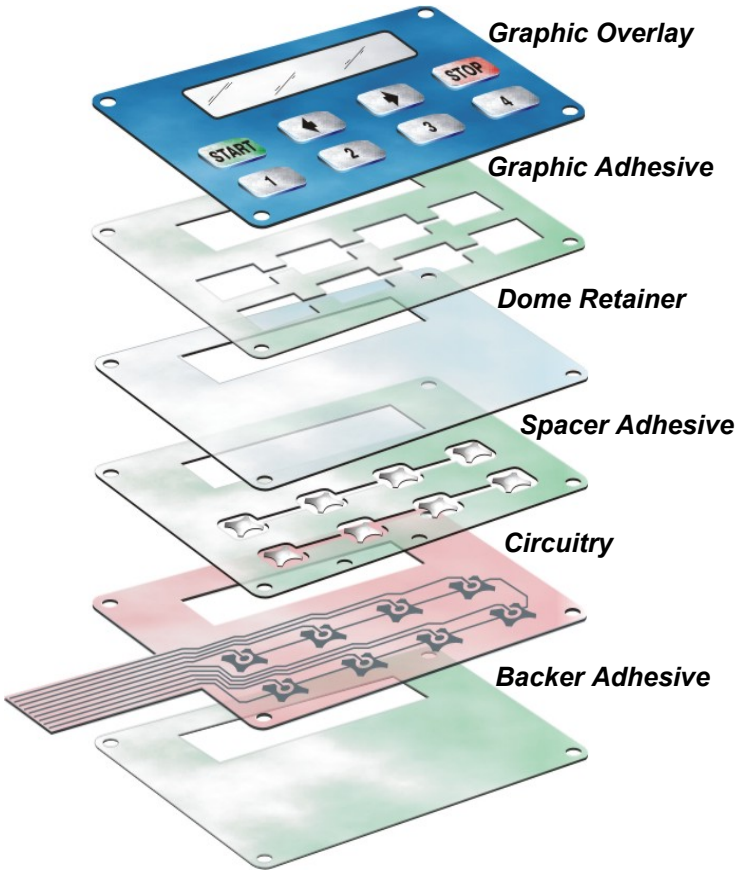
ELECTRICAL

- How many contact points will there be?
- What type pinout or matrix will be used? (common bus, X-Y matrix)
- What closed loop resistance will be acceptable?
- Will electrostatic or EMI shielding be necessary?

APPEARANCE

- Will edges be exposed, recessed, or covered with a bezel?
- Will embossing be required?
- Will there be different parts to the same product? (sets)
- How many colors will be needed?

BASIC MEMBRANE SWITCH CONSTRUCTION



Graphic Overlay Material Selection

The proper selection of a graphic material is critical in order to ensure that the appropriate aesthetic qualities as well as the longevity requirements of the final product will be achieved.

The two most widely used graphic materials are polycarbonate and polyester. For the purposes of membrane switch applications, polycarbonate comes in thicknesses of .005" - .030" thick while polyester comes in thicknesses of .005" - .010". Each can be purchased in the following finishes: gloss, mattes (various levels), and textures.

Polyester has greater tensile strength than does polycarbonate, which often allows it to withstand millions of actuations before fracturing. Also, polyester has a greater resistance to a broad range of chemicals. Due to these advantages, SSI recommends utilizing polyester as the graphic overlay for most applications.

Graphic Design and Preparation

- **Blueprints** – Provide drawings that clearly dimension all physical characteristics including color breaks and copy.
- **Colors** – Identify colors by using Pantone (PMS) color number or a color sample. It is important to supply the exact standard for which our color match will be evaluated. Be cognizant of how colors contrast with one another in order to maximize the legibility of the text and symbols.
- **Background** – Dark backgrounds and light text will provide greater clarity and show less wear and dirt.
- **Artwork** – It is possible for customers to supply useable artwork, but they should consult SSI first to ensure that proper artwork specifications are met.
- **Borders and Outlines –** Avoid outlines close to cutouts or outer edges, or circles within circles, as any misregistrations will be visually accentuated. *(continued on next page)*

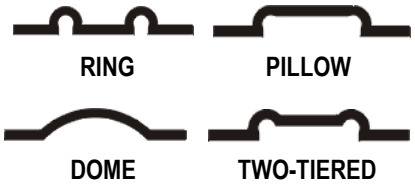
Graphic Design and Preparation (cont.)

