Membrane switches explained:
How to tailor the perfect front panel solution
Membrane switches offer an extremely reliable and ultra-customisable solution for device front panels. Their numerous advantages and features have led to the adoption of membrane switches, panels and keypads by organisations in many sectors.

There are several considerations to bear in mind when purchasing a membrane switch. Customers should consider the implications to the electronic product that the membrane switch will be used on, as well as the manufacturing process and potential costs. These issues should be discussed in conjunction with the manufacturer in order to get the best solution.

Detailing what the membrane will be used for, the environment it will be used within, and for what purpose can really help to establish the design of your membrane switch. Potential restrictions – such as budget and timescale – must also be considered carefully during the decision-making process, as they will naturally affect what is possible.
HOW ARE YOU PLANNING TO USE YOUR MEMBRANE SWITCH?

Different environments and industries have different priorities. Healthcare is a prime example: organisations in this sector have exacting requirements for front panels that can be met through membrane switch technology, such as the need for a panel solution that can stand up to water or chemical contamination.

As well as the environment in which the membrane switch will be required, it is vital to consider the precise purpose of the device it will be added to. For instance, the principal consideration with some heavily used applications – such as keypads – will be their durability, so the materials they are made from must be robust and boast extremely low defect rates. This is a particularly important issue for industrial manufacturers whose products will be used frequently.

Directives governing membrane switch manufacturing

The manufacturing of membrane switches is governed by various standards and directives designed to ensure that they are both safe and able to function correctly in the industries in which they are used. In this section, we examine those guidelines and the impact they have on your finished membrane switch.

- **ROHS** - As the Restriction of Hazardous Substances (ROHS) in Electrical and Electronic Equipment Directive was transposed into UK law in 2013, we are able to supply products that use ROHS compliant materials.

- **ATEX** - Comprising two EU directives, ATEX describes the equipment and type of work permitted in environments with an explosive atmosphere. To be ATEX-approved, membrane switches must be capable of operating reliably within the most extreme environments.

- **IP Code** - Depending on the environment in which they are being used, membrane switches may have to withstand intrusion from solid objects, dust, water and more. The IP Code indicates the amount of protection offered against solids and liquids. At Fine Cut, we supply membranes sealed up to IP67 rating standard, meaning they are dust-tight and can be immersed in up to one metre of water.
One of the many benefits of membrane switches is their customisability. They can be tailored to meet a wide range of specific requirements. However, to guarantee effective customisation, the manufacturer must have a clear picture of exactly what buttons and functions are required.

As such, buyers should ask themselves several questions before discussing the functionality and design of membrane switches with their manufacturer. Key considerations at this stage should include whether or not the product needs to be:

- **Sealed** – provides a surface that can be easily cleaned and sterilised
- **Illuminated** – means the membrane switch will be more visible in low light
- **Water-proofed**
- **Compliant with RoHS**
- **ATEX-approved**
- **Anti-microbial**
- **Chemical-resistant** – this can be achieved through using UV-cured textures

It is also important to discuss the exact operation of the membrane switch in terms of the product or piece of equipment it will be used on. Depending on its function, tactile feedback may be necessary; this could be the case if error-free data entry is vital.

Tactile response can be delivered via two means: stainless steel domes or thermally formed polyester “polydomes”:

- Stainless steel domes come in a variety of sizes and can be inserted into the membrane build using a dome retention layer. The actuation force ranges from 180 to 700 grams, depending on the size of the dome.

- In thermally formed polydomes, the actuation force is altered by changing the height and size. They are more costly than using steel domes, but are much quieter than metal alternatives. As such, they are often used in sensitive environments like hospitals and recording studios. Furthermore, they do not decoin or move around, which can be a problem in metal switches.
If the equipment is likely to be used in low-light conditions, your membrane switch may require backlighting. This process - which involves the strategic placement of lights into the switch construction - can be used to create keypads and legends, and make the display easier to read. Several backlighting techniques exist, each with its own cosmetic and cost advantages and disadvantages to consider:

- **LEDs**
  Mainly used as indicator lights, LEDs are a highly popular backlighting choice thanks to their low cost, reliability and long lifespan, wide variety of colours, and the fact that they emit very little heat. Different intensities - such as LEDs specifically designed to be seen outdoors - are also available.

- **Fibre optic lighting**
  Fibre optic lights typically comprise 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 – typically, one or more LEDs. This cost-effective method allows for more uniform backlighting across a wider area of the keypad. The life of fibre optic lighting systems is longer than for EL lights at around 100,000 hours, based on the performance of a typical LED. Power requirements are very low (just 20-50 mA) and they are capable of withstanding extreme temperatures and humidity.

- **Electroluminescent (EL) lighting**
  These lamps contain phosphors, which convert electric energy into light - a highly efficient process that reduces power consumption and loss through heat or infrared emissions. As the phosphors tend to decay when used for extended periods at high voltages and frequencies, they are best used in environments with low or no lighting in which the backlight is not always on. The thin profile and high durability make this solution suitable for most membrane switch constructions, and they are also able to deliver balanced lighting across the entire area of the membrane switch.
At Fine Cut, our membrane switch panels are almost exclusively produced from polyester-based materials, which offer superb environmental performance under even the most challenging of conditions. However, it should be noted that Fine Cut also has the expertise to manufacture from other materials when the application, specification or environment requires.

Compared to other flexible materials, polyester has a superior life cycle and is more resistant to chemicals. Life cycle tests performed on polyester have shown no signs of wear after one million cycles.

We also use polycarbonate for the production of membrane keypads. Polycarbonate is a cheaper alternative to polyester and works well in situations where fewer than 40,000 cycles are expected.

