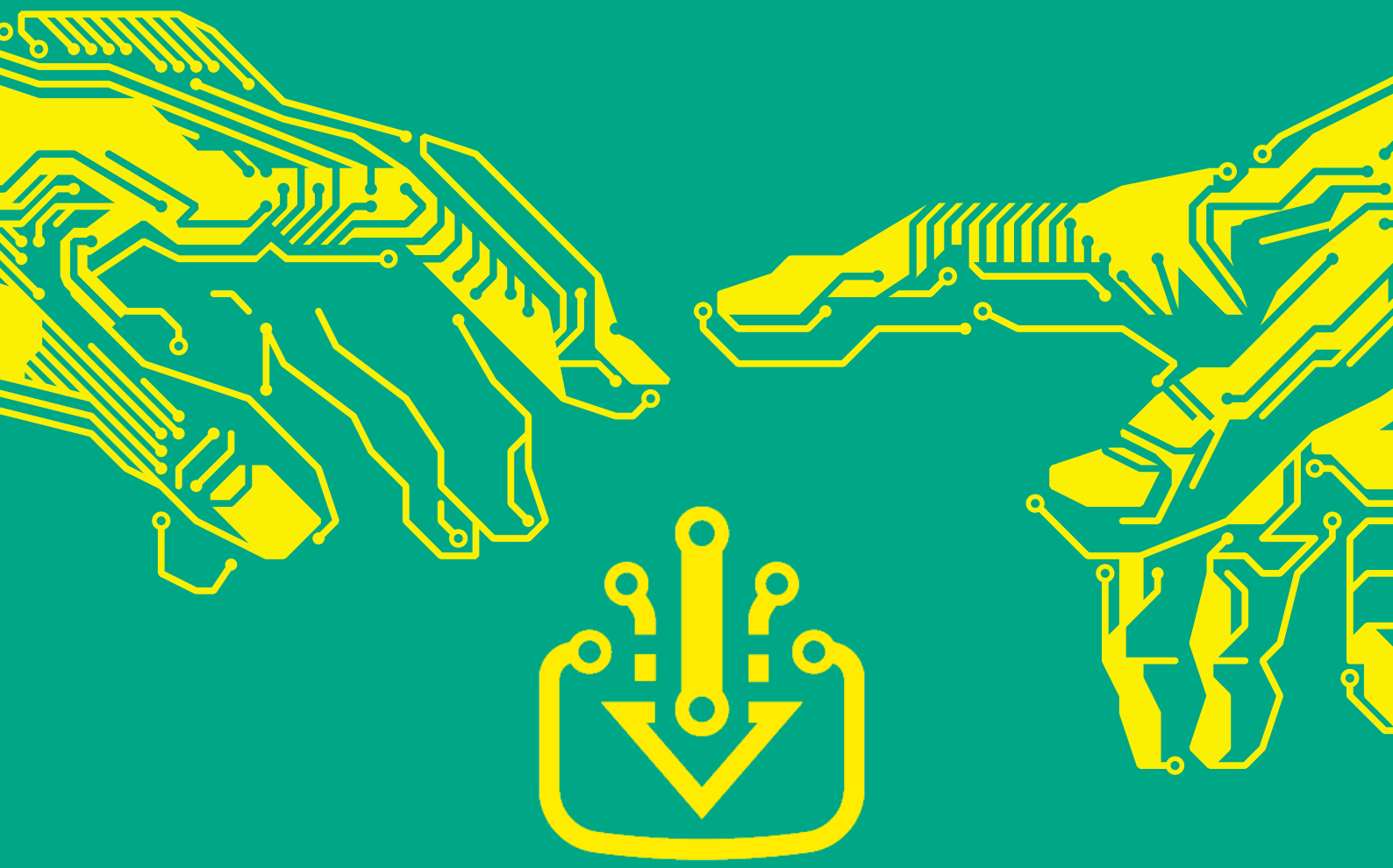

# INPUT SYSTEMS

TECHNICAL INFORMATION

KSG

pcb · smarter · together

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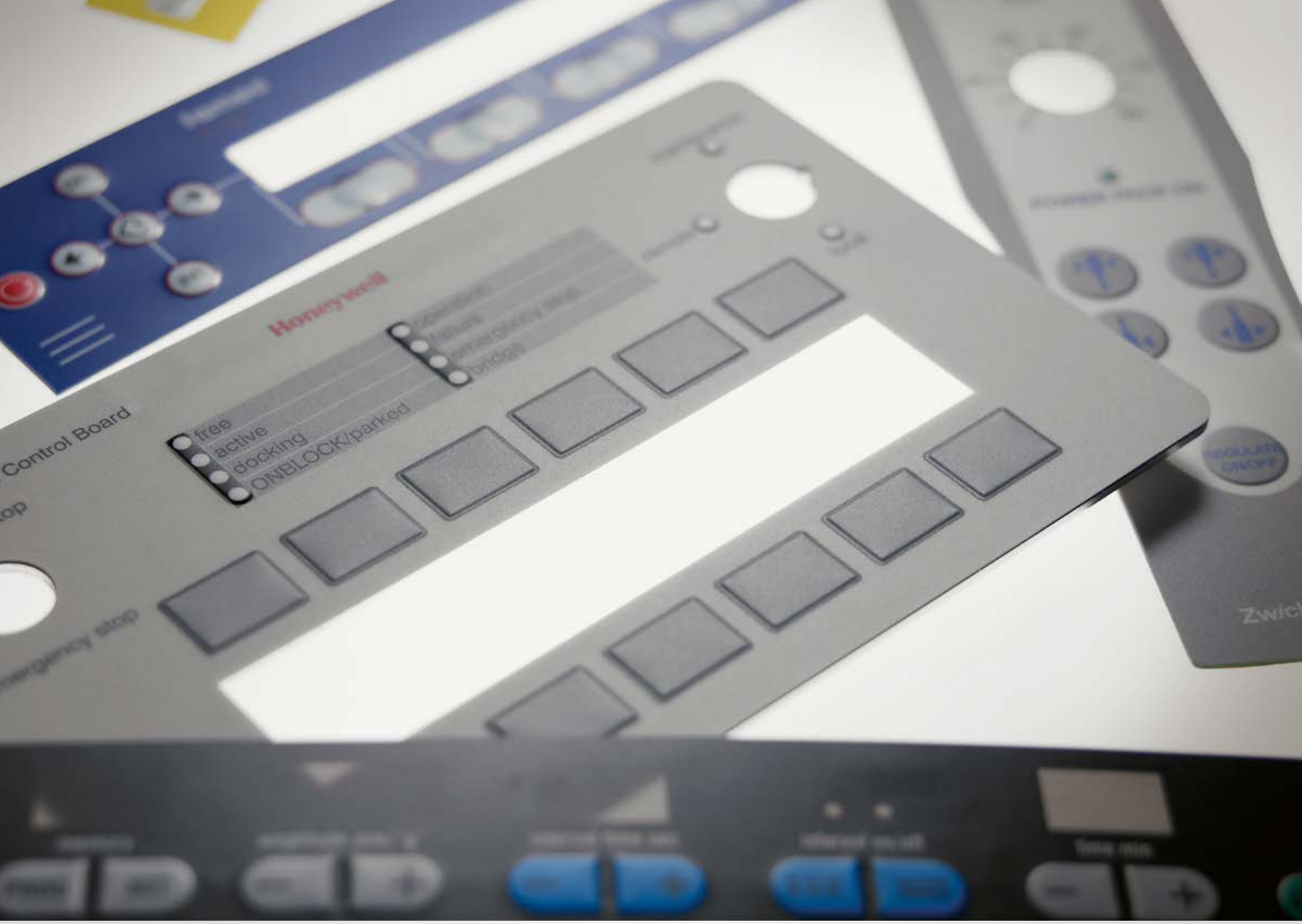



# 1 INTRODUCTION

## Our input systems are as individual as our customers' requirements.

We manufacture input systems for customers in sectors such as measurement and control technology, medical technology, automotive, as well as telecommunications and printing technology.

