Industrial Line

Electro holding magnets for industrial applications
We develop solutions!

Kendrion develops, manufactures and markets high-quality electromagnetic and mechatronic systems and components for industrial and automotive applications. For over a century we have been engineering precision parts for the world’s leading innovators in passenger cars, commercial vehicles and industrial applications.

As a leading technology pioneer, Kendrion invents, designs and manufactures complex components and customised systems as well as local solutions on demand. Committed to the engineering challenges of tomorrow, taking responsibility for how we source, manufacture and conduct business is embedded into our culture of innovation. Rooted in Germany and headquartered in the Netherlands, our expertise extends across Europe to the Americas and Asia. Created with passion and engineered with precision.

In the business unit Industrial Magnetic Systems (IMS) the focus lies on electromagnetic actuators and mechatronic assemblies for applications in power engineering, safety engineering, machine building, automation technology and other industries. With the experience of our traditional brands Binder, Neue Hahn Magnet and Thoma Magnettechnik we are successful in our markets as an industry expert with a high technological competence.

We offer you both customer-specific and standardised products. Our assemblies are based on powerful and reliable single-stroke, holding, locking, spreader, control, rotary, vibratory solenoids and solenoid valves. We always think in terms of solutions.

Our strength lies in new developments for our customers. Our engineers are specialists for innovative products with optimum technical properties. Furthermore, we develop mechanical assemblies, modern drive electronics and sensor systems to your requirements.

Our products are manufactured in Germany at the parent companies Donaueschingen and Engelswies as well as in the USA, China and Romania. This ensures efficient project management and a needs-oriented delivery for our internationally operating customers.

By means of segmented production areas we can implement both small quantities and large series with an optimum degree of automation.

We guarantee top quality. All products are tested and developed in compliance with the norm DIN VDE 0580 for electromagnetic devices and components or according to industry-specific standards of our customers. In many cases our products are tested and certified by external associations. among others according to the CSA, VdS and ATEX guidelines. Our quality management system is certified according to DIN EN ISO 9001 and our environmental management system fulfils the norm ISO 14001.

With our subsidiaries in Switzerland, Austria, Italy, the USA, China and our worldwide distribution network we are your ideal partner on site.

Kendrion – We magnetise the world

www.kendrion.com
Industrial Line - Direct Current Holding Solenoids

The DC holding solenoids of the Industrial Line are divided into two different designs and variants. They are available in round or rectangular design resp. in the systems “electromagnetic holding solenoids” and “permanent magnetic holding solenoids”.

Electromagnetic Holding Solenoids

Electromagnetic holding solenoids are pot magnets and consist of a magnet housing and a DC-excited coil. In switched-on state the open magnetic circuit allows to hold resp. span ferromagnetic workpieces. When the voltage is switched off the workpiece to be held falls off. Potential remanence, especially with light parts, can be avoided by attaching a non-magnetic foil. The holding system works with a very low operating current and without wear (maintenance-free).

Permanent Magnetic Holding Solenoids

These holding solenoids consist of a permanent magnetic holding system to hold ferromagnetic workpieces and of an excitation winding which neutralizes the magnetic field at the holding surface when switched on. Due to this principle these holding solenoids are preferably used where long holding times are required and the device is switched on for short times only. Furthermore, they are used as safety magnets in transportation devices as loads are held reliably even in the case of power failure.

In both systems the maximum holding forces are only reached depending on the surface roughness of the material, the material thickness and in case of full coverage (air gap = 0mm). Furthermore, the holding forces refer to 90% nominal voltage and warmed up condition.

