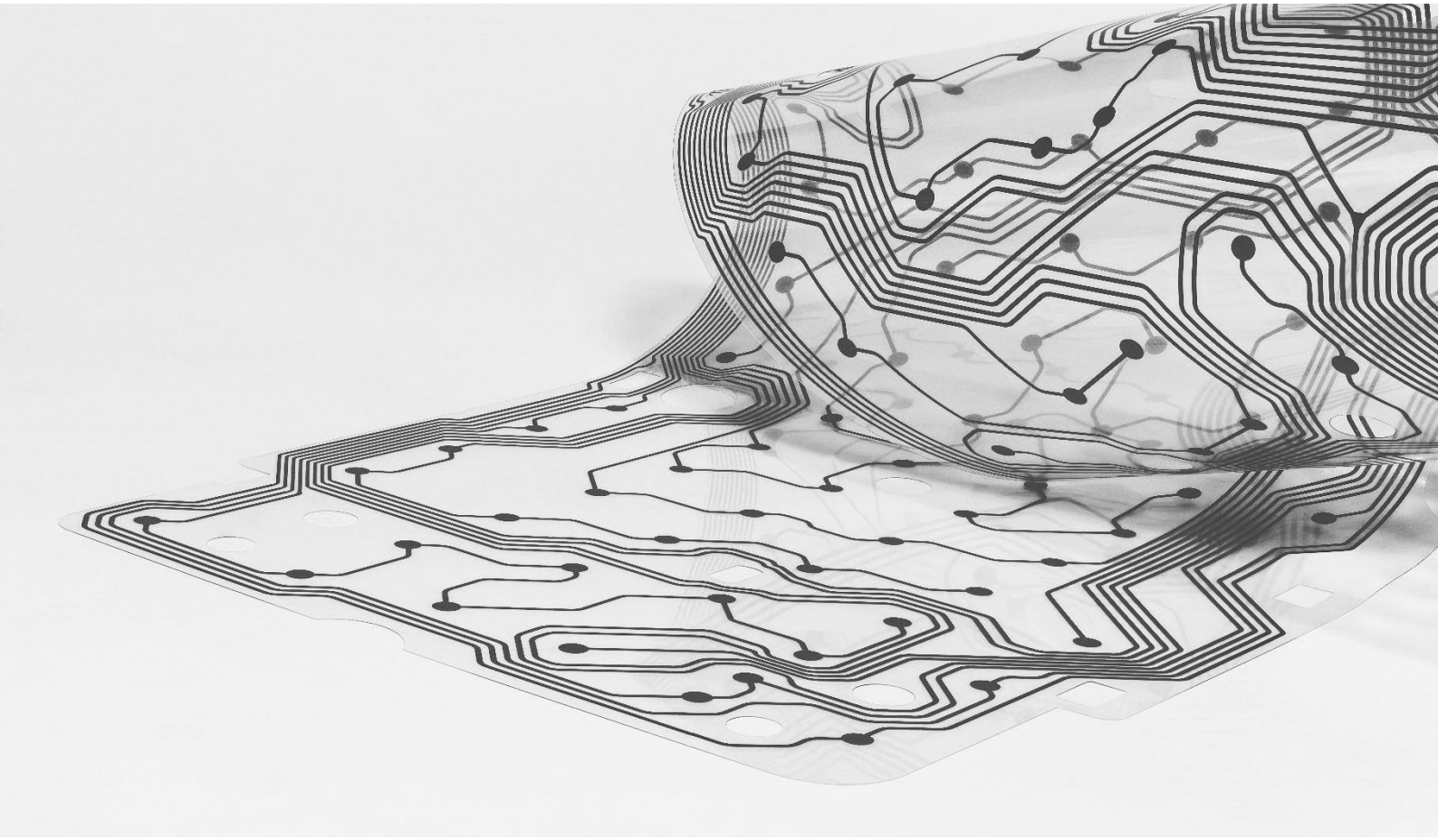
DIAMOND HMI COMPONENTS

MEMBRANE KEYBOARD DESIGN GUIDE



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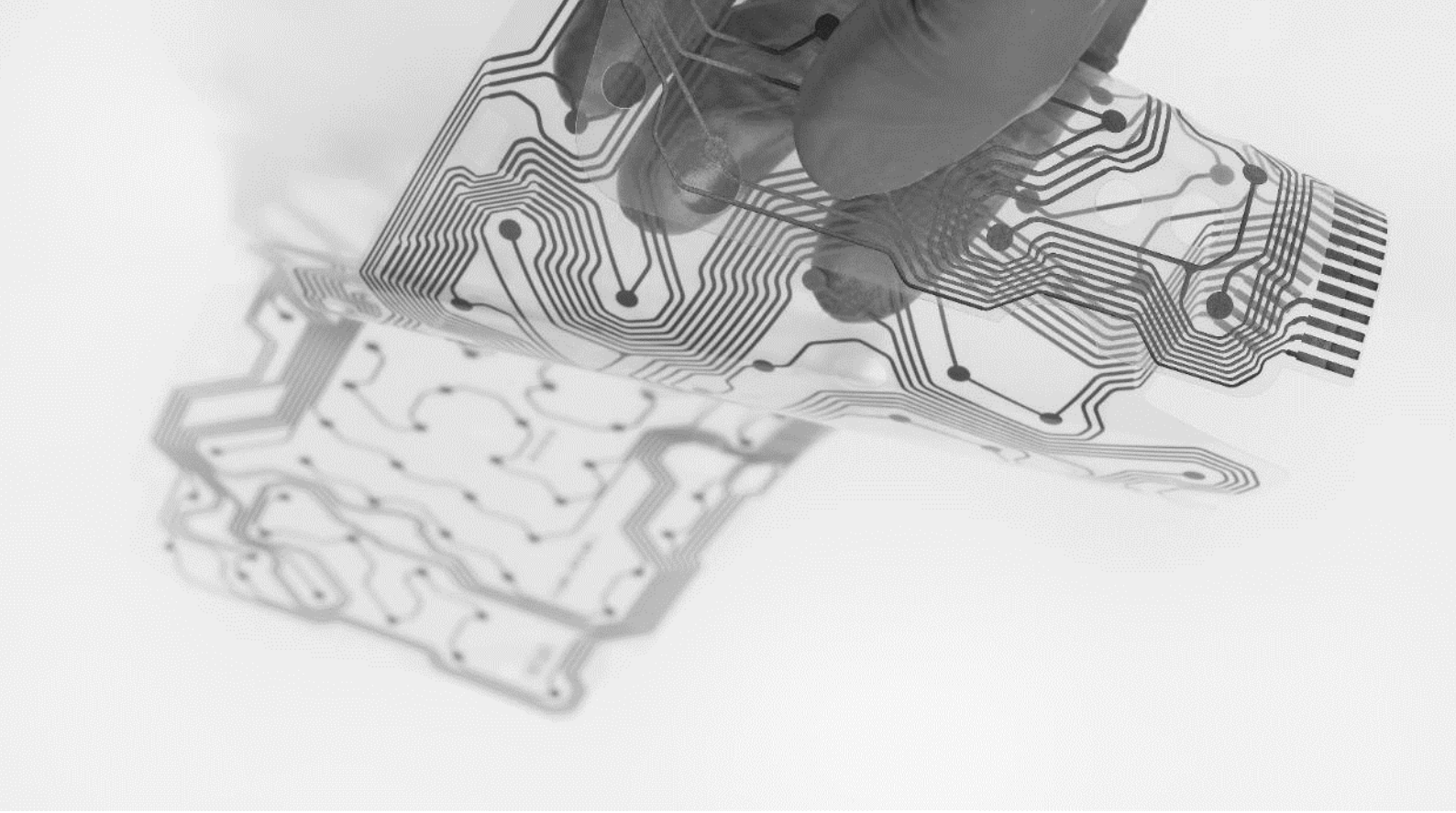

Introduction to Membrane Keypads

Membrane switch technology has developed into a reliable interface solution with many advantages. The sealed nature of the overlay makes them an excellent front panel solution where environmental concerns or frequent cleaning are an issue. Advances in additional features that can be incorporated into the membrane design, coupled with its reliability and ability to offer aesthetic flexibility, make it the solution of choice for many industrial applications.

Membrane switches differ from mechanical switches as they have a low profile, can be sealed from the environment and in most cases have a longer life. Our design guide outlines the features available and construction guidelines. Diamond HMI is an experienced interface solutions supplier. Our engineers equipped to help you design a switch that meets all your cost and environmental requirements. Effective communication between both parties enable a successful membrane switch design. Full details of design and environmental concerns need to be stipulated at the beginning of the process so our engineers can advise you of the best membrane panel solution.