Our manufacturing expertise makes us the ideal partners for complete solutions and for connections to the PCB.

Benefits

- From the connection to the PCB, by way of the film stack-up, through to assembly – everything from a single source
- Our processing expertise with long-term partners means that we can offer you the right solution for every requirement
- Optimum price-performance ratio from small runs to large-scale production
- High-quality polyester or polycarbonate materials
- Tabs for zero insertion force or crimp connectors/socket contacts – customised for your needs and market requirements
- Layout and colour schemes according to your wishes. Our advice can be a decisive factor in the functionality of your product

KSG

# WE PRODUCE QUALITY IN UNLIMITED VARIETIES

Since 1981, KSG's product range has included a wide variety of input systems. Thanks to our many years of experience, we are now able to provide membrane keyboards to customers in all areas of industry and offer them a broad range of options.

The KSG Technology Guide contains the **standardised** information concerning the scope of supplies and services of our input systems. We would be pleased to discuss any additional requirements with you personally.

## Variants and options

- Classical membrane keyboards with many different types of embossing, various stack-ups and integrated components

- Display and touch screen panels with mounting of glass elements and touch screens


- Membrane keyboards mounted directly onto PCBs, with components assembled on the rear

- Silicone keypads, also in combination with the corresponding PCB

- Capacitive keyboards

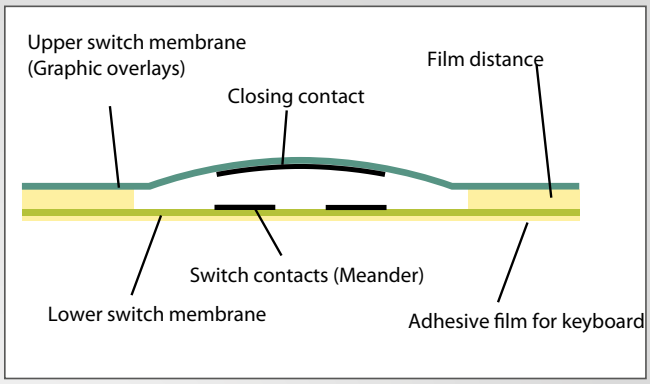
- Lighting

Special solutions can be individually developed and implemented. Together with our partners, we can also produce combinations of all the above technologies.

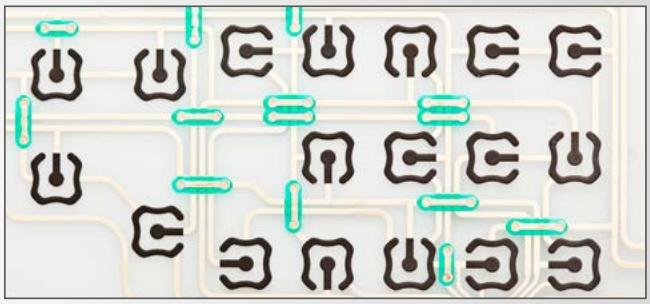
# 2 MEMBRANE KEYBOARDS

## 2.1 Basic principles

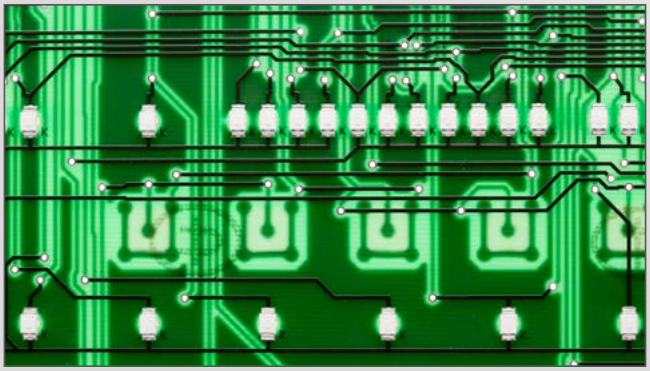
Membrane keyboards consist of a multilayer film with at least four layers: Polyester films with thicknesses of between 0.10 and 0.25 mm are used as the graphic overlays. The bonding and spacing of the individual layers is achieved by means of polyester bases in thicknesses of between 0.05 and 0.30 mm, coated on both sides with acrylic adhesives. The circuit of the membrane keyboard can either be applied by screen printing on polyester films using polymer pastes with a high silver content, or it can be implemented as a PCB. With membrane circuits, non-conductive parts of the circuits can be overprinted with a UV-curable insulating varnish. This makes it possible to implement bridges (similar to vias on PCBs). The adhesive film is applied as the final layer. This is tailored to the specific application and the housing material.