The following basic data are defined as standard:

<table>
<thead>
<tr>
<th>Nominal Voltage</th>
<th>Duty Cycle</th>
<th>Protection class</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 Volt, DC</td>
<td>Electromagnetic holding solenoids 100%</td>
<td>IP 65 = device (protection against dust and hose water)</td>
</tr>
<tr>
<td></td>
<td>Permanent magnetic holding solenoids 25% 100%</td>
<td>IP 54 = device (protection against dust and splashing water)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IP 00 = electrical connection (no protection)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IP 20 = electrical connection over termina (protection against foreign substances)</td>
</tr>
</tbody>
</table>

If the application is based on different conditions the holding force is reduced accordingly. Depending on the design the holding surface can be partly zinced or rather polished. Therefore, the customer may have to ensure corrosion protection.

The solenoids are manufactured and tested acc. DIN VDE 0580. Depending on the quantities required other voltages and modifications are possible at extra cost. Design subject to change.
Industrial Magnetic Systems

Product portfolio

Electromagnetic Holding Solenoids
Series GTB

This series includes a complete product range of round solenoids.

These solenoid systems are preferably used in fixture construction and in the industrial areas automation, transportation and handling.

Electromagnetic Holding Solenoids
Series GTH

Compared to the series GTB these solenoids offer a higher holding force with similar dimensions. This is achieved by a larger dimensioning of the central pole.

These solenoid systems are preferably used in machine and tool manufacture, where air gap adjustments are not required.

Electromagnetic Holding Solenoids
Series 10 331

This series excels by its extremely flat design and a through-hole for spindle or shaft attachment.

This series is preferably used in the handling and robotics area, where installation space is narrow, flat and limited by the customer.

Features

Size: Ø 15 - 250 mm
Holding force: 36 - 30,000 N

Features

Size: Ø 15 - 100 mm
Holding force: 45 - 4,890 N

Features

Size: Ø 56 / 110 and 170 mm
Holding force: 750 - 5,000 N
**Electromagnetic Holding Solenoids**

**Series 10 310**

The electromagnetic holding bars are DC holding systems. The magnetic circuit which is open in switched on condition allows to hold ferromagnetic workpieces.

These solenoid systems are preferably used in general machine building, for handling and in safety technology for machine building.

**Permanent Magnetic Holding Solenoid**

**Series 01 310**

These permanent magnetic holding rods are electrically switchable holding solenoids.

These systems are preferably used where long holding times without energy consumption are required and a load or workpieces must be held reliably and safely in the case of power failure.

**Permanent Magnetic Holding Solenoid**

**Series 01 320 / PEM**

These permanent magnetic holding solenoids are electrically switchable holding systems.

These systems are used where in currentless state a load, a workpiece or machine parts must be held reliably and safely.

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**Features**

**Size:**
- Length 100 - 600 mm
- Width 32 - 60 mm

**Holding force:** 880 - 10,400 N

**Size:**
- Length 150 mm or 200 mm
- Width 60 mm

**Holding force:** 1,000 - 1,530 N

**Size:**
- Ø 12 - 150 mm

**Holding force:** 8 - 3,500 N
Electromagnetic Holding Solenoid
Series GTB

This series includes a complete product range of round solenoids.

As connections there are free braids resp. cables for GT100B and higher. With sizes GT025B to GT080B a terminal is also possible.

The coil is potted with resin (protection class IP65) resp. unpotted (protection class IP54). The complete magnet housing including holding surface is zinced. The mounting is achieved by a central thread at the rear side of the housing.

Application
These solenoid systems are preferably used in fixture construction and in the industrial areas automation, transportation and handling.

Lateral force loading equates to a displacement force \( F_v \) of approximately \( \frac{1}{4} F_n \).

