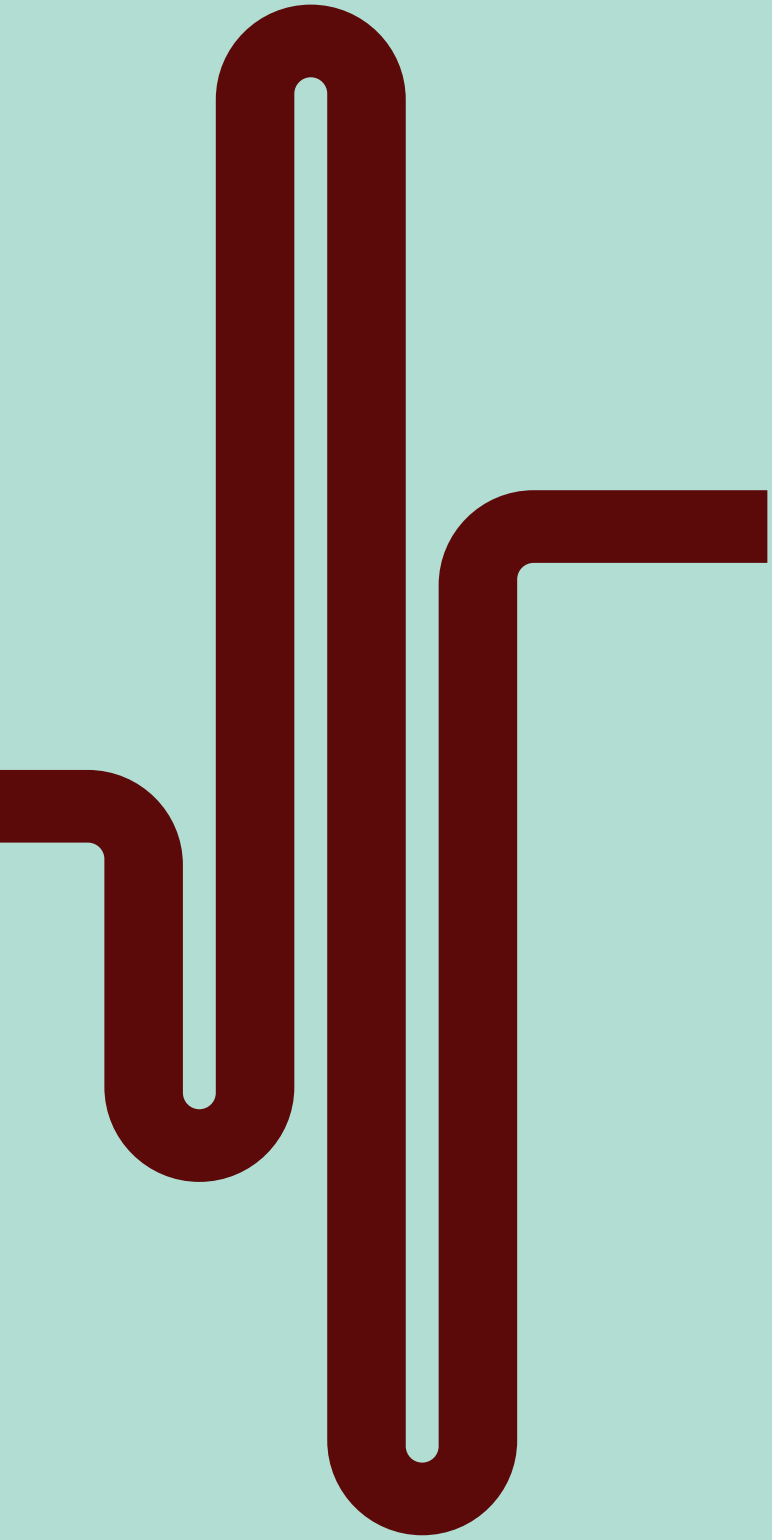
mekoprint



Membrane keypads

Design options and practical considerations

HMI design guide series

Applications and design options

Membrane keypads are used across industrial equipment, medical devices and electronic control systems. They are often chosen where space is limited, sealing is required and a thin, integrated HMI solution is preferred.

The construction is based on printed functional layers stacked into a compact assembly. This allows graphics, tactility, lighting and protection to be integrated into a single component.

