CONTENTS

COBALT RARE EARTH MAGNETS

General Description ............................................................... 3
DIANET series and Basic characteristics
Horizontal magnetic field molding ............................................ 4
Vertical magnetic field molding ................................................. 5
Temperature characteristics (B-H curves) ............................... 6
Reliability data ...................................................................... 7
Measuring method of DIANET ............................................... 8
Cautions When Using Magnets ............................................ 9
SII BM business unit is implementing following actions ......... 10
Seiko instruments’ Cobalt Rare Earth Magnets have been widely applied and appreciated to the state-of-the-art electronic machinery and equipment, such as rotary devices, acoustic instruments and equipment, and communications systems. Its applications are expanding increasingly.

**Features**
- Very narrow range of deviation in magnetic characteristics allows machinery and equipment to stabilize.
- High coercive force and large maximum energy product are suitable for miniaturizing machinery and equipment and also for making them thinner.
- With improvements in orientation characteristics using our company’s unique raw material processing technology, we have realized products with higher level performance and higher precision than that of conventional vertical magnetic field molding and horizontal magnetic field molding products.
- A variety of magnet products having a high-dimension accuracy is available.
- Superior heat-resistant feature allows the usage in 300°C max.

**Manufacturing process**

```
Resolution
|
Pulverization
|
Powder processing
|
Vertical magnetic field molding
|
Horizontal magnetic field molding
|
Sintering
|
Grinding
|
Inspection
|
Magnetization
|
Inspection
|
Packaging shipment
```
MAGNETIC PRODUCTS

DIANET SERIES AND BASIC CHARACTERISTICS

HORIZONTAL MAGNETIC FIELD MOLDING

MOLDING MODEL SAMPLE

APPLICATIONS
- WATCH ROTOR (Photo left)
- CORELESS MOTOR (Photo right)
- ROTATIVE DEVICE AS HIGH PERFORMANCE MICRO MOTOR

BASIC CHARACTERISTICS

<table>
<thead>
<tr>
<th>Item</th>
<th>Designation</th>
<th>UP/UPPER:CGS UNIT/SI UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual magnet flux density</td>
<td>Br(G)</td>
<td>DM-20  DM-26  DM-28  DM-30  DM-32</td>
</tr>
<tr>
<td></td>
<td>Br(T)</td>
<td>8700–9200 10100–10600 10500–11000 10600–11300 11000–11600</td>
</tr>
<tr>
<td>Coercive force</td>
<td>bHc (Oe)</td>
<td>8500–9200 5000–7000 6000–10000 477–796 5500–9500</td>
</tr>
<tr>
<td></td>
<td>bHc (kA/m)</td>
<td>676–732 398–557 477–796 438–756</td>
</tr>
<tr>
<td></td>
<td>iHc (Oe)</td>
<td>&gt;8500 &gt;5000 &gt;7000 &gt;557 &gt;6000</td>
</tr>
<tr>
<td></td>
<td>iHc (kA/m)</td>
<td>&gt;676 &gt;398 &gt;557 &gt;477</td>
</tr>
<tr>
<td>Maximum energy product max</td>
<td>BHmax (MGOe)</td>
<td>19–21 25–27 27–29 26–30 28–32</td>
</tr>
<tr>
<td>Reversible permeability</td>
<td>(µr)</td>
<td>DM-20  DM-26  DM-28  DM-30  DM-32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.05</td>
</tr>
<tr>
<td>Reversible variation of temperature (%/°C)</td>
<td>DM-20  DM-26  DM-28  DM-30  DM-32</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.03–0.05</td>
</tr>
<tr>
<td>Curie temperature (°C)</td>
<td></td>
<td>700–750 800–850</td>
</tr>
<tr>
<td>Coefficient of thermal expansion (×10⁻⁶/°C)</td>
<td>DM-20  DM-26  DM-28  DM-30  DM-32</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.0 9.8</td>
</tr>
<tr>
<td>Density (g/cm³)</td>
<td></td>
<td>8.2–8.5 8.3–8.5</td>
</tr>
<tr>
<td>Hardness (HV)</td>
<td></td>
<td>&gt;530 &gt;550</td>
</tr>
<tr>
<td>Stiffness (Kg/mm²)</td>
<td></td>
<td>19±2 16±2</td>
</tr>
<tr>
<td>Electric Resistance (Ω ⋅ m)</td>
<td></td>
<td>0.8×10⁻⁶</td>
</tr>
</tbody>
</table>