- **Text** – Block lettering provides the most legible copy. Try to use common fonts. When logos or symbols are used, it is best to supply film positives or accurate black and white artwork for SSI to scan. Positive letter strokes should be a minimum of .008" and .012" for negative letter stroke.

Embossing

Raising certain areas of the graphic overlay can offer a unique look to your product as well as provide an important function.

SSI can emboss graphics in two ways: hard-tooled emboss and print emboss. As the name implies, hard-tooled emboss utilizes male and/or female dies to form the graphic overlay in a variety of shapes and styles. Common hard-tooled embossing types include:



In the case of a ring emboss, borders are usually raised .005" to .010" high and .040" to .070" wide. The maximum emboss height is typically limited to 6 times material thickness of polyester and 9 times material thickness of polycarbonate. Embossed corners should have a minimum of .010" radii.

Print emboss, on the other hand, is a tool-less process involving printing multiple passes of ink to build up certain shapes on a graphic overlay. This option works best with the ring style or embossing detailed graphic entities. Among the advantages of print emboss is the elimination of stress on the material often caused by the forming process. Better adhesion to the sub-layer is achieved because the graphic stays flat. Print emboss height is limited to .006" - .010".

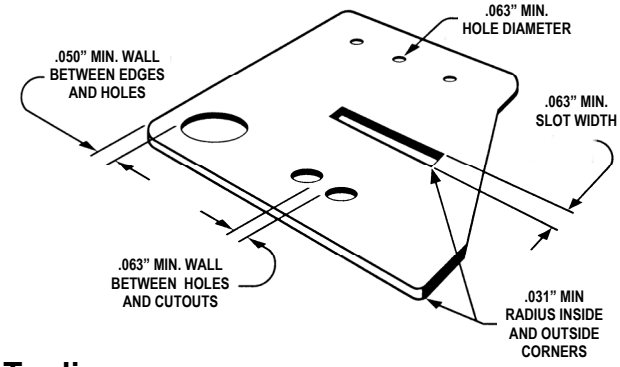
PRINT VS. HARD-TOOLED EMBOSS

Basic Layout and Tolerances

- Edge clearance: keypads should be a minimum of .150" from the edge of the switch panel.
- Allow at least .125" between keypads or printed circuitry to the edge of a window.
- Circuitry tolerances should be +/-.015".
- Avoid too many keypads in a small area. Keypads smaller than .375" diameter can be awkward to operate and often offer a less than optimal tactile feel.

Cutout Position Specifications

- .063" minimum wall between holes and cutouts
- .063" minimum hole diameter
- .050" minimum between edges and holes
- .063" minimum slot widths
- .031" minimum radius inside and outside corners



Tooling

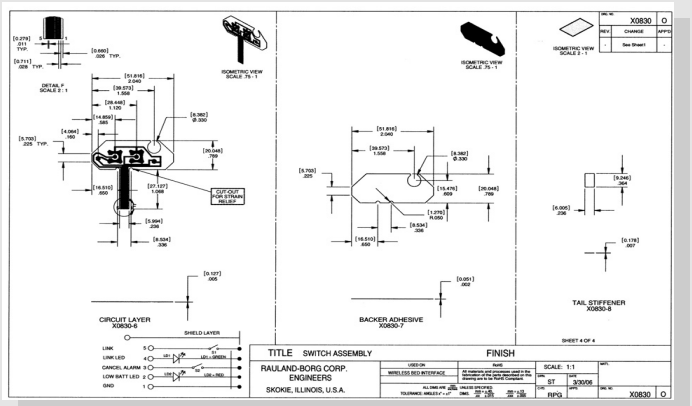
The standard tooling for membrane switches is steel rule dies. Steel rule dies normally achieve a tolerance of +/-.010 when cutting material up to .025" in thickness. When cutting materials .030" and over, steel rule dies will lose their accuracy and sharpness, making acceptable die cutting more difficult.