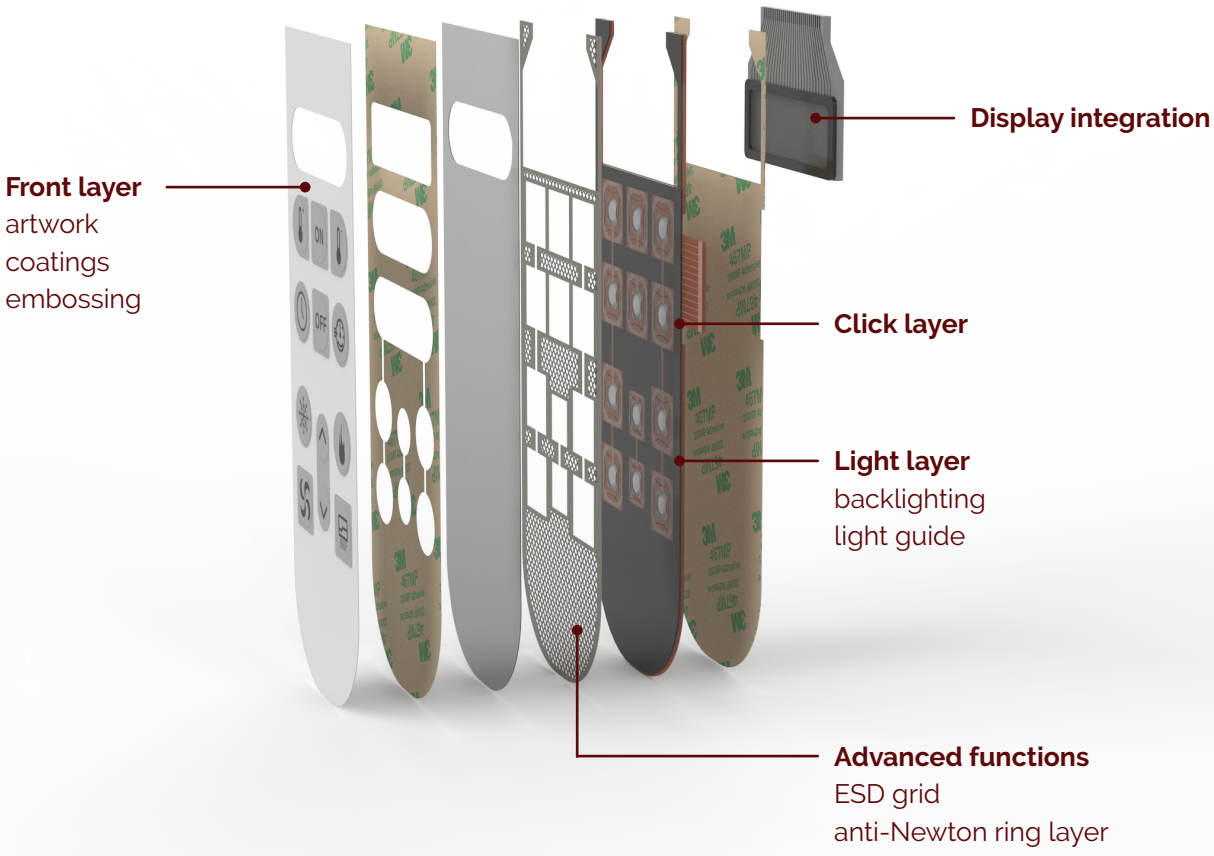
Many functions are defined in printed layers rather than mechanical parts. Therefore, membrane keypads offer a high degree of flexibility. The key to using this flexibility well is making the right design decisions early in the development process.

Design parameters & layer structure

Many functions in a membrane keypad are integrated directly into printed and laminated layers. Graphics, tactility, backlighting, protection and electrical functions are combined in a compact stack-up rather than added as separate components. This gives a high degree of flexibility and makes it possible to solve complex requirements within a very thin and sealed construction.

The layered structure also means that the elements are closely connected, which makes early planning important.

This guide explains the membrane keypad one layer at a time, focusing on the key considerations for each layer.



Design guidelines

FRONT LAYER

Artwork

The front layer defines both the visual appearance and a large part of the functionality of a membrane keypad. It is typically made from polyester (PET) or polycarbonate (PC), using transparent base materials that allow colour, texture and light behaviour to be defined through inks and coatings.

Texture with gloss contrasts
Gloss and matte contrasts create visual structure without adding complexity. Key functions can be highlighted while surrounding areas remain visually calm.

Tinted display windows
Display windows can be tinted in the artwork to improve contrast and readability. This is especially useful for 7-segment displays or status indicators.

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FRONT LAYER

Artwork

This allows white LEDs to be used while defining colour in the artwork, which can simplify the electronics across product variants.

Tinted symbols
Backlit symbols can be tinted directly in the artwork, allowing white LEDs to be used while defining colour in the front layer.

Deadfront effect
With the deadfront effect, symbols remain hidden until illuminated. This keeps the interface clean and ensures that only relevant information is visible when needed.

