Somaloy® 5P

Material Data
What is the most important property for your application?

Somaloy® is an isotropic, high resistive Soft Magnetic Composite (SMC) material for electromagnetic applications. Somaloy makes it possible to design innovative, compact and powerful components that match your specific application and future demands. The secret is the unique 3D flux properties and net-shaping opportunity.

Höganäs develop and provide the Somaloy product range which comprises press-ready powder mixes. Each Somaloy product has properties that can be carefully tailored to ensure optimum performance in your specific component and application. We will help you with material selection that suits your specific needs in your development process.

The Somaloy product family
The Somaloy product family includes 3 groups; 1P, 3P and 5P with different performance levels (P):
- Somaloy 1P Baseline
- Somaloy 3P Mechanical strength, permeability
- Somaloy 5P Lowest losses

Comparing SMC data to electric steel-sheets
SMC data is measured on single ring components (OD55/ID45/H5 mm) via square cross-section. The measured SMC sample is a full magnetic core component that can be compared to a punched and stacked electric steel-sheet pack representing the same geometry. Data for electric steel-sheets are normally given for a single sheet, tested with an Epstein frame test. SMC is not tested by this method and thereby data is not directly comparable. Additional design factors aimed for electric steel-sheet stacks does not apply for SMC.

Find out more
Contact your local sales representative or visit www.hoganas.com/electromagnetic
List of content

Overview
Somaloy® 5P Product Portfolio .................................. 4
Typical data of all products with the compaction pressure of 800 MPa

Detailed material data
Large particles #40
Somaloy 700HR 5P 800 MPa .................................. 5
Somaloy 700HR 5P 600 MPa .................................. 6
Somaloy 1000 5P 800 MPa .................................. 7
Somaloy 1000 5P 600 MPa .................................. 8

Medium particles #100
Somaloy 130i 5P 800 MPa .................................. 9
Somaloy 130i 5P 600 MPa .................................. 10

Fine particles #200
Somaloy 110i 5P 800 MPa .................................. 11
Somaloy 110i 5P 600 MPa .................................. 12
## Somaloy®

### Product portfolio

<table>
<thead>
<tr>
<th>Somaloy material</th>
<th>Density [g/cm³]</th>
<th>Resistivity [µOhm m]</th>
<th>TRS ambient [MPa]</th>
<th>B@ 10000 A/m [T]</th>
<th>Hmax</th>
<th>Core losses @ 1T [W/kg]</th>
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<th>TRS ambient [MPa]</th>
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<th>Hmax</th>
<th>Core losses [W/kg]</th>
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<td>1 kHz 1 T</td>
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<th>TRS ambient [MPa]</th>
<th>B@ 10000 A/m [T]</th>
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<td>5 kHz 0.5 T</td>
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<td></td>
<td>1 kHz 1 T</td>
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<td>Fine particles #200</td>
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<td>18000</td>
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<td>220</td>
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</table>

Typical product data 800 MPa compaction pressure, magnetic data measured according to CEI/IEC 60404

For more information, please contact your local sales representative.
### General

**Base material:** Somaloy 700HR 5P  
**Additive(s):** 0.3% 5P Lube  
**Compaction:**  
- Pressure: 800 MPa  
- Die temperature: 100°C  
**Heat treatment:**  
- Atmosphere: Nitrogen  
- Temperature: 650°C

### Mechanical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Standards</th>
</tr>
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<tbody>
<tr>
<td>Transverse rupture strength/150°C [MPa]</td>
<td>SS-ISO 3325</td>
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<tr>
<td>Tensile strength/Yield strength [MPa]</td>
<td>SS-EN 10022-1, ISO 2740</td>
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<td>Compressive Strength/Yield [MPa]</td>
<td>650/110</td>
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<tr>
<td>Young's modulus [GPa]</td>
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<td>Poisson's ratio</td>
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<tr>
<td>Impact Energy</td>
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### Physical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Standards</th>
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<tr>
<td>Density [g/cm³]</td>
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<td>Thermal expansion [K]</td>
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<td>Thermal conductivity [W/mK]</td>
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<tr>
<td>Resistivity [μΩm]</td>
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### Powder properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Standards</th>
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<tbody>
<tr>
<td>Apparent density [g/cm³]</td>
<td>3.30</td>
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<td>Flow [s/50g]</td>
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<tr>
<td>Green density [g/cm³]</td>
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<td>Green strength [MPa]</td>
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<td>Springback [%]</td>
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<td>Heat treated dim. change [%]</td>
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<td>Total dim. change [%]</td>
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### Magnetic properties

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<th>Property</th>
<th>Standards</th>
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<td>BH10000A/m</td>
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<td>Hc [A/m]</td>
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<td>µr-max</td>
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### Magnetising curve

Data adjusted for use in Finite Element modelling

<table>
<thead>
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<th>H[A/m]</th>
<th>µM[T]</th>
<th>B[T]</th>
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<td>63</td>
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<table>
<thead>
<tr>
<th>H[A/m]</th>
<th>µM[T]</th>
<th>B[T]</th>
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### Core loss

