Contactless power transmission
Maintenance-free electrical connection
Let's connect

Whitepaper

Contactless power transmission
Maintenance-free electrical connection

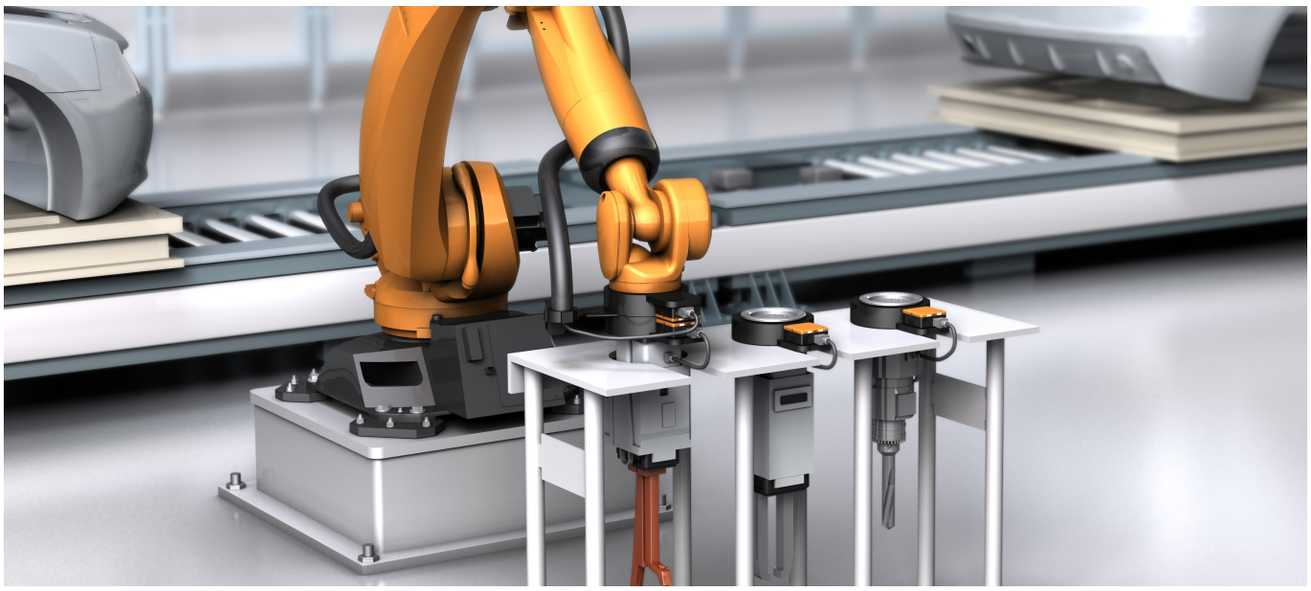
Contactless power transmission over short distances is based on the inductive connection between two electric circuits. Completely dispensing with electrical contacts and the associated possibility of mechanically separating source and consumer results in a wide range of possible applications. The system is particularly attractive for mobile consumers and special environmental conditions, which require an increased protection degree or are subjected to a great deal of mechanical wear.

In short: compared with conventional connection technology for electrical consumers, such as plug-in connectors, this type of power transmission is an interesting alternative.

Typical areas of application

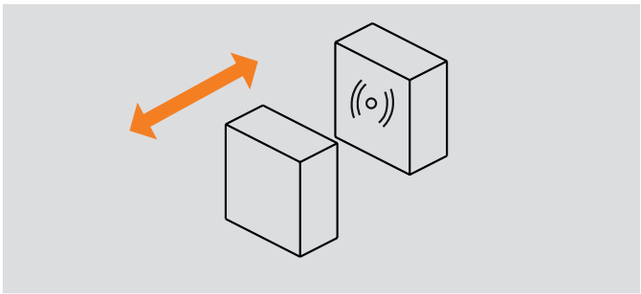
- Applications in which power is to be transmitted to rotating, mobile consumers (shafts, rotary tables, etc.)
- Wireless bridging of spacing and/or an air gap which is required by the specific design or wanted for any other reason
- Applications requiring a high degree of protection or with stringent hygiene requirements (automotive sector, food industry, medical technology etc.)
- Automated charging of mobile systems

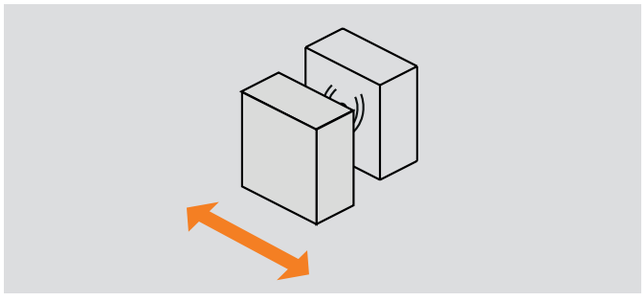
- Applications with frequent plugging cycles resulting in increased maintenance work and/or a high failure rate (tool-changing systems on robots, etc.)

