
Membrane Switch Design Guide



RSP Inc. is your trusted source for membrane switches, EL lamps, plastic injection molding, rubber keypads, turn-key assemblies and contract manufacturing.

We have over 50 years of manufacturing and design experience. We have domestic capabilities for laser cutting rapid prototype membrane switches and producing medium-sized production runs at competitive pricing. We have offshore production capabilities for a variety of jobs large and small offering world-class pricing.

The top layer of a membrane switch is the graphic interface between the user and the machine. While other layers are essential to overall performance, it is a well designed and attractive graphic layer that impresses the user first. The other layers of the membrane switch need to support the graphic layer by providing the qualities and functionality you need.

RSP Inc. works with each customer to design the optimal switch that meets your needs. We can maximize a switch for appearance, functionality and price. RSP Inc. prides itself on testing each switch to your specifications so that there are no failures in the field.

The membrane switch can be the most important part of a product; do not trust the design and construction to just any supplier.

If you need additional information please contact us directly at (414) 546-4417.



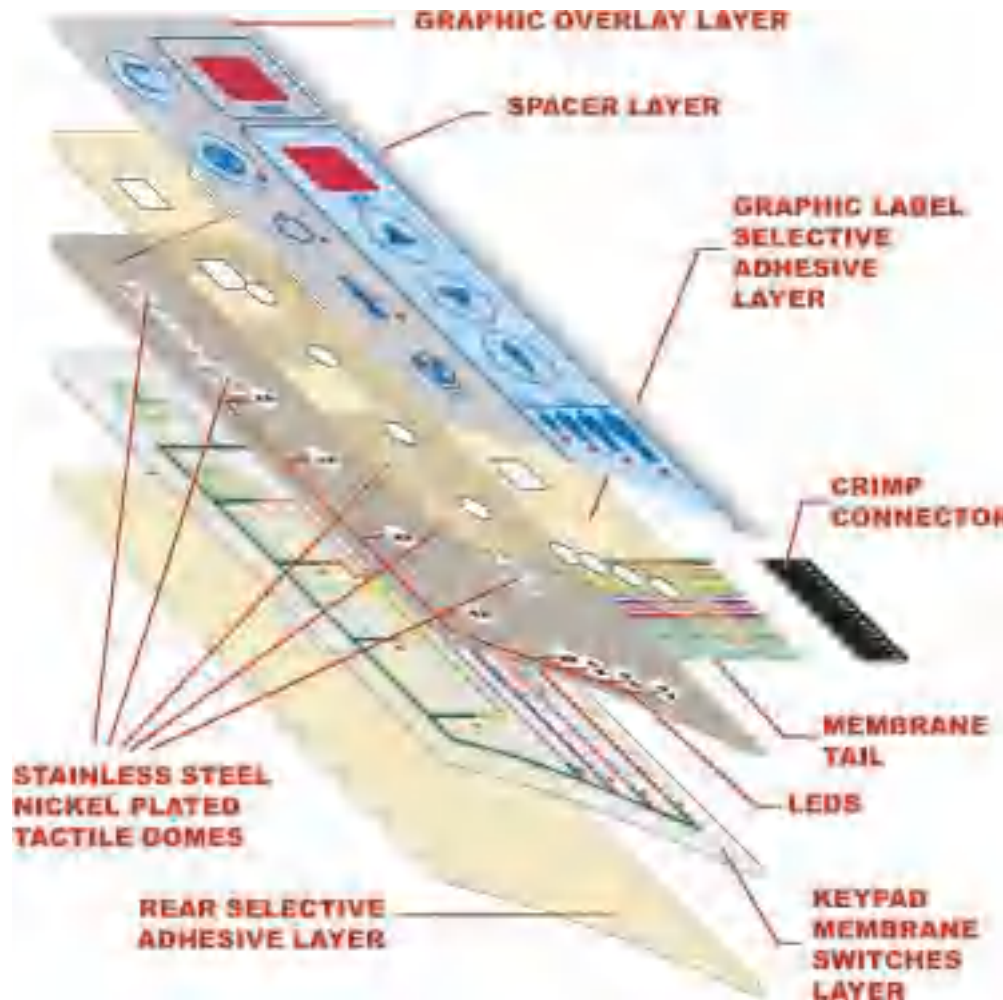
Membrane Switch & Plastic Molded Bezel



*Membrane Switch, Plastic Molding
& Silicone Rubber Wrap*

Membrane Switch - Standard Construction - Membrane Keypad

Figure One



Construction Considerations

RSP Inc. designs custom membrane switches to your specification. Ideally, the membrane switch will be designed simultaneously with the rest of your product. (Please note that we have the capability to provide you with many other parts for your project as well, such as the PCB, plastic enclosure, and even turn-key assemblies). Since we want you to have the best membrane switch possible, here are things to consider during the design phase.

Mechanical

- What material type is the switch laminated to? This will determine the adhesive needed.
- Will tactile response be required?
- Is actuation force a factor? The usage effects whether you want a heavy or light force to actuate the key.

Environmental

- Will this product be used indoors or outdoors? Does this product need NEMA 4 construction? NEMA 4 provides a degree of protection against falling dirt, rain, sleet, snow, windblown dust, splashing water and hose-directed water.
- Is this product exposed to the elements?
- What temperatures and humidity range will this product experience?
- What type of solvents and cleaning solutions will come into contact with the switch?

Electrical

- How many switches will there be?
- What type of pinout will be used (common bus, X-Y matrix, other)?
- What closed loop resistance is acceptable?
- Will Electromagnetic (EMI) or Electrostatic (ESD) shielding be necessary?

Appearance

- Will edges be exposed? It is best to place the membrane switch into a recess that is the same or greater thickness as the membrane switch to avoid accidental interaction.
