

Electromagnetic Information

We have put together a small selection of information from our projects so that you may read up on the most important electromagnetic terms at your leisure. For any other questions, please contact our consultants who would be happy to personally assist you.

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01. Basic Knowledge

Electromagnets are now found in almost all areas of daily life. You likely hold the first one in your hand shortly after getting out of bed in the morning: an electric toothbrush. Instead of using an electric motor, it uses a small magnet which enables the brush head's movements with a simple and inexpensive electronic control. It's smaller, lighter, and more reliable than an electric motor and even more efficient.

A push of your car's remote will precisely unlock an electromechanical actuator and the door in so doing. Electromagnetic injection valves dispense exactly the required amount of fuel into each engine cylinder after starting it.

Safety-related applications also benefit from the indispensable use of electromagnets in today's world. Their high level of reliability, robustness and versatility give them an ever-increasingly wider range of applications in industrial and automotive sector.

Electromagnets move more than you think!

With the exception of special applications such as a medical MRI scanner in which a very heavy and liquid helium-cooled superconducting magnet of an extremely strong static magnetic field excites atomic nuclei in the human body, the technical fields usually require a specific motion, attraction, or holding force in most cases. This may be a linear (translational) working motion, rotary, static or specifically dynamic holding force. For example, these could include motions used in fire protection systems, to fuse work pieces or to lock/unlock mechanisms.

For developers, it is important to know which solutions are possible with electromagnets, which major types and designs are available and what is important for the intended application. This technical introduction which deals specifically with electromagnets for technical applications gives developers and project managers an overview of operating principles, designs, concept definitions and technical characteristics of the various electromagnets at hand.

02. Characteristics/Designs/Models

Lifting magnet

A lifting magnet is energised by field winding (coil) and produces an electromagnetic force between the inner and the outer pole. Ferromagnetic parts are recorded through this open system.

Single direction magnet

A single direction magnet can be activated by energising the coil. The lifting movement is made possible by a stroke lift in a stroke end position by the electromagnetic action of force. The resetting may be made by externally applied forces (i.e. spring force). Pushing and pulling device models are fundamentally different in nature.

Single direction magnet, monostable

A monostable single direction magnet is equipped with a permanent magnet. This keeps the moving armature in the stroke end position using a specific holding force after the field winding coil is energised without additional energy input. It is reset by external reset forces, but only after the permanent magnetic field was temporarily neutralised by a corresponding momentum.

Single direction magnet, bistable

A bistable single direction magnet has a monostable lifting magnet opposite two fixed stroke end positions which include a particular permanent magnet motor, have no energy supply and occupy the respective stroke position. The two positions can be switched with either a current pulse of different polarity or by an additional, second field winding.

Double-acting magnet

A double-acting magnet has three positions. The so called mid-position is defined by external forces acting on the magnet. It is equipped with two separate coils. Depending on the current supply, a field winding (coil) follows the lifting movement of the armature from the central position in one of the two stroke end positions.

Reversing linear magnet

The reversing linear magnet is also equipped with two coils. However, as opposed to a double-acting magnet, it has only two lifting positions. A lifting movement is made by energising one of the two field windings. Depending on which of the coils is energised, a lifting movement occurs from one lifting position or the other. By having a constant current from one of the two windings, the lifting position is maintained.

Rotary magnet

A rotary magnet is actually a lifting magnet which converts a relatively short stroke movement into a relative rotary movement. Resetting is possible by means of an external force. Rotary magnets usually turn to both the left and right.

AC magnet

An AC magnet has an extremely short turn-on time. It is characterised by very high starting power. The magnet consists of assembled sheet metal parts. Essentially, the armature must reach the end position as it is turned on. Otherwise the field winding (coil) burns due to high currents. An AC magnetic deflects as the current feed makes a humming noise.

Operating conditions

Ambient maximum temperature of +40° C wherein the average value cannot exceed 35° C over a period of 24 hours. The lower limit of ambient temperature is -5° C. Altitude max 1000 meters above sea level. Relative humidity of the ambient air is given as 50% at 40° C [at lower temperatures, higher humidities are allowed (0% at 20° C)]. Condensation must be avoided. Low levels of dust, smoke, fumes or corrosive gases.

03. Stroke, Magnetic Force and Work

Stroke

A magnet stroke (path) is taken from a starting position's armature in a stroke start position to a stroke end position and back again. This path is called a stroke or stroke distance. The stroke starting position is the starting position of an armature before the start of a stroke movement or specifically following its completion of its resetting in the starting position. The end position is the position of an armature which results from current, the field winding, and finally an electromagnetic force action.

Magnet force

A given magnet force FM is the mechanical force used to reduced friction generated in the stroke direction. It is reliable at 90% of the rated voltage and maximum heat. Magnets are mounted with good thermal conductivity so that the magnetic force can be increased by adjusting the performance of the operating conditions. Increasing the magnetic force is made possible when the ambient temperature is permanently below 35° C. If necessary, the power must be reduced when the ambient temperature rises constantly above 35° C. This causes a reduction of the magnetic force. Table values of the magnetic force are subject to a scatter of $\pm 10\%$. The list values increase by about 10% in nominal operating voltage.

Stroke work

The stroke work W is the integral of the magnet force FM over the magnet stroke s. Nominal stroke work consists of a static and a dynamic stroke work ($W = \text{static } W + \text{dynamic } W$).

04. Voltage, Current and Power

Voltage

The nominal voltage U_n of a DC lifting magnet is the voltage for which it was calculated and interpreted. The permanent allowable voltage change of the stroke magnet is +10% to -10% of nominal voltage. The guidelines of the currently applicable IEC standard voltage are to be considered. For preferred voltages, please refer to the DC lifting magnet data sheets. The information listed on the product data sheets concerning magnetic force and power consumption is valid for the specified voltages.

Current

The rated current I_N is obtained at nominal voltage U_n and at a field winding temperature of 20° C.

Power

The power P_n , also called nominal power at 20° C, is the product of the nominal voltage U_n and the nominal current I_n at a coil temperature of t_{20} (20° C). It can be found in the product data sheets.