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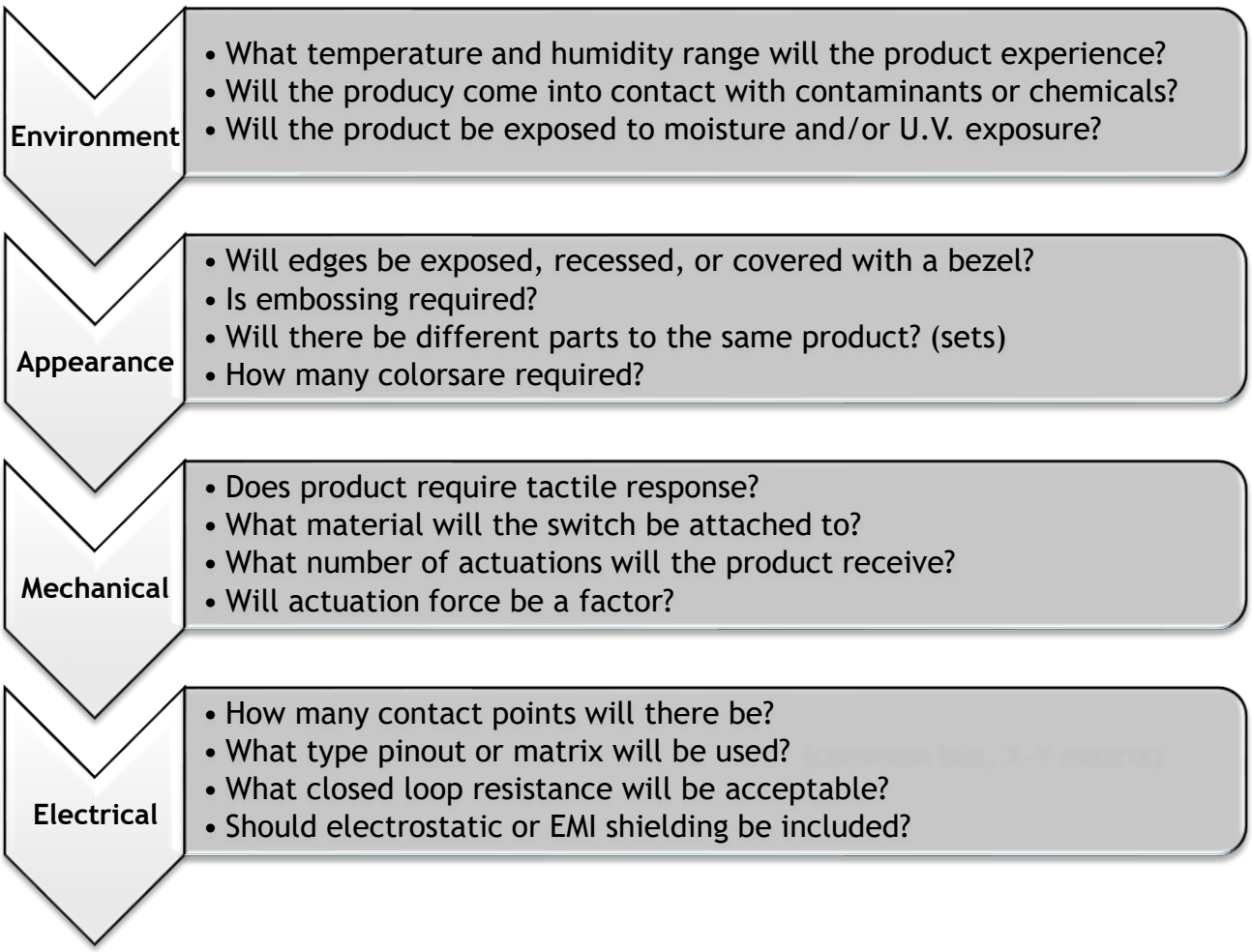
Before you start you need to ask yourself...



Application Marketplaces

Application Marketplaces for Membrane Keypads

Membrane keypads can be used within a vast range of industry applications, custom made to suit many external environmental factors.

Examples include:

- Medical & Healthcare Devices
- Machinery
- Instruments & Meters
- Industrial Control
- Household Appliances
- Aviation & Marine Control
- Automobile & Rail Transit
- Telecommunication & Networking Devices

Key benefits of Membrane Switching – Quick Overview

Thin and lightweight	Easy integration into application panels, and the ability to create more compact designs.
Limitless shape constraints and customisation	Flexible and diverse keypad assemblies available. Membrane keyboards can be tailored to meet a wide range of specific requirements.
Low tooling cost	Compared with other keypad technologies membrane keypads have significantly lower tooling costs.
Long Switch life	Membrane keyboards have a long switch life making them a good choice when they are required to be frequently used in their intended environment.
High IP Rating	We can provide water ingress protection level of up to IP67 depending on their construction.
Antimicrobial coatings	Available for medical applications or areas where a high level of cleanliness needs to be maintained, the coating helping inhibit bacterial growth and endure harsh cleaning agents.
Robust and resistant	Can withstand water, chemical contamination, or exposure to dust or dirt.
UV Stable Material	Available for outdoor applications.
Backlighting capability	They can incorporate spot, icon/text or entire surface illumination.

Designing a Membrane Keypad

Materials

The overlay is the top layer of the membrane switch and the main area the users sees in the switch assembly; therefore, appearance, functionality and durability all contribute to a successful switch solution it is also essential that the overlay material lasts as long as the application requires and can withstand the environment it is in. There is a variety of material options for membrane overlays, however Polyester (PET) is the most commonly used. Polyester is a material that has a superior life cycle and chemical resistance properties in comparison to other flexible materials.

In life cycle testing, polyester shows no signs of wear at 800,000 cycles and in tests certain structures can last many million operations. Originally, polycarbonate (PC) was used due to ease of printing but with recent improvements in Polyester coatings Polyester is now the go to material specified for all applications.

Also, with PC the life cycle data shows that it begins to crack at 30,000 cycles. For this reason, Diamond recommends the use of polyesters in most applications. Both polyester and polycarbonate are available with a variety of textures and hard coats. In their uncoated, glossy form both materials can scratch very easily. Therefore, gloss materials should always be hard coated. General guidelines of material properties can be seen in the table on page 7, which shows a selection of what is available, full specifications of which can be supplied on request.

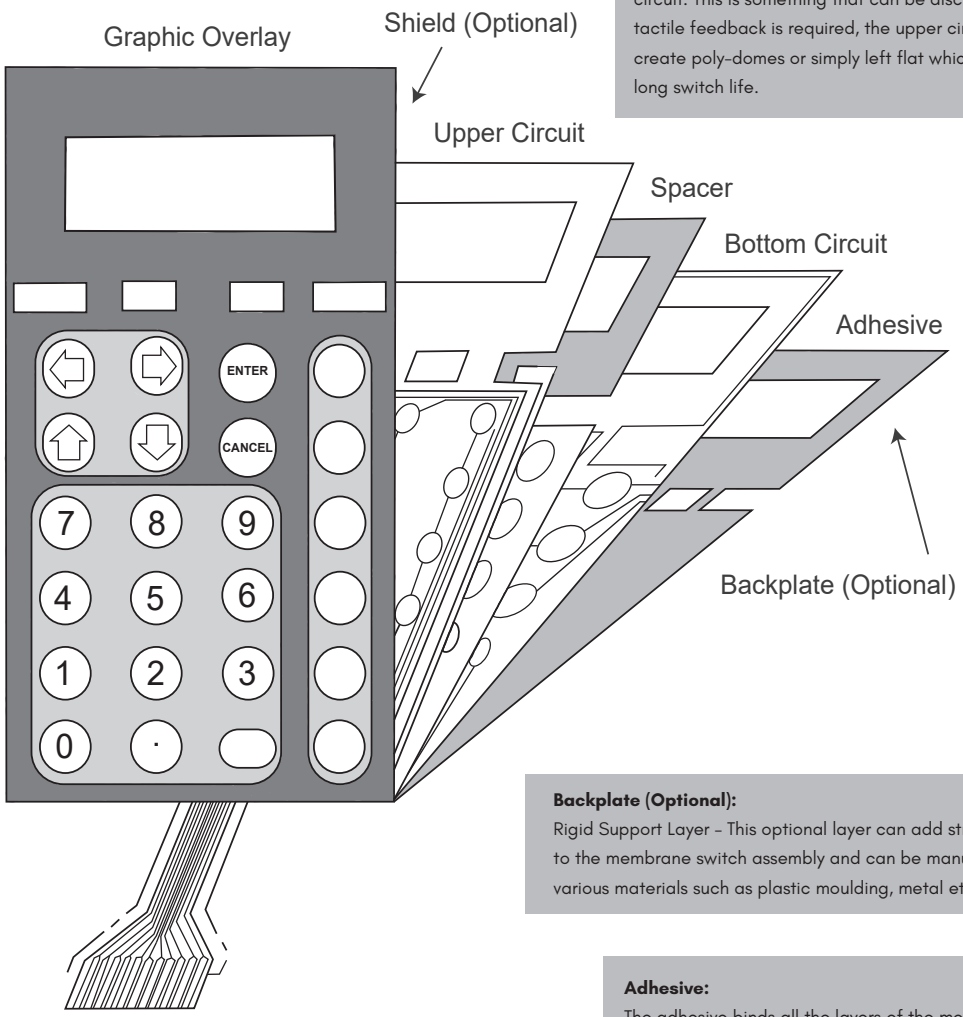
Structure

A typical construction of a membrane keyboard is displayed in the diagram below. Depending on the design requirements different layers can be added or removed.

Graphic Overlay:
This is the area which the user interacts with, it is important that the choice of material and finish suits application environment. Preventing damage and protecting the panel from external elements such as chemical solvents, or scratching. We print the graphic sub-surface using screen or digital printing. It is important that time is taken to create a graphic interface that enables the users to operate the keypad correctly. Our engineers will suggest where they think improvements can be made.

Shield (Optional):
This is an option where a layer above the switches can be coated with conductive inks to provide RF Shielding (EMI), this coating can also be printed onto the Upper Circuit layer removing the need for an additional layer depending on the chosen construction.

Upper Circuit:
There is not always a need for an upper circuit within a membrane switch when a metal dome is used. The number of keys and overall construction will determine the decision of incorporating an upper circuit. This is something that can be discussed with our engineers. If tactile feedback is required, the upper circuit can be embossed to create poly-domes or simply left flat which provides an exceptionally long switch life.



Spacer:
This layer separates the top circuit from the bottom circuit, functioning as a seal and has air channels to allow air to move between switch connections, the circuit spacer is a double-sided adhesive layer. It is worth considering if you wish to vent the air internally or externally which may affect the IP rating.

Backplate (Optional):
Rigid Support Layer - This optional layer can add structural integrity to the membrane switch assembly and can be manufactured from various materials such as plastic moulding, metal etc.

Adhesive:
The adhesive binds all the layers of the membrane switch together, as well as mount the membrane switch assembly to the application. The purpose of membrane switch adhesive is to ensure the membrane switch assembly stays securely adhered throughout the life of the product. At Diamond HMI we specify the appropriate adhesive type and thickness to bond your membrane keypad depending on your equipment with the most commonly used mounting adhesive being 3M.

Bottom Circuit:
The lower circuit is typically a polyester-printed layer with silver-filled electrically conductive inks and dielectric inks to which LED`s can also be integrated. This layer also terminates as a flexible tail that serves as the interconnect to controller PCB's or other electronics. It can also be a PCB or FPC if different connections or a 0.5mm finer pitch is required enabling the traces to be either side of the tail along with the fitting of SMT components.

Achieving the Right Look

When designing a membrane keypad there are many different options available to ensure that you design an engaging graphic interface that works well within the application. While the underlying layers contribute to the functionality of the application, the overlay is the piece that interacts directly with the user. To help ensure the desired look is achieved we offer design assistance from simple colour and overlay material selection, to complex design elements. At Diamond HMI we have a wide range of design capabilities such as colour matching, embossing, and textured finishes. The graphic overlay can help enhance user engagement and satisfy aesthetic requirements. Our engineers provide support throughout the design process to ensure customers have confidence in the suitability of their finished product.