Advantages
- Maximum Holding force with low air gaps
- Compact design
- Manifold connection options
- Optimised copper and iron ratio

Technical Data
- Standard nominal voltage: 24 V DC
- Duty cycle: 100% ED
- Insulation class: E

Accessories
- You find suitable anchor plates on page 23
Cross sections

Type GT015B bis GT090B with free braids

Type GT100B to GT250B with cable

Type GT025B to GT080B with terminal

Technical Data

<table>
<thead>
<tr>
<th>Designation</th>
<th>Diameter (d1) x height (h) [mm]</th>
<th>Max. holding force [N]</th>
<th>Nominal power [W]</th>
<th>Thickness counter plate [mm]</th>
<th>Thread (m) x depth (t) [mm]</th>
<th>Clearance (x) [mm]</th>
<th>Cable-/Lead length (L) [mm]</th>
<th>Weight [kg]</th>
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<td>300</td>
<td>26</td>
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</table>

Special voltage configurations are available on request
+49 7575 208 0 or sales-ims@kendrion.com
Holding Force Curves

Holding forces $F_H$ depending on air gap $\delta$ between holding solenoid and workpiece and on the indicated layer thickness of the counter plate. The values are valid for workpieces of material S235JR with 100% coverage of the holding surface, 90% of nominal voltage and warmed up condition (appr. 70 K excessive temperature without additional heat dissipation).

- **GT015B011**
  - Layer thickness $\equiv$ Material thickness:
    - $a = 1$ mm
    - $b = 2$ mm

- **GT018B001**
  - Layer thickness $\equiv$ Material thickness:
    - $a = 1$ mm
    - $b = 3$ mm

- **GT025B001**
  - Layer thickness $\equiv$ Material thickness:
    - $a = 1$ mm
    - $b = 2$ mm
  - Layer thickness $\equiv$ Material thickness:
    - $a = 1$ mm
    - $b = 2$ mm
    - $c = 3.6$ mm

- **GT032B001**
  - Layer thickness $\equiv$ Material thickness:
    - $a = 1$ mm
    - $b = 2$ mm
  - Layer thickness $\equiv$ Material thickness:
    - $a = 1$ mm
    - $b = 2$ mm
    - $c = 3$ mm
    - $d = 4.5$ mm

- **GT050B001**
  - Layer thickness $\equiv$ Material thickness:
    - $a = 1$ mm
    - $b = 2$ mm
  - Layer thickness $\equiv$ Material thickness:
    - $a = 1$ mm
    - $b = 3$ mm
    - $c = 5$ mm
    - $d = 8$ mm

- **GT063B001**
  - Layer thickness $\equiv$ Material thickness:
    - $a = 1$ mm
    - $b = 2$ mm
  - Layer thickness $\equiv$ Material thickness:
    - $a = 1$ mm
    - $b = 3$ mm
    - $c = 4$ mm
    - $d = 6$ mm

- **GT070B001**
  - Layer thickness $\equiv$ Material thickness:
    - $a = 1$ mm
    - $b = 2$ mm
  - Layer thickness $\equiv$ Material thickness:
    - $a = 1$ mm
    - $b = 3$ mm
    - $c = 4$ mm
    - $d = 7$ mm
Holding Force Curves

Holding forces $F_H$ depending on air gap $\delta$, between holding solenoid and workpiece and on the indicated layer thickness of the counter plate. The values are valid for workpieces of material S235JR with 100% coverage of the holding surface, 90% of nominal voltage and warmed up condition (appr. 70 K excessive temperature without additional heat dissipation).

**GT080B001**

Layer thickness $\equiv$ Material thickness:
- $a = 1$ mm
- $b = 3$ mm
- $c = 6$ mm
- $d = 10$ mm

**GT090B001**

Layer thickness $\equiv$ Material thickness:
- $a = 1$ mm
- $b = 3$ mm
- $c = 6$ mm
- $d = 10$ mm

**GT100B001**

Layer thickness $\equiv$ Material thickness:
- $a = 3.5$ mm
- $b = 5.5$ mm
- $c = 7.5$ mm
- $d = 10.5$ mm

**GT150B001**

Layer thickness $\equiv$ Material thickness:
- $a = 5$ mm
- $b = 8$ mm
- $c = 12$ mm
- $d = 17$ mm

**GT180B001**

Layer thickness $\equiv$ Material thickness:
- $a = 5$ mm
- $b = 9$ mm
- $c = 13$ mm
- $d = 21$ mm

**GT250B001**

Layer thickness $\equiv$ Material thickness:
- $a = 13$ mm
- $b = 18$ mm
- $c = 21$ mm
- $d = 29$ mm
Compared to the series GTB these solenoids offer a higher holding force with similar dimensions. This is achieved by a larger dimensioning of the central pole.