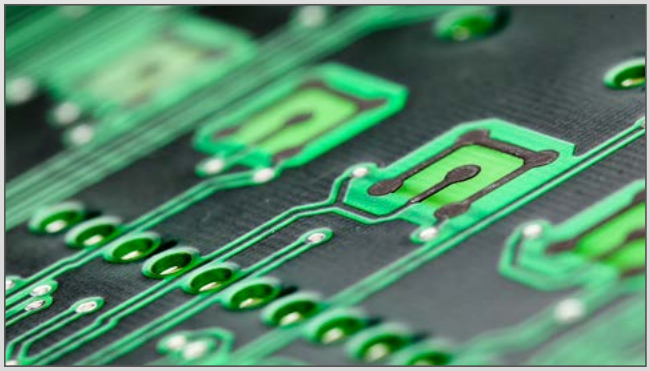



Konstruktion einer einfachen Folientastatur im Querschnitt



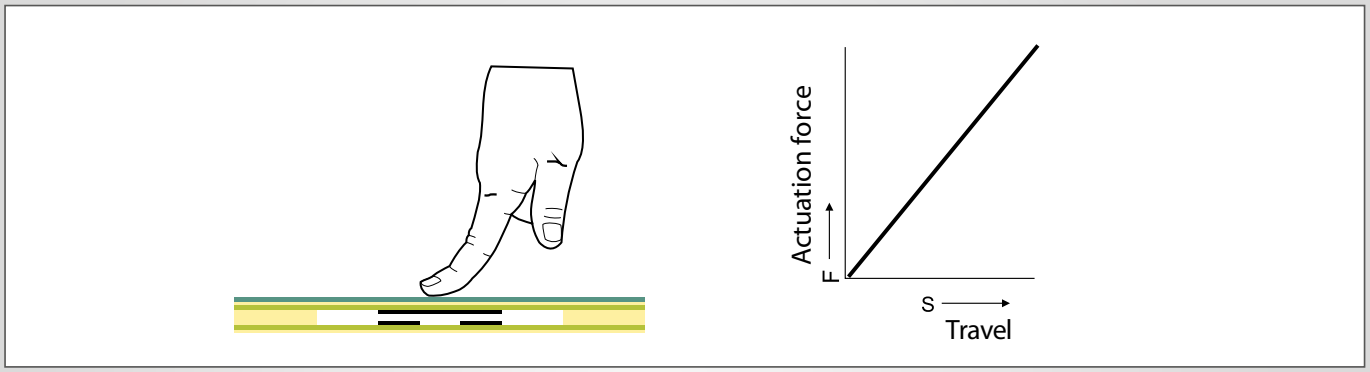
Use of PCBs as a lower circuit layer which also acts as the keyboard's base plate.



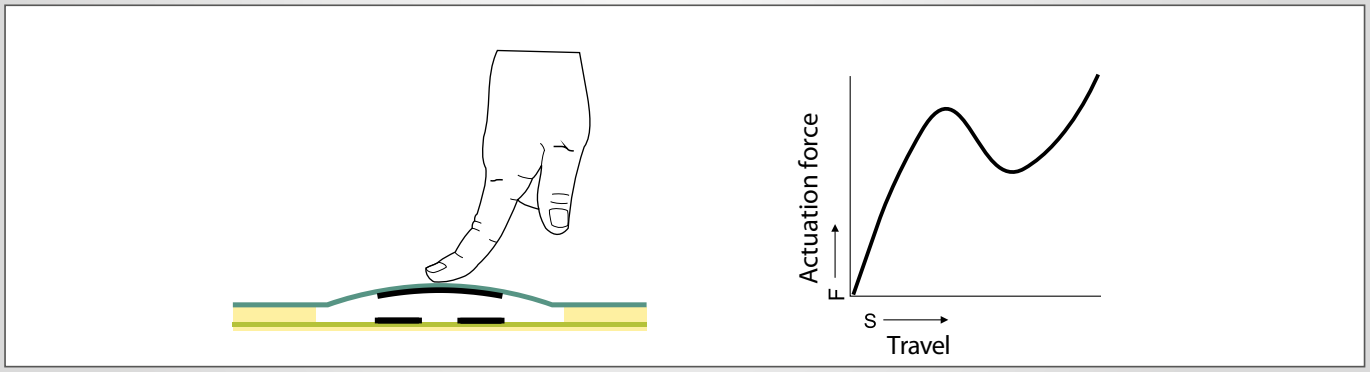


The use of dome-embossed graphic overlays or metal snap domes results in a clearly defined positive click action, as these variants offer tactile feedback when a key is pressed.

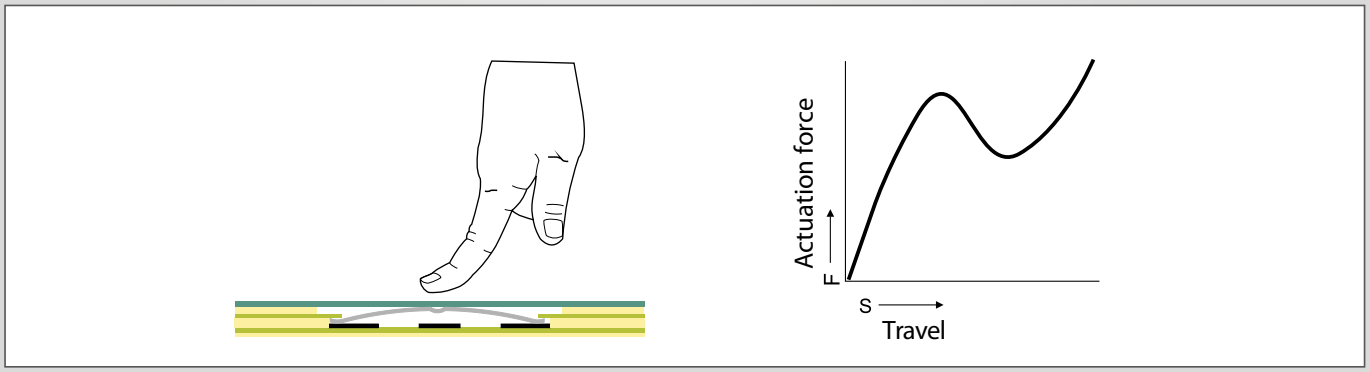
On non-embossed keyboards, the force/travel diagram is linear (no tactile feedback), while on tactile keyboards it is non-linear, as shown in the following diagrams.




