



**WAEZHOLZ**

# Electrical steel strip grades and coating systems

High-performance materials. Unparalleled precision.

# YOUR FUTURE IS WHAT DRIVES US. ELECTRICAL STEEL STRIP GRADES FOR NEW IDEAS.

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Our customers inspire us each and every day with their ideas for the electric drive systems and generators of tomorrow. We meet the resulting challenges with high-performance, non-grain oriented electrical steel strip and with services tailored to their individual needs. This is how we help our customers enter a very important market – the future.

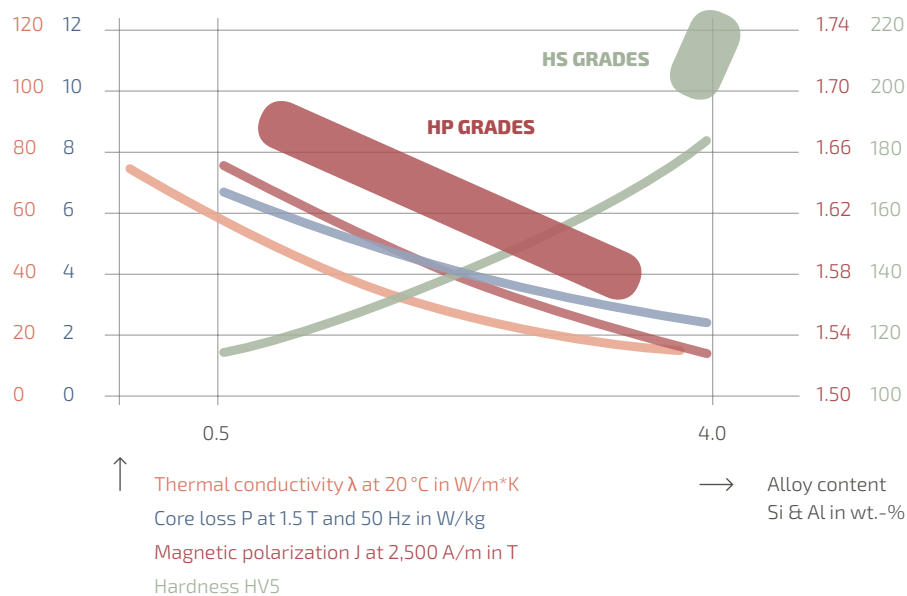
### **Our philosophy: Tailor-made materials**

What are your material requirements? Extremely thin electrical steel strip for high-frequency applications, perhaps only 0.10 millimeters thick? Excellent dimensional accuracy within the range of a few thousandths of a millimeter? High-strength electrical steel strip with a yield strength of over 500 MPa? Or do you maybe need combination coatings made of insulating varnish and bonding varnish? Whether your goal is efficiency, performance, speed, scalability, lightweight construction or a combination of these factors – come and talk to us about it.

The demands placed on electrical machines are wide-ranging and must always be viewed in conjunction with the respective purpose of application. This is why we combine our electrical steel expertise with our extensive knowledge of the industrial, energy, and automotive sectors. In this context, we support customers at all stages of the value chain. Our mission is to actively assist our customers in opening up new markets by developing innovative solutions together. And we will stop at nothing to achieve it.



# ELECTRICAL STEEL STRIP GRADES. FOR EVERY OCCASION.





We offer a wide range of electrical steel strip grades. And you benefit from the fact that we can provide you with exactly the material that has the right magnetic properties for your own specific application. This is important because it ensures that you not only obtain the performance you require from the electrical steel strip, but also an exceptional level of efficiency. We can make the best possible use of this potential if our customers get us involved at an early stage of development.



For further information visit  
[waelzholz.com/electrical-steel-strip](https://waelzholz.com/electrical-steel-strip)

**01** Continuous annealing furnace:  
 The electrical steel strip is annealed in a continuous process in order to adjust its magnetic and mechanical properties.

**02** Spectrum of electrical steel strip properties:  
 Important properties of Waelzholz's electrical steel strip grades, such as thermal conductivity, core losses, magnetic polarization, and hardness as a function of the alloy content, at a glance.