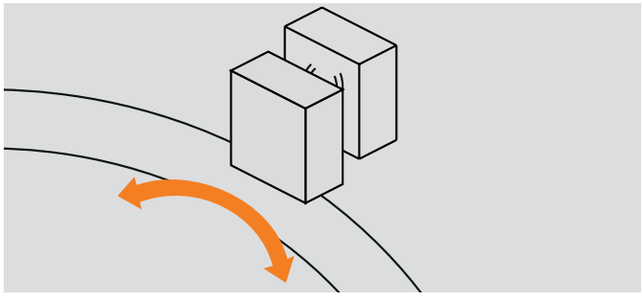


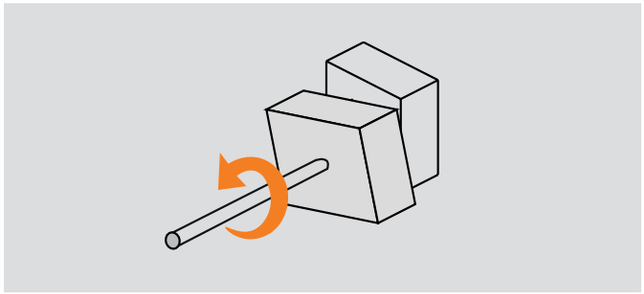
Functional examples

Contactless power transmission isn't just replacing plug connections, it's creating new ways of establishing connections. The two connection elements (the primary and secondary sides) can be brought together from any direction and power can even be transmitted when the elements are rotating. Completely new applications are possible because a connection can be established by automatically bringing the two elements together.









Technology

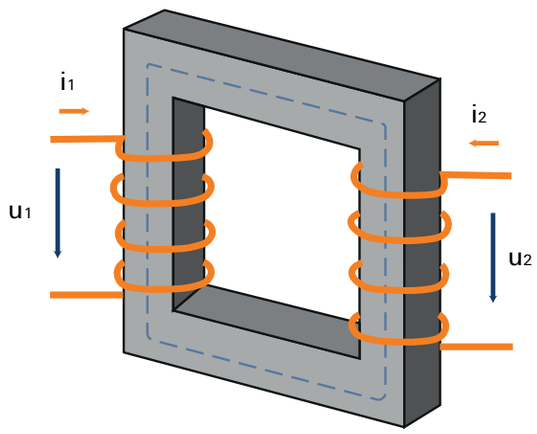
The main part of a system for contactless, inductive power transmission consists of a transformer-type arrangement of at least two coils of wire. As with traditional grid transformers (figure on left), the coil facing the electrical source of power in normal operation is known as the primary side and that facing the electrical load the secondary side.

Unlike traditional transformers, the coils of wire in a contactless power transmission system are not spread over one closed, magnetically soft core, but over two separate cores (figure on right). The primary and second sides are mechanically separated from one another by an air gap. Depending on the application in hand, such a gap may be several millimetres across.

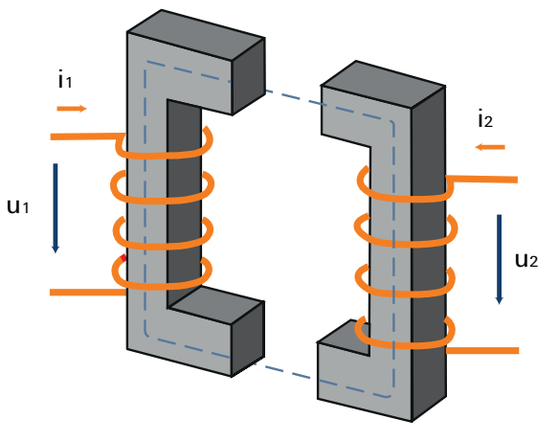
The magnetic coupling between the coils greatly influences the efficiency and performance of the transmission path. This depends on the spacing between the coils in relation to their diameter. This means that a larger spacing or a horizontal offset between the coils lowers the coupling factor and therefore reduces the transmittable power. The efficiency and maximum for the transmittable power also fall with the coupling factor. The losses in the transmitter's coils can be reduced by means of compensation, for example by positioning capacitors in series with the leakage inductances. They then compensate for the inductive share of the leakage inductance through the capacitive voltage component of the capacitor. Changing the operating frequency influences the transmittable power according to the volume of the coupler. The higher the coupler frequency, the higher the system's power to be transmitted.

The physical basis of contactless power transmission, electromagnetic induction, was discovered by Michael Faraday and Nicols Tesla and is used in transformers, for example. To simplify matters, we can imagine contactless power transmission as a "sawn through" transformer, consisting of two physically separate parts: the primary side and the secondary side.