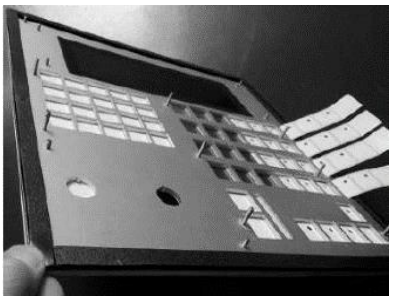
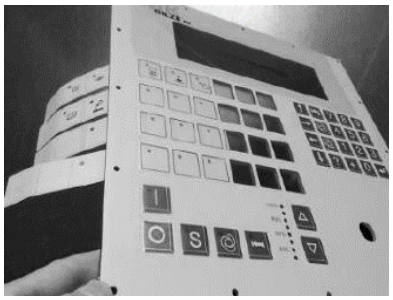
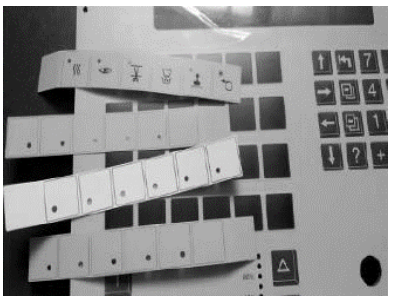
Interface Thickness Options

Overlay thickness usually depend on the amount of tactile feedback required. The thicker the overlay, the less the tactile feedback, giving the switch a heavier feel. If you require a switch with tactile feedback a thinner overlay would be better suited. An overlay thickness between 0.130mm and 0.180mm for a switch with a stainless-steel dome construction will provide excellent tactile feedback. Our engineers will provide you with the best options based on designers button and function requirements. The thickness of the overlay can also affect wear of graphics. (See printing colours section, on page 11).

Customisable Legends

In some applications, it is desirable to have the flexibility to change certain designated keys graphics when the switch is assembled to the end product. This gives customers the ability to use one standard keypad across different models of similar instruments. Typical applications for when customisable legends are used are for example, labelling on vending machines when the products vary, or when multiple language options are needed, designating zones for fire alarms, or just giving a product a different branding.

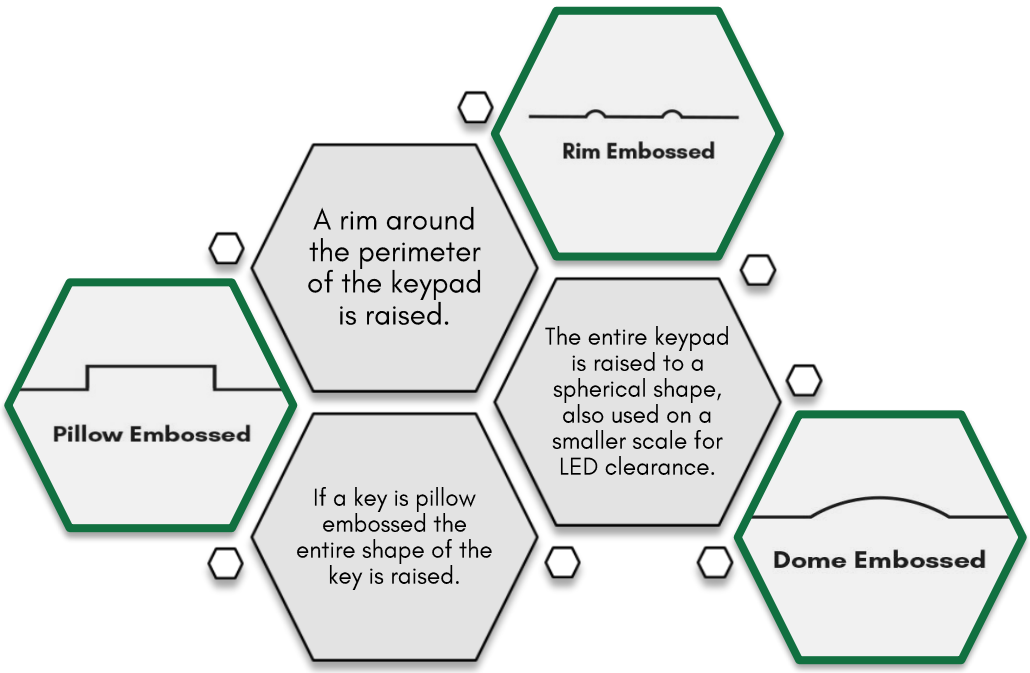
When designing a switch with customisable legends, a transparent window is placed in the area that will have changeable legends. An oversized pocket is put behind this clear area so that the legend card can be inserted from the rear or side and viewed through the window. The entire overlay has the same texture, which helps disguise that the legends are viewed through a window. We recommend that the background colour be different than the colour surrounding the window; this also helps disguise the legend card.

Embossing

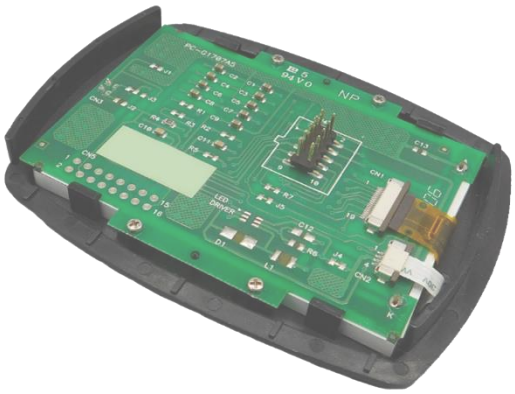
In many applications, it is desirable to emboss the keys to enhance the look of the switch and provide tactile feel. Embossing has become a standard feature of a membrane switch. We provide rim, pillow, and dome embossed keys. Rim and Pillow embossed keys have a typical height of 1.5mm x the base thickness with the dome being much higher to provide a tack tile response.

Other areas on the switch such as custom logos and multi-level shapes including Braille and LED windows can also be embossed. Polyester material has increased flexibility which makes it a good choice of material for a switch that requires keys embossing however it should be remembered if subjected to high temperatures this can relax and in higher temperature applications a metal dome switch is advised.



HMI Full Assembly

We can also provide a full-assembly service to our customers, this enables us to provide the membrane keypad, custom outer case, and PCB. This can help our customers by providing an easier supply chain process and delivering the product completely finished.



Graphic Overlay Finishes

There are a range of different finishes available for polyester and polycarbonate overlays, including gloss, Fine & Velvet matte textured and brushed steel effect. These begin as a clear material with the graphic inks printed on the reverse side (sub-surface printing) of the product. However, gloss overlays can be susceptible to scratches over time and so generally a fine texture is used over the surface. There is also the option to include both finishes on a membrane, this is known as selective texture. Selective textures are printed on the front side (top-surface printing) of the product to allow for clear LED/LCD windows. This can help incorporate an attractive design element.

Material	Manufacturer	Base Film	Coated	Finish	Embossable	Benefits	UL Rating	Thickness (mm)
Autotex	MacDermid Autotype	Polyester	Textured	Fine or Velvet Texture	Yes	Chemical Resistant	UL94-HB	0.15, 0.20 & 0.28
Autotex XE	MacDermid Autotype	Polyester	Hard Coat	Fine or Velvet Texture	Yes	Chemical & Ultraviolet Light Resistant	UL94-VTM2	0.15 & 0.20
Autotex AM	MacDermid Autotype	Polyester	Hard Coat	Fine Texture	Yes	Anti Microbial	UL94-VTM2	0.15 & 0.20
Autotex Steel	MacDermid Autotype	Polyester	Textured	Steel Texture	Yes	Chemical Resistant	UL94-HB	0.15 & 0.20
Autoflex EBG Gloss	MacDermid Autotype	Polyester	Hard Coat	Goss	Yes	Chemical Resistant	UL94-VTM2	0.13, 0.18 & 0.25
Autoflex EBA Anti-glare	MacDermid Autotype	Polyester	Hard Coat	Gloss	Yes	Chemical Resistant	UL94-HB	0.13, 0.18 & 0.25
Lexan	General Electric	Polycarbonate	No	Textured	Yes	Good Ink Adhesion	UL94-HB	0.125 & 0.175
Lexan	General Electric	Polycarbonate	No	Gloss	Yes	Good Ink Adhesion	UL94-HB	0.125 & 0.175

Windows

The overlay materials used in membrane switches are transparent to begin with. Colours are then screen printed on the back of the overlay material. Areas that do not have colour printed on them become windows. Window areas can have a variety of hard coats or textures added to them. We recommend that small, discrete LED indicator windows have the same texture as the background to aid light diffusion and can also have a coloured filter.

Larger windows for LCD's may need a window with less light-diffusing characteristics. Window coatings usually have anti-glare characteristics or optical clarity. The closer the display is to the overlay, the less effect the coating will have on display readability. In recent years Optical bonding of thicker materials which can be attached to the thinner window material has also been developed if more strength is required.

Artwork

Generally, most customers supply their artwork in an electronic .ai (Adobe Illustrator) file, EPS, or any other vector graphic program. Diamond offers complete artwork layout services if required although to speed this process up Ideally the customer would normally specify font, styles, and colours. Any artwork for logos or special symbols would also need to be supplied and once all the information has been collated, we would send an artwork proof for approval prior to manufacturing samples.

Colour Matching

There are many systems that a customer can use to communicate colour requirements to us. Pantone Matching System (PMS) is the most popular. It identifies colours by specific numbers. This system was originally devised for use in the offset printing industry but has become a common tool for all types of printing. The Pantone System is very popular because it is inexpensive and simple to use. The disadvantage of this system is that there are slight variations in the colours from sample book to sample book. The colours also fade with time, and books need to be replaced annually. It is worth noting that Pantone reference book samples are printed with offset inks on white paper which can be gloss or white where we are printing subsurface on plastic with differing finishes which may cause the end result to look slightly different, in this case a colour sample may be better to match to.

Other Colour reference systems we can use include British Standard and RAL colour references. If a customer has their own defined colour and wishes to supply a colour sample, we can match the sample colour. However, as mentioned above it should be kept in mind that colours will appear different when printed on different substrates. This is especially true in the case of subsurface printing on membrane switch overlays. Colour samples are supplied to customers on request. We can provide a sample of the actual ink to be used in production applied to the same substrate from which the part will be made.

Printing

As mentioned earlier the overlay material is clear to begin with, the artwork is then printed on the reverse side, to protect the design. This is known as subsurface printing. There are two printing options, either silk screen or digital printing, they can be used separately or together. Silk screen printing uses Pantone and other colour standards as mentioned above and provides high resistance to light exposure. Digital printing using CMYK colour standards can be used to create special effects such as fine Vignettes however is not advisable for high volume production as it is a slower process and subsequently the costs are high.