# NO grades

Waelzholz's particularly thin NO grades offer low core losses at high frequencies. Our top grades achieve magnetic properties that go well beyond the standard specifications. Like our NO 30-15 grade with a strip thickness of 0.3 mm that achieves a core loss of max. 15 W/kg at 400 Hz and 1 T. The exceptional dimensional accuracy of just a few thousandths of a millimeter also guarantees extremely homogeneous stacking.

## Electrical steel strip according to DIN EN 10303

| Grade <sup>1)</sup> | Nominal thickness<br>in mm | Max. core loss at       |                         |                           | Min. mechanical properties  |                          |                         |
|---------------------|----------------------------|-------------------------|-------------------------|---------------------------|-----------------------------|--------------------------|-------------------------|
|                     |                            | 1.0 T/400 Hz<br>in W/kg | 1.0 T/700 Hz<br>in W/kg | 1.0 T/1,000 Hz<br>in W/kg | R <sub>p0.2</sub><br>in MPa | R <sub>m</sub><br>in MPa | A <sub>80</sub><br>in % |
| NO 10               | 0.10                       | 13                      | 25                      | 39                        | 330                         | 450                      | 12                      |
| NO 15               | 0.15                       | 14                      | 25                      | 43                        | 330                         | 450                      | 12                      |
| NO 20-12            | 0.20                       | 12                      | 28                      | 45                        | 420                         | 500                      | 11                      |
| NO 20-13            | 0.20                       | 13                      | 29                      | 48                        | 420                         | 500                      | 12                      |
| NO 20-15            | 0.20                       | 15                      | 32                      | 55                        | 330                         | 450                      | 13                      |
| NO 25-13            | 0.25                       | 13                      | 32                      | 55                        | 420                         | 500                      | 11                      |
| NO 25-14            | 0.25                       | 14                      | 34                      | 62                        | 420                         | 500                      | 12                      |
| NO 25-17            | 0.25                       | 17                      | 40                      | 67                        | 330                         | 450                      | 13                      |
| NO 27-14            | 0.27                       | 14                      | 35                      | 63                        | 420                         | 500                      | 11                      |
| NO 27-15            | 0.27                       | 15                      | 37                      | 68                        | 420                         | 500                      | 12                      |
| NO 27-18            | 0.27                       | 18                      | 42                      | 70                        | 330                         | 450                      | 13                      |
| NO 30-15            | 0.30                       | 15                      | 38                      | 70                        | 420                         | 500                      | 11                      |
| NO 30-16            | 0.30                       | 16                      | 41                      | 71                        | 420                         | 500                      | 12                      |
| NO 30-19            | 0.30                       | 19                      | 45                      | 75                        | 330                         | 450                      | 13                      |
| NO 35-18            | 0.35                       | 18                      | 44                      | 73                        | 420                         | 500                      | 11                      |
| NO 35-19            | 0.35                       | 19                      | 48                      | 77                        | 420                         | 500                      | 12                      |
| NO 35-22            | 0.35                       | 22                      | 54                      | 85                        | 420                         | 500                      | 13                      |

Max. width: 1,000 mm. <sup>1)</sup> Adjustments to magnetic and mechanical properties possible after consultation.



## High frequencies. High demands.

Our HF grades feature both low nominal thicknesses and extremely low core losses – even lower than standard specifications. As a result, Waelzholz is setting new benchmarks in the industry. Optimized microstructures and precisely adjusted alloy concepts maximize magnetic performance – for a material that meets your most stringent requirements in high-frequency magnetic applications.

### Examples of electrical steel strip HF grades

| Grade <sup>1)</sup> | Nominal thickness<br>in mm | Max. core loss at       |                         |                           | Min. mechanical properties  |                          |                         |
|---------------------|----------------------------|-------------------------|-------------------------|---------------------------|-----------------------------|--------------------------|-------------------------|
|                     |                            | 1.0 T/400 Hz<br>in W/kg | 1.0 T/700 Hz<br>in W/kg | 1.0 T/1.000 Hz<br>in W/kg | R <sub>p0.2</sub><br>in MPa | R <sub>m</sub><br>in MPa | A <sub>80</sub><br>in % |
| NO 20-11.6 HF       | 0.20                       | 11.6                    | 26                      | 43                        | 420                         | 500                      | 11                      |
| NO 25-12.5 HF       | 0.25                       | 12.5                    | 30                      | 52                        | 420                         | 500                      | 11                      |
| