A Guide to Switches

Switching electrical energy has always been one of the most important functions of electrical engineering. “Light on - light off”; ‘Machine on - machine off’. In the past, the number of technologies that could be used was still very modest, so the choice was easy. Things are different today. The market offers a wide range of options, especially in the low-voltage sector. Let's take a closer look at the whole picture.

The classic par excellence: the mechanical switch is very reliable and an excellent choice for a wide range of applications. The picture shows the SCHURTER MSM II 22 with ring illumination.

The switching of electrical circuits has been a central element of energy distribution and usage since the early days of electrical engineering. As early as the discovery of electric current, pioneers such as Alessandro Volta and Michael Faraday recognized the need to interrupt and enable the flow of electricity in a controlled manner. In the early days, simple mechanical switches were used that controlled the flow of electricity by manually opening and closing a contact.

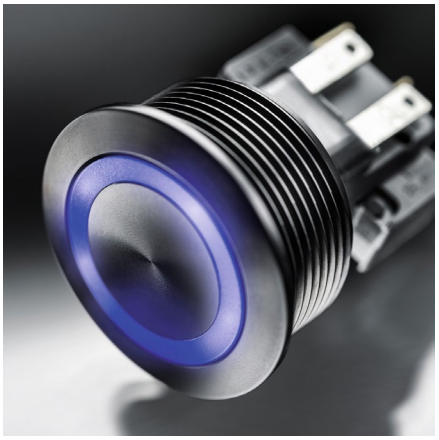
As industrialization progressed and electrical devices and systems became more widespread, the importance of reliable and safe switching mechanisms increased exponentially. Switches not only became essential control elements for consumers, but also played a decisive role in protecting systems and people from electrical hazards such as short circuits or overloads. The continuous development of switching technologies was therefore closely linked to the increasing requirements for safety, reliability, efficiency and user-friendliness.

Today's Switch Technologies

In the course of time, various switch technologies have been developed that are based on different physical principles. Technologies in use today include mechanical, electronic, piezoelectric, capacitive, inductive and other specialized switches. Each of these technologies has specific characteristics, advantages and limitations that make them more or less suitable for a given application.

Mechanical Switches

Mechanical switches are the most classic form and are based on physical contacts that are opened or closed by a mechanical movement. They are usually actuated by pressing, turning or tilting an element. They are often simple in design, inexpensive and offer direct haptic feedback, which makes operation intuitive. Mechanical switches can switch high currents and are therefore suitable for applications that require a high current-carrying capacity, such as light switches or industrial switches. However, mechanical parts are subject to natural wear and tear, which limits their service life. In addition, phenomena



SCHURTER MSM RD: Design version of a mechanical stroke switch

such as contact bounce can occur, in which the rapid opening and closing of the contacts leads to undesirable electrical interference.

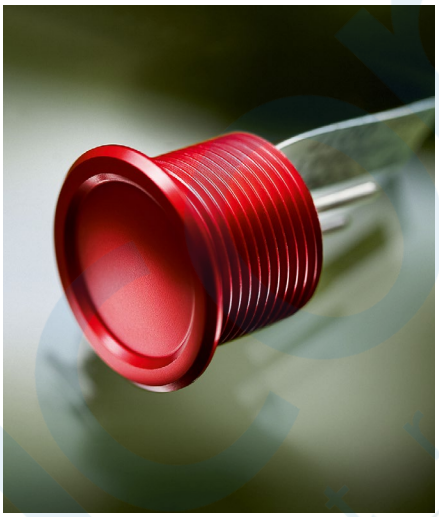
Electronic Switches

Electronic switches use semiconductor components such as transistors or thyristors to control the flow of current. They contain no moving parts and are controlled by electrical signals. This enables a high switching speed and a long service life. Electronic switches are noiseless and therefore ideal for digital applications where fast and reliable switching is required, such as in computers and smartphones. However, they can be sensitive to overvoltages, electro-magnetic interference or high temperatures. In addition, they often require additional circuits for control and can allow leakage currents when switched off.