It is important to consider the thickness of the graphic overlay as this will protect the panel design from damage or wear by the operator or environment. Selective textures and window clearing lacquers are the only inks printed on the top surface of the overlay and are UV coated to create a durable finish.

Drawing

We use the latest version of AutoCAD to generate our drawings and artwork. It is helpful for customers to supply us with an AutoCAD DWG file, or as an alternative, a DXF. We can also use 3D files such as STP & IGES file for mechanical dimensions. We can convert other files to a usable format should the above not be available. Once the full design has been completed, we will send a drawing set detailing all the layers etc. for approval prior to manufacturing samples.

Construction Features

Mechanical Tolerances

Steel rule dies are typically used to fabricate the various layers of a membrane switch as they are low cost and easily formed into complex shapes. Standard manufacturing tolerances when using these are +/- 0.25 however a Tolerances of +/- 0.15mm can be achieved with hard steel tooling although the cost of such tooling is very high. It is also worth noting that a printing tolerance of +/- 0.25 can be compounded to the cutting tolerance however to offset this all layers below the graphic overlay are inset to prevent the possibility of them becoming visible.

Operation Force: 200-400g **Lifetime Test:** >500000

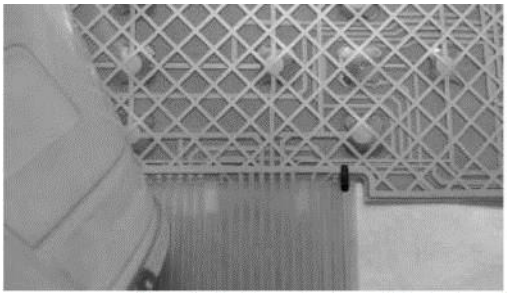
Operation Force: 250-500g **Lifetime Test:** >500000

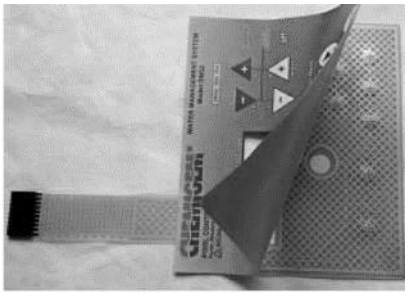
Wiring Schematics

The schematics of a switch may be specified by the customer if necessary. However, as with any circuit layout the more freedom we are allowed the more efficient layout we can produce. This has the advantage of shorter development time and a simpler circuit layout, which may reduce manufacturing cost. Membrane switches can be designed with a common bus or in a matrix. Matrix layouts are desirable for keyboards with many keys to simplify the interconnect. With very complex Circuits or limited space double sided FPC can be used which also gives the option of top or bottom tail connection and finer pitch tracks such as 0.5mm. The Loop resistance of a switch is the function of trace width and length and in most applications using silver inks the loop resistance is less than 100 Ohms.

RF Shielding (EMI)

To reduce Electromagnetic Field from the assembly RF Shielding can be incorporated into the design. Several options are available for shielding membrane switches. The most common methods are printed carbon or silver, both can be printed on the top side of the upper circuit or disc retainer to act as a shield. Silver is usually printed on the entire surface or a grid pattern to reduce cost as it is the more expensive of the two and the shield can be connected to the ground through the connector, or, by a tab with a slot that can be mechanically connected to the ground. We can also incorporate an ITO film (conductive Indium Tin Oxide coated film) over any window areas to prevent leakage if the customer feels it`s necessary.



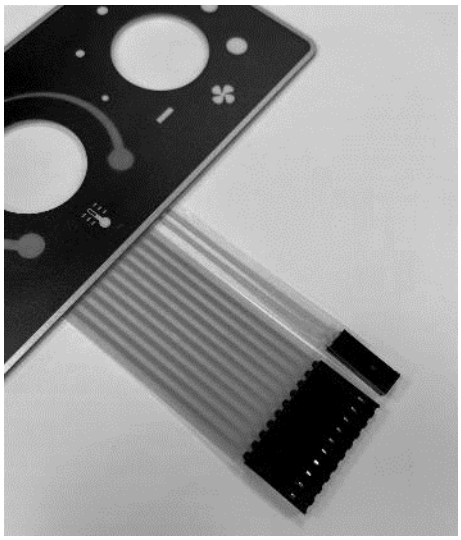


ESD protection (Electrostatic Discharge)

Another option to consider is if the product will require ESD protection, this can be achieved by simply ensuring all circuit tracks are kept at least 5mm from the edge or with a ground trace around the perimeter of the circuit layer (often used when using a PCB for a lower circuit).

Tail Exit Point

Flexible membrane switches are connected using a flexible tail cut from the circuit material. The length of the circuit tail can be if required to terminate to other functioning parts of the system, providing flexibility on where the exit point can be. 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 in the circuit. It should be noted that Mylar based circuits with Silver Tracks must not be folded at 90° as this will crack the tracks. R3 mm is the minimum permissible bend which can be supplied pre-formed. FPC (Copper based) circuits can be folded at right angles. When an increased level of water protection is required it is beneficial if the tail can be located within the assembly, often a window location is an ideal place, please ask our Engineers for best advice.



Interconnections

Interconnectors are attached to the tail exit point, connecting the keypad and the device it will control. At Diamond HMI we offer a variety of interconnectors to suit many applications.

Mechanical specifications for most interface terminations are standard. However, circuit construction techniques can be designed for compatibility with specific types of interface terminations systems. When selecting an interconnector for your membrane switch, several factors should be considered including cost, reliability, performance, design, and environment.

The flexible tail that exits a membrane switch usually has single row tracks of 2.54 mm (.100") centres. This tail can be connected to a circuit with a row of crimped connectors or alternatively to an interface with a ZIF (Zero Insertion Force) connector of 1mm pitch when using Silver on Mylar or 0.5mm pitch when using FPC.

ZIF connectors are low cost, lightweight, secure, and require very little force for insertion. When using a ZIF connector, the membrane switch is designed with exposed contacts on the top surface at the end of the tail. The customer then inserts the tail into the ZIF connector. ZIF connectors are readily available with locking mechanisms in 1.0 mm pitch to suit. When using a ZIF connector, you should specify either the specific connector or the requirements for the connector. FPC Flex circuits can be terminated with solder tabs that can be soldered directly onto the circuit board, they can have a interconnect soldered onto the surface or also be designed to suit 0.5mm pitch ZIF connectors with the added advantage of having the exposed contacts on either side of the tail.

Screen Printed Flexible Circuits & Crossovers

Flexible printed circuits are an array of conductors bonded to a thin dielectric film. The thinness and streamlined design reduce package size and weight, typical flex circuits used in membrane switches are made with screen printed silver-filled ink. The process is carefully controlled to ensure maximum conductivity, adhesion and flexibility. This type of circuit is single-sided, so does not utilise feedthroughs and is the lowest cost option.

When designing the circuit if space is tight then the tracks can cross on the same surface through use of a dielectric crossover this is when a dielectric material is screen printed in the area the trace is crossed over, and then silver jumpers are printed on the top of the dielectric. Another option is to use double sided FPC circuits which have tracks on the top and bottom of the substrate connected with feedthroughs this is when FPC double sided Polyamide material is used which is photo etched but this option is more expensive to use.

Rigid Membrane Switches

Rigid membrane switches also known as PCB membrane switches, use a rigid FR4 grade PCB instead of using screen-printed flexy circuits. This construction provides a robust panel, ideal for smaller designs where dense circuit patterns or trace routing limitation exist.

Rigid switches are good for extreme environments. They can provide easy integration of additional components such as LEDs and resistors. Rigid switches can be single-sided, double-sided, or multi-layered, they also have a lower electrical resistance and high conductivity. Gold plating can be added for critical applications where exposure to chemicals or corrosion may occur.

Tactile Membrane Switches using Domes

The relatively short travel of membrane switches means it is often preferable to provide users with some feedback. Tactile feedback can be added with the integration of snap domes with different forces, noticeable to the operator. There are two types of domes available for membrane switches: stainless steel and polyester.

Stainless steel domes are most commonly used as they are not affected by heat and come in a wide range of sizes and forces for the customer to choose, they can also be nickel and Gold plated and with or without dimples our team can assist you with samples of all styles and offer advice to assist your choice.

Polyester domes are embossed into the top circuit or overlay of the membrane switch. These domes require relatively expensive machined tools that are built specifically for each design. Originally as volumes increase, polyester domes became more cost-effective because they did not need to be assembled individually. However, with the introduction of automated placement, metal domes are now almost as cost effective. Polyester domes relax and lose their tactile feel at high temperatures and are not recommended for an application that will experience temperatures above 55ºC (131ºF).

Actuation Force

Key actuation force is chosen by the customer however to assist we can supply samples and also advise based on previous experience of what may be most suitable for their application. For metal domes the

typical actuation forces range between 170g to 700g (1.6 to 6.8 Newtons). Metal domes have a much wider range of sizes and actuation force than poly domes. Polyester domes actuation forces are usually between 225g to 350g (2.2 to 3.4 Newtons) however due to their manufacturing process and material variations this is not as accurate as stainless-steel domes. The tolerance on metal dome actuation force is +/- 40g but the end result can vary depending on the membrane construction.

Moisture Resistant Designs

Moisture resistant options are available for membrane keypads that will be used in an environment with humidity, dirt, and liquid spills, it is recommended that the assembly be environmentally sealed. This is achieved by the construction method chosen. Also, to avoid damage from condensation any exposed contacts should be coated with carbon. If the intended environment of the keypad is particularly harsh additional precautions should be made, such as a perimeter seal to provide a barrier between the switch and the part perimeter.

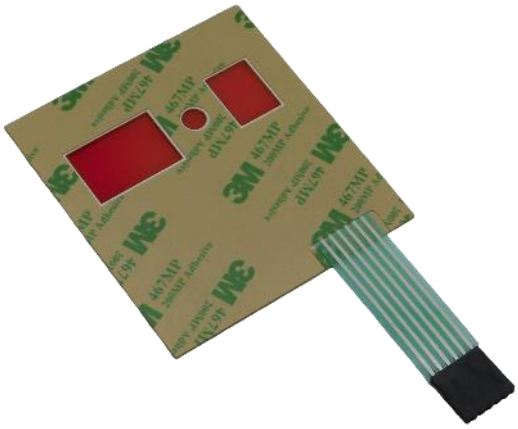
Life Cycle Testing

Diamond has an ongoing program of life cycle testing to ensure that all our switch designs will continue to function beyond 1 million cycles. However, many designs can be expected to last much longer. Specific life requirements should be communicated to Diamond's engineering department before designing begins so we can best advice, we can also arrange life testing of your product on completion of samples if required.