The electrical connection is made by free braids. The coil is vacuum potted, the magnet housing is zinced and the holding surface is polished. The mounting is achieved by a central thread at the rear side of the housing.

Application
These solenoid systems are preferably used in machine and tool manufacture, where air gap adjustments are not required. Please observe, that the complete functioning of the device is only guaranteed if the counter plate is placed exactly.

Lateral force loading equates to a displacement force $F_v$ of approximately $\frac{1}{4} F_h$.

Advantages
- High holding force with low power consumption
- Compact design
- Optimised copper and iron ratio
- Strong holding force with direct mounting of the counter plate

Technical Data
- Standard nominal voltage: 24 V DC
- Duty cycle: 100% ED
- Insulation class: E

Accessories
- You find suitable anchor plates on page 23
Technical Data

<table>
<thead>
<tr>
<th>Designation</th>
<th>Diameter (d1) x height (h) [mm]</th>
<th>Max. holding force [N]</th>
<th>Nominal power [W]</th>
<th>Thickness counter plate [mm]</th>
<th>Thread (m) x depth (t) [mm]</th>
<th>Clearance (x) [mm]</th>
<th>Cable-/ Lead length (L) [mm]</th>
<th>Weight [kg]</th>
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<tbody>
<tr>
<td>GT015H050</td>
<td>15 x 12</td>
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<td>112</td>
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<td>M3x5</td>
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<td>14.4</td>
<td>M16x24</td>
<td>36</td>
<td>200</td>
<td>2.20</td>
</tr>
</tbody>
</table>

Special voltage configurations are available on request
+49 7575 208 0 or sales-ims@kendrion.com
This series excels by its extremely flat design and a through-hole for spindle or shaft attachment.

The connection is made by free braids on the rear of the housing. The magnet housing is zinced and the coil is vacuum potted. The mounting is achieved by means of one resp. several central bores which are accessible from the pole surface.

Application
This series is preferably used in the handling and robotics area, where installation space is narrow, flat and limited by the customer.

Lateral force loading equates to a displacement force $F_v$ of approximately $1/4 F_n$.

Advantages
- High holding force with low power consumption
- Extremely flat design

Technical Data
- Standard nominal voltage: 24 V DC
- Duty cycle: 100% ED
- Insulation class: E

Accessories
- You find suitable anchor plates on page 23
Cross Sections

Type 10 33106A00

Type 10 33111A00

Type 10 33117A00

Technical Data

<table>
<thead>
<tr>
<th>Designation</th>
<th>Diameter (d1) x height (h) [mm]</th>
<th>Max. holding force [N]</th>
<th>Nominal power [W]</th>
<th>Thickness counter plate [mm]</th>
<th>Thread (m) x depth (t) [mm]</th>
<th>Clearance (x) [mm]</th>
<th>Cable- / Lead length (L) [mm]</th>
<th>Weight [kg]</th>
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<td>110 x 21</td>
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<td>14.7</td>
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<td>10 33117A00</td>
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</table>

Special voltage configurations are available on request
+49 7575 208 0 or sales-ims@kendrion.com
Holding Force Curves

Holding forces $F_H$ depending on air gap $\delta_L$ between holding solenoid and workpiece and on the indicated layer thickness of the counter plate. The values are valid for workpieces of material S235JR with 100% coverage of the holding surface, 90% of nominal voltage and warmed up condition (appr. 70 K excessive temperature without additional heat dissipation).