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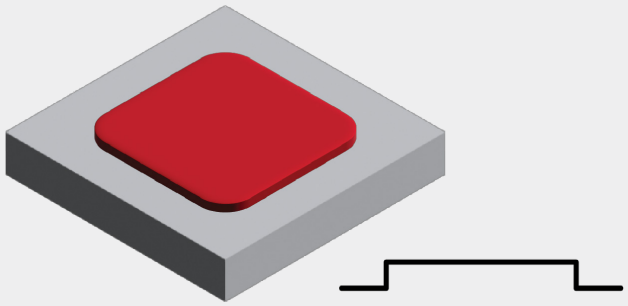
FRONT LAYER

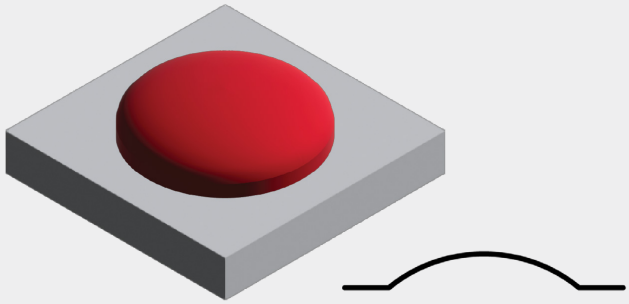
Embossing

PET foil is typically used for embossed membrane keypads with high actuation requirements, as it offers good dimensional stability and long lifetime. PC foil is more often used where actuation demands are lower or where forming, rigidity or specific surface coatings are required. As a rule of thumb for PET, embossing height should be approximately 2.5 times the material thickness. When embossing is combined with a separate tactile component, care should be taken to avoid overlapping tactile sensations.



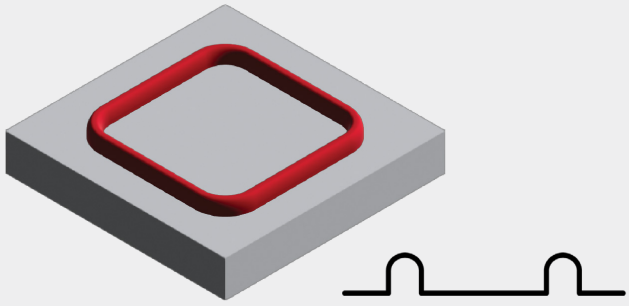
Raised flat embossing

Single-curved embossing with a soft surface transition. Used to subtly highlight keys or areas without strong tactile feedback.



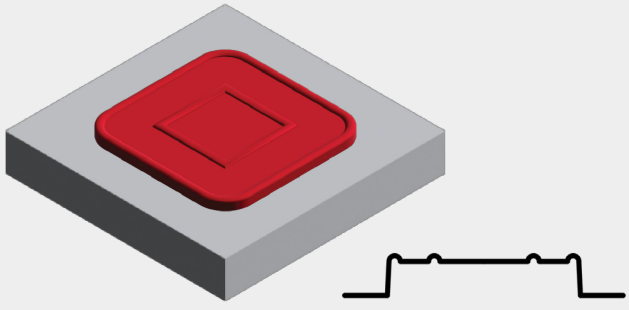
Dome embossing

Double-curved embossing that provides clearer tactile feedback and a more defined click feeling.



Rim embossing

Raised outline around a key or keypad area. Used for orientation by touch and to define functional zones or the active keypad area. Rim embossing can also be used to hide small level differences between adjacent surfaces, such as transitions between keypad, display or housing.



Multi-level embossing

Two embossing heights on one key, often combining a dome with a raised icon for improved orientation without looking.