Mounting Adhesive

In most cases, flexible membrane switches are shipped to our customers with a pressure-sensitive adhesive on the backside. 3M's 467MP is the most popular adhesive, excellent for bonding to smooth metal and high energy plastic surfaces. For rougher surfaces, we recommend 3M's 468MP. Some surfaces, such as powder-coated surfaces have lower surface energy; for these, there are specific adhesives that are more appropriate. If you are uncertain as to the correct adhesive for mounting your surface, contact our product support team to discuss your requirements.

It is essential to always clean the surface before installing a membrane switch. If the alignment is difficult, we recommend that you remove a small corner of the backing, align the membrane switch, stick the corner down, bend back the membrane switch and remove the rest of the liner.



Never bend a membrane switch in an LED or dome area as the LED joint may fail and the metal dome may crease resulting in failure which may not occur immediately. After the membrane switch is correctly located, rub it down with firm pressure. We use pressure-sensitive adhesives because they need pressure to ensure a strong bond; the adhesive will continue to cure for many days. It will have reached 90 per cent of its ultimate bond within 72 hours of installation under most conditions. No testing of the adhesive should be done within 72 hours of installation.

Carrier Plates

In some applications, it is desirable to have the membrane switch mounted to a rigid sub-panel. Aluminium steel and stainless-steel sub-panels are commonly used and can be supplied with a variety of hardware installed. However, other options include polycarbonate or acrylic. It is important to keep in mind that the sub-panel must have different mechanical dimensions to allow for assembly tolerances. The sub-panel should be 0.5 mm smaller than the membrane switch in both height and width. All cut-outs and holes should be 0.7 mm larger. Cut-outs behind windows should be 1.5 mm larger than the window. These general guidelines are intended to help ensure that the sub panel is not visible after assembly.

Backlighting Options

We offer several backlighting solutions for viewing legends in low light applications. The process involves the strategic placement of lights into the switch construction to enhance products usability. There is a range of things to consider when deciding upon backlighting for a membrane keyboard such as power and heat consumption, and functionality of application.

Adding backlighting to a membrane switch provides an indication to users for applications used during the night or in dark environments or help workers avoid pressing the wrong buttons. The most common backlighting methods used are **Light Guide Film (LGF)** which in recent years has replaced **Fibre Optics and Electroluminescent (EL)** panels however customers still use **LEDs** for small areas. LGF, EL & Fibre panels offer the advantage of uniform light over a larger area. However, depending on the type of membrane interface and the way it will be used, ultimately depends on what backlighting is right for the application.

Embedded Light Emitting Diodes (LED)

It is common to include small surface mounted LEDs into membrane switches. This is a very simple way to add lighting to a switch. A standard membrane switch is not thick enough to accommodate the package size of most surface mounted LEDs. For this reason, the overlay may be embossed in the window area, or extra spacers may be added to the switch construction. Silver conductive epoxies are usually used to mount the LEDs to the circuit. LED lighting is better suited to small areas that require illumination.

Electroluminescent (EL) Lighting

Electroluminescent lighting contains phosphors that convert electric energy into light. As the phosphors tend to decay when used for extended periods, EL lighting is best used in environments with low or no lighting in which the backlight is not always on. They can deliver balanced lighting across the entire area of the membrane switch, suitable for most membrane switches. EL Lighting is also slightly more expensive and light output may reduce over time.

Fibre Optic Lighting

Fibre optic lighting usually consists of two or more layers of fibre optic cloth woven into a rectangular area that emits light. Fibres extending from one end of the cloth are bundled together and connected to a light source. Fibre optic lighting allows uniform backlighting across a wider area of the keypad, power requirements are very low, and they are capable of withstanding extreme temperatures and humidity and is a slightly more expensive form of backlighting.

Light Guide Film (LGF)

LGF is a thin film that will direct light produced by side-firing, or right-angle, LEDs across the area that needs to be backlit. The film is placed directly below the graphic overlay and above the circuit layer so that the light will not be obstructed by any circuit traces or tactile devices without impacting the tactile response and only increasing the overall assembly thickness by a small amount. Multiple LGF films can be used within one application to provide independent discrete backlighting to different graphic features. Different coloured LEDs can be used to achieve unique lighting effects or white LEDs can be used to light different printed graphics on the overlay. Light guide film provides a good quality of even light distribution across the chosen illumination area below is a guide to assist in deciding if this is the best technology for your design.

Summary

At Diamond Electronics we have many years' experience in the manufacture and supply of Human Machine Interfaces and whilst we endeavour to cover all aspects, products are constantly evolving and so please contact us so that we can offer the best on site or remote support for your project. On commissioning us to produce your products we will handle each stage of the process assisting with concept, design, drawing and sample production to ensure your product is designed correctly and delivered on time.

Glossary

Actuation Force: The maximum force measured prior to or including the point at which keypad contact is achieved.

Backlighting: A flexible layer within a membrane switch construction that illuminates select areas of the overlay, such as text or graphic symbols. (LGF, EL or optical fibres).

Circuit: Functioning component (sub-layer) of a membrane switch; typically made of a silver conductive ink printed on polyester. Also, can be a flexible copper circuit, a PCB or polyester printed with other conductive materials.

Connector: A device that provides electrical connection.

Dielectric: A material which is a nonconductor of electricity (insulator).

Digital Printing: Method of printing from a digital-based image directly to a variety of media or substrates.

Electro-luminescent Lighting (EL): Light produced by charging phosphors.

Embossing: Embossing creates a raised surface of a button, visually enhancing interface.

RF Shielding (EMI): Electromagnetic Interference (Radio Frequency Interference). Radiated energy from electrical devices, lightning and similar sources which interferes with the proper operation of electronic circuitry.

ESD: Electrostatic Discharge. Potential transfer of high electrical charge between objects by contact or through the air.

Environmental Shielding: The application of a gasket layer in a membrane switch, to prevent damage

caused by moisture.

Feedback: The mechanism by which the operator senses that a switch has been activated; audio, visual, or tactile

Feedthrough: A conductor used to carry a signal through an enclosure or printed circuit board.

Fiber Optic: Extruded materials, such as certain plastic filaments, which provide paths for light.

Flexible Printed Circuit (FPC): Photo etched polyamide with copper.

Graphic Overlay: Top layer of a membrane switch (the graphic interface between a device and user) generally made of polyester or polycarbonate.

LED (Light Emitting Diode): Bright and robust. Most frequently used as an indicator lamp.

Light Guide Film: A more recently developed backlighting technology that uses LEDs to create a solid film of light.

Membrane Switch: An electronic switch that consists of printed circuits, that acts as a user-interface, allowing the communication of commands from users to electronic devices and machinery.

Metal Dome: Stainless steel or composition of metals that are used to obtain a specific tactile feedback.

Operating Life: The useful life of a switch typically terminated by outright failure or by reaching predesignated end-of-life criteria.

Polyester Dome: A keypad on a membrane that has been dome-embossed on the overlay or top circuit layer to add tactile feedback when the switch is activated. The dome shape, which is usually formed by a hydro-forming process, can vary in size and shape to achieve a desired “force” and tactile “feedback” of the keypad.

Pantone Matching System (PMS): An ink colour designation system commonly used in a variety of industries, including printing as well as the manufacturing of paint, fabric, and plastics.

Polycarbonate: A plastic material originaly used for overlays due to its excellent clarity, stability, printing, and die cutting characteristics.

Polyester: A plastic material often used for overlays, also known as polyethylene terephthalate (PET) more commonly used due to its long flex life and chemical resistance.

Prototype Tooling: Method of fabricating prototype components without using steel rule dies (hard tooling) allowing changes before production runs without expensive tooling charges.

Screen Printing: Method of printing by forcing ink though a mesh selectively. This is done by closing parts of the mesh with a stencil.

Sealed Membrane Switch: A switch or switch panel where the internal circuitry and contacts are completely sealed from outside elements.

Selective Texture: A transparent texture finish printed on specific areas on an overlay to accentuate design elements.

Shield: A layer of polyester material that is printed with conductive ink to protect a switch from RF (EMI).

SMD / SMT: Surface Mount Device / Surface Mount Technology

Sub-Surface Printing: Imaging on the reverse (second surface) of an overlay so the printed graphic is protected from wear by the material.

Spacer: An insulated non-conductive substrate with openings at switch locations to separate the upper and lower circuit layers.

Substrate: A layer of film in a laminate. In flexible circuitry, the plastic film to which the electrically conductive materials is laminated or screen-printed.

Switch: The electronic layer of a membrane switch consisting typically of a top circuit, a spacer, and a bottom circuit.

Tactile Response: A collapse or snapback of a membrane switch prior to contact closure or after contact opening.

Tactile Switch: A switch assembly that provides a tactile ratio greater than zero. Tactile switches give the user immediate physical feedback that the switch has been activated. Tactile feedback on a membrane switch can be achieved by using a stainless-steel dome or a poly-dome construction.

Tail Exit Point: The portion of the flexible circuit outside the keypad area, used to connect the electrical leads from the switch assembly to the main unit. Contains an integral electrical connector or provisions for a connector.

Termination: How a switch is connected to the device it activates.

Radio Frequency Interference (RFI): High frequency radio waves.

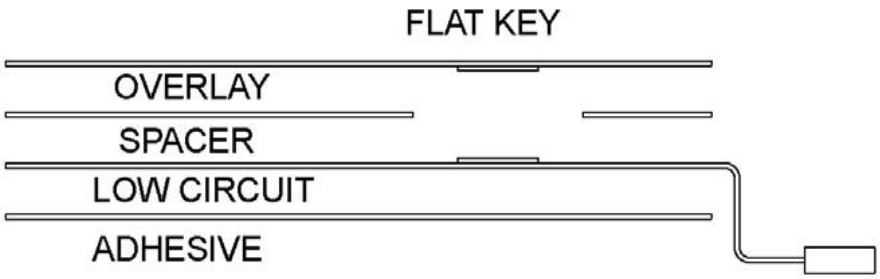
Rigid Membrane Switch: A membrane switch with a rigid lower PCB circuit.