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<th>300 Hz</th>
<th>400 Hz</th>
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<th>600 Hz</th>
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<th>800 Hz</th>
<th>900 Hz</th>
<th>1000 Hz</th>
<th>2000 Hz</th>
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<td>17</td>
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<td>23</td>
<td>26</td>
<td>66</td>
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<tr>
<td>1.0T</td>
<td>3.2/3.9</td>
<td>6.6</td>
<td>14</td>
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<td>80</td>
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<td>241</td>
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<td>1.5T</td>
<td>6.6/7.9</td>
<td>13</td>
<td>28</td>
<td>44</td>
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<td>100</td>
<td>121</td>
<td>144</td>
<td>168</td>
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Measured according to CE/IEC 60404-6:2003 on ring sample (OD55 ID45 H5 mm).

### Loss model

\[
P_{\text{tot}} = K_h \cdot f \cdot B^{1.75} + K_{\text{ep}} \cdot f^2 \cdot B^2 + \frac{B^2 \cdot f^2 \cdot \rho \cdot \text{resistivity} \cdot 1000}{1.8 \cdot \rho \cdot \text{resistivity} \cdot 1000}
\]

Model is verified up to 1.5T and 5000Hz.

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### General

**Base material:** Somaloy 700HR 5P  
**Additive(s):** 0.3% 5P Lube  
**Compaction:** Pressure: 600 MPa  
**Heat treatment:** Atmosphere: Nitrogen  
**Temperature:** 600°C

#### Mechanical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Standards</th>
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</thead>
<tbody>
<tr>
<td>Transverse rupture strength 150°C</td>
<td>60/60 MPa</td>
<td>SS-ISO 3325</td>
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<tr>
<td>Tensile strength/Yield strength</td>
<td>20/20 MPa</td>
<td>SS-EN 10022-1, ISO 2740</td>
</tr>
<tr>
<td>Compressive Strength/Yield</td>
<td>530/110 MPa</td>
<td>ASTM E 899</td>
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<tr>
<td>Young’s modulus</td>
<td>150 GPa</td>
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<tr>
<td>Poisson’s ratio</td>
<td>- 0.23</td>
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<td>Impact Energy</td>
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#### Physical properties

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<th>Property</th>
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<td>26 W/m*K</td>
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<tr>
<td>Resistivity</td>
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<td>Four point measurements on nom. size OD 55mm ID 45mm Height 5mm</td>
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#### Powder properties

<table>
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<tr>
<th>Property</th>
<th>Value</th>
<th>Standards</th>
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<tbody>
<tr>
<td>Apparent density</td>
<td>3.30 g/cm³</td>
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<td>Flow</td>
<td>33 s/50g</td>
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<td>Green density</td>
<td>7.39 g/cm³</td>
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<td>Green strength</td>
<td>13 [MPa]</td>
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<td>Total dim. change</td>
<td>-0.08 %</td>
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#### Magnetic properties

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<th>Standards</th>
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#### Magnetising curve

Data adjusted for use in Finite Element modelling

#### Core loss

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<th>Frequency [Hz]</th>
<th>50/60 Hz</th>
<th>100 Hz</th>
<th>200 Hz</th>
<th>300 Hz</th>
<th>400 Hz</th>
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<th>700 Hz</th>
<th>800 Hz</th>
<th>900 Hz</th>
<th>1000 Hz</th>
<th>2000 Hz</th>
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<tbody>
<tr>
<td>0.5 T</td>
<td>1.0/1.2</td>
<td>2.0</td>
<td>4.0</td>
<td>7.0</td>
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<td>62</td>
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<td>1.5 T</td>
<td>6.8/8.2</td>
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<td>30</td>
<td>47</td>
<td>65</td>
<td>85</td>
<td>107</td>
<td>130</td>
<td>155</td>
<td>181</td>
<td>209</td>
<td>572</td>
</tr>
</tbody>
</table>

Measured according to CEI/IEC 60404-6:2003 on ring sample (OD55 ID45 H5 mm).

#### Loss model

\[ P_{tot} = K_h \cdot f \cdot B^{1.75} + K_{ep} \cdot f^2 \cdot B^2 + \frac{B^2 \cdot f^2 \cdot d}{1.8 \cdot \rho \cdot \text{resistivity} \cdot 1000} \]

\[ f \] Frequency [Hz]  
\[ B \] Field strength [T]  
\[ \rho \] Density [g/cm³]  
\[ \text{resistivity} \] [μΩm]  
\[ d \] Smallest cross section of component [mm]

Model is verified up to 1.5T and 5000Hz.