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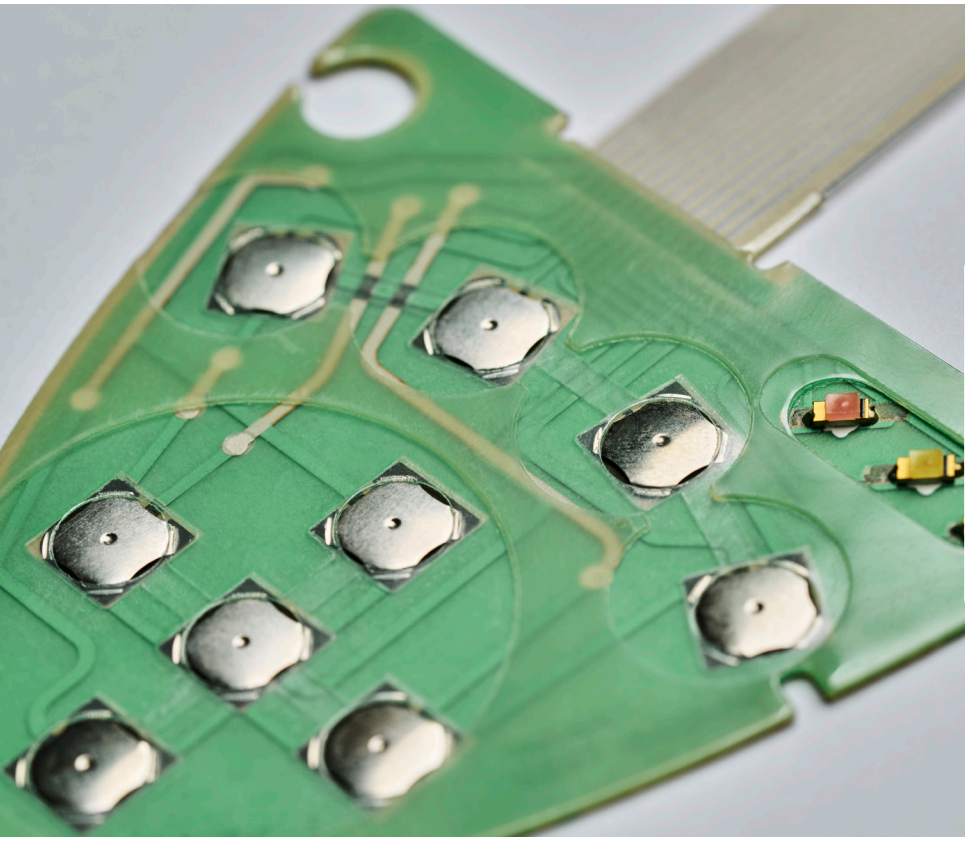
CLICK LAYER

Tactile feedback

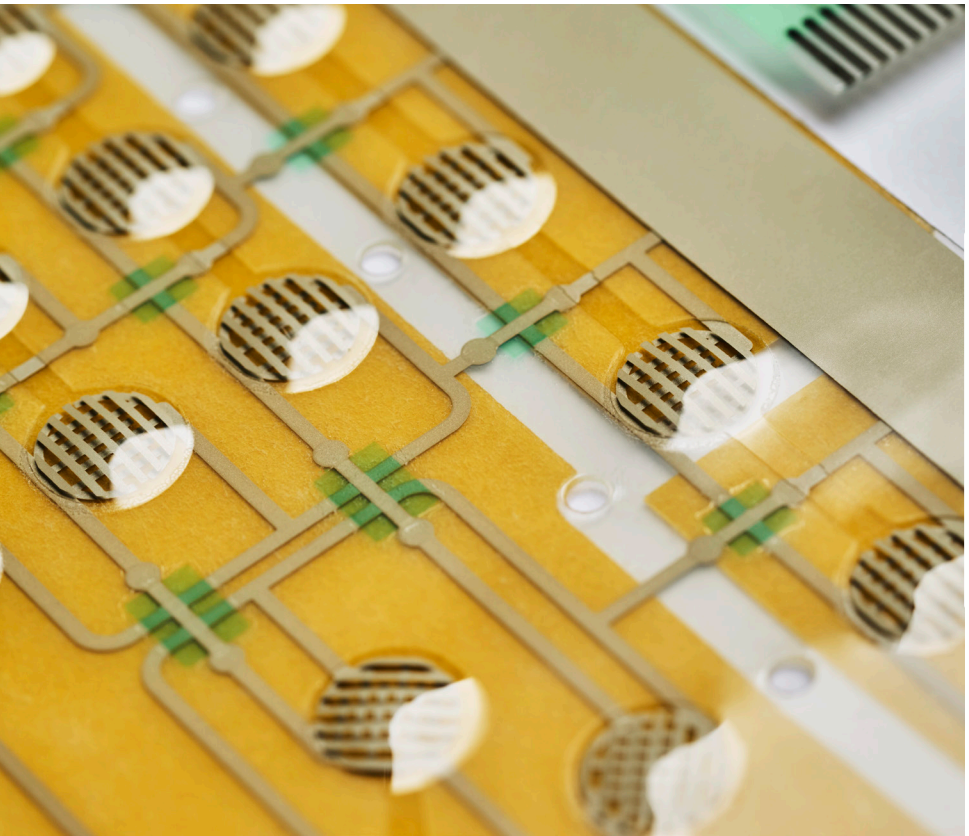
The click layer defines how a membrane keypad feels and sounds when operated. The click solution should be selected based on: required number of actuations, environmental conditions such as temperature, sound level and user expectations. Early selection helps ensure reliable performance and avoids later redesign.