Windows: Clear gloss Portions of the membrane switch overlay material that do not have colour printed on them. Hard-coats and textures can be applied to these areas as well.

ZIF Connector: Zero Insertion Force connector

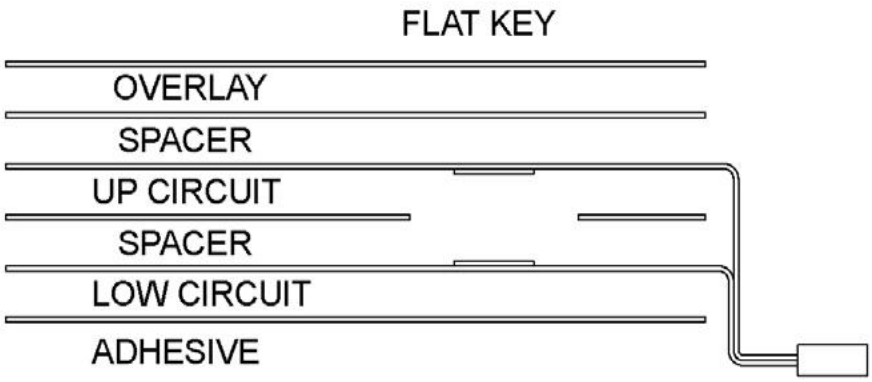
Design Layer Diagrams

MODEL:RDB1



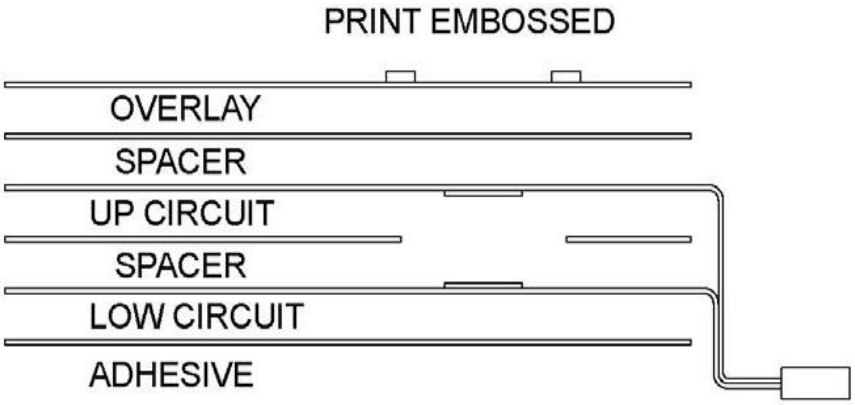
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	10 mA
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	50g±25
TRAVEL	0.27mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-10˚C～+50˚C
STORAGE TEMPERATURE	-20˚C～+60˚C
HUMIDITY	95% RH

MODEL:FT-1



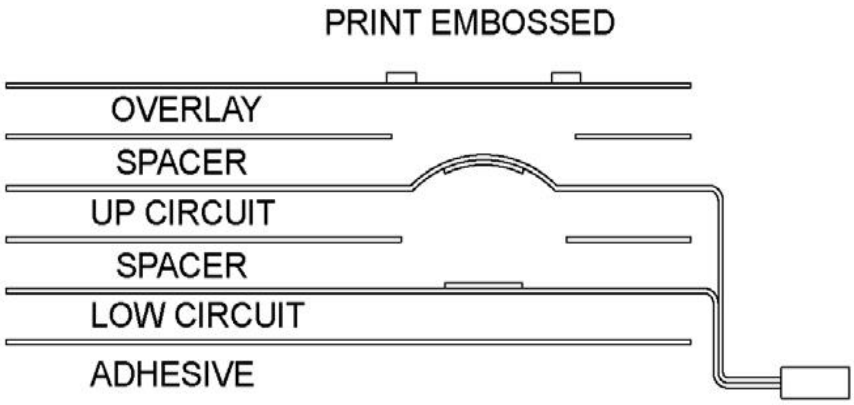
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	10 mA
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	50g±25
TRAVEL	0.27mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-10°C～+50°C
STORAGE TEMPERATURE	-20°C～+60°C
HUMIDITY	95% RH

*MODEL:*EMP



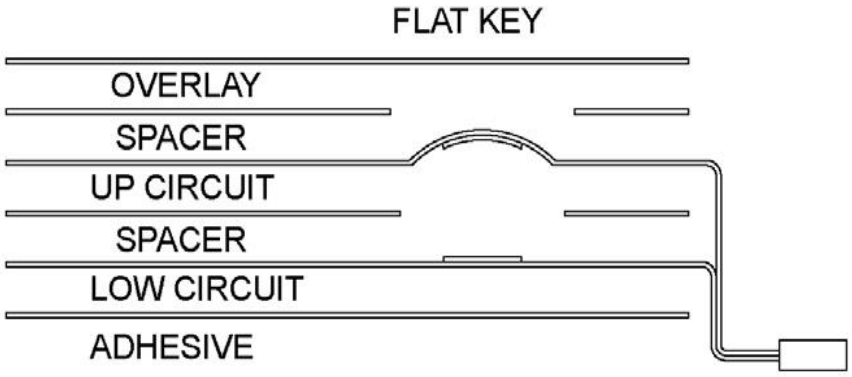
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	50-350g±25
TRAVEL	0.1-0.227mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-20˚C～+80˚C
STORAGE TEMPERATURE	-25˚C～+85˚C
HUMIDITY	95% RH

MODEL:RDB1



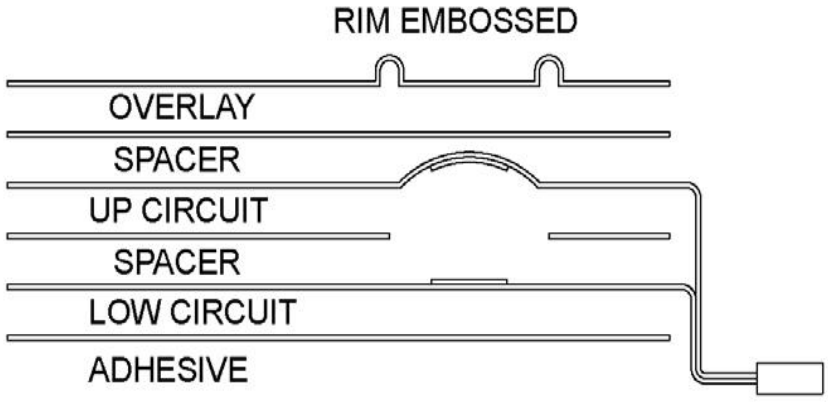
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	10 mA
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	50g±25
TRAVEL	0.27mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-10°C～+50°C
STORAGE TEMPERATURE	-20°C～+60°C
HUMIDITY	95% RH

MODEL:EMC



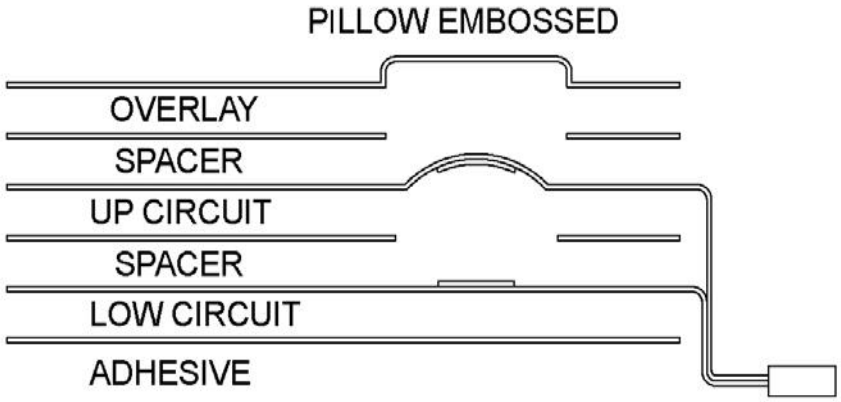
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-450g±80
TRAVEL	0.6-1.2mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-10˚C～+50˚C
STORAGE TEMPERATURE	-20˚C～+60˚C
HUMIDITY	95％ RH

MODEL:EMGC 1



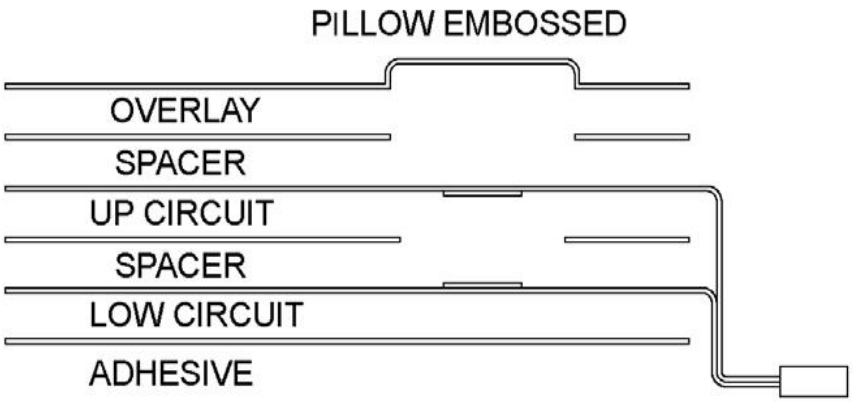
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-450g±80
TRAVEL	0.6-1.2mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-10°C～+50°C
STORAGE TEMPERATURE	-20°C～+60°C
HUMIDITY	95% RH

MODEL:EMGC2



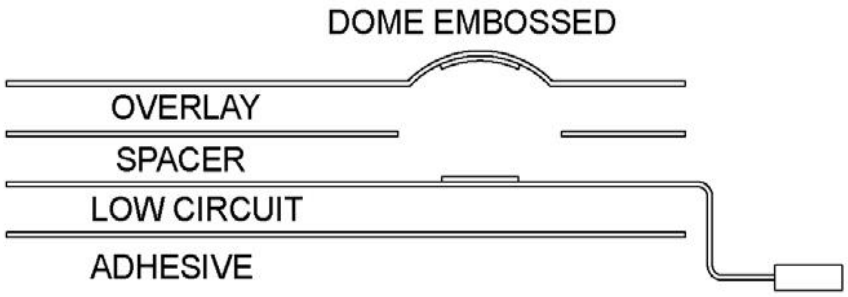
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-450g±80
TRAVEL	0.6-1.2mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-10°C～+50°C
STORAGE TEMPERATURE	-20°C～+60°C
HUMIDITY	95% RH