Layer thickness $\equiv$ Material thickness:

- **10 33106A00**
  - $a = 1.5$ mm  
  - $b = 4$ mm  

- **10 33111A00**
  - $a = 1$ mm  
  - $b = 3$ mm  
  - $c = 6$ mm

- **10 33117A00**
  - $a = 2$ mm  
  - $b = 4$ mm  
  - $c = 10$ mm
The electromagnetic holding rods are DC holding systems. The magnetic circuit which is open in switched on condition allows to hold ferromagnetic workpieces.

The electrical connection is made at two connecting screws which are easily accessible within the device and can be reached via a Pg gland. This gland can be screwed in alternately from the side or from the bottom.

The coil is vacuum potted, the magnet housing is zinged and the holding surface is ground. For mounting there are thread bores at the bottom side of the device.

Application
These solenoid systems are preferably used in general machine building, for handling and in safety technology for machine building.

Lateral force loading equates to a displacement force $F_v$ of approximately $1/4 F_h$.

Advantages
- High holding force with low power consumption
- Compact design
- Manifold connection options

Technical Data
- Standard nominal voltage: 24 V DC
- Duty cycle: 100% ED
- Insulation class: E
- Pg-cable gland: HELUTOP HT-MS / M12 x 1,5
Technical Data

<table>
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<th>Max. holding force [N]</th>
<th>Nominal Power [W]</th>
<th>Thickness counter plate [mm]</th>
<th>Thread (m) x depth (t) [mm]</th>
<th>Number of threads (y)</th>
<th>Clearance (y1) [mm]</th>
<th>Clearance (y2) [mm]</th>
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<td>8.00</td>
</tr>
</tbody>
</table>

Special voltage configurations are available on request
+49 7575 208 0 or sales-ims@kendrion.com

**Holding Force Curves**

Holding forces $F_h$ depending on air gap $\delta_1$ between holding solenoid and workpiece and on the indicated layer thickness of the counter plate. The values are valid for workpieces of material S235JR with 100% coverage of the holding surface, 90% of nominal voltage and warmed up condition (appr. 70 K excessive temperature without additional heat dissipation).
Layer thickness ± Material thickness:

10 31001A1

Layer thickness ± Material thickness:

10 31002A1

Layer thickness ± Material thickness:

10 31003A1

Layer thickness ± Material thickness:

10 31004A1

Layer thickness ± Material thickness:

10 31005A1

Layer thickness ± Material thickness:

10 31006A1

Layer thickness ± Material thickness:

10 31007A00

Layer thickness ± Material thickness:

10 31008A00

Layer thickness ± Material thickness:

10 31009A00

Layer thickness ± Material thickness:

Layer thickness ± Material thickness:

Layer thickness ± Material thickness:
These permanent magnetic holding rods are electrically switchable holding solenoids. They consist of a permanent magnet and a DC-excited coil (vacuum potted) to neutralize the permanent magnetic field at the pole surface. The open magnetic circuit allows to hold ferromagnetic workpieces.

The electrical connection is made at two connecting screws which are easily accessible within the device and can be reached via a Pg gland.

This gland can be screwed in alternately from the side or from the bottom. The coil is vacuum potted, the magnet housing is zinced and the holding surface is ground. For mounting there are thread bores at the bottom side of the device.

Application
These systems are preferably used where long holding times without energy consumption are required and a load or workpieces must be held reliably and safely in the case of power failure.

Lateral force loading equates to a displacement force $F_v$ of approximately $1/4 F_n$.

Advantages
- Saving of energy by currentless holding
- High holding force
- No remanent magnetization after neutralization
- Safe holding even in the case of power failure

Technical Data
- Standard nominal voltage: 24 V DC
- Duty cycle: 25% ED
- Insulation class: E
- Pg-cable gland: HELUTOP HT-MS / M12 x 1,5

Safety note
- The attractive or repulsive forces of the permanent magnet can cause skin-contusion through sudden collide, even with larger distances. Therefore always wear protective gloves and glasses.
Cross Section