Metal domes

Metal domes provide a clear, stable click with consistent tactile feedback over a long lifetime.

They are well suited for industrial applications with high actuation requirements.



Polydomes

Polydomes create a softer and quieter click by using embossed structures in the membrane.

They are typically used where low noise or gentle feedback is preferred, and actuation demands are moderate.

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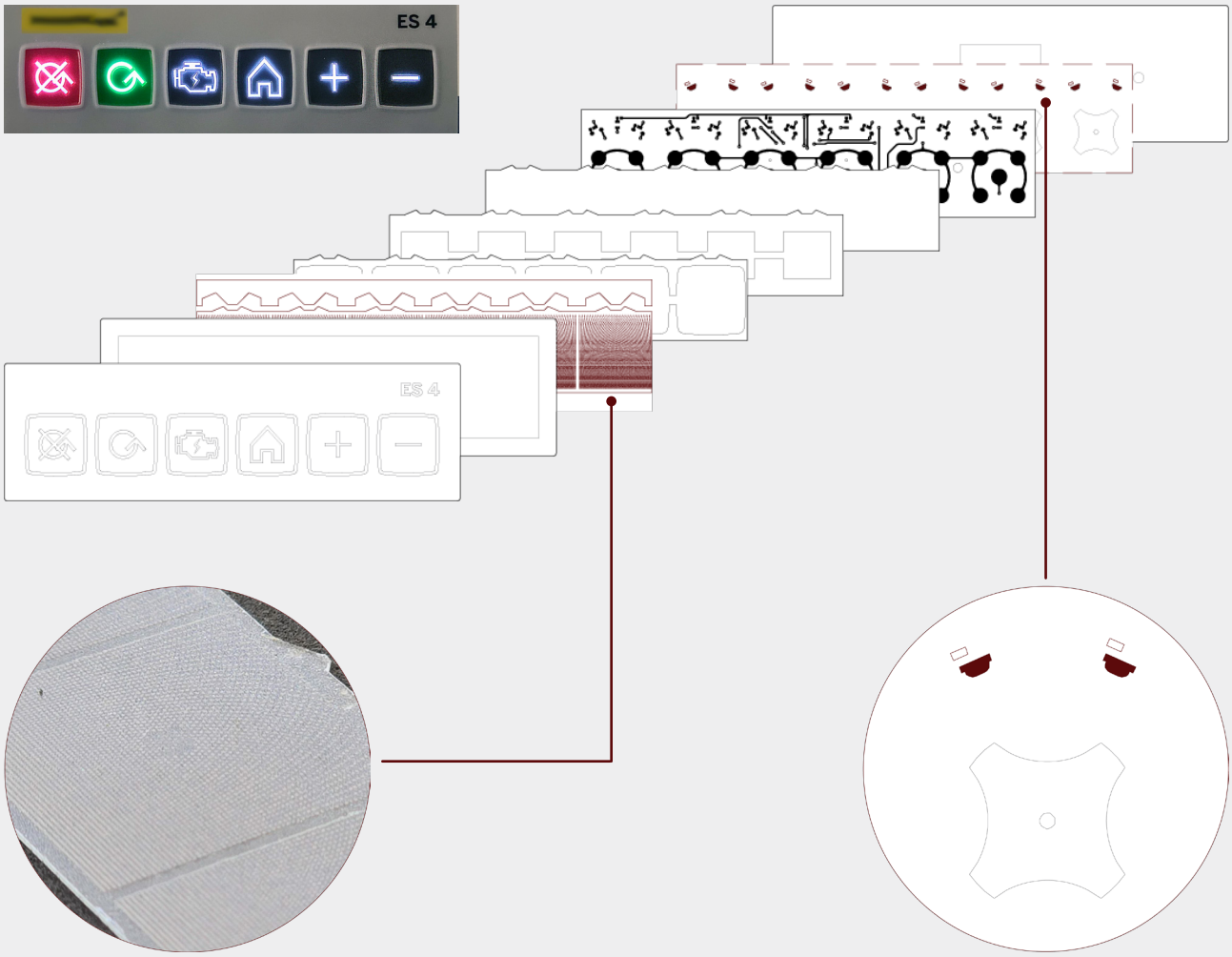
LIGHT LAYER

Backlighting

The main challenge with backlighting in membrane keypads is achieving even light distribution within very limited thickness. This can be addressed by diffusing or directing the light within the layer stack, using solutions such as light guide films, diffuser films, diffuser inks or silicone bricks.



Light guide film

Light guide films distribute light away from the LED source and direct it upwards through the symbols.