Hard tooling (male/female punch dies) can achieve a tolerance of +/- .002". However, cost is significantly greater than steel rule dies.

In many cases, membrane switch layers can be laser cut to tolerance of +/-.005" or less. Laser cutting does not require tooling charges but typically increases the piece price.

Creating a blueprint for a membrane switch?
Don't forget these important specifications!

- Overall size of part
- Keypad centers
- LED locations
- Diameter of corners
- Size and Location of Cutouts
- Size and location of windows
- Location of tail exit point
- Location of graphic entities
- Electrical schematic
- Identify "pin 1"
- Color specifications
- Tail Length



Embedded LEDs

As a substitute to mounting LEDs on a sub-board, SSI can provide membrane switches with LEDs embedded inside the membrane switch. This method can prove very effective particularly when a printed circuit board is not needed directly behind the membrane switch.

Due to the profile of a surface mount LED in relation to the thickness of a membrane switch, it may be necessary to emboss the graphic overlay to accommodate the thickness differential. SSI can use several standard LEDs for this application.

Backlighting Options

Historically, membrane switches have been backlit using discrete incandescent light sources. Though relatively inexpensive, this method does not allow for backlighting the actual contact areas due to the opacity of the conductive materials that we use. More recently, SSI has incorporated both fiber optic and electroluminescent panels, which are embedded between the graphic overlay and circuitry layers of the membrane switch. These panels allow for the complete backlighting of the entire surface of the part. Additionally, because these light sources are very flexible they do not inhibit the actuation forces of the given keypad positions.

Electroluminescent panels typically offer a brighter, more even flow of light. Also, EL offers greater design flexibility because the glowing element is discretely applied. EL, however, has a half-life of approximately 10,000 hours so marrying the technology with the proper application is critical. EL also requires an inverter to function properly. Fiber optic panels, on the other hand, are powered by LEDs that can easily be replaced.

Tactile Feedback

Tactile feedback can be obtained using either metal or plastic domes. Though the use of tactile devices puts a greater stress on the graphic overlay material, most designs can ensure reaching actuation levels over 1,000,000.

Polydomes require a one-time engineering charge but often provide piece price advantages over metal domes. Metal domes on the other hand typically provide the most flexibility to maximize the tactile feel of a given project.

Both types of tactile methods can be provided in several different keypad sizes. As a rule, the smaller the dome, the more difficult it is to achieve an acceptable tactile feel.

Moisture Resistance

One of the most valuable attributes of a membrane switch is its inherent ability to resist moisture. This characteristic allows membrane switches to continue functioning despite spills and moderate exposure to moisture and liquids. In cases where moisture resistance is more critical, SSI can incorporate numerous safeguards including full coverage dielectric coatings, carbon ink overprints, and pressure sensitive gaskets.

Despite our ability to protect against moisture, not all designs can be guaranteed not to fail unless the customer takes certain precautions. With rigorous environments, for example, a distance of .5" should be kept from any keypad to the perimeter of the part as well as from the tail exit point to the nearest keypad. In most cases, outdoor applications or parts requiring prolonged submersion should incorporate a watertight bezel that attaches to the front of the membrane switch.

Connector Interface

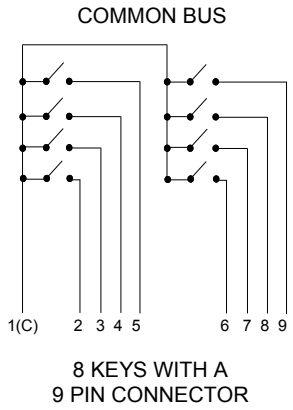
The standard connector SSI integrates in their membrane switch is one that will interface to .025" square posts on .100" centers. This header is commonly available by a multitude of manufacturers. These connectors come in both a plain style and a latching option.

In addition, SSI can design the circuitry tail so that it will slide into a board mounted connector. These LIF and ZIF connectors commonly come in .049"(1.25mm) and .039" (1mm) trace spacing. Keep in mind that due to the connector manufacture's tolerances, 1mm trace spacing may add additional part and tooling cost to the membrane switch.