Note) Magnetic characteristics may be changed depending upon customer's specified dimensions and shape. For details, please contact us.
**APPLICATIONS**

- BUZZER
- OPTICAL PICKUP
- OPTICAL ISOLATOR
- INNER PHONE
- ABS SENSOR

(From left of left photo)

(From left of right photo)

**BASIC CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Item</th>
<th>Designation</th>
<th>SmCo5 1-5based</th>
<th>Sm2Co17 2-17based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td></td>
<td>DM-16</td>
<td>DM-18</td>
</tr>
<tr>
<td>Residual magnet flux density Br(G) Br (T)</td>
<td>7700–8200 0.77–0.82</td>
<td>8100–8700 0.81–0.87</td>
<td>8400–9000 0.84–0.90</td>
</tr>
<tr>
<td>Reversible permeability (μr)</td>
<td>1.05</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Mechanical Characteristics**

- Reversible variation of temperature (%/°C) 0.03–0.05
- Curie temperature (°C) 700–750 800–850
- Coefficient of thermal expansion (×10⁻⁵/°C) 8.0 9.8
- Density (g/cm³) 8.2–8.5 8.3–8.5
- Hardness (HV) >530 >550
- Stiffness (Kg/mm²) 19±2 16±2
- Electric Resistance (Ω ⋅ m) 0.8×10⁻⁶

Note) Magnetic characteristics may be changed depending upon customer's specified dimensions and shape. For details, please contact us.
Temperature

MAGNETIC PRODUCTS

DM16 B-H

Permeance coefficient

B(KG)

-H(kOe)

-20˚C

0˚C

25˚C

50˚C

100˚C

150˚C

200˚C

250˚C

DM18 B-H

Permeance coefficient

B(KG)

-H(kOe)

-20˚C

0˚C

25˚C

50˚C

100˚C

150˚C

200˚C

250˚C

DM20 B-H

Permeance coefficient

B(KG)

-H(kOe)

-20˚C

0˚C

25˚C

50˚C

100˚C

150˚C

200˚C

250˚C

DM22 B-H

Permeance coefficient

B(KG)

-H(kOe)

-20˚C

0˚C

25˚C

50˚C

100˚C

150˚C

200˚C

250˚C

DM26 B-H

Permeance coefficient

B(KG)

-H(kOe)

-20˚C

0˚C

25˚C

50˚C

100˚C

150˚C

200˚C

250˚C

DM28 B-H

Permeance coefficient

B(KG)

-H(kOe)

-20˚C

0˚C

25˚C

50˚C

100˚C

150˚C

200˚C

250˚C

DM30/32 B-H

Permeance coefficient

B(KG)

-H(kOe)

-20˚C

0˚C

25˚C

50˚C

100˚C

150˚C

200˚C

250˚C
### Reliability data

#### Environmental test

<table>
<thead>
<tr>
<th>Item</th>
<th>Condition</th>
<th>Result</th>
<th>Magnetic characteristics</th>
<th>External appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaving test at high temperature</td>
<td>100°C x 1000h</td>
<td>⊘</td>
<td>⊘</td>
<td>⊘</td>
</tr>
<tr>
<td>Heat cycle test</td>
<td>−10°C to +70°C, 1h, 50cycle</td>
<td>⊘</td>
<td>⊘</td>
<td>⊘</td>
</tr>
<tr>
<td>High temperature moisture shelf test</td>
<td>80°C, 90%, 1000h</td>
<td>⊘</td>
<td>⊘</td>
<td>⊘</td>
</tr>
<tr>
<td>PCT test</td>
<td>120°C, 2atm, 100%, 100h</td>
<td>⊘</td>
<td>⊘</td>
<td>⊘</td>
</tr>
</tbody>
</table>

Note: For guaranteed reliability of contents, please arrange a separate meeting.

#### Shock resistance test

Cobalt rare earth magnet has a nature of cracking and chipping when external shock is added (as magnets hit each other etc.). It is recommended to coat Ni plating when using cobalt rare earth magnet according to your application.

- No magnetic powder due to crack or chip is generated.
- Operation speed of assembly line is increased.

The chart shows the occurrence ratio of crack and chip after two magnets are hit by their magnetic attraction in distance A. (n = 10 pcs.)