[www.hoganas.com/electromagnetic](http://www.hoganas.com/electromagnetic)
### General

**Base material:** Somaloy 1000 5P

<table>
<thead>
<tr>
<th>Additive(s):</th>
<th>0.3% 5P Lube</th>
</tr>
</thead>
</table>

**Compaction:**
- **Pressure:** 800 MPa
- **Die temperature:** 100°C

**Heat treatment:**
- **Atmosphere:** Nitrogen
- **Temperature:** 650°C

### Mechanical properties

<table>
<thead>
<tr>
<th>Standards</th>
<th>Mechanical properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-ISO 3325</td>
<td>Transverse rupture strength/150°C [MPa] 65/65</td>
</tr>
<tr>
<td>SS-EN 10022-1, ISO 2740</td>
<td>Tensile strength/Yield strength [MPa] 20/20</td>
</tr>
<tr>
<td>ASTM E9-89a</td>
<td>Compressive Strength/Yield [MPa] 570/110</td>
</tr>
<tr>
<td>ASTM E 1876-99</td>
<td>Young’s modulus [GPa] 140</td>
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<tr>
<td>ASTM E 1876-99</td>
<td>Poisson’s ratio - 0.23</td>
</tr>
<tr>
<td>SS-EN 10045, SS-EN 25754</td>
<td>Impact Energy [J] 1.8</td>
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### Physical properties

<table>
<thead>
<tr>
<th>Standards</th>
<th>Physical properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-ISO 2738</td>
<td>Density [g/cm³] 7.52</td>
</tr>
<tr>
<td>ASTM E 229/MPF 35</td>
<td>Thermal expansion [K⁻¹] 11 e⁻06</td>
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<tr>
<td>ISO 22007-2</td>
<td>Thermal conductivity [W/m·K] 21</td>
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<tr>
<td>ASTM E9-89a</td>
<td>Resistivity [μΩm] 90</td>
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### Powder properties

<table>
<thead>
<tr>
<th>Standards</th>
<th>Powder properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 3923/1</td>
<td>Apparent density [g/cm³] 3.18</td>
</tr>
<tr>
<td>ISO 4490</td>
<td>Flow [s/50g] 35</td>
</tr>
<tr>
<td>ISO 3995</td>
<td>Green density [g/cm³] 7.52</td>
</tr>
<tr>
<td>ISO 3995</td>
<td>Green strength [MPa] 17</td>
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<tr>
<td>ISO 4492, ISO 2740</td>
<td>Springback [%] 0.19</td>
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<tr>
<td>ISO 4492, ISO 2740</td>
<td>Heat treated dim. change [%] -0.10</td>
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<tr>
<td>ISO 4492, ISO 2740</td>
<td>Total dim. change [%] 0.09</td>
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### Magnetic properties

<table>
<thead>
<tr>
<th>Standards</th>
<th>Magnetic properties</th>
</tr>
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<tbody>
<tr>
<td>EIC 6040-4</td>
<td>B[8]10000A/m [T] 1.59</td>
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<td>EIC 6040-4</td>
<td>Hc, [A/m] 124</td>
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<td>EIC 6040-4</td>
<td>μr,max - 720</td>
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### Magnetising curve

**Data adjusted for use in Finite Element modelling**

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<thead>
<tr>
<th>H[A/m]</th>
<th>μ₀M[T]</th>
<th>B[T]</th>
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<tbody>
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<tr>
<td>0.21</td>
<td>0.21</td>
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<tr>
<td>0.45</td>
<td>0.45</td>
<td>0.45</td>
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<td>0.65</td>
<td>0.65</td>
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<tr>
<td>0.85</td>
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<td>0.85</td>
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<tr>
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<td>1.25</td>
<td>1.26</td>
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### Core loss

<table>
<thead>
<tr>
<th>Loss model</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_h$ 0.062</td>
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<table>
<thead>
<tr>
<th>[W/kg]</th>
<th>50/60 Hz</th>
<th>100 Hz</th>
<th>200 Hz</th>
<th>300 Hz</th>
<th>400 Hz</th>
<th>500 Hz</th>
<th>600 Hz</th>
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</thead>
<tbody>
<tr>
<td>0.5T</td>
<td>0.9/1.1</td>
<td>1.9</td>
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<td>7.0</td>
<td>9.0</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>1.0T</td>
<td>3.2/3.9</td>
<td>6.6</td>
<td>14</td>
<td>22</td>
<td>31</td>
<td>41</td>
<td>52</td>
</tr>
<tr>
<td>1.5T</td>
<td>6.5/7.9</td>
<td>14</td>
<td>29</td>
<td>46</td>
<td>65</td>
<td>86</td>
<td>109</td>
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</tbody>
</table>

| $P_{tot} = K_h \cdot f \cdot B^1.75 + K_{sp} \cdot f^2 \cdot B^2 + \frac{B^2 \cdot f^2 \cdot \rho \cdot d}{1.8 \cdot \rho \cdot \text{resistivity} \cdot 1000}$ |

Model is verified up to 1.5T and 2000Hz.