Printed lacquer dots control where the light exits the guide, and their size and placement are tuned to achieve even illumination.

Placement of LEDs

LED placement is critical for light guide performance. Side-view LEDs emit light into the edge of the light guide film rather than directly behind the symbols.

The guided light is then redirected by lacquer dots towards the required illuminated areas.

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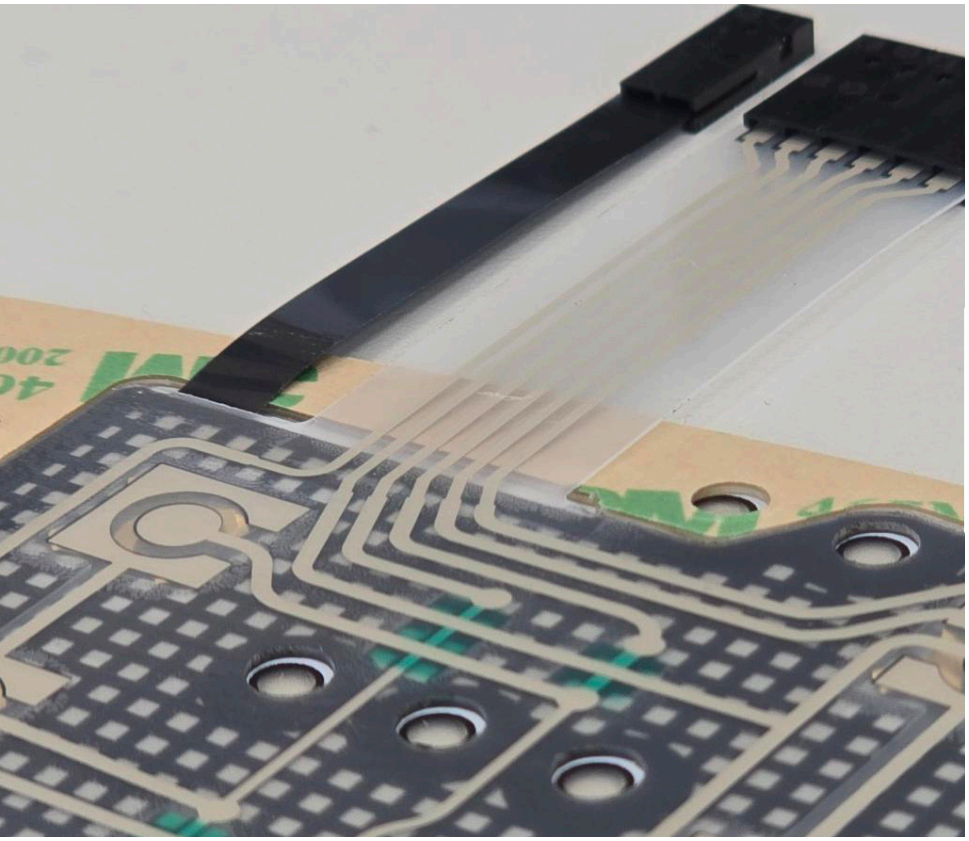
FUNCTIONAL LAYERS

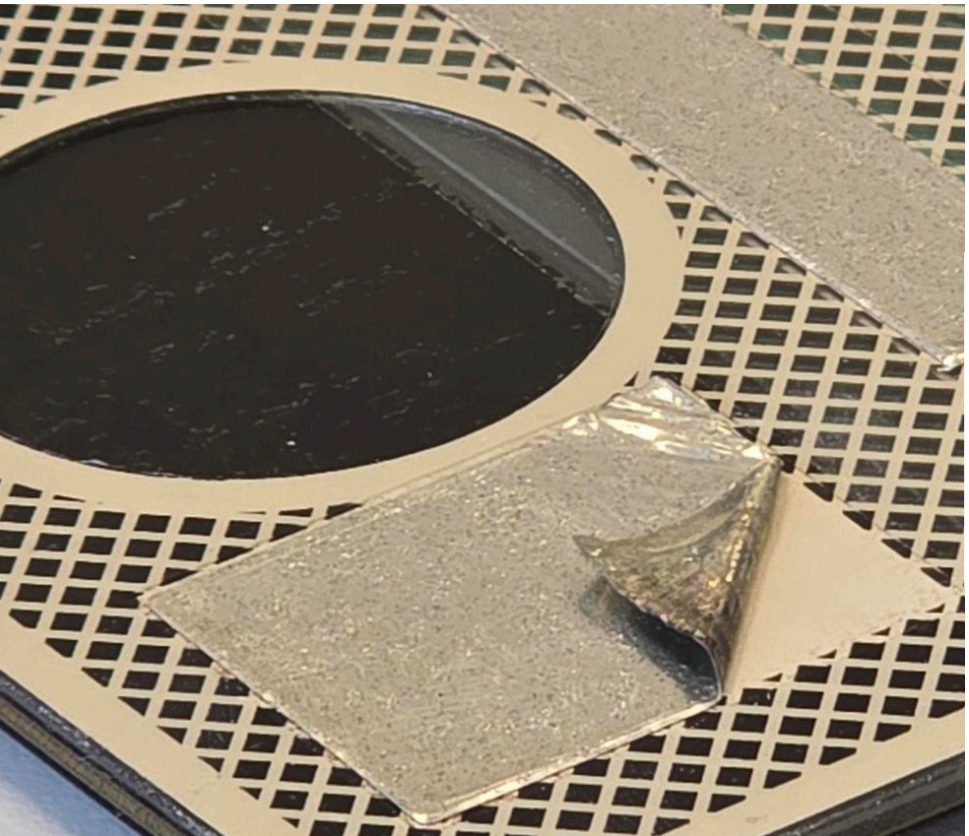
ESD grids

One of the key strengths of membrane keypads is the ability to integrate additional functions directly into the layer stack. By building shielding into printed and laminated layers, sensitive electronics can be protected against electrostatic discharge without adding separate components or increasing overall thickness. Protection can be achieved using carbon or silver meshes integrated into the keypad.



Carbon mesh

Carbon meshes are typically grounded via a separate tail, allowing connection to a grounding point elsewhere in the assembly.



Silver mesh

Silver meshes are printed with conductive silver and combined with solid contact pads and conductive adhesive, enabling grounding directly through a metal housing when the keypad is mounted.

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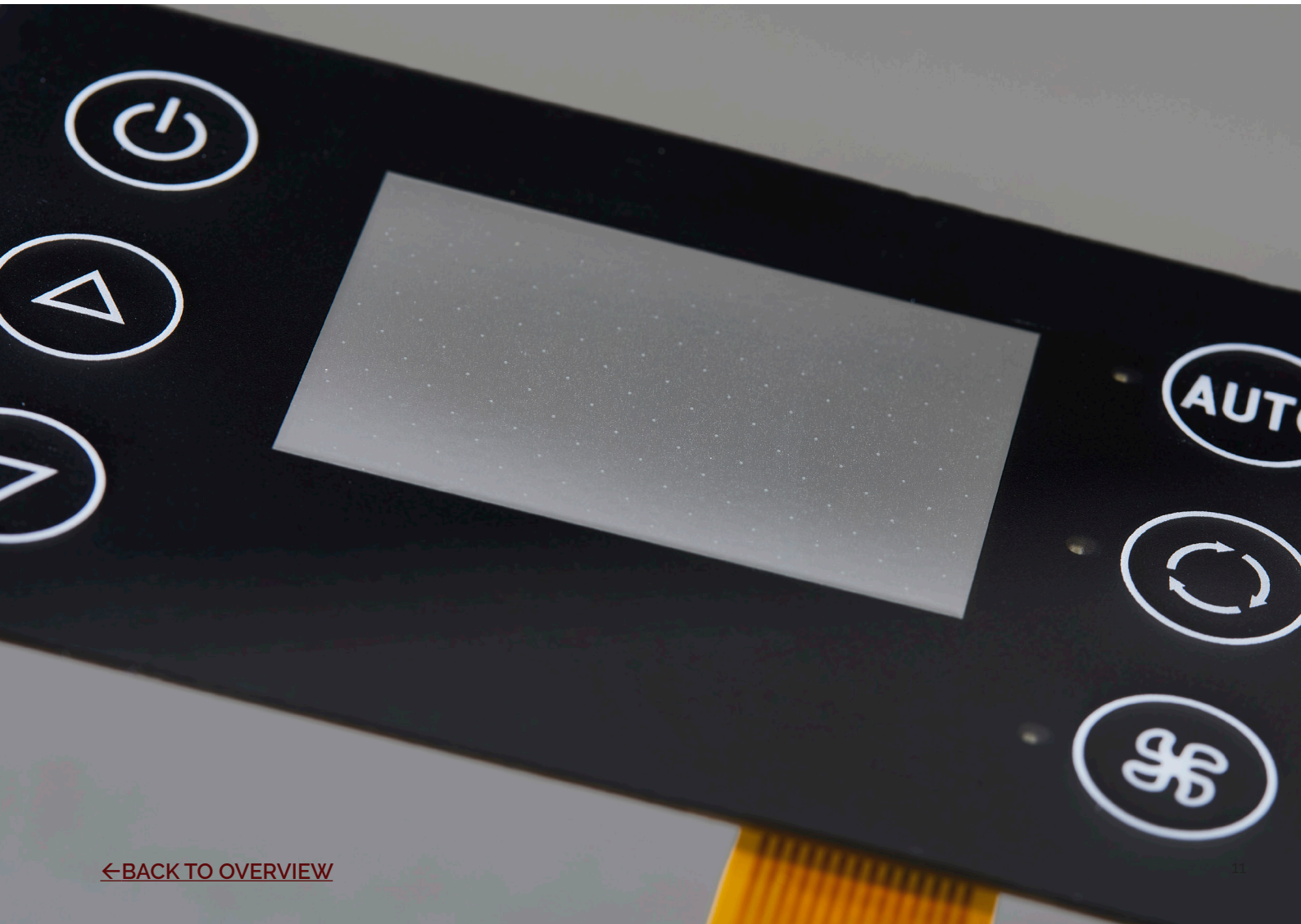
FUNCTIONAL LAYERS