SCHURTER MSS: electronic switch with ring illumination and protection class IP6K9K

Piezoelectric Switches

Piezoelectric switches are based on the piezoelectric effect, in which very specific materials generate electrical voltage when subjected to mechanical pressure. Pressure on the switch generates a voltage that is used to trigger the switching process. This technology is very robust as it contains no moving parts and is therefore suitable for applications that require high reliability and durability.



SCHURTER PSE: Piezo switch for use in extremely harsh environments

Piezoelectric switches are resistant to mechanical stress, environmental influences and can be realized in waterproof designs. They are used in medical technology, industrial plants and outdoor applications. However, they are more expensive to manufacture and offer less haptic feedback than mechanical switches.

Capacitive Switches

Capacitive switches detect changes in the electrical field when a conductive object, such as a finger, comes close to them. Physical contact is not even necessary, which makes this technology particularly interesting for applications where hygiene and design play a crucial role. They enable flat and seamless surfaces, making them ideal for touchscreens, household appliances and modern control panels. The disadvantages are their sensitivity to moisture and dirt, which can lead to operating errors. They also require permanent monitoring of the electrical field, which leads to higher energy consumption.

SCHURTER CPS: capacitive switch with ring illumination in metal housing

Inductive Switches

Inductive switches work on the principle of electromagnetic induction and detect metallic objects through changes in a generated magnetic field. They are wear-free and insensitive to environmental influences such as dirt, dust and moisture. Because of their properties, they are often used in automation and industrial applications, for example for position sensing or as safety sensors. However, their range is limited and they can only detect metallic objects, which limits their applications.

The best suited technology

Selecting the optimal switch technology for a specific application is a complex process that must take into account a variety of factors. It is not only about understanding the technical specifications of the switches, but also about meeting the requirements of the application, the environmental conditions and the expectations of the end users.

Application areas and their requirements

The first step in the selection process is to analyse the application. Industrial applications have different requirements than consumer goods or medical devices. In industry, factors such as ruggedness, reliability in extreme conditions and high switching cycles can be critical. In consumer goods, design, ease of use and cost are often more important.

Environmental Conditions

The environmental conditions in which the switch will operate have a significant influence on the choice. In humid or dusty environments, non-contact technologies such as capacitive or inductive switches are advantageous as they are less susceptible to wear or malfunction. For outdoor applications or areas with extreme temperatures, piezoelectric switches may be the best choice as they are resistant to environmental influences.

Lifetime and Switching Cycles

The expected life and number of operations are also important criteria. Applications requiring millions of operations benefit from technologies without mechanical wear parts, such as electronic or piezoelectric switches. Mechanical switches may be less suitable due to wear and possible contact problems.

Economic Efficiency

The available budget and the cost structure of the project also influence the decision. Mechanical switches are generally cost-effective and suitable for particularly price-sensitive applications. High-end technologies such as piezo electrical or special electronic switches can be more expensive. In return, however, they also offer additional advantages that justify the higher price.

User Experience and Design

In applications where user interaction is paramount, aspects such as tactile feedback, ease of use and design are critical. Mechanical switches offer direct tactile feedback that is appreciated by many users. Capacitive switches, on the other hand, allow modern, low-profile designs and can be installed under glass or plastic surfaces, making them attractive for products with high design requirements.

Safety Requirements

In sicherheitskritischen Anwendungen müssen Schalter zusätzliche Anforderungen erfüllen. Hier sind Zuverlässigkeit, Fehlerfreiheit und oft auch redundante Systeme gefragt. Elektronische Schalter können mit zusätzlichen Sicherheitsfunktionen ausgestattet werden, während mechanische Schalter in bestimmten Fällen aufgrund ihrer Einfachheit bevorzugt werden.