#### Magnetism per Temperature Change

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>50</th>
<th>85</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>240</th>
<th>250</th>
<th>260</th>
<th>270</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM-30-S</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>−1.1%</td>
<td>−6.3%</td>
<td>−6.9%</td>
<td>−7.9%</td>
<td>−8.4%</td>
</tr>
<tr>
<td>DM-30-L</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Note) Values above are only for reference and depend on materials, operation point of magnetic circuit (permeance coefficient). Please contact us for details.
The effect of grinding to magnetic properties

Before grinding:
\[ \phi 10 \times t10 \text{mm} \]

After grinding:
\[ \phi 1.0 \times t0.5 \text{mm} \]

There is no inferiority in characteristics of Cobalt Rare Earth Magnet compared with micro magnet.

Measuring Method of DIANET

There are two methods to measure the magnetic characteristic of a magnet; the essential magnetic characteristic is measured in non-operational status to assure the materials used or the production lot, and the simple measurement method to measure the magnetic flux generated when the magnet is in use.

To Measure Magnetic Reduction Curve; essential characteristics to assure the materials used.

Vibrating Sample Magnetometer (VSM)

Measure Br, Hc and Bhmax using a Vibrating Sample Magnetometer.

To Measure Flux of completed product (magnet in use) - Simple Measurement

Fluxmeter and search-coil are used to measure magnetic flux, and gauss meter is used to measure the magnetic flux density frequently.

Measuring the calibration of search coil and hall probe is very important.

There are two ways to calibrate;

1) Measure and select the best calibration.
2) Calibrate, using a high-accuracy standard sample. We recommend using a standard sample when setting magnetic characteristics.
Cautions When Using Magnets

**Warning**

- It is extremely dangerous to place magnets near persons who have electronic medical devices such as pacemakers installed. There is a risk of damage to normal operation status of the medical device. Please use with highest caution.
- Be careful not to swallow magnets. If a magnet has been swallowed, consult a physician immediately. Keep magnets out of the reach of children.

**Caution**

- The magnetic characteristics values in the catalogue are not guaranteed values during use. Depending on the size and shape used, a magnet may not achieve the magnetic characteristics values noted in the catalogue. Confirm in advance by using a sample, etc.
- When magnetization is performed by the customer, allocate sufficient magnetic field for the material and coercive force. When the strength of the magnetic field is insufficient, magnetic characteristics of the original design specifications may not be obtained. Consult with the manufacturer for the size of the magnetic field needed for magnetization.
- Avoid using and storing magnets in the following environments. Weather resistance differs according to the material of each magnet, so consult in advance about corrosion prevention, etc.
  1. Corrosive gas atmosphere (Cl, NH3, SOx, NOx)
  2. Highly conductive environment (in water containing electrolytes, etc.)
  3. Hydrogen atmosphere
  4. Acidic, alkaline, or organic solvents, etc.
  5. In water or oil
- When using an adhesive to bond the yoke and hole piece, etc., of two magnets, confirm reliability by inspecting the type, volume, conditions, and strength, etc., of the adhesive.
- When performing processes such as press fitting or shrink fitting, there is a risk of degradation of the magnetic characteristics or cracking of the magnet or its counterpart materials. Be sure to confirm in advance by using a sample.
- A magnetized magnet absorbs debris such as iron powder, so remove it from its packing case in a dust free environment.
- Magnets are susceptible to shock, and cracking and chipping occur easily, so handle with care. When cracking or chipping occur during handling, there is a risk of degradation of characteristics or strength.
- Magnets are generally made from materials that chip easily, so handle with care. Store in a place where shock will not occur. In addition, be sure to store in a location where the magnet will not come into contact with rainwater, etc.
- Magnetized magnets should be covered with a non-magnetic material such as a wooden box after clearly marking the fact that the magnet is magnetized.
- When a magnet is placed close to a magnetic tape, floppy disk, prepaid card, ticket, or electronic watch, there is a risk that the magnetic recording will be damaged and that the item will become magnetized and no longer be usable. There is also a risk of cards and tickets becoming unusable due to the effect of an electronic key, so do not place electronic keys in your pocket together with cards, tickets, etc.
- Persons who are sensitive to or have allergic reactions to metal may develop rashes or redness of the skin if they come into contact with a magnet. If such reactions are known to occur, do not touch magnets.
- Typically, components of a magnet may begin to dissolve in water, so do not drink water that has been in contact with a magnet.
- Magnets typically crack easily. A magnet fragment may enter the eye or cause injury, so use caution in handling.
- The absorption force of magnets is strong, so be careful not to let your hand get pinched.
- The alloy powder of rare earth magnets is specified by fire safety law as class II (flammable solid) and class I hazardous materials. There is a danger of ignition or inflammation of fine powder generated due to friction during use of a magnet, so do not use in such a way that risks generating magnetic powder.
- There is a danger of auto-ignition with fine particles of rare earth magnets, so when processed by the customer, do not leave chips or filings in the atmosphere, and be sure to store these in a container filled with water. As a preparation in case a fire starts, have sand available for use. If a fire begins, cover the fire with the sand, and remove flammable objects.
- Avoid storing in locations with high temperature and high humidity.
Environmental Activities at SII Micro Parts Ltd. (SMP)