- Will embossing be required? Embossing improves a user's ability to locate keys.

Design Stage

Artwork

RSP Inc. accepts many different formats of artwork files. To find out if we can work with your artwork, please send a file with contact information to sales@ryanscreenprinting.com. If you do not have artwork or need help with your design, our graphic artist and engineering experts can also design the graphics overlay and circuitry for you. Common file types accepted by RSP Inc. include:

- Adobe Illustrator -AI or EPS
- CorelDraw - CDR
- AutoCAD - DWG or DXF
- Portable Document Format - PDF

Sample / Re engineering

If you have a sample part, providing it to your sales associate can be very helpful for quoting and rebuilding. If drawings are available, a sample can confirm colors and construction in cases where the membrane switch was not built to specifications. If there are not drawings, in the case of a replacement membrane switch on a machine, a sample may be the only mean available to construct the schematics, match colors, and specify the layers.

Color samples provide the best method of color matching. If an exact match is necessary, please let your sales professional know so that a sample can be provided to you for approval.

- Pantone Matching System (PMS ###)
- Color Samples - Preferred samples are 3" x 3" on polyester or polycarbonate

BEFORE



FROM
CUSTOMER

AFTER



REBUILT

Production Drawings

During the design process RSP Inc. will supply the customer with the same prints that move with the job through production.

Customer can visually see each layer of the switch including key placement and circuitry when needed.

- Design support team ready to assist
- Color printed proofs (when needed)
- Artwork is approved by customer before any production run is started.

Prototyping

A prototype is a cost-effective method for creating and executing your design with a minimum investment in tooling and development time. Often there are changes in size, colors, cut out locations and shape after a prototype run. RSP Inc. is able to produce most prototypes with a little or no hard tooling which provide significant savings.

- Rapid prototypes
- Precision laser cut prototypes
- Fast implementation of design changes and updates

Graphic Overlay Design Elements

Material

Polyester is the most commonly used overlay material because of its durability and functionality. Polycarbonate is also used on some projects when a thickness greater than .010" is required. Materials come in a variety of gloss levels, textured finishes and thickness. It is important to choose a material that not only looks good but offers the life expectancy and characteristics that you require. If you are embossing the membrane switch or need more than 100,000 actuations use a polyester material. Testing has shown that a polyester membrane is good for over 1,000,000 actuations. The circuit can typically last over 5,000,000 cycles. Therefore, the overlay is the weakest part of the switch and thus determines the overall switch rating.