Flat non-tactile membrane keyboard



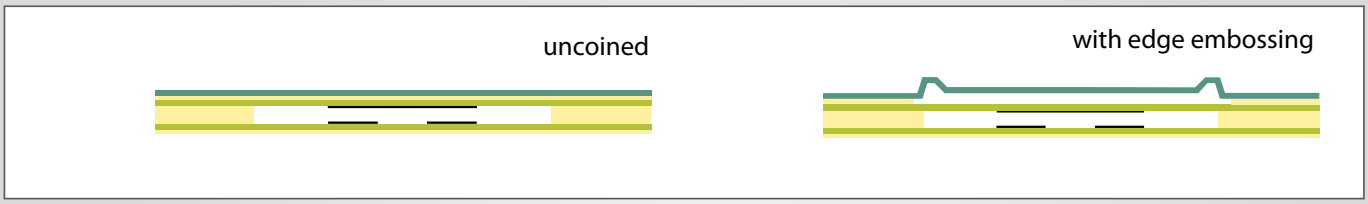

Tactile keyboard with dome embossing




Flat tactile membrane keyboard with snap domes

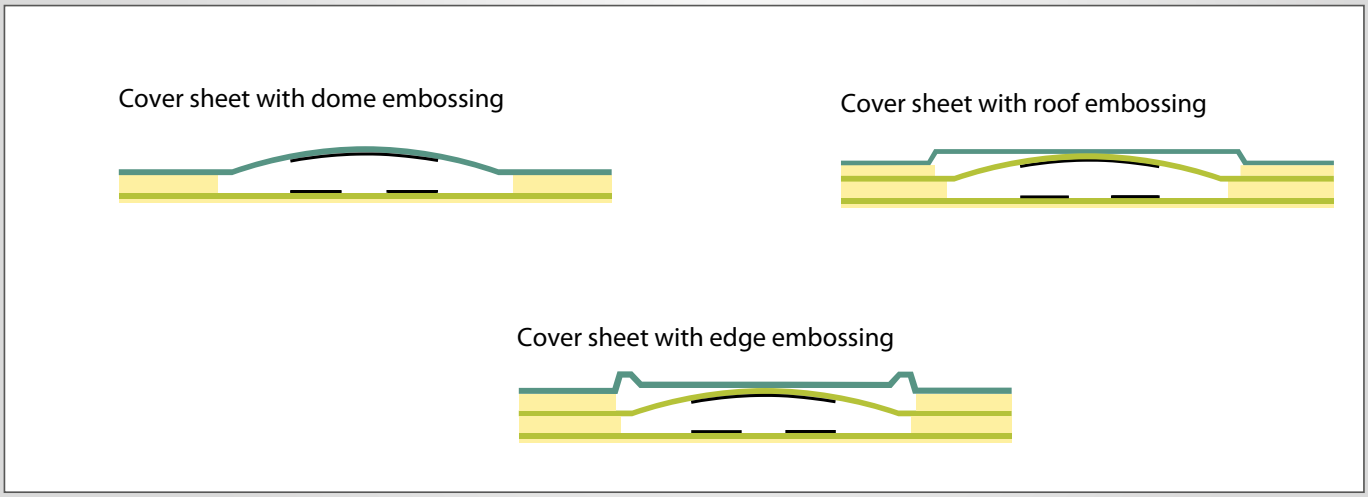
## 2.2 Implementation

### 2.2.1 Keyboards without tactile feedback

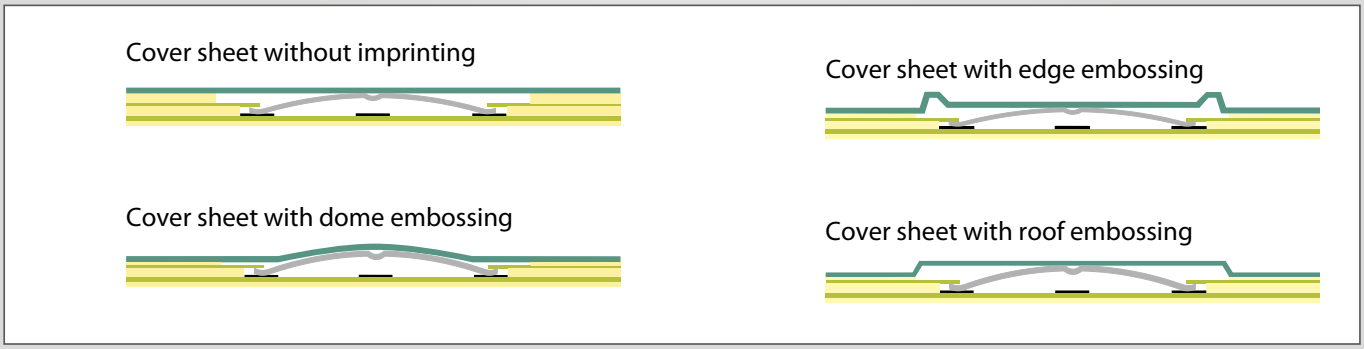



### 2.2.2 Keyboards with tactile feedback

#### 2.2.2.1 Keyboards with embossing

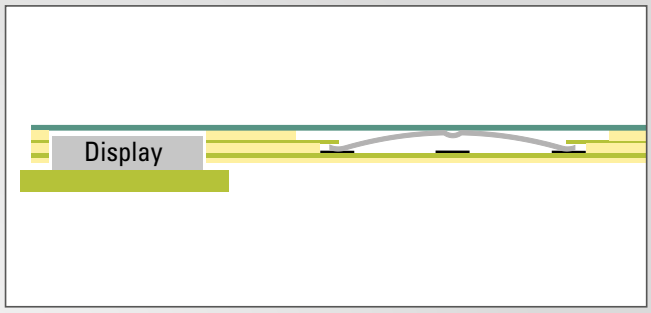



#### 2.2.2.2 Keyboards with metal snap domes



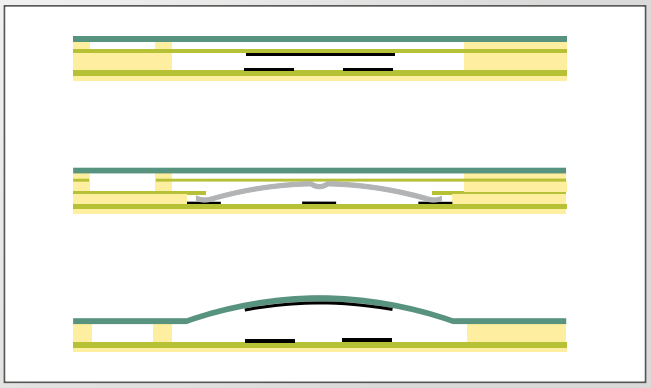
## 2.2.3 Keyboards with overlay windows

LEDs and LED or LCD displays can be mounted behind the graphic overlay. The display windows are represented graphically on the overlay. With LED displays, it is possible to mount a transparent colour filter (red, green, yellow, blue, black) on the back of the overlay. Clear, anti-glare or matt polyester films are used for the manufacture of the graphic overlays. With clear and anti-glare films, a textured coating can be applied to the surface and the display windows can be recessed. Matt films can also be made transparent with a clear coating in the areas of the windows, which also produces an anti-glare effect.




## 2.2.4 Keyboards with insertable legends

To enable the individual labelling of keys or keyboard parts, pockets can be created in the spacer film below the graphic overlay, into which individual legend strips can be inserted from the back or front of the keyboard. The graphic overlay is transparent in this area. Insertable legends next to the keys are possible with all types of keyboard. Labelling on the key surface itself can only be implemented on non-tactile keyboards or if metal snap domes are used. For the legend strips, we recommend paper or foil strips with a thickness of 0.10 mm.



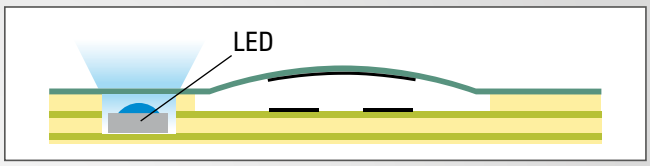
## 2.2.5 Keyboards with integrated LEDs

The most economical mounting option is to use PCBs as the carrier plate for the keyboard and LED circuits. In this case, LEDs or other components are soldered from the rear of the PCB using SMD techniques. The use of 0.45 mm thick LEDs also makes assembly possible on the front in the key area, which removes the need for recesses behind the LEDs on the base plate.