Lacquer dots

The same layered approach can also be used to solve optical challenges. When displays or glass surfaces are placed behind printed windows, direct contact between surfaces can cause Newton rings or rainbow-like effects. Lacquer dots are small, screen-printed features applied on the backside of the window to create a controlled distance between surfaces.

This is a simple and effective way to prevent optical interference and keep the display clear and uniform. The dots are visible, but they eliminate Newton rings without adding extra components or thickness.



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DISPLAY

Display integration

Displays can be integrated directly into membrane keypad assemblies, creating a single, finished HMI front rather than a set of separate components. By integrating the display from the backside of the keypad, mechanical alignment is simplified and optical performance is easier to control.

In many cases, the display is bonded directly to the window using an optically clear adhesive (OCA). This results in a complete assembly with one tail for the keypad and one for the display, ready to be connected during final assembly. Considering display integration early reduces assembly steps, simplifies the supply chain and helps avoid redesign.

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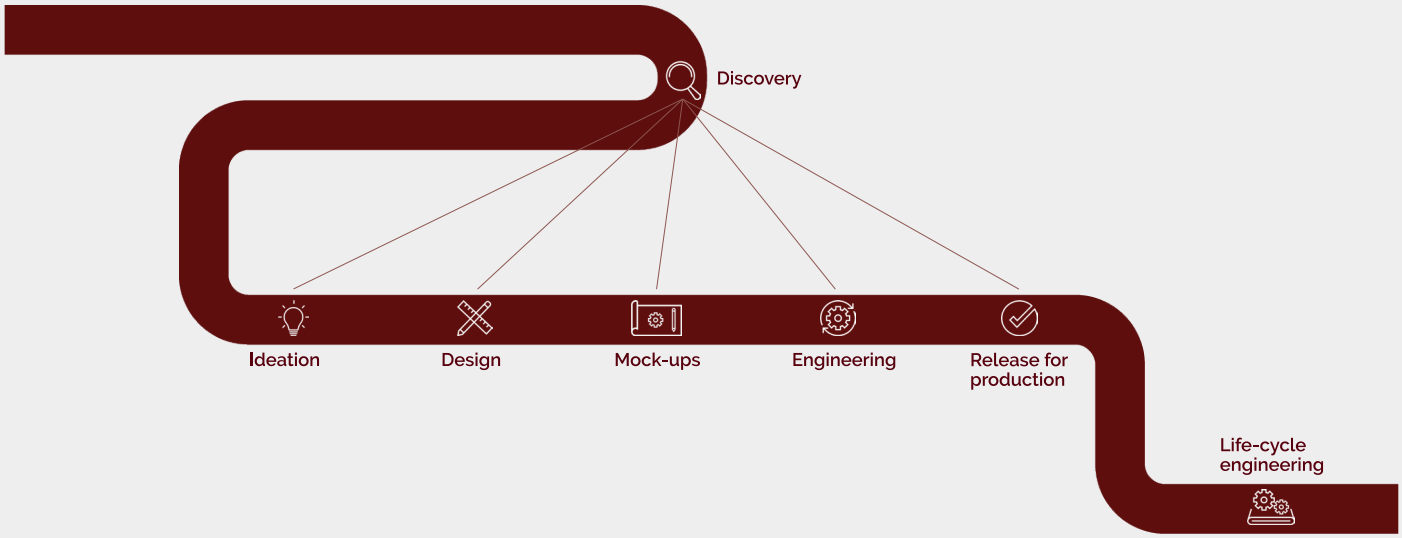
HMI design services

We support customers with design and engineering services for HMI solutions, from early concept to release for production.

Services are structured in stages, allowing support to be added where it creates the most value.



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