**Loss model**

- **$K_h$** Hysteresis loss coefficient
- **$K_{sp}$** In particle eddy current coefficient
- **$f$** Frequency [Hz]
- **$B$** Field strength [T]
- **$\rho$** Density [g/cm³]
- **$d$** Smallest cross section of component [mm]
### Somaloy® 1000 5P

**Mechanical properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse rupture strength/150°C</td>
<td>SS-ISO 3325</td>
<td>65/65</td>
<td></td>
</tr>
<tr>
<td>Tensile strength/Yield strength</td>
<td>SS-EN 10002-1, ISO 2740</td>
<td>25/25</td>
<td></td>
</tr>
<tr>
<td>Compressive Strength/Yield</td>
<td>ASTM E8-89a</td>
<td>480/110</td>
<td></td>
</tr>
<tr>
<td>Young’s modulus</td>
<td>ASTM E 1876-99</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Poisson’s ratio</td>
<td>-</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>Impact Energy</td>
<td>SS-EN 10045, SS-EN 25754</td>
<td>1.8</td>
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**Physical properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
<th>Value</th>
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<tbody>
<tr>
<td>Density</td>
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<td>Thermal expansion</td>
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<td>Thermal conductivity</td>
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<tr>
<td>Resistivity</td>
<td>-</td>
<td>80</td>
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**Powder properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparent density</td>
<td>ISO 3923/1</td>
<td>3.18</td>
</tr>
<tr>
<td>Flow</td>
<td>ISO 4490</td>
<td>35</td>
</tr>
<tr>
<td>Green density</td>
<td>ISO 3927</td>
<td>7.42</td>
</tr>
<tr>
<td>Green strength</td>
<td>ISO 3995</td>
<td>15</td>
</tr>
<tr>
<td>Springback</td>
<td>ISO 4492, ISO 2740</td>
<td>0.17</td>
</tr>
<tr>
<td>Heat treated dim. change</td>
<td>ISO 4492, ISO 2740</td>
<td>-0.09</td>
</tr>
<tr>
<td>Total dim. change</td>
<td>ISO 4492, ISO 2740</td>
<td>0.08</td>
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</table>

**Magnetic properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>B@40000A/m</td>
<td>IEC 60404-4</td>
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</tr>
<tr>
<td>B@10000A/m</td>
<td>IEC 60404-4</td>
<td>1.53</td>
</tr>
<tr>
<td>Hc</td>
<td>IEC 60404-4</td>
<td>125</td>
</tr>
<tr>
<td>μr -max</td>
<td>IEC 60404-4</td>
<td>700</td>
</tr>
</tbody>
</table>

**Magnetising curve**

- Data adjusted for use in Finite Element modelling

**Core loss**

<table>
<thead>
<tr>
<th>Frequency [Hz]</th>
<th>50/60 Hz</th>
<th>100 Hz</th>
<th>200 Hz</th>
<th>300 Hz</th>
<th>400 Hz</th>
<th>500 Hz</th>
<th>600 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5T</td>
<td>1.0/1.2</td>
<td>2.0</td>
<td>4.0</td>
<td>7.0</td>
<td>9.0</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>1.0T</td>
<td>3.3/4.0</td>
<td>6.8</td>
<td>15</td>
<td>23</td>
<td>33</td>
<td>43</td>
<td>55</td>
</tr>
<tr>
<td>1.5T</td>
<td>6.8/8.3</td>
<td>14</td>
<td>30</td>
<td>48</td>
<td>68</td>
<td>90</td>
<td>114</td>
</tr>
</tbody>
</table>

**Loss model**

\[
P_{\text{tot}} = K_h \cdot f \cdot B^{1.75} + K_{ep} \cdot f^2 \cdot B^2 + \frac{B^2 \cdot f^2 \cdot \rho}{1.8 \cdot \rho \cdot \text{resistivity} \cdot 1000}
\]

Model is verified up to 1.5T and 2000Hz.
### General

**Base material:** Somaloy 130i 5P  
**Additive(s):** 0.3% 5P Lube  
**Compaction:** Pressure: 800 MPa  
**Heat treatment:** Atmosphere: Nitrogen

#### Mechanical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse rupture strength/150°C</td>
<td>SS-ISO 3325</td>
</tr>
<tr>
<td>Tensile strength/Yield strength</td>
<td>SS-EN 10022-1, ISO 2740</td>
</tr>
<tr>
<td>Compressive Strength/Yield</td>
<td>ASTM E9-89a</td>
</tr>
<tr>
<td>Young’s modulus</td>
<td>ASTM E 1876-99</td>
</tr>
<tr>
<td>Poisson’s ratio</td>
<td>ASTM E 1876-99</td>
</tr>
<tr>
<td>Impact Energy</td>
<td>SS-EN 10045, SS-EN 25764</td>
</tr>
</tbody>
</table>

#### Powder properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparent density</td>
<td>ISO 5395/1</td>
</tr>
<tr>
<td>Flow</td>
<td>ISO 4490</td>
</tr>
<tr>
<td>Green density</td>
<td>ISO 3927</td>
</tr>
<tr>
<td>Green strength</td>
<td>ISO 3995</td>
</tr>
<tr>
<td>Springback</td>
<td>ISO 4492, ISO 2740</td>
</tr>
<tr>
<td>Heat treated dim. change</td>
<td>ISO 4492, ISO 2740</td>
</tr>
<tr>
<td>Total dim. change</td>
<td>ISO 4492, ISO 2740</td>
</tr>
</tbody>
</table>