Technical Data

<table>
<thead>
<tr>
<th>Designation</th>
<th>Length (l) x width (b) x height (h) [mm]</th>
<th>Max. holding force [N]</th>
<th>Nominal Power [W]</th>
<th>Thickness counter plate [mm]</th>
<th>Thread (m) x depth (t) [mm]</th>
<th>Number of threads (y)</th>
<th>Clearance (y₁) [mm]</th>
<th>Clearance (y₂) [mm]</th>
<th>Clearance (x₁) [mm]</th>
<th>Clearance (x₂) [mm]</th>
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<td>1000</td>
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<td>M8x10</td>
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<td>30</td>
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<td>18</td>
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<tr>
<td>01 31008A00</td>
<td>201.5 x 60 x 50</td>
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<td>M8x10</td>
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</table>

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Holding Force Curves

Holding forces \( F_H \) depending on air gap \( \delta_L \) between holding solenoid and workpiece and on the indicated layer thickness of the counter plate. The values are valid for workpieces of material S235JR with 100% coverage of the holding surface and warmed up condition.

Layer thickness \( a = 6 \text{ mm} \) Material thickness: \( b = 3 \text{ mm} \)

Layer thickness \( a = 8 \text{ mm} \) Material thickness: \( b = 3 \text{ mm} \)
These permanent magnetic holding solenoids are electrically switchable holding systems. They consist of a permanent magnet and a DC-excited coil to neutralize the permanent magnetic field at the pole surfaces. The open magnetic circuit allows to hold ferromagnetic workpieces.

The connection is made by free braids resp. cables for 01 320010B and higher. The coil is vacuum potted, the magnet housing is zinced and the holding surface is ground.

The mounting is achieved by central bores on the bottom.

Applications
These systems are used where in currentless state a load, a workpiece or machine parts must be held reliably and safely.

Lateral force loading equates to a displacement force $F_v$ of approximately $1/4 F_n$.

Advantages
- Saving of energy by currentless holding
- High holding force
- No remanent magnetization after neutralization
- Safe holding even in the case of power failure

Technical Data
- Standard nominal voltage: 24 V DC
- Duty cycle: 25% ED / 100% ED
- Insulation class: E

Safety note
- The attractive or repulsive forces of the permanent magnet can cause skin-contusion through sudden collide, even with larger distances. Therefore always wear protective gloves and glasses.

Accessories
- You find suitable anchor plates on page 23
### Technical Data

<table>
<thead>
<tr>
<th>Designation</th>
<th>Diameter (d1) x height (h) [mm]</th>
<th>Max. holding force [N]</th>
<th>Nominal power [W]</th>
<th>Thickness counter plate [mm]</th>
<th>Thread (m) x depth (t) [mm]</th>
<th>Clearance (x) [mm]</th>
<th>Cable-/Lead length (L) [mm]</th>
<th>Weight [kg]</th>
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</tbody>
</table>

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**Special voltage configurations are available on request**

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---

<table>
<thead>
<tr>
<th>Designation</th>
<th>Diameter (d1) x height (h) [mm]</th>
<th>Max. holding force [N]</th>
<th>Nominal power [W]</th>
<th>Thickness counter plate [mm]</th>
<th>Thread (m) x depth (t) [mm]</th>
<th>Clearance (x) [mm]</th>
<th>Cable-/Lead length (L) [mm]</th>
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<tbody>
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**Special voltage configurations are available on request**

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Holding forces $F_H$ depending on air gap $\delta_l$ between holding solenoid and workpiece and on the indicated layer thickness of the counter plate. The values are valid for workpieces of material S235JR with 100% coverage of the holding surface and warmed up condition.

Layer thickness $=\quad$ Material thickness: 2.5 mm

Layer thickness $=\quad$ Material thickness: 3 mm

Layer thickness $=\quad$ Material thickness: 4.5 mm

Layer thickness $=\quad$ Material thickness: 6 mm

Layer thickness $=\quad$ Material thickness: 5 mm

Layer thickness $=\quad$ Material thickness: 9 mm

Layer thickness $=\quad$ Material thickness: 7.5 mm

Layer thickness $=\quad$ Material thickness: 9 mm
The anchor plate has to be selected according to the size of the holding solenoid. The plates are designed for the optimum holding forces and are larger in diameter than the corresponding holding solenoids. This allows for an easier fixation on the solenoid while mounting.