The conductive bonding of chip LEDs on a membrane circuit represents another possible integration variant. When gluing the composite keyboard to the keyboard carrier, care should be taken to subject the keyboard to the least possible torsion and bending. This stack-up requires keyboards to have a greater overall height, which can be achieved in the following ways:

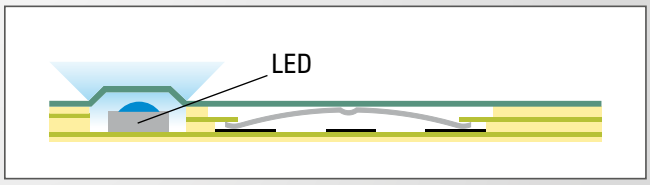
### 2.2.5.1 Integrated LEDs on their own switch membrane

With this design, the LEDs are conductively bonded on their own circuit layer and the spacer films are sufficiently high that the LEDs can be accommodated within the height of the keyboard. This design requires two separate cable outlets for the circuit layers. (1x keyboard, 1x LED layer)



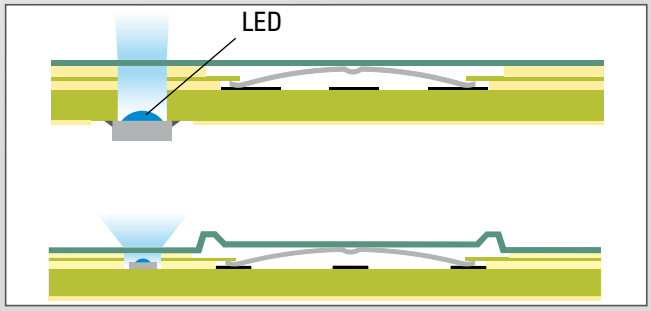

### 2.2.5.2 Integrated LEDs on a common switch membrane

In this case, the space required for the LEDs is created by embossing the graphic overlay. The circuits for the LEDs and the keyboard are on the same layer and can therefore be connected to the device by a common connector.




## 2.2.6 Membrane keyboards combined with PCBs

With this design, a PCB forms the lower circuit layer. The remaining keyboard stack-up corresponds to the standard designs, as described in the preceding sections.

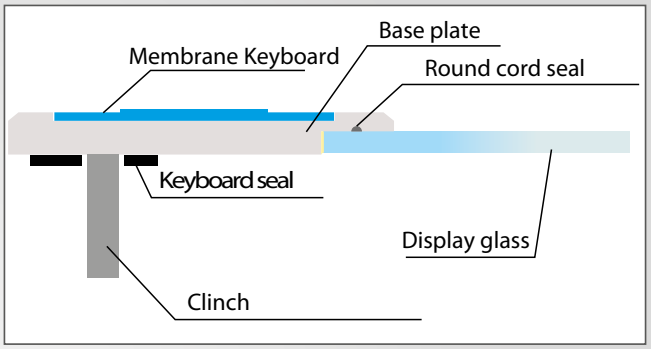


## 2.2.7 Keyboards on base plates

The bottom layer of the membrane keyboards is an adhesive surface, which is protected during transportation by silicone paper or a separating foil. If required, KSG can laminate the keyboards to the device housing (supplied by customer or purchased from KSG).

Base plates consisting of a wide variety of materials are supplied bonded to the keyboards: glass elements, touch screens and seals are already mounted.

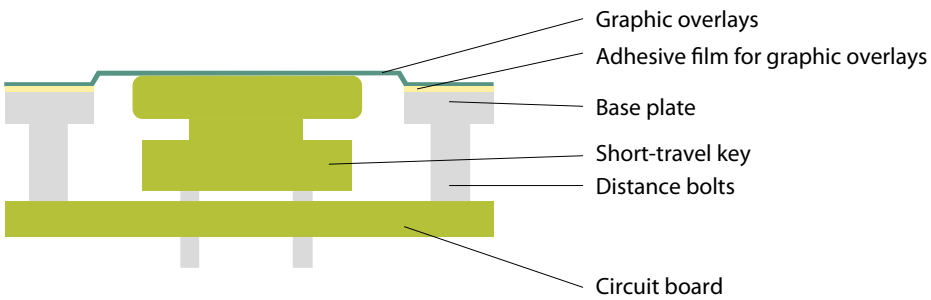
Possible base plate materials:
Aluminium alloys in all standard thicknesses from 1.50 mm
Other materials such as CrNi steel or plastic sheets are possible on request.




Mounting studs and sockets are pre-inserted by KSG. When selecting the stud and socket length, the base plate thickness must be taken into account.

## 2.2.8 Overlays

Overlays are all the graphic overlays and stack-ups manufactured by KSG without switching elements, irrespective of how the customer subsequently processes them. The further design possibilities are the same as for membrane keyboards (embossing, overlay windows, mounting on base plates etc.). These overlays are made of polyester, polycarbonate or clear PVC and are back printed. Other materials, which are, however, only suitable for surface printing, include coloured PVC films and aluminium films. As with keyboards, they are bonded to base plates with an adhesive layer, which is adapted to the substrate in question.



# 3 CAPACITIVE KEYBOARDS

Capacitive keyboards are characterised by a very robust and visually appealing design. The surface may consist of glass of up to 7 mm thickness or of a polymer such as polycarbonate or acrylic with a thickness of up to 5 mm.

Multi-coloured printing is carried out on the rear side, while the front side incorporates a variety of antireflective or other types of coatings and structures.

Single keys, but also rotary and slider control knobs are available for operating these screens. The sensors are either mounted on a printed circuit board under the glass or are fitted in form of film sensors. The system can be fine-tuned by individually adjusting the sensors to match the specifications of the materials used and the required sensitivities of the keys.
The threshold values of the sensors can thus also be adapted to particular ambient conditions in order to eliminate possible interfering factors such as impurities and moisture (water drops).

Lighting using LED and fibre-optic pressure sensor technology is also possible, and we can offer complete lighting of key surfaces as well as logo lighting with dimming effects.

## 3.1 Glass

Keyboards with glass surfaces can be manufactured in many executions.

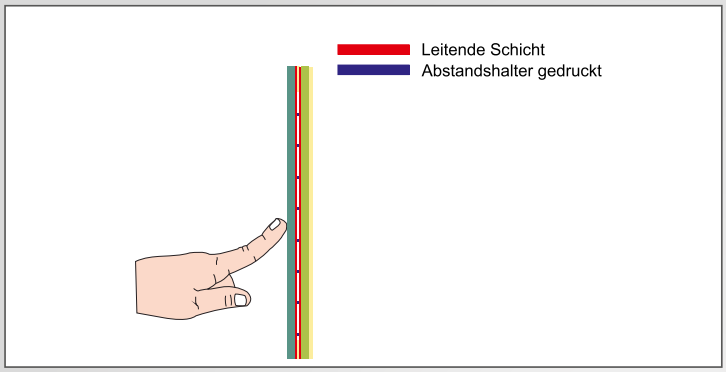
The first thing to consider is the selection of the glass to be used: clear, with anti-reflective optical coating, with anti-reflective chemical coating, tempered glass, the thickness of the glass.

The next question to address is that of machining: simple cuts, ground or polished edges, additional milling for breakthroughs, or surface grinding for fingertip guide creation are all possible.

# 4 TOUCH SYSTEMS

## Touchscreen overview

### 4.1 Resistive




Resistive touch screens consist essentially of two conductive layers which are electrically connected to one another by finger pressure. When actuated, the outer layer comes into contact with the inner layer at a specific point.

We distinguish between 4 -, 5 -, 6 -, 7 - and 8-wire touch screens. They all work in a similar fashion but the scanning of the layers takes place in ever finer grids.