Generally, for excellent tactile feel in a switch with stainless steel domes we recommend an overlay material thickness of between .006" and .008". Thicker overlays will decrease the tactile feedback and thinner material will decrease the life.

One of our most commonly used materials in the construction of the top layer of a membrane switch is Autotex V8 for indoor use and Autotex V8XE for outdoor use. In testing and field experience, this material has proven itself to be superior. When comparing other membrane switch quotes, make sure you compare not only the price, but the types of material being used. RSP Inc. puts the type of material being used right on the quote.

Textured Background

The surface texture can either be printed by RSP Inc. or supplied and the material by its manufacturer. Hard-coat textured materials are more durable than printed textures. Extended use keypads should avoid having a printed texture, satin, or glosses. When a material is used that has a hard coat texture (like Autotex V8) a window is "wetted out" from the texture.

A wet out window is the printed area where a clarifying ink is used to create a clear window. The resulting window will not be as clear as non-coated polyester but it is acceptable in most applications.

Embossing

Embossing is a process that can greatly enhance the look of a membrane switch and improve the user experience. There are two methods for embossing. First, you can use a male and female die. This allows for a clean finish but has height limitations. The second method is hydro-forming: it allows for greater embossing heights but is more expensive. Typically, a material is embossed 1 to 1.5 times the thickness of the base material. It is possible to emboss to a higher multiple, but the durability of the keypad is sacrificed.

- Perimeter embossing requires a minimum distance of .030" to the edge of the material.
- Key-to-key distance should be a minimum of .050"



Tactile Feel

Because membrane switches have relatively short travel, it is often desirable to provide users tactile feedback and "snap" action.

There are two types of domes that provide tactile feel, stainless steel and molded polyester domes (polydomes). Stainless steel domes are commonly used in small to medium run jobs. They offer the longest actuation life and a better tactile feel than polydomes. RSP Inc. maintains an inventory of domes ranging from 3mm in size and a variety of shapes.

Polydomes can be formed into the upper circuit or the graphics layer. There is additional molding tooling needed which increases the tooling costs. Because individual domes do not need to be placed above each contact polyester domes are often used in larger quantities.

Our engineering staff will provide expert advice on the type of domes best suited for your application.

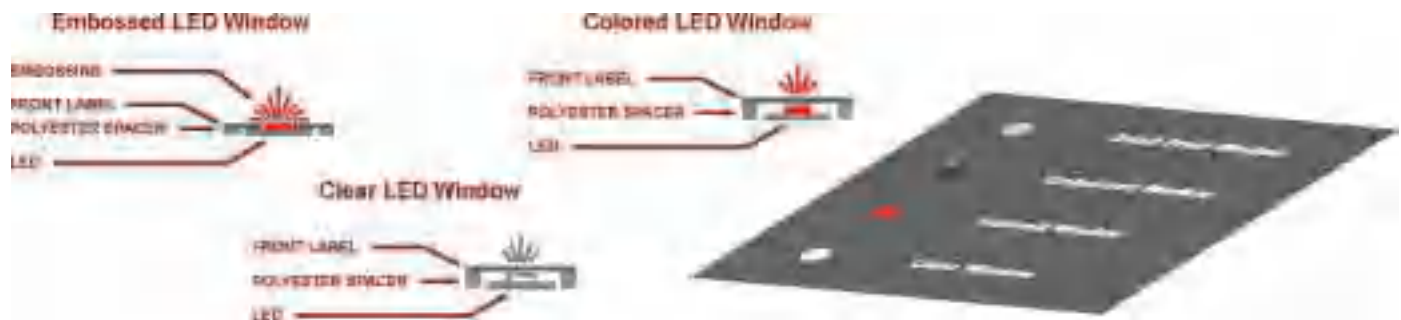
Lighting Design Elements

LED's (Light Emitting Diodes)

RSP Inc. can provide many different types of integrated LEDs. The selected graphics overlay material is usually clear with gloss or matte finish.

The LED needs a translucent window on the graphic layer to allow the light to shine through. The window can be clear or match the color of the LED (or any color specified).

LED's can either be surface mounted to the circuit layer or be on a separate LED layer.