If the anchor thickness is smaller or materials with an inferior surface quality are used the holding force is reduced. The complete anchor is protected against corrosion by a zinc layer. The mounting is achieved by a through-going thread boring.

### Cross Section

![Anchor Plate Cross Section](image)

<table>
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<th>Mounting thread (c)</th>
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</tr>
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<td>GT100B001-200</td>
<td>107 x 15</td>
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</table>
Ferromagnetic
Magnetic properties of substances with a permeability $\mu_r \gg 1$.

Open Magnetic Circuit
The entirety of all parts penetrated by the magnetic flux $\Phi$ which is supplemented by the workpiece (anchor).

Magnetic Pole N (North) S (South)
The place where the magnetic flux leaves resp. enters the holding solenoid.

Holding Force $F_H$
The force required to tear off a workpiece perpendicular to the holding surface when the device is switched on. The details in the data sheets refer to the total holding surface and an optimal material thickness.

Displacement Force $F_V$
The force required to displace a workpiece parallel to the holding surface when the device is switched on. Depending on the quality of the workpiece surface it amounts to 20...30% of $F_H$ ($\frac{1}{4} F_H$).

Air Gap $\delta$
The mean distance between the holding surface of the solenoid and the bearing area of the workpiece. Shape and roughness of the surfaces facing each other and non-magnetic substances between them (e.g. galvanic coatings, varnish, scale) determine its size.

Remanence
The holding force remaining between holding solenoid and workpiece when the device is switched off without reversion of polarity. Depending on the workpiece and material it amounts to 20 and 40% of $F_H$.

Insulation Class
Depending on the permanent heat resistance the insulation classes are divided acc. DIN VDE 0580.

**Technical Explanations**

### Ferromagnetic
Magnetic properties of substances with a permeability $\mu_r \gg 1$.

### Open Magnetic Circuit
The entirety of all parts penetrated by the magnetic flux $\Phi$ which is supplemented by the workpiece (anchor).

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The holding force remaining between holding solenoid and workpiece when the device is switched off without reversion of polarity. Depending on the workpiece and material it amounts to 20 and 40% of $F_H$.

### Insulation Class
Depending on the permanent heat resistance the insulation classes are divided acc. DIN VDE 0580.

#### Thermal Class
- **Y**: 95 °C
- **A**: 105 °C
- **E**: 120 °C
- **B**: 130 °C
- **F**: 155 °C
- **H**: 180 °C

#### Maximum permitted limit temperature

### Reversion of Polarity
Reduction of the remanence remaining between holding surface and workpiece by means of a time or current dosed reverse pulse.

### Demagnetization
Reduction of the field intensity $H_c$ in the workpiece. It involves a polarity reversal with decreasing amplitude.

### Relative Duty Cycle ED
The ratio between duty cycle and circular-trip time, e.g. expressed in per cent (% ED). In general, the electromagnetic holding solenoids are designed for 100% ED and Permanent Magnetic Holding Solenoids are designed for 25%.

### Warmed Up Condition
The excessive temperature identified acc. DIN VDE 0580, increased by the reference temperature. Unless otherwise indicated the reference temperature is 35°C.