4-wire technology
This represents the simplest option to manufacture, whereby a DC voltage is applied on both layers in opposite conductors. The position of the finger can be calculated from the resistance of the wires.
In the case of 4-wire technology, the precision of measurement quickly deteriorates, since uniformity is limited by the constant mechanical strain of the outer polymer layer.

5-wire technology
Here, the top conductive layer is not used for determining the position but only for transferring the current from the bottom layer while being connected to an additional fifth wire. A decline in precision can be avoided in this way.

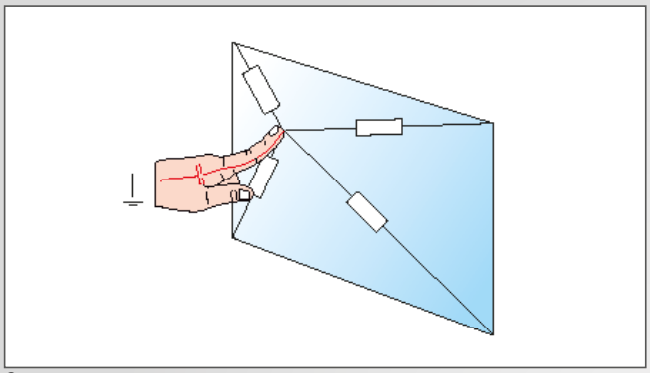
6- and 7-wire technology
These are variations of the 5-wire technology. In both cases, the voltages are not probed from the connecting wires but from additional measuring wires.

8-wire technology
This is a variant of the 4-wire touch screen, which applies the four-wire measurement principle.

Benefits of resistive systems
- Allow precise positioning with stylus pens
- Can be operated with gloves and, in the public sector, also by prosthetic arm wearers

Disadvantages of resistive systems
- Limited multi-touch capabilities
- Usually less accurate than capacitive systems
- Wear due to mechanical stressing of the outer film
- Unwanted actuation by contact with objects during transport

## 4.2 Capacitive



Structure

Surface capacitive touch screen
This technology is only rarely used. It consists in applying a film coated with metal oxide to a glass or Plexiglas panel. When an AC voltage is applied on the corners, touching the screen with a finger changes the capacitance, and this change is measured at the corners as a current during the discharge.

Projected capacitive touch screen
This is currently the most widespread technology variant. Here, two conductive layers are mounted on the back of the glass plate isolated from each other. Because operation takes place directly on the pure glass surface, the design is very robust and virtually wear-free. Multi-touch operation with more than one finger as well as gesture control are both possible.

Advantages of capacitive systems

- Very resistant to environmental influences
- High temperature resistance

Disadvantages of capacitive systems

- Operation only possible with the fingers, not with conventional styluses
- Special gloves and stylus pens with conductive surfaces required

## Inductive touchscreens

This technology is used in graphics systems, and only works with a special stylus or mouse with magnifier and inductive coil.

The advantage of these systems lies in its use — the system is not disturbed by the resting hand or other objects, the surface can also consist of glass, additional information can be entered with the help of further buttons on the stylus pen/input system using different induction currents.

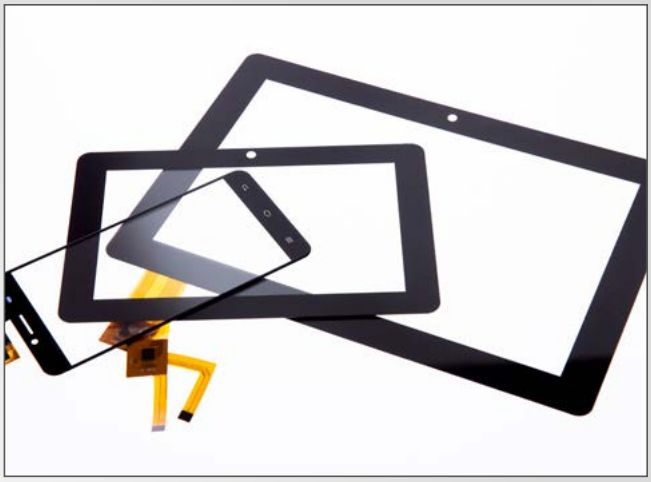
The main disadvantage are the high energy requirements of the system, which significantly hinders a mobile application.

## Implementation of touch systems

Assembly of the touchpad under the film by:

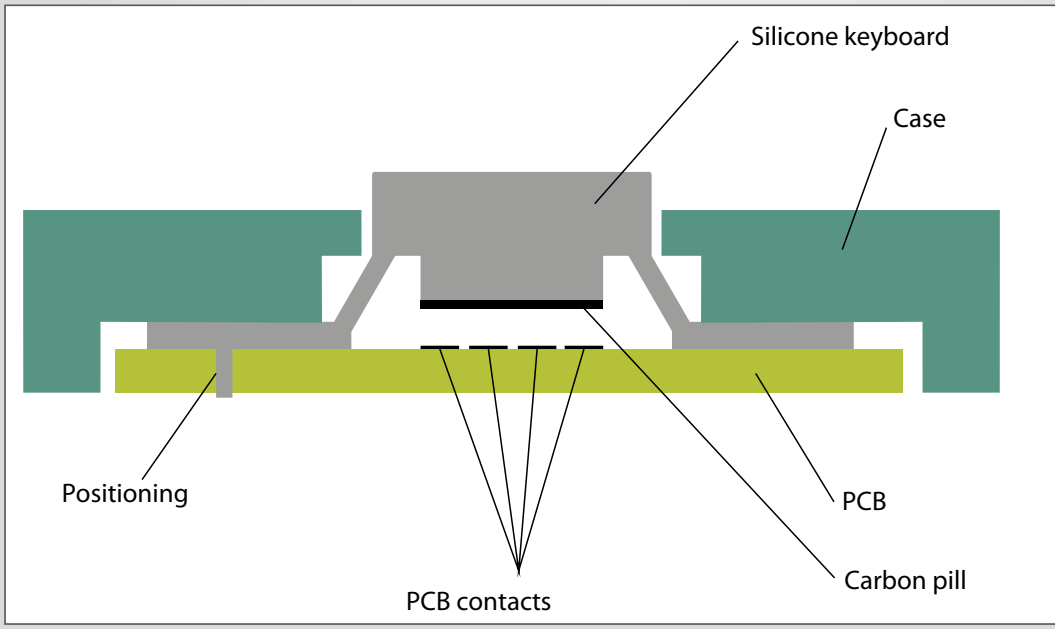
- Liquid optical bonding in a clean room
- Transparent adhesive film bonding in a clean room
- Cutting out suitable for capacitive applications and glass surfaces

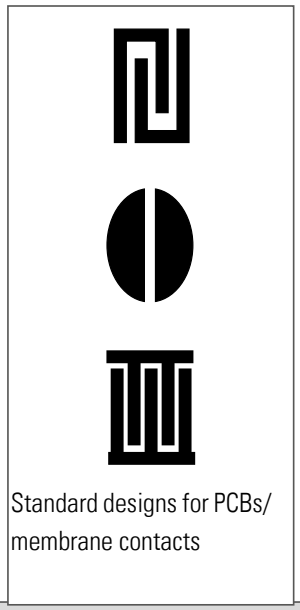
Assembly of touchpad and display with the necessary seals to make the unit liquid and dust-proof, EMC protection, back case for display and controller, touch controller.
Printing of glass overlays, machining of glass for manufacturing recessed grips and similar applications.