Because the iron core naturally conducts magnetic fields better than air, efficiency and performance drop the more the spacing between the two sides is increased. Applications are only possible or efficient if the air gap between the primary and secondary sides is just a few millimetres.



Traditional transformer



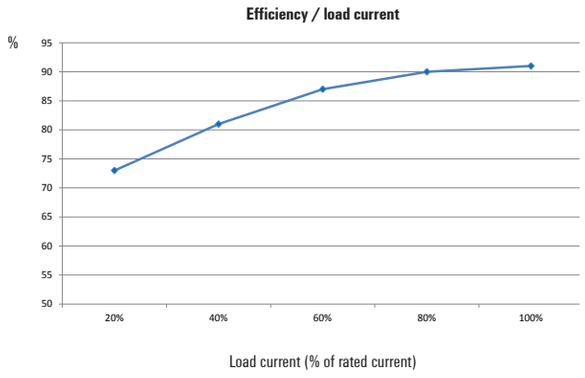
Transformer with air gap (contactless transmission system)

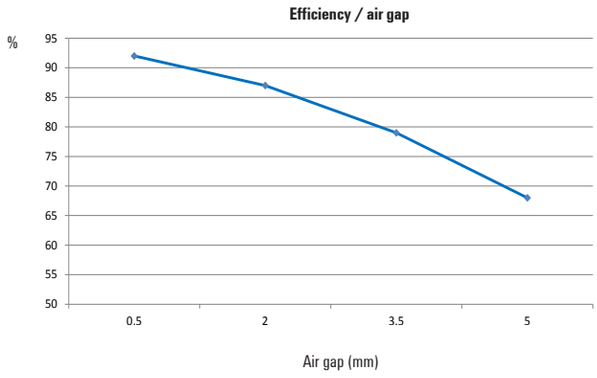
Dependencies of system parameters

Contactless power transmission is a system which depends on many variables. These are primarily the size of the air gap, eccentricity, ambient temperature, cooling, input voltage and secondary current rating. If one variable changes, the transmission behaviour changes too. For example, efficiency usually improves as the load current increases and falls when the air gap or eccentricity increases.

These dependencies are of course not linear. Diagrams are the best way of explaining this. In the scenarios outlined below, all variables are kept constant and only the dependency between efficiency and load current / air gap is shown.

Typical diagram for contactless transmission





Benefits of contactless transmission

The main reason for using contactless power transmission is that the conventional form of connection using plug-in connectors may cause problems in some applications. These include, for example, contact erosion with increased contact resistance and the resultant high level of warming, no transmission due to a missing contact resulting from a high level of wear to the contact surface or failure caused by mechanical problems such as bent contacts.

Contactless transmission technology not only eliminates such problems, but also offers more mechanical freedom and a range of applications that is not possible with a conventional plug connection.

In contrast to the conventional plug-in connectors, FreeCon Contactless from Weidmüller allows the connection to be controlled by a PLC. The system is activated by a PLC output for this purpose. An additional contactor for switching the load is superfluous.

Of course, the main benefit is due to the fact that the transmission is contactless so there are no mechanical problems and there is no wear. The connection components, i.e. the primary and secondary sides, also always have IP protection (in accordance with IP 65 for example) – regardless of whether the connection is closed or not. A plug connection on the other hand is not protected when unplugged and therefore becomes contaminated.

The benefits of contactless power transmission do come at the cost of a considerably higher purchase price than the plug-in connector. However, in the applications stated below the additional costs very quickly pay for themselves because the costs for maintenance and replacements during operation are much lower. Especially in the case of interruptions to production due to a defective plug-in connector, the contactless system pays for itself immediately.

What needs to be noted?

Due to the way it works, contactless transmission has a certain efficiency level. This means that part of the supplied power is converted into heat in the transmission system. There are therefore very few systems for higher power levels of 200 to 500 W.

When installing the two transmission components, the user has to ensure that the heat produced is dissipated via metal surfaces; an additional heat sink may have to be used. For maximum efficiency, the air gap between the components should be as small as possible.

The system may heat up a lot during normal operation. Caution must therefore be exercised if touching it directly. With high power levels, the electromagnetic fields should also be noted. The rules of the employer's liability insurance associations BGR B11 must be noted in particular.

Summary: New prospects

Contactless transmission technology offers significant benefits in many applications despite higher purchase costs. In cases where a manual plug connection is not an option, advanced applications with automated couplings can be implemented.

All in all, contactless power transmission offers many new prospects for automation.

Further information about contactless power transmission is available at www.weidmueller.com/contactless.

The brochure entitled "Contactless power transmission – maintenance-free and up to 240 W", order number: 2058470000, also contains a detailed overview of contactless power transmission.

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