Application examples

- **Mechanical Switch:** Ideal for household appliances, light switches and applications where cost and simplicity are paramount.
- **Electronic Switch:** Suitable for digital devices, computers, smartphones and applications that require fast switching operations and a long service life.
- **Piezoelectric Switch:** Perfect for industrial control systems, medical devices and outdoor applications where robustness and resistance to environmental influences are important.
- **Capacitive Switch:** Preferred in modern household appliances, touchscreens and control panels with high design standards and requirements for easy cleaning and hygiene.
- **Inductive Switch:** Used in automation technology for position monitoring, safety systems and wherever

Application	Mechanical Switches	Electronic Switches	Piezoelectric Switches	Capacitive Switches	Inductive Switches
Household Appliances	Very suitable	Suitable	Less suitable	Very suitable	Not suitable
Industrial Automation	Suitable	Very suitable	Very suitable	Suitable	Very suitable
Medical Devices	Suitable	Suitable	Very suitable	Suitable	Less suitable
Consumer Goods (e.g., Smartphones)	Less suitable	Very suitable	Suitable	Very suitable	Not suitable
Outdoor Applications	Less suitable	Suitable	Very suitable	Suitable	Very suitable
High-Current Switching	Very suitable	Suitable	Less suitable	Not suitable	Not suitable
Touchscreens and Modern Interfaces	Not suitable	Very suitable	Suitable	Very suitable	Not suitable

contactless and wear-free switching operations are required.

Trends and Developments

Switch technology is constantly evolving, driven by new materials, advances in semiconductor technology and increasing demands for energy efficiency and miniaturization. Intelligent switches with integrated sensors and communication capabilities are becoming increasingly important.

Conclusion

Choosing the right switch technology requires an understanding of the technical capabilities and limitations of the various technologies, as well as careful consideration of the specific requirements of the application. By considering factors such as application, environment, lifetime, cost and user experience, the optimum solution can be found that makes both technical and economic sense.

About SCHURTER

The SCHURTER Group is a globally successful Swiss technology business. With our components ensuring the clean and safe supply of power, input systems for ease of use, we impress our customers with agility and excellent product and service quality.

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Special Case: Contactless Switches

For some years now, there have also been switches that do not even need to be “pressed”. Contactless switches enable a switching operation to be triggered without physical contact. They use technologies such as infrared, ultrasound or capacitive proximity sensors to detect and respond to movement or proximity.

Applications

- **Hygiene Zones:** They minimise the transmission of germs in hospitals, food processing plants and public sanitary facilities.
- **Public Areas:** Control of automatic doors, elevators and contactless payment systems.
- **Industry:** Machine control in automation where wear and contamination need to be reduced.
- **Consumer Goods:** Smart home devices and applications that offer increased ease of use.

Advantages

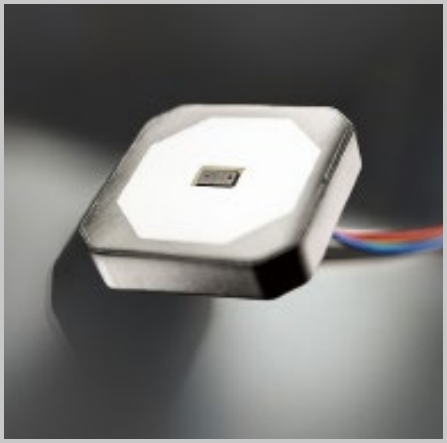
- **Hygiene:** Avoidance of germ transmission by eliminating physical contact.
- **Long service life:** No mechanical parts means less wear and tear.
- **Ease of Use:** Simple and intuitive use without effort.
- **Design freedom:** Enables slim, modern designs through integration behind surfaces such as glass or plastic.

Disadvantages

- **Malfunctions** Sensitivity to dust or moisture can lead to unintentional triggering.
- **Costs:** Higher acquisition costs due to more complex technology compared to mechanical switches.
- **Energy Consumption:** Continuous operation of the sensors requires a continuous power supply.
- **Complexity:** Integration requires additional electronics. This can make maintenance and repair more difficult.

Summary

Contactless switches offer significant advantages in terms of hygiene, durability and ease of use, but are associated with higher costs and potential sensitivities. They are ideal for applications where cleanliness and ease of use are paramount and are becoming increasingly important in many industries.



SCHURTER THS: Contactless switch with ToF technology for discreet installation