# 5 SILICONE KEYBOARDS

Silicone keyboards are gaining in popularity in industrial automation, medical technology, and above all the consumer goods industry. They represent a cost-effective alternative to conventional membrane keyboards. The design possibilities are extremely varied and can be combined with technologies used in the manufacturing of membrane keyboards, such as snap domes under the switching mats or PCBs.



| | |
|---|---|
| Contact materials | Carbon printed<br>Carbon pill, injection-moulded<br>Metal plates, injection-moulded – gold-plated surface |
| Materials | Different grades of hardness available |
| Colours | Possibilities range from colourless milky transparent up to full colour; the transparent materials are suitable for backlighting |
| Legends | Screen printing on the surface or metallic painting and then laser treatment of the painted surface (laser engraving) |
| Surface cover | • PU matt liquid transparent surface coating over the printing<br>• PU gloss liquid transparent surface coating over the printing<br>• Dipped epoxy coating- keys are oversprayed with transparent epoxy resin, matt or glossy surface<br>• Plastic keycaps, printed/unprinted<br>• Metal keycaps, printed/etched/engraved |
| Actuation forces | 80-400 g, depending on the design and the material thickness and hardness; tactile feedback is possible by shaping the key edges, there is also the option of placing metal snap domes under the keys. |


KSG

# 6 TECHNOLOGIES

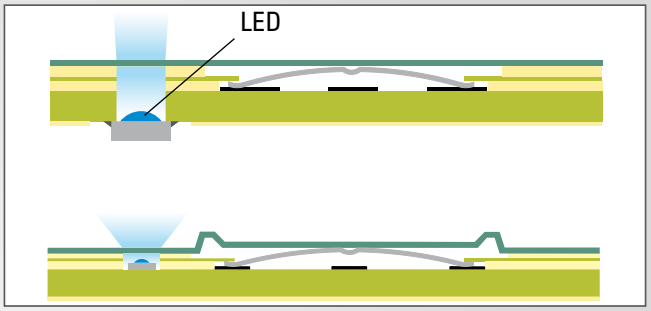
## 6.1 Lighting

Our customers are increasingly focussing on individual illumination of the keys and areas found on their input systems.

We have been proactive and are able to provide our customers different ways to incorporate lighting into their product designs.

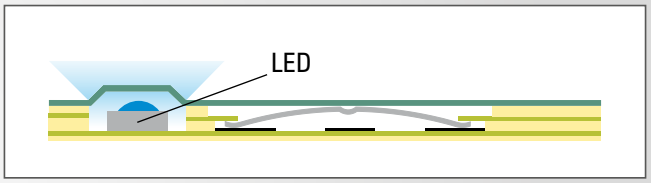
LED Spot lighting

LEDs are soldered/glued onto a film or a printed circuit board behind the graphic overlay.




LED Area lighting

In this case, the design needs to incorporate coloured fibre optics or inlays, which distribute the light from the LED. SIDELEDs are used in this case.




Backlighting on capacitive keyboards

## 6.2 Digital printing

Digitally printed graphic overlays

Graphic overlays can also be back printed using 6-colour (including white) machines in a similar way as with screen printing technology. Digital printing technology makes it possible to create colour gradients but also enables us to respond quickly and cost-effectively (elimination of films and screens) to the increasingly smaller print runs of overlay designs. We can deliver prototypes within a few days.
Individual designs with numbers or names are also possible.


Clear coat prints for display windows are made in a combined production process using screen printing, while coloured transparent windows can be printed digitally. Blocking prints for light blocks must also be applied using screen printing, because digital colours have less ink coverage.

# 7 GENERAL INFORMATION

## 7.1 Materials used

To ensure the outstanding quality of keyboards and overlays, only the highest grade of materials and raw materials are used; KSG guarantees this by means of receiving inspections and continuous process controls.

The materials to be used for the graphic overlays are selected in conjunction with the customer from a tried and tested range of films, and the adhesive films are coordinated to the relevant substrate – in the case of plastics, it is necessary to determine the exact designation of the material.

### 7.1.1 Materials for graphic overlays for keyboards

| POLYESTER FILM - PET | |
|---|---|
| Material | Application |
| PET clear<br>PET clear with increased scratch resistance | Mainly keyboards with film windows, also in combination with transparent colours in the display recesses. A textured finish may be applied to the surface in the areas outside the windows. |
| PET satin<br>PET semi-matt<br>PET matt<br>PET brushed steel texture | Universal, the texture on the surface can be made transparent by printing with clear coat to enhance readability. On films with a linen or brushed aluminium texture, only a complete texture is possible. (For the use of clear coat, see Section 2.3) All films used are back printed, so that only the graphic overlay material is on the surface facing the operator, and the printing is protected by the overlay. |
| PET anti-reflective | As above. In spite of a slight turbidity (15-20%), highly suitable for display applications, since there is an anti-glare effect, and the film has better scratch resistance than highly transparent films. |
| PET AM | Polyester films with an antimicrobial surface coating are used for medical applications or in the food industry. |

## 7.1.2 Materials for graphic overlays

Essentially, the same materials are used as for membrane keyboards. In addition, the following are used:

| PC POLYCARBONATE FILM | |
|---|---|
| Material | Application |
| PC matt<br>PC clear | For all types of overlays on which no keys are pressed (not suitable for short-travel applications), film is back printed. |

| PVC FILM | |
|---|---|
| Material | Application |
| PVC clear<br>PVC colour<br>Aluminium film AL<br>Aluminium film | Universal, printing is from above. Self-adhesive backing is standard. |

## 7.2 Chemical resistance

The degree of chemical resistance depends on the basic materials used. PET has better chemical resistance than polycarbonate. Under normal operating conditions the films can be used without hesitation; if special cleaning or diluting solutions are used, please consult KSG.

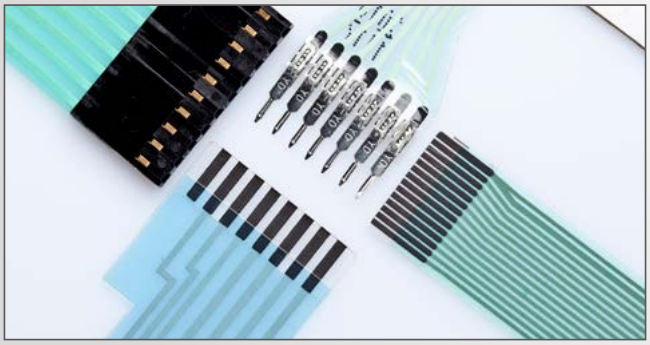
## 7.3 Colours of the graphic overlays

These can be defined in accordance with RAL, Pantone, HKS or other colour systems; in the case of special colours, a colour sample must be provided for spectral analysis. Since the graphic overlays are given a matt finish, slight colour variations (attenuation of colour intensity, light refraction as a result of texture) may occur compared to the colour charts. It is recommended that the final decision on colours should be made in consultation with KSG.