The adhesives we use in our membrane switches come from premium suppliers such as 3M, Fasson and Tecman.

Overlay materials

RFI/ESD/EMC shielding: What is it, and do you need it?

Plastics are increasingly being used in place of metals when it comes to manufacturing casings for electronic and electrical equipment, particularly if weight reduction is one of the key design requirements. Building lighter-weight products improves portability, which can be a key consideration in sectors such as healthcare. Plastics are also less expensive than metals, are easier to mould or cast, and give manufacturers greater design flexibility.

However, despite the many clear benefits that plastics hold over metals, they have one clear disadvantage: they are completely pervious to EMC, RFI and ESD interference, and provide no protection against electrostatic discharge, all of which are factors that could lead to a major electronic failure.

Electric charge could travel around the perimeter of a membrane switch then ground itself through LCD displays or other circuit board components. Furthermore, rapid electrical discharge across the front of a membrane switch could induce the current behind it.

Fortunately, membrane switches can incorporate shielding – either aluminium, printed or ITO-coated polyester – that protects against the induced currents caused by electromagnetic interference.
Consider function as well as form

The materials your membrane switch is manufactured from are, of course, hugely important. But it is just as important to consider the specific buttons and functions that are required, coupled with the looks of the finished switch.

The decoration of a membrane switch may be as essential as its function, so a clear specification of colours, patterns and logos must be provided to the manufacturer. Not only will this have a major impact on ease of use, but it also gives companies the opportunity to display their branding and any other useful information in a prominent position on the electrical and electronic equipment.

One important consideration at this stage is the specific ergonomic requirements of the electronic equipment in question.

For instance, the membrane switch may require embossing so that the keys can be easily located. Individual keys and features can be embossed to fulfil your precise ergonomic needs.

The form and style of the display window must also be taken into account. The overlay materials used to produce membrane switches are originally clear, before having colours printed onto the back. Naturally, this means that areas left free of colour become windows. These see-through spaces can then be customised to suit the requirements of the end user; a variety of hard coats and textures can be applied, allowing for the display to be water-clear or offer anti-glare characteristics – perfect for larger windows covering LEDs, LCDs or VFDs.
WHAT ARE THE MANUFACTURING PROCESSES AND OPTIONS? DO THEY FIT WITH TIMESCALES AND BUDGET?

The processes that your membrane switch must go through will naturally have a major impact on its design and, ultimately, the manufacturing phase. It is therefore important to discuss a range of questions with the manufacturer, such as:

- Will the electrical and electronic equipment be used in harsh or extreme conditions?
- Will the membrane switch need interchangeable inserts?
- Does it require LEDs?
- Will it be tactile/non-tactile or a mixed panel?
- What is the circuit design of the end product?
- The finish – what materials will it be made from?
- Will it require embossing? If so, the following types of embossing - or a combination of each - are available:
  - Rim emboss – just the edge of the button
  - Pillow emboss – the whole button with a flat top
  - Dome emboss – the whole button with a domed top

An embossing tool is generally made up of a male and female tool with an emboss height of approx 0.01 inches.

Hydroforming can increase the height of the emboss, but is significantly more expensive.

Having learned about the exact requirements of your membrane switch, the manufacturer will be able to give you a more accurate timescale and budget for delivery.
WHAT ARE THE BENEFITS OF MEMBRANE SWITCHES?

Highly versatile and reliable, membrane switches offer a cost-efficient, reliable and flexible alternative to printed overlays with mechanical surface mounted keypads. They are high-quality, can be customised to suit the needs of the end user, and the advanced manufacturing processes used in their development lead to quick turnaround times.

Benefits by sector

Naturally, the advantages of membrane switches will vary from sector to sector. For instance, while a healthcare provider would benefit from the ability to add an antimicrobial coating, this may be less relevant to OEMs. Here, we take a look at the specific benefits of membrane switch technology across some of the sectors in which they are used.

**Healthcare:**
- They can be manufactured with antimicrobial coatings and materials to reduce the possibility of contamination
- Membrane switches can be sealed to protect against water or chemical contamination, even from some of the harshest chemicals and bleaches
- Buttons and functions can be illuminated – potentially vital in a hospital environment where clarity is key to guard against errors being made
- Durable coatings ensure that all graphics and text remain legible throughout the life of the product

**Industrial:**
- The polyester-based materials that make up the vast majority of our membrane switches are extremely durable, with a life cycle that far exceeds that of alternatives such as polycarbonates – vital to industrial organisations given their often extreme working environments

**OEMs:**
- The hard-wearing quality of membrane switches is also highly beneficial to OEMs, as their regular use and harsh working conditions will place significant strain on electrical and electronic equipment
- As they can be sealed and water-proofed, membrane switches are extremely easy to clean – even with harsh chemical cleaning products
- Given the wide range of applications involved in OEM processes, the highly customisable nature of membrane switches is a significant advantage

Thanks to the sheer scale of customisation available, membrane switches can be adapted to withstand several different and highly challenging environments. Achieving this will understandably require effective design and realisation; as such, it is vital for the buyer to fully consider how they want their finished membrane switch to look and function before speaking to the manufacturer.
Why choose Fine Cut?

Fine Cut offers a full in-house design capability to help meet the specific customer requirements for each membrane. We offer comprehensive production facilities, allowing us to provide customers with anything from low-volume and prototyping runs to high-volume production runs that meet ISO9001 standards. Fine Cut is also an SC21-approved supplier.

To further help our customers, we also have the capability to manufacture stainless steel or aluminium support boards for the membrane and can fully complete the build, only leaving the customer to connect to the PCB. We can offer a full, custom-built package.