#### Magnetic properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>B8H4000A/m [T]</td>
<td>IEC 60404-4</td>
</tr>
<tr>
<td>B8H10000A/m [T]</td>
<td>IEC 60404-4</td>
</tr>
<tr>
<td>Hc, -max [A/m]</td>
<td>IEC 60404-4</td>
</tr>
<tr>
<td>( \mu_r ) -max</td>
<td>IEC 60404-4</td>
</tr>
</tbody>
</table>

#### Magnetising curve

Data adjusted for use in Finite Element modelling

#### Core loss

<table>
<thead>
<tr>
<th>[W/kg]</th>
<th>50/60 Hz</th>
<th>100 Hz</th>
<th>250 Hz</th>
<th>500 Hz</th>
<th>750 Hz</th>
<th>1000 Hz</th>
<th>2000 Hz</th>
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<tbody>
<tr>
<td>0.5T</td>
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<td>27.4</td>
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<td>1.0T</td>
<td>2.01</td>
<td>4.01</td>
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<td>27.4</td>
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<td>4.01</td>
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<td>9.01</td>
<td>27.4</td>
<td>59.9</td>
<td>107.0</td>
</tr>
</tbody>
</table>

Model is verified up to 0.5T-1.5T and 5000 Hz.

#### Loss model

\[
P_{\text{tot}} = K_h \cdot f \cdot B^2 + K_{ep} \cdot f^2 \cdot B^2 + \frac{B^2 \cdot f^2 \cdot d^2}{1.8 \cdot \rho \cdot \text{resistivity} \cdot 1000}
\]

Model is verified up to 0.05T-0.2T and 5-50 kHz.

### Somaloy® 130i 5P

Base material: Somaloy 130i 5P  
Additive(s): 0.3% 5P Lube  
Compaction: Pressure: 800 MPa  
Heat treatment: Atmosphere: Nitrogen  
Pressure: 800 MPa  
Die temperature: 80°C  
Temperature: 650°C

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<tr>
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<td>SS-EN 10022-1, ISO 2740</td>
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<tr>
<td>Compressive Strength/Yield</td>
<td>ASTM E9-89a</td>
</tr>
<tr>
<td>Young’s modulus</td>
<td>ASTM E 1876-99</td>
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<tr>
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<td>ASTM E 1876-99</td>
</tr>
<tr>
<td>Impact Energy</td>
<td>SS-EN 10045, SS-EN 25764</td>
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#### Powder properties

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</tr>
<tr>
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<td>ISO 3927</td>
</tr>
<tr>
<td>Green strength</td>
<td>ISO 3995</td>
</tr>
<tr>
<td>Springback</td>
<td>ISO 4492, ISO 2740</td>
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<tr>
<td>Heat treated dim. change</td>
<td>ISO 4492, ISO 2740</td>
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<tr>
<td>Total dim. change</td>
<td>ISO 4492, ISO 2740</td>
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#### Magnetic properties

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<th>Standard</th>
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<tbody>
<tr>
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<td>IEC 60404-4</td>
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<tr>
<td>B8H10000A/m [T]</td>
<td>IEC 60404-4</td>
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<tr>
<td>Hc, -max [A/m]</td>
<td>IEC 60404-4</td>
</tr>
<tr>
<td>( \mu_r ) -max</td>
<td>IEC 60404-4</td>
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#### Magnetising curve

Data adjusted for use in Finite Element modelling

<table>
<thead>
<tr>
<th>H[A/m]</th>
<th>( \mu_r ) M[T]</th>
<th>B[T]</th>
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<td>0.00</td>
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<td>0.04</td>
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<tr>
<td>205</td>
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<td>0.07</td>
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<tr>
<td>361</td>
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<tr>
<td>7841</td>
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</table>

<table>
<thead>
<tr>
<th>H[A/m]</th>
<th>( \mu_r ) M[T]</th>
<th>B[T]</th>
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<tbody>
<tr>
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<td>304770</td>
<td>2.72</td>
<td>2.41</td>
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</table>

Model is verified up to 0.5T-1.5T and 5000 Hz.

#### Core loss

<table>
<thead>
<tr>
<th>[W/kg]</th>
<th>50/60 Hz</th>
<th>100 Hz</th>
<th>250 Hz</th>
<th>500 Hz</th>
<th>750 Hz</th>
<th>1000 Hz</th>
<th>2000 Hz</th>
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<tbody>
<tr>
<td>0.05T</td>
<td>2.3</td>
<td>6.2</td>
<td>16</td>
<td>29</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>0.1T</td>
<td>9.2</td>
<td>24</td>
<td>64</td>
<td>113</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2T</td>
<td>36</td>
<td>95</td>
<td>250</td>
<td>442</td>
<td></td>
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<td></td>
</tr>
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</table>

Measured according to CEI/IEC 60404-6:2003 on ring sample (OD55x ID45x H5 mm).