## 7.4 Circuit and electrical connection

The circuit can be designed as a matrix, with the keys implemented individually with a common connection, or with the keys fully separated. The circuit is supplied in the form of a code sheet or a circuit diagram. At the same time, the customer should define the sequence and designate the first pin (or confirm that KSG may select the assignment as it sees fit).

Design of connectors:
1. Crimped sockets with housing
2. Crimped pins without housing
3. Solder contacts
4. Contact surfaces for direct plugging of zero insertion force (ZIF) connectors grid 1.00, 1.25, 1.27 and 2.54 mm possible, stiffening of the cable ends to the dimension required by the mating connector (generally 0.30 mm). The cable type must be indicated in the specification. Mating parts or contact pins are not supplied with the keyboards.



The tracks of the output cable are electrically insulated with insulating varnish; if required, this can be reinforced with glued-on foil. The minimum bending radius of the cable must be r > 3 mm; with values lower than this or in the event of kinking, damage may occur to the tracks.

## 7.5 Digital data

Documents can be supplied in the following manner:
Electronically by e-mail, modem or by supplying drawings.
The supplied documents must be provided with dimensions, since transferring data from one format to another may result in changes in the drawings. In such cases, therefore, it is not possible to carry out checks with the original data.

| Possible data formats | |
|---|---|
| Corel Draw | .CDR |
| AutoCAD | .DWG<br>.DXF |
| HPGL | .PLT |
| Adobe Illustrator | .AI<br>.EPS |

Other importable formats based on CorelDRAW are possible.

# 8 TECHNICAL SPECIFICATIONS

## 8.1 Electrical

| | |
|---|---|
| Switching voltage | On gold contact base, min. 20 mV<br>On silver or carbon contact base, min. 100 mV<br>Max. 25 VAC, standard voltage 5 to 12 VAC |
| Switching current | max. 20 mA AC, standard 1 to 5 mA AC |
| Switching capacity | max. 100 mW with resistive load |
| Contact resistance | The total contact resistance of the keyboard consists of the contact resistance of the closed contact combined with the resistance of the tracks. The contact resistance is specified as loop resistance and measured directly at the cable outlet. The resistance of the contact is very small and can therefore be disregarded in most cases.<br>The total contact resistance is derived from the track length between the contact point and the output cable (7 to 14 Ω with a track length of 100 mm). When designing interfaces and keyboard drivers, a maximum limit of 1000 Ω should be taken into account, even if the typical contact resistance is generally much lower. If required, a separate agreement can be made with KSG. |
| Insulation resistance | Between adjacent pins on the cable outlet, with open contacts min. 100 MΩ |
| Dielectric strength | Between adjacent pins, with open contacts U = 300 Vmax<br>Between all interconnected terminals and<br>a metal base plate U = 500 Vmax<br>If required, a separate agreement can be made with KSG. |

## 8.2 Mechanical

| | |
|---|---|
| Service life | At least 1 million cycles with a switching voltage of 12 VAC, 2 mA and resistive load |
| Test frequency | 1 Hz |
| Switching force | recorded actuation force + 20% N, max. 7.0 N |
| Test procedure | 16 hours testing, 8 hours rest period<br>Test ram: Polyurethane material with a hardness of approximately 45 Shore A,<br>diameter 8 mm and spherical actuation surface. |
| Actuation force | Non-tactile keyboards: 1.5 to 3.0 N<br>Tactile keyboards:<br>• with embossed switch membrane or graphic overlay 2.0 to 3.5 N<br>• with metal snap dome 2.0 to 8.0 N |

## 8.3 Climatic

| | |
|---|---|
| Operating temperature | -25°C to +70°C |
| Storage and transportation temp. | -40°C to +80°C at normal atmospheric pressure |
| Protection class of keyboards | IP 64 (protection against dust and splashing water), other protection classes possible by arrangement |

## 8.4 Tolerances

| | | | |
|---|---|---|---|
| Tolerances | up to 250 mm | 250 to 400 mm | over 400 mm |
| | +/- 0.2 mm | +/- 0.3 mm | +/- 0.4 mm |
| Mechanical tolerances | Max. +/-0.2 mm between two printed symbols or lines on the same layer<br>Max. +/-0.2 mm between printed lines or symbols and punched contours on the same layer<br>Max. +/-0.2 mm between punched contours on the same layer<br>If required, a separate agreement can be made with KSG. | | |

# 9 SPECIFICATIONS AND TECHNICAL DOCUMENTS

Parameters that are relevant for pricing and production are derived from the technical specifications for input systems and overlays, both at the time of the enquiry and in the course of an order. It is therefore very important that definition of the "desired state" should be as exact as possible, for the reasons below.

- Pricing
- Smooth production process
- Lead time, delivery date

The documents should contain the following information:

- Mechanical drawing
- Circuit diagram or switch matrix
- Definition of graphic overlay in the form of data or as a sketch, if the design is produced by KSG
- Colour details
- Key type
- Additional specifications

# FAST AND INDIVIDUAL

- Production of prototypes
- Prototype quality corresponding to series production, based on the customer's design
- Each front panel is made to measure

# INFORMATION AND ADVICE

## We will be pleased to support you with

- Intensive advice in the product development phase and in the design of the keyboard
- Advice on the development and implementation of new projects on site
- Extensive expertise in terms of connection to the PCB
- Long-standing experience in processing, from prototypes to large-scale production

## Team input systems

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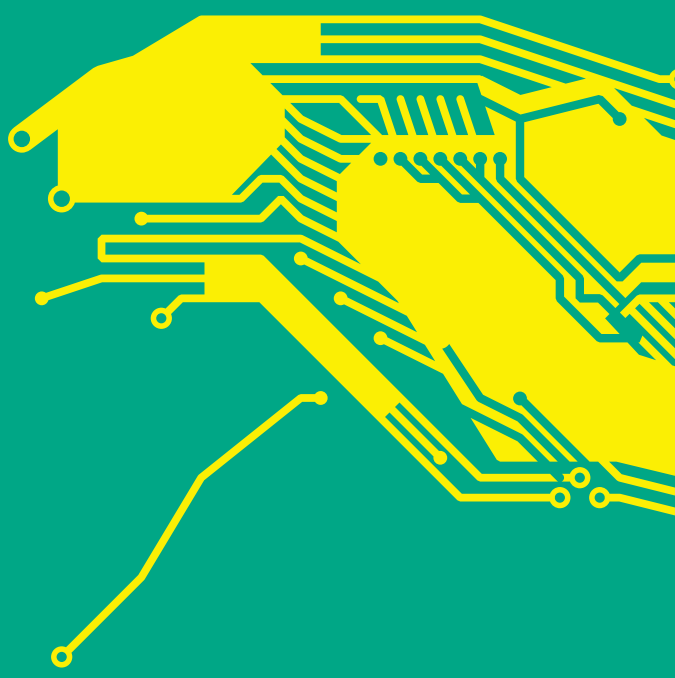

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