Fiber Optic Backlighting

Fiber optic backlighting does not wear out. In a typical design, two or more layers of woven fiber optic cloth are used to form a rectangular light emitting area. The fiber optic product is typically 0.068" (1.7mm) thick and anywhere from 1 sq inch to over 100 sq inches. The fibers coming off one end are then bundled into a circular ferrule and coupled to one or more LED light sources. Fiber optic panels never need replacement. Remote light sources offer 10,000 to 100,000 hours life. Optical Fibers are not effected by extremes in humidity (0% to 100%) or temperature (-40 to +85 deg C)

Electroluminescent Lamps (EL Lamps)

EL Lamps are a good option for backlighting membrane switches. They are lower priced compared to fiber optics and offer additional design flexibility. The color of light emitted from an EL can vary depending on the phosphors that are used. Some common colors are blue/green and yellow/green, white, blue and orange. The life of an EL Lamp varies based on the way it is used. EL Lamps have a half life: once they reach their half life the brightness starts to fade rapidly. If the light is just being turned on when you hit a key on a switch the lamp will take a very long time to reach its half life of approximately 3000-8000 hours depending upon the quality of the phosphor being used. EL Lamps are not a good choice if the lamp is on for an extended period of time. To help expand the life of an EL Lamp you can have it fade or flash, this could double the life of the lamp.

Internal Design Elements

Upper and Lower Circuit Layer

The upper circuit layer in a membrane switch can be a tactile metal dome, polydome, or polyester. It depends on the type of switch you are building and the actuation requirements. Typical polyester layers are .005“ thick.

Conductive Traces

Conductive traces are generally printed silver on polyester.

RSP Inc. can also supply you with **printed circuit board** or **copper flex circuit**.

- Traces usually have a minimum line thickness of .016”
- Standard line thickness of .025“

Spacer / Insulator

Insulators vary in thickness from .002” to .010” and are generally polyester with double-sided acrylic adhesive. In a membrane switch with tactile domes, the spacer layer creates a gap so that the dome is not pre-actuated (under pressure). In a non-tactile membrane switch the spacer layer creates a gap between the upper and lower circuit layers.

EMI / ESD / RFI Shielding

Printed conductive inks, aluminum foil, copper foil or Indium Tin Oxide (ITO) is employed in membrane switch designs to minimize the impact of electromagnetic interference (EMI), electric static discharge (ESD), or radio frequency interference (RFI).

Connectors

RSP Inc. uses a variety of connectors.

Standard connector

- 0.100” pitch Male/Female, and Solder Tab
- Plating-Tin or Gold

Zero Insertion Force (ZIF) Connector

- This connector is designed for installation of ZIF Connectors
- 1 mm spacing standard

Adhesive

RSP Inc. typically uses a .002” adhesive on back of the overlay and throughout the internal membrane switch. On the rear of the membrane we use 3M adhesive standard; 3M is recognized in the industry for outstanding adhesion and life span. Make sure when you compare quotes that each supplier is using 3M adhesive. Most membrane switches are constructed from 3M’s 200MP family of adhesives. Internally, a .002” adhesive is typically used (3M 467).

Adhesion qualities are affected by the substrate surface energy (high or low), types of materials used, the required bonding requirements, environmental concerns and a number of other factors. Your sales associate can help you decide which is best for your project.

Sub-Panel / Back Plate

Most membrane switches are mounted to a back plate or sub-panel. RSP Inc. can supply you with a variety of different materials and finishes.

- Custom Molded Plastic - injection molded plastic built to your specifications
- Plastic Panel (Acrylic, Lexan, Polycarbonate, etc...) - flat die cut or laser cut plastic in a variety of thicknesses
- Aluminum - brushed, anodized, sealed, unsealed, dyed
- Stainless Steel - brushed, sanded, and other finishes.

Printed Circuit Board

A printed circuit board can act as the lower switch layer. RSP Inc. can supply single or multi-layer PCB's.

Studs or standoff can be integrated into the PCB with the board acting as a supporting panel. PSB can also be assembled directly to the housing

References

- A. Die Cutting Tolerances
- B. Electrical and Mechanical Specifications
- C. Membrane Switch Blueprints
- D. Glossary

A. Die Cutting Tolerances

Standard tolerances for the industry are +/- .010"

Laser cutting tolerances on our machinery are +/- .004" depending upon the material.