SMP’s Environmental Policy

Sendai is a beautiful metropolis blessed with glories of green woods. The Hirose-River flowing through the city is one of the cleanest streams in Japan where sculpin and sweetfish still enjoy living. SMP is located along the upper stream of the river. As a keenly eco-conscious company, SMP remains vigorously committed to global and local environmental protection by way of blending with the fiery greenness.

Based on the above policy, the following six environmental approaches are now being implemented throughout SMP.

1. **Enrich the Lineup of Eco-Products**
   - **Green products**: Enrich the lineup of green products that comply with ISO14021 or its equivalent Environmental Label Type II. Green products will account for 70% or more of the total of our products by the end of FY2005.
   - **Restricting the use of Hazardous Substances (RoHs) regulation-compliance products**: Provide customers with eco-products that comply with toxic chemicals control directives, rules, regulations and standards defined by EU and other foreign countries as well as customer’s specific requirements.

2. **Promote Energy Conservation**
   - Reduce CO₂ emission per production output greatly while advancing an increase in the production output by way of investing in state-of-the-art energy-saving facilities and systems used in the manufacturing processes.

3. **Reduce the Total Emission of Waste**
   - Develop a comprehensive waste reduction and reuse project throughout SMP by providing all employees with proper instructions. Our goal is achieving a reduction in 3% every year of the total emission of waste, including recycled and valuable resources.

   - We achieved the final disposal amount zero (Zero Emission) in 2004, and will continue to keep this.

4. **Emission of Chemical Substances**
   - We set up our goal of reducing emission of the chemical substances defined in the Pollutant Release and Transfer Register (PRTR) law by half in three years. To achieve this goal, we deploy reducing activity based on our criteria.

5. **Green Purchasing**
   - Proceed with a green purchasing campaign for manufacturing materials and expand its application to other purchased products and materials where appropriately.

6. **Green Life**
   - Deploy a clean-up and beautification campaign in areas around three times a year with the participation of all employees at SMP. Expand its activity to a clean-up of the Hirose-River, too.
IMPORTANT

1. The information herein is subject to change without notice.
2. Neither reproduction nor duplication of this catalog in whole or part is allowed without the prior written approval of SII Micro Parts Ltd.
3. The colors of the products reproduced herein may be different from the actual colors. Check color on actual products before using the product.
4. Circuits and respective application methods described herein are for reference only. SII Micro Parts Ltd. is not responsible for any and all infringement or damages to the rights of third parties (including industrial properties) caused by the use of circuits or application methods herein. SII Micro Parts Ltd. shall not license any industrial properties owned by SII Micro Parts Ltd. or any third party through this catalog.
5. When products described herein include Strategic Products (or Services) stipulated in the Foreign Exchange and Trade Control Law, they shall not be exported without permission of governmental authorities.
6. The products described herein are designed for consumer equipment and cannot be used as part of any device or equipment which influences the human body or requires a significantly high reliability, such as physical exercise equipment, medical equipment, disaster prevention equipment, gas related equipment, vehicles, aircraft and equipment mounted on vehicles.
SII Micro Parts Ltd. who manufactures the products described in this catalog holds the ISO-9001 quality management system certificate and the ISO-14001 environmental management system certificate.

SII, only achieved by the finest artisans and craftsmen in Japan's long history. Based on our 60 years history of precision watch manufacturing, SII embodies TAKUMI as the core of our DNA. Our TAKUMI spirit comes to life in all of our components through lower power consumption, high precision and continuous commitment to challenge and improve.

Released in February 2006