MODEL:EMG 1



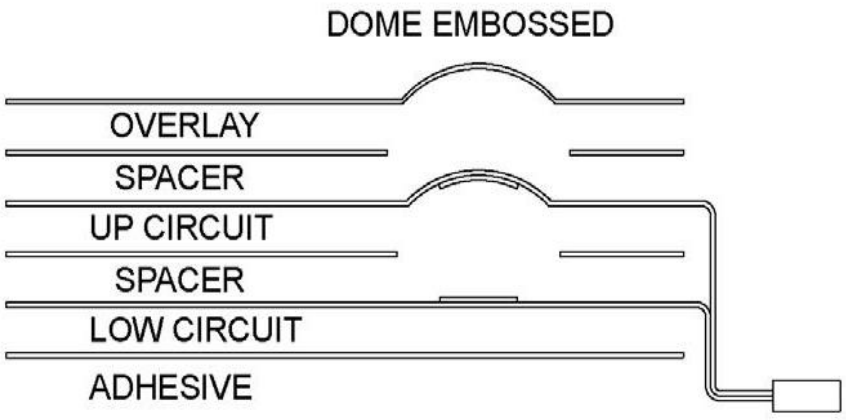
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-350g±25
TRAVEL	0.1-0.227mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-10°C～+50°C
STORAGE TEMPERATURE	-20°C～+60°C
HUMIDITY	95% RH

MODEL:EMG 2



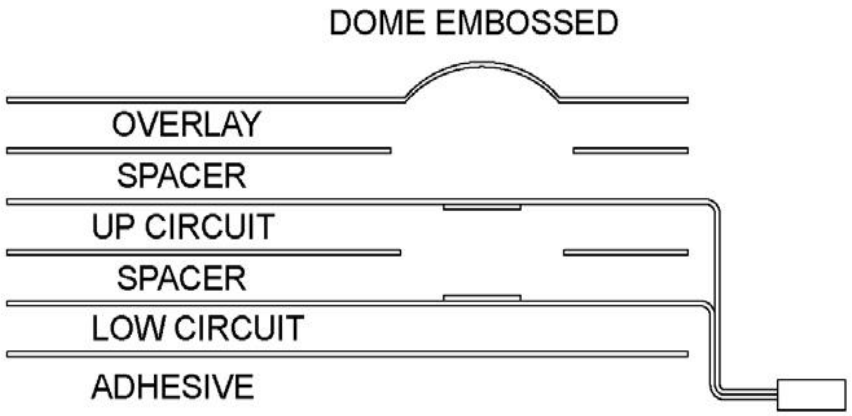
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-350g±80
TRAVEL	0.6-1.2mm
LIFE CYCLE	200,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-10˚C～+50˚C
STORAGE TEMPERATURE	-20˚C～+60˚C
HUMIDITY	95% RH

MODEL:EMGC 3



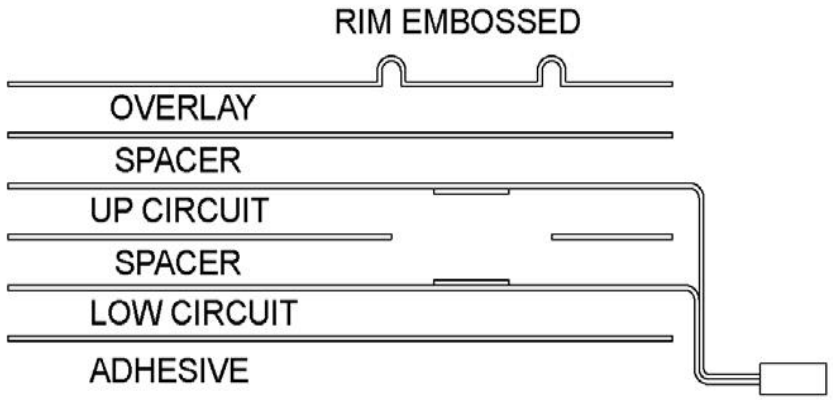
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-450g±80
TRAVEL	0.6-1.2mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-10°C～+50°C
STORAGE TEMPERATURE	-20°C～+60°C
HUMIDITY	95% RH

MODEL:EMG 3



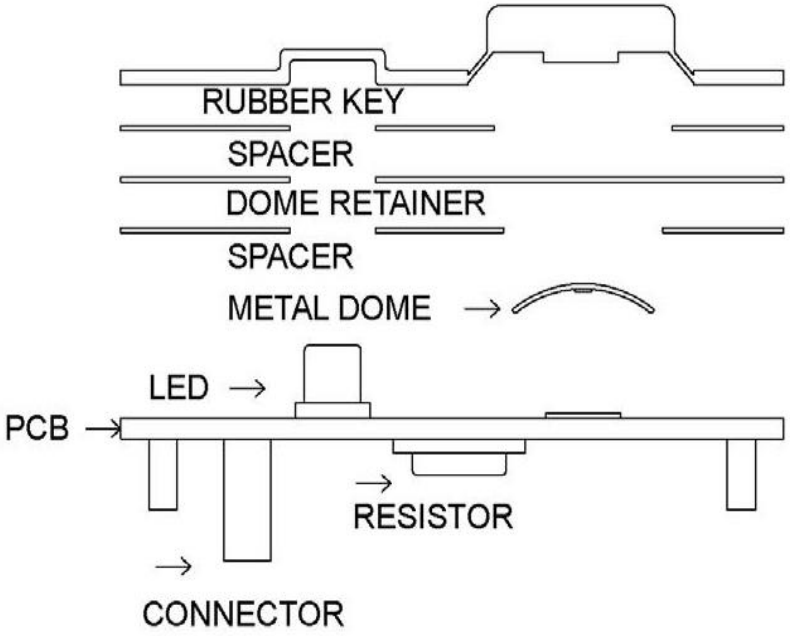
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	50g±25
TRAVEL	0.6-1.2mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-10˚C～+50˚C
STORAGE TEMPERATURE	-20˚C～+60˚C
HUMIDITY	95% RH

MODEL:EMG 4



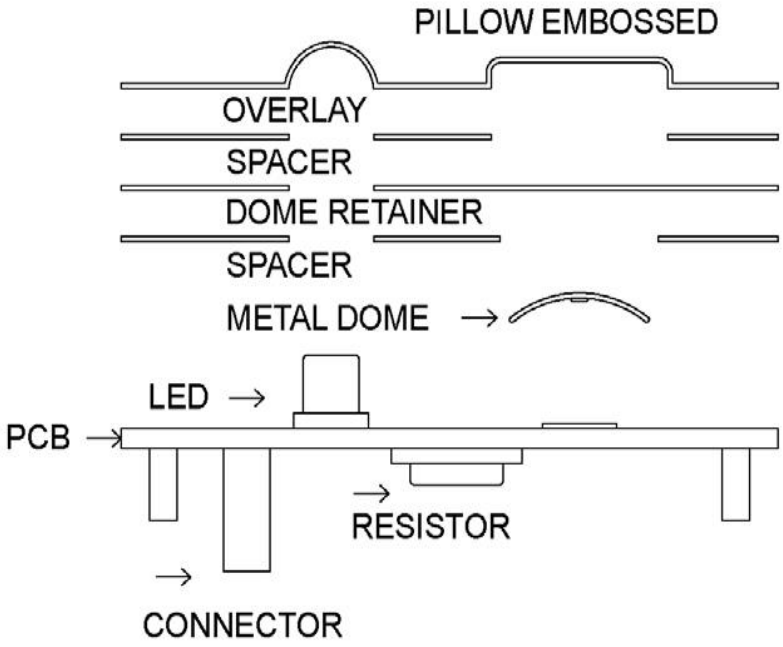
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	200-350g±50
TRAVEL	0.1-0.27mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-20°C～+80°C
STORAGE TEMPERATURE	-25°C～+85°C
HUMIDITY	95% RH

MODEL:RDB 1



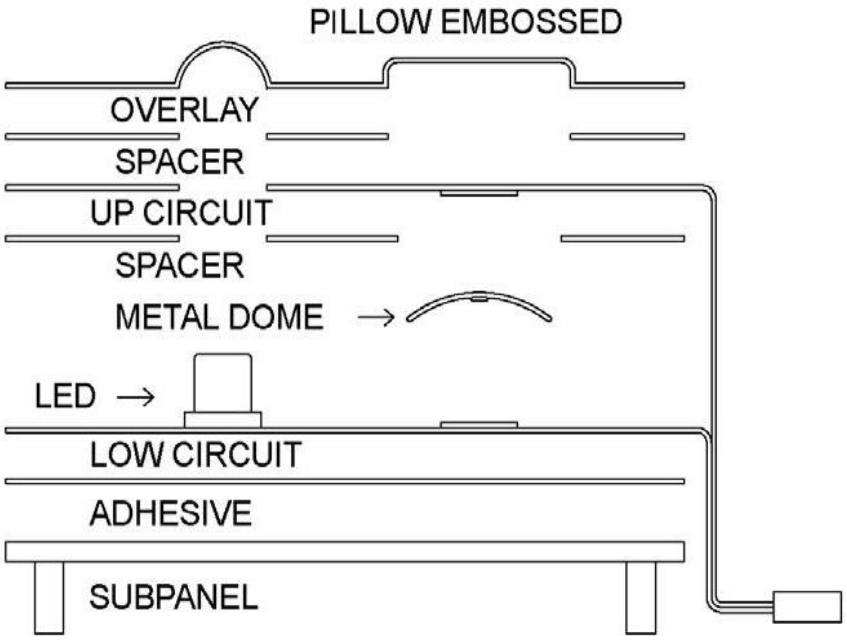
ELECTRICAL : FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL :	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-450g±80
TRAVEL	0.27-0.75mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL :	
OPERATING TEMPERATURE	-20˚C～+80˚C
STORAGE TEMPERATURE	-25˚C～+85˚C
HUMIDITY	95% RH

MODEL:EMG DB1



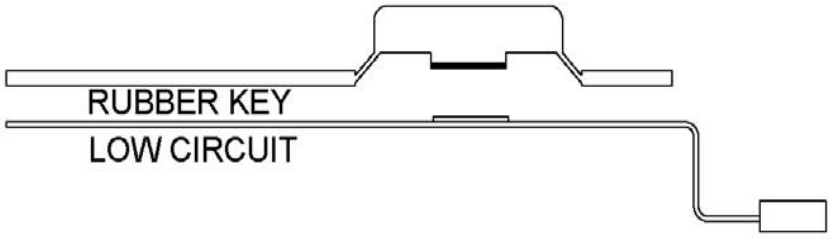
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-450g±80
TRAVEL	0.27-0.75mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-20˚C～+80˚C
STORAGE TEMPERATURE	-25˚C～+85˚C
HUMIDITY	95% RH

MODEL:EMG DS1



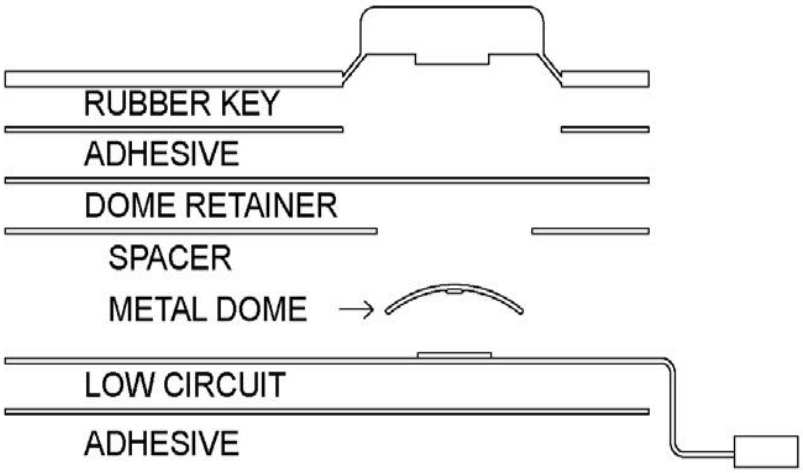
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-450g±80
TRAVEL	0.27-0.75mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-20°C～+80°C
STORAGE TEMPERATURE	-25°C～+85°C
HUMIDITY	95% RH

MODEL:RC 1



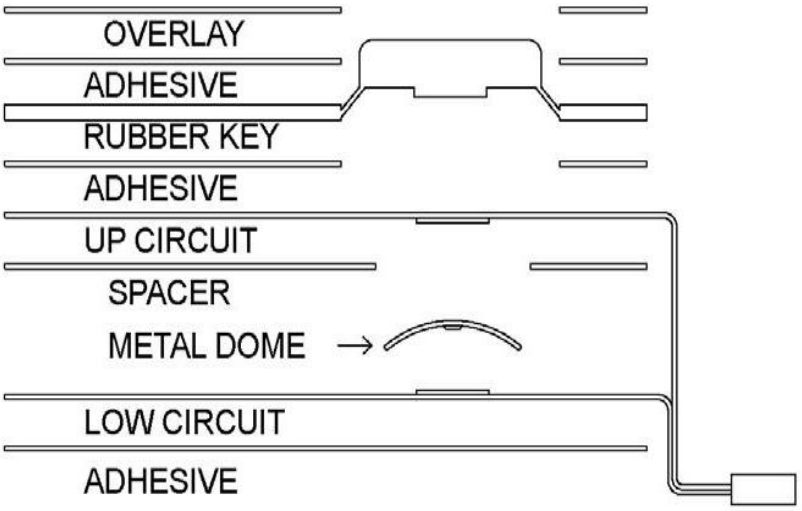
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	150-350g±80
TRAVEL	0.27-0.5mm
LIFE CYCLE	5,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-20˚C～+80˚C
STORAGE TEMPERATURE	-25˚C～+85˚C
HUMIDITY	95% RH

MODEL:RCD 1



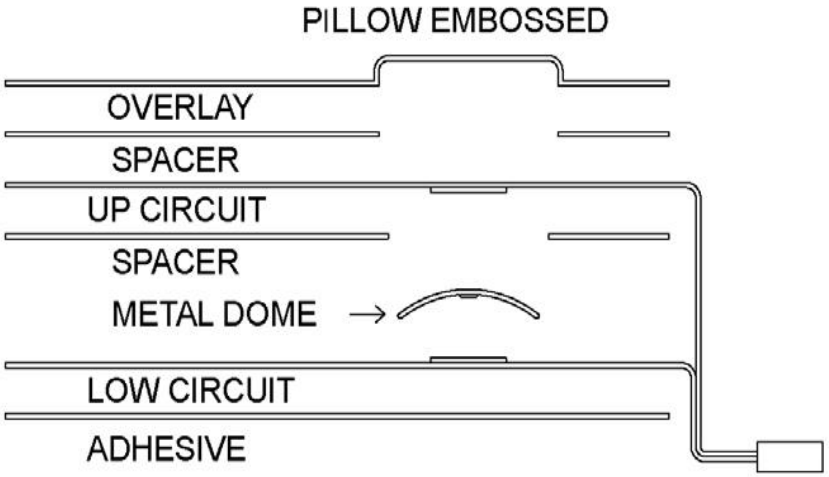
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-450g±80
TRAVEL	0.27-0.75mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-20˚C～+80˚C
STORAGE TEMPERATURE	-25˚C～+85˚C
HUMIDITY	95% RH

MODEL:GRCD 1



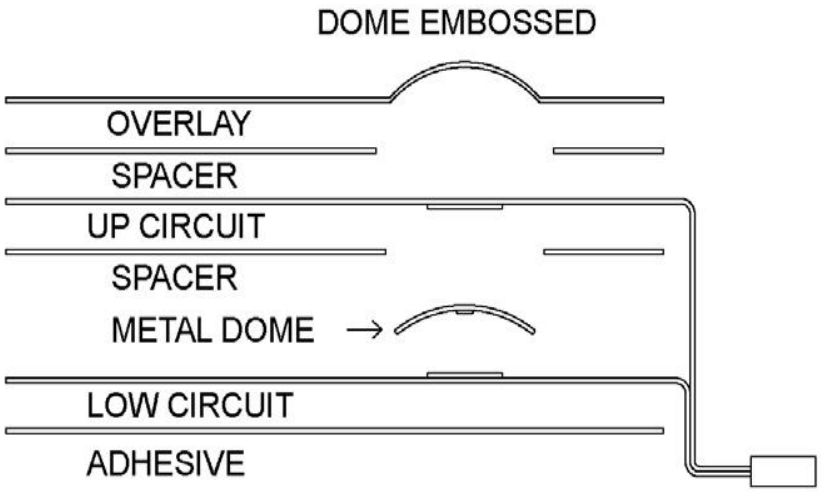
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA MAX
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-450g±80
TRAVEL	0.27-0.75mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-20˚C～+80˚C
STORAGE TEMPERATURE	-25˚C～+85˚C
HUMIDITY	95% RH

MODEL:EMGD 1



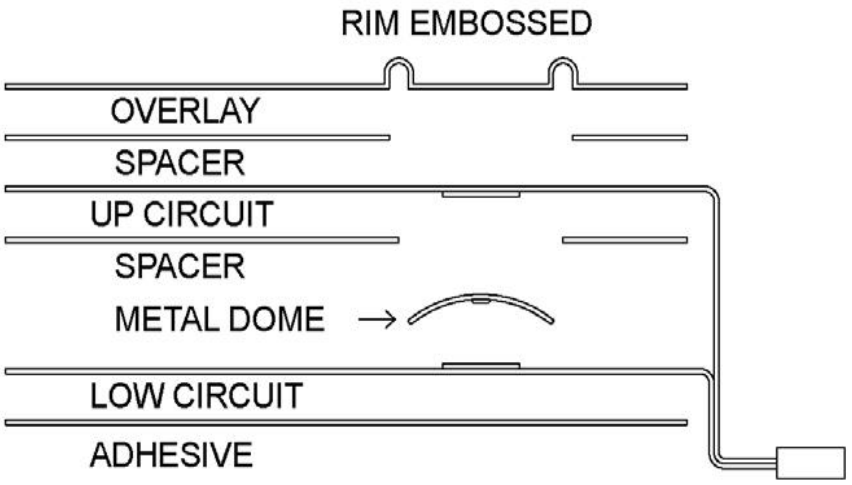
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	10 mA
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ/DC 100
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	220-400g±50
TRAVEL	0.27-0.75mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-20°C～+80°C
STORAGE TEMPERATURE	-25°C～+85°C
HUMIDITY	95% RH

MODEL:EMGD 2



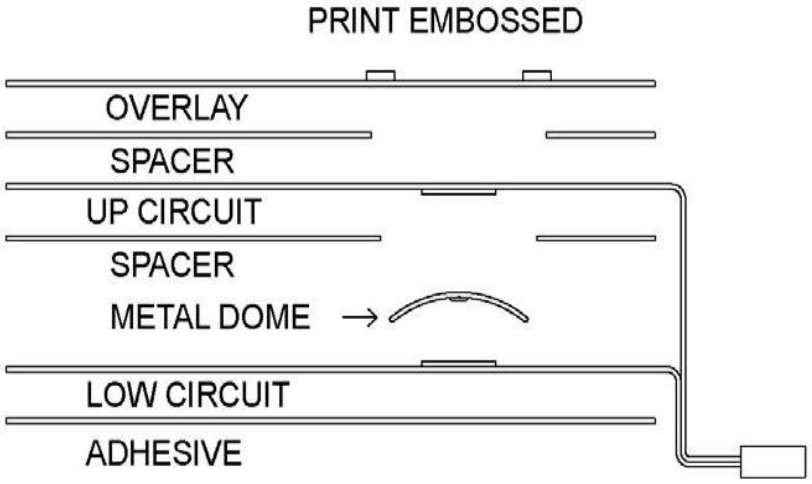
ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-450g±80
TRAVEL	0.27-0.75mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-20˚C～+80˚C
STORAGE TEMPERATURE	-25˚C～+85˚C
HUMIDITY	95% RH

MODEL:EMGD 3



ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-450g±80
TRAVEL	0.27-0.75mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-20˚C～+80˚C
STORAGE TEMPERATURE	-25˚C～+85˚C
HUMIDITY	95% RH

MODEL:EMGPD 1



ELECTRICAL： FLAT MEMBRANE KEYPAD	
VOLTAGE	35 VDC Max
CURRENT	100 mA Max
CIRCUIT RESISTANCE	＜100Ω
INSULATION RESISTANCE	100 MΩ / DC 100V
MECHANICAL：	
DIMENSIONAL TOLERANCES	±0.25mm
ACTUATION FORCE	250-450g±80
TRAVEL	0.27-0.75mm
LIFE CYCLE	1,000,000-
ENVIRONMENTAL：	
OPERATING TEMPERATURE	-20˚C～+80˚C
STORAGE TEMPERATURE	-25˚C～+85˚C
HUMIDITY	95% RH