B. Membrane Switch - Electrical and Mechanical Specifications

Electrical

1. Configuration - momentary SPST normally open
2. Current Rating - 30V - 100MA to 120V - 10MA maximum
3. Breakdown -220 V RMS
4. Closed - 100 MEG OHMS contact resistance minimum
5. Open - 10 MEG OHMS contact resistance minimum

6. Capacitance - 30 Picofarads

7. Life -

- a. Flat Switch - approximately 5 million cycles
- b. Domed Circuit - approximately 1 million cycles
- c. Metal Dome - approximately 5 million cycles

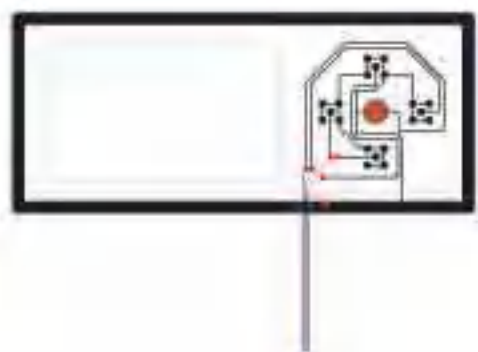
8. Contacts - Silver to silver. RSP Inc. uses only high quality silvers since low quality silver may not last as long and may contribute to silver migration (the tendency of silver to spread or “creep” especially when exposed to moisture).

Mechanical & Environmental

Typical Switch Specification			
<i>Mechanical</i>	Non-Tactile	Tactile Metal Dome	Tactile Polydome
Key Travel	.011”	.024”	.
Actuation Force	28-280 grams	260-650 grams	
Life Cycle (up to)	5,000,000	5,000,000	5,000,000
<i>Enviromental</i>			
Operating Temp	-22° F - 150° F	-22° F - 150° F	-22° F - 150° F
Storage Temp	72° F	72° F	72° F
Storage Life	1 year	1 year	1 year
<i>Electrical</i>			
Contact Rating	28 VDC at 30mA	28 VDC at 30mA	28 VDC at 30mA
Contact Resistance	<200 ohms	<200 ohms	<200 ohms
Contact Bounce	<10 ms	<10 ms	<10 ms

C. Membrane Switch Blueprints

Standard Membrane Switch Blueprint 1



D. Glossary	
Actuation Force	Maximum force measured prior to or at the point at which keypad contact closure is achieved.
Anodize	Electro-chemical oxidation of aluminum to form aluminum oxide with a porous nature. Anodized layer can be durably colored, is not-conductive, non-corrosive and resistant to abrasion.
Arcing	Discharge of electricity (spark) that may occur when contacts are opened or closed. Can reduce the life.
Circuit	Functioning sub-layer of a membrane switch. Typically printed with silver on a polyester substrate.
Contact Bounce	Intermittent contact opening and contact closure that might occur after actuation of the switch.
Dead Front	Achieved by printing a translucent ink in the area over a graphic so that the graphic is only visible when backlit.
Halftone	Image seen as a pattern of various size and shaped dots.
L.E.D.	Light emitting diode.
Non-tactile Switch	Switch assembly that has a tactile ratio of zero. (no "snap" when pushed)
Overlay	Top layer of a membrane switch. It is the graphical interface.
Prototyping	Method of constructing membrane switches in short runs with little or no "hard" tooling costs.
Schematic	Drawing that shows the electrical interconnections and functions of a specific circuit.
Silver Migration	The tendency of silver to migrate or spread especially when exposed to moisture. Under the right conditions silver can migrate several millimeters in just seconds. When a switch is designed properly and high quality materials are used this problem is greatly reduced.
S.M.D.	Surface mount device (like an LED).
S.M.T.	Surface mount technology.
Sub-surface printing	Printing on the back of the overlay (2nd surface printing). Extend the life of the overlay.
Tactile Response	Sudden collapse (snapback) of a membrane switch.
Termination	How a switch gets connected to the device.
Transparent	Transmitting light without appreciable scattering, object beneath remain visible.