#### Loss model

\[
P_{\text{tot}} = K_h \cdot f \cdot B^2 + K_{ep} \cdot f^2 \cdot B^2 + \frac{B^2 \cdot f^2 \cdot d^2}{1.8 \cdot \rho \cdot \text{resistivity} \cdot 1000}
\]

Model is verified up to 0.5T-1.5T and 5000 Hz.

\[
P_{\text{tot}} = 90 \cdot B^{1.97} \cdot f^{1.40}
\]

Model is verified up to 0.05T-0.2T and 5-50 kHz.

**www.hoganas.com/electromagnetic**
Somaloy® 130i 5P

**General**

Base material: Somaloy 130i 5P

Additive(s): 0.3% 5P Lube

Compaction: Pressure: 600 MPa

Die temperature: 80 °C

Heat treatment: Atmosphere: Nitrogen

Temperature: 650 °C

**Mechanical properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse rupture strength/150°C [MPa]</td>
<td>SS-ISO 3325</td>
<td>40/40</td>
</tr>
<tr>
<td>Tensile strength/Yield strength [MPa]</td>
<td>SS-EN 10002-1, ISO 2740</td>
<td>20/20</td>
</tr>
<tr>
<td>Compressive Strength/Yield [MPa]</td>
<td>ASTM E9-89a</td>
<td>310/120</td>
</tr>
<tr>
<td>Young’s modulus [GPa]</td>
<td>ASTM E 1876-99</td>
<td>90</td>
</tr>
<tr>
<td>Poisson’s ratio</td>
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<tr>
<td>Impact Energy [J]</td>
<td>SS-EN 10045, SS-EN 25754</td>
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**Physical properties**

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<thead>
<tr>
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<th>Standard</th>
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<tr>
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<td>Thermal expansion [K-1]</td>
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<td>11 e-06</td>
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<td>Thermal conductivity [W/m*K]</td>
<td>ISO 22007-2</td>
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<tr>
<td>Resistivity [μΩm]</td>
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<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Powder properties</td>
<td>Standards</td>
<td></td>
</tr>
<tr>
<td>Apparent density [g/cm³]</td>
<td>ISO 3923/1</td>
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<tr>
<td>Flow [s/50g]</td>
<td>ISO 4490</td>
<td>22</td>
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<tr>
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<td>ISO 3927</td>
<td>7.33</td>
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<td>Green strength [MPa]</td>
<td>ISO 3995</td>
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<td>Springback [%]</td>
<td>ISO 4492, ISO 2740</td>
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<tr>
<td>Heat treated dim. change [%]</td>
<td>ISO 4492, ISO 2740</td>
<td>-0.09</td>
</tr>
<tr>
<td>Total dim. change [%]</td>
<td>ISO 4492, ISO 2740</td>
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</tr>
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**Magnetic properties**

<table>
<thead>
<tr>
<th>Property</th>
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<th>Value</th>
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<tbody>
<tr>
<td>Bθ40000A/m [T]</td>
<td>IEC 60404-4</td>
<td>1.09</td>
</tr>
<tr>
<td>Bθ100000A/m [T]</td>
<td>IEC 60404-4</td>
<td>1.41</td>
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<tr>
<td>Hc, -max [A/m]</td>
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<td>µr, -max</td>
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**Magnetising curve**

Data adjusted for use in Finite Element modelling


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<td>1.48</td>
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<td>0.07</td>
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<td>0.13</td>
<td>74652</td>
<td>1.82</td>
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<tr>
<td>501</td>
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<td>0.21</td>
<td>99652</td>
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<td>1.97</td>
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<td>124652</td>
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<td>2.07</td>
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<td>1.30</td>
<td>304652</td>
<td>1.95</td>
<td>2.32</td>
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</table>

**Core loss**

<table>
<thead>
<tr>
<th>Power loss [W/kg]</th>
<th>50/60 Hz</th>
<th>100 Hz</th>
<th>250 Hz</th>
<th>500 Hz</th>
<th>750 Hz</th>
<th>1000 Hz</th>
<th>2000 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5T</td>
<td>0.12/1.4</td>
<td>2.5</td>
<td>6.3</td>
<td>13</td>
<td>21</td>
<td>29</td>
<td>68</td>
</tr>
<tr>
<td>1.0T</td>
<td>4.1/4.9</td>
<td>8.3</td>
<td>22</td>
<td>46</td>
<td>72</td>
<td>101</td>
<td>242</td>
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<tr>
<td>1.5T</td>
<td>8.3/10</td>
<td>17</td>
<td>44</td>
<td>94</td>
<td>149</td>
<td>210</td>
<td>510</td>
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</tbody>
</table>

**Loss model**

Kₘ = 0.081

Kₑ = 0.000020

Pₜₗ = Kₘ * f * B²^2.95 + Kₑ * f² * B² + B² * f² * d² / 1.8 * ρ * resistivity * 1000

Model is verified up to 0.5T-1.5T and 5000Hz.