### Protection Class
Designates the kind of shielding of the device against outer influences.

<table>
<thead>
<tr>
<th>Code letters</th>
<th>Code no. 1</th>
<th>Code no. 2</th>
<th>Scope of protection</th>
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<tbody>
<tr>
<td>6</td>
<td>5</td>
<td>1</td>
<td>Protection against dust penetration</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>1</td>
<td>Protection against dust deposit</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>1</td>
<td>Protection against grain-shaped foreign substances</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>1</td>
<td>Protection against small foreign substances</td>
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<tr>
<td>2</td>
<td>3</td>
<td>1</td>
<td>Protection against medium-sized foreign substances</td>
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<tr>
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<td>1</td>
<td>No protection</td>
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</table>

### Magnetic Flux $\Phi$
Every permanent magnetic holding solenoid or electromagnetic holding solenoid generates a magnetic field at the holding surface between the north and south poles. By covering it with a workpiece the open magnetic circuit is closed and the usable magnetic flux $F$ is increased. The number of lines of force penetrating a random surface $A$ vertically per $\text{cm}^2$ is the flux density or the magnetic induction $B$.

$$\Phi = B \times A$$

The higher the magnetic flux $\Phi$ penetrating the workpiece is in case the holding surface remains unchanged or the higher induction $B$ is the higher will be holding force $F_H$.

$$F_H = \left(\frac{B}{5000}\right)^2 \times (A_1 \times A_2)$$

It is determined by the unfavourable resistance in the magnetic circuit. So the maximum holding force a workpiece can achieve depends on:
- the size of its bearing area
- its material properties
- the roughness of its bearing area
- the covering of the magnetic holding surface in per cent
- the air gap $\delta$

### Workpiece and Bearing Area
The bearing area is the contact area with which the workpiece rests on the holding solenoid. It does not always equal the size of the workpiece. The holding force per surface unit of a holding solenoid is almost identical across the total holding surface.
Technical Explanations

Particularly by the size of its bearing area the workpiece determines the maximum holding force to be achieved.

Workpiece and Material

The components of the holding solenoids which carry the magnetic flux are out of soft iron of high permeability. Due to the high magnetic conductivity of these parts the maximum holding force to be achieved depends, among other things, on the permeability of the workpiece. The workpieces differ in their structural constitution and composition. Additions of carbon, chrome, nickel, manganese, molybdenum, copper, etc. reduce the magnetic conductivity. In addition, the holding force is reduced if workpieces are hardened. The higher the hardness the more unfavourable is the magnetic conductivity.

\[ B = f(H) \]

Fixing and grouping

Using several holding solenoids

a) A non-rigid fixing is required for every holding solenoid so that each one can adapt to uneven surfaces (Fig. 1).

b) Every holding solenoid should be springmounted below a transverse rail to dampen the stroke acceleration so that in the case of uneven bearing surfaces the difference between the loads carried by the individual magnets does not vary too greatly (Fig.2).
Overview of Catalogue

**Classic Line**
- single-stroke solenoids
- compact design
- individual fixing
- mono- and bistable version

**High Performance Line**
- square single-stroke solenoids
- high force with small installation space
- modular system
- short pull-in times

**High Power Line**
- round single-stroke solenoids
- high forces and stroke travels
- short switching times
- also reversible solenoids

**Control Power Line**
- control solenoids
- extremely fast
- switching
- short strokes
- precise switching

**Electro Holding Magnets**
- door holding magnet
- design and functionality
- VdS, CE, EN 1155,
- EN 14637 tested
- great variety

**Industrial Line**
- industrial holding magnets
- high holding force with low power consumption
- compact design
- variable connections

**Oscillating Line**
- vibratory solenoids
- wide product range for transportation of bulk material
- low wear
- compact design
Elevator Line
- spreader solenoids
- especially designed for elevator brakes
- extremely high forces
- any mounting position

ATEX Line
- explosion-proof solenoids
- prevent the occurrence of sparks and light arcs
- dynamic and reliable switching

Locking Line
- locking solenoids
- high transverse forces
- integrated feedback of locking function
- compact design

System Line
- operated by AC
- extremely short activation times
- very high pull-in forces

Rotary solenoids
Assemblies
Customer-specific solutions
Please contact us for special or customer-specific solutions.

Kendrion Donaueschingen/Engelswies GmbH
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Mail: sales-ims@kendrion.com
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We will find the best solution for you.

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