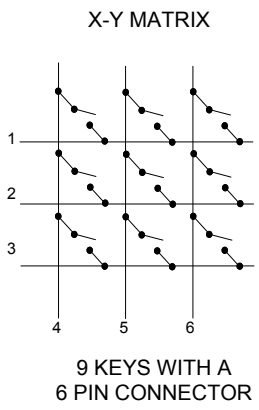
The last option for connector interface is the solder tab. This option simply involves SSI stitching a tab onto the end of the membrane switch tail so that it can be directly soldered to a printed circuit board.

Electrical Layout and Specifications

- A pinout and/or schematic for a common bus or X-Y matrix should be supplied.
- Closed loop resistance is normally between 50 and 200 ohms.
- Switch contacts are usually rated to carry no more than 50 mA. The power rating (current x voltage) should be kept below 1.5 watts.



8 KEYS WITH A
9 PIN CONNECTOR

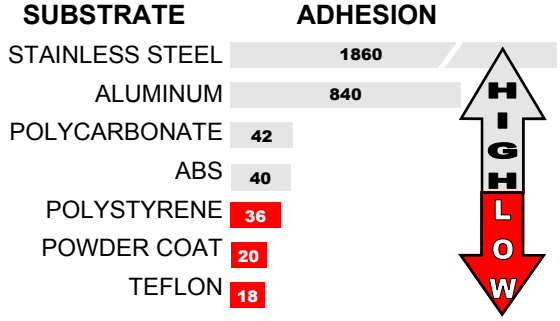


9 KEYS WITH A
6 PIN CONNECTOR

Backer Adhesive Selection

A wide variety of pressure sensitive adhesives are available to bond the membrane switch to a substrate. Selection of the best adhesive will depend upon such factors as environmental conditions, type of substrate (metal, plastic, paint) and smoothness of the surface.

In general, low surface energy materials as well as rough surfaces provide more difficult substrates for which to adhere. Here is a guideline of the surface energy of several popular substrates (in dynes/cm):



The 3 Most Important Steps in Expediting the Design of Your Membrane Switch

1 Provide Clear, Accurate Design Information

Have you included all the pertinent information?

- ► overall size
- ► keypad centers
- ► LED location
- ► diameter of corners
- ► size & location of cutouts
- ► size & location of windows
- ► location of tail exit point
- ► location of graphic entities
- ► schematic: What side is pin 1 on?
- ► color specifications
- ► tail length (including connector?)
- ► black & white outputs or files of logos & symbols

2 Answer Design Questions Expeditiously

Soon after your purchase order has been placed, SSI's design team will review your design information and compile any questions that they may have. An SSI representative will be contacting you to expeditiously address these issues. Your active participation in resolving these questions is critical for the timely design of your product!

3 Approve Graphic Artwork and Circuitry Schematic in a Timely Fashion

Typically, within 2 weeks after placing a purchase order, you will receive a fax or electronic file of our blueprint and artwork for approval. Please look over this information carefully. Contact us immediately after its review. In the case of a membrane switch, we will continue with the design by laying out the circuitry traces. Again, this will be faxed or e-mailed to you for approval and your timely feedback is essential.

Sketch/Notes:

Are you Providing the Information in the Most Efficient Format?
(In order of preference)

1. AutoCAD Files (.DWG) *see instructions below*
2. .DXF Files
3. Corel Draw Files (.CDR)
4. Detailed Blueprint (hardcopy)

If the above vector formats are not available, we would prefer the following file types for logos and symbols:
.JPG, .PDF, .TIF

AutoCAD file Instructions:

1. Reduce files to two layers (drawing layer and dimension layer)
2. Create a DWG and/or DXF file (AutoCAD Version 2000 or older)
3. Purge all symbols, blocks, and XREF's

SSI ELECTRONICS, INC.

www.ssielectronics.com
Phone: 800-866-8510 Fax: 616/866-8882
8080 Graphic Drive, NE Belmont, MI 49306