Pₜₗ = 97 * B²^2.95 * f².45

Model is verified up to 0.005T-0.2T and 5-50 kHz.
## Mechanical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse rupture strength/150°C (MPa)</td>
<td>SS-ISO 3325</td>
</tr>
<tr>
<td>Tensile strength/Yield strength (MPa)</td>
<td>SS-EN 10002-1, ISO 2740</td>
</tr>
<tr>
<td>Compressive Strength/Yield (MPa)</td>
<td>ASTM E 89a</td>
</tr>
<tr>
<td>Young’s modulus (GPa)</td>
<td>ASTM E 1876-99</td>
</tr>
<tr>
<td>Poisson’s ratio</td>
<td>0.23</td>
</tr>
<tr>
<td>Impact Energy</td>
<td>SS-EN 10045, SS-EN 25754</td>
</tr>
</tbody>
</table>

## Physical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density ([g/cm³])</td>
<td>SS-ISO 2738</td>
</tr>
<tr>
<td>Thermal expansion ([kJ])</td>
<td>ASTM E 223/MMF 35</td>
</tr>
<tr>
<td>Thermal conductivity ([W/m·K])</td>
<td>ISO 2207-2</td>
</tr>
<tr>
<td>Resistivity ([μΩm])</td>
<td>18000</td>
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</table>

## Magnetic properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>B@40000A/m ([T])</td>
<td>ISO 60404-4</td>
</tr>
<tr>
<td>B@100000A/m ([T])</td>
<td>ISO 60404-4</td>
</tr>
<tr>
<td>Hc, -max ([A/m])</td>
<td>ISO 60404-4</td>
</tr>
<tr>
<td>μf, max -</td>
<td>ISO 60404-4</td>
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</table>

## Powder properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparent density ([g/cm³])</td>
<td>ISO 3923/1</td>
</tr>
<tr>
<td>Flow ([s/50g])</td>
<td>ISO 4490</td>
</tr>
<tr>
<td>Green density ([g/cm³])</td>
<td>ISO 3927</td>
</tr>
<tr>
<td>Green strength (MPa)</td>
<td>ISO 3995</td>
</tr>
<tr>
<td>Springback [%]</td>
<td>ISO 4492, ISO 2740</td>
</tr>
<tr>
<td>Heat treated dim. change [%]</td>
<td>ISO 4492, ISO 2740</td>
</tr>
<tr>
<td>Total dim. change [%]</td>
<td>ISO 4492, ISO 2740</td>
</tr>
</tbody>
</table>

## Magneticising curve

Data adjusted for use in Finite Element modelling

<table>
<thead>
<tr>
<th>H [A/m]</th>
<th>μf[M][T]</th>
<th>B[T]</th>
</tr>
</thead>
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<td>0.00</td>
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<tr>
<td>185</td>
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<td>0.04</td>
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<td>321</td>
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<td>0.08</td>
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<td>581</td>
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<td>0.15</td>
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<tr>
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<td>0.22</td>
</tr>
<tr>
<td>1232</td>
<td>0.34</td>
<td>0.34</td>
</tr>
<tr>
<td>2434</td>
<td>0.63</td>
<td>0.63</td>
</tr>
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<td>3361</td>
<td>0.80</td>
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<td>1.16</td>
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<td>10343</td>
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<td>1.35</td>
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</table>

<table>
<thead>
<tr>
<th>H [A/m]</th>
<th>μs[M][T]</th>
<th>B[T]</th>
</tr>
</thead>
<tbody>
<tr>
<td>17216</td>
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<td>1.53</td>
</tr>
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<td>1.69</td>
<td>1.73</td>
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<td>50401</td>
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<td>1.87</td>
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<tr>
<td>75401</td>
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<td>1.97</td>
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<tr>
<td>100401</td>
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<td>2.10</td>
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<td>230401</td>
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<td>280401</td>
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<td>305401</td>
<td>2.02</td>
<td>2.41</td>
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## Core loss

<table>
<thead>
<tr>
<th>Frequency [Hz]</th>
<th>[W/kg]</th>
<th>5 kHz</th>
<th>10 kHz</th>
<th>20 kHz</th>
<th>30 kHz</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.05T</td>
<td>1.7</td>
<td>4.4</td>
<td>11</td>
<td>19</td>
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<td>1.0T</td>
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<td>7.0</td>
<td>18</td>
<td>46</td>
<td>79</td>
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<tr>
<td>1.5T</td>
<td>0.2T</td>
<td>29</td>
<td>74</td>
<td>188</td>
<td>326</td>
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</table>

## Loss model

\[ P = K_h \cdot f \cdot B^2 \cdot \mu_r \cdot f^1.35 \cdot r^d \cdot \rho \cdot \text{resistivity} \cdot 1000 \]

Model is verified up to 0.5T-1.5T and 5000 Hz.

\[ P = 88 \cdot B^2 \cdot \mu_r \cdot f^{1.35} \]

Model is verified up to 0.05T-0.2T and 5-50 kHz.
## Somaloy® 110i 5P

### Mechanical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse rupture strength/150°C [MPa]</td>
<td>44/44</td>
<td>SS-ISO 3325</td>
</tr>
<tr>
<td>Tensile Strength/Yield strength [MPa]</td>
<td>25/25</td>
<td>SS-EN 10022-1, ISO 2740</td>
</tr>
<tr>
<td>Compressive Strength/Yield [MPa]</td>
<td>300/130</td>
<td>ASTM E8-89a</td>
</tr>
<tr>
<td>Young's modulus [GPa]</td>
<td>80</td>
<td>ASTM E 1876-99</td>
</tr>
<tr>
<td>Poisson's ratio</td>
<td>0.23</td>
<td>ASTM E 1876-99</td>
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<tr>
<td>Impact Energy [J]</td>
<td>0.7</td>
<td>SS-EN 10045, SS-EN 25754</td>
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### Physical Properties

<table>
<thead>
<tr>
<th>Property</th>
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<tr>
<td>Density [g/cm³]</td>
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<td>Thermal conductivity [W/m*K]</td>
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### Powder Properties

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<th>Value</th>
<th>Standard</th>
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</thead>
<tbody>
<tr>
<td>Apparent density [g/cm³]</td>
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<td>Flow [s/50g]</td>
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<td>ISO 4490</td>
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<td>Green density [g/cm³]</td>
<td>7.17</td>
<td>ISO 3927</td>
</tr>
<tr>
<td>Green strength [MPa]</td>
<td>10</td>
<td>ISO 3995</td>
</tr>
<tr>
<td>Springback [%]</td>
<td>0.18</td>
<td>ISO 4492, ISO 2740</td>
</tr>
<tr>
<td>Heat treated dim. change [%]</td>
<td>-0.14</td>
<td>ISO 4492, ISO 2740</td>
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<tr>
<td>Total dim. change [%]</td>
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### Magnetic Properties

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<tbody>
<tr>
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<tr>
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<td>EIC 60404-4</td>
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<td>Hc, -max [A/m]</td>
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<td>EIC 60404-4</td>
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<tr>
<td>µr -max</td>
<td>-210</td>
<td>IEC 60404-4</td>
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### Magnetising Curve

Data adjusted for use in Finite Element modelling

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</tr>
</thead>
<tbody>
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<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.5T</td>
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<td>0.13</td>
<td>0.13</td>
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<tr>
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<td>1.11</td>
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<td>0.28</td>
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<tr>
<td>3.0</td>
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<td>0.57</td>
<td>0.58</td>
</tr>
<tr>
<td>3.5</td>
<td>1.65</td>
<td>0.73</td>
<td>0.74</td>
</tr>
<tr>
<td>4.0</td>
<td>1.92</td>
<td>0.90</td>
<td>0.90</td>
</tr>
<tr>
<td>4.5</td>
<td>2.19</td>
<td>1.06</td>
<td>1.07</td>
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<tr>
<td>5.0</td>
<td>2.46</td>
<td>1.22</td>
<td>1.24</td>
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</tbody>
</table>

### Core Loss

<table>
<thead>
<tr>
<th>Frequency [Hz]</th>
<th>50/60 Hz</th>
<th>100 Hz</th>
<th>250 Hz</th>
<th>500 Hz</th>
<th>750 Hz</th>
<th>1000 Hz</th>
<th>2000 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5T</td>
<td>1.5/1.8</td>
<td>3.0</td>
<td>7.6</td>
<td>16</td>
<td>24</td>
<td>33</td>
<td>71</td>
</tr>
<tr>
<td>1.0T</td>
<td>5.0/6.0</td>
<td>10</td>
<td>26</td>
<td>53</td>
<td>81</td>
<td>111</td>
<td>245</td>
</tr>
<tr>
<td>1.5T</td>
<td>10/12</td>
<td>21</td>
<td>52</td>
<td>108</td>
<td>167</td>
<td>229</td>
<td>509</td>
</tr>
</tbody>
</table>

### Loss Model

| Ks | 0.100 |
| Ksp| 0.000011 |

\[ P_{loss} = K_s \cdot f \cdot B^2 + K_{sp} \cdot f^2 \cdot B^2 + B^2 \cdot f^2 \cdot \rho \cdot \text{resistivity} \cdot 1000 \]

Model is verified up to 0.5T-1.5T and 5000Hz.

<table>
<thead>
<tr>
<th>[W/kg]</th>
<th>5 kHz</th>
<th>10 kHz</th>
<th>20 kHz</th>
<th>30kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5T</td>
<td>2.0</td>
<td>5.2</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>1.0T</td>
<td>8.3</td>
<td>21</td>
<td>54</td>
<td>93</td>
</tr>
<tr>
<td>0.2T</td>
<td>34</td>
<td>86</td>
<td>219</td>
<td>378</td>
</tr>
</tbody>
</table>

### Core Loss Model

\[ P_{loss} = 99 \cdot B^{2.35} + f^{1.35} \]

Model is verified up to 0.05T-0.2T and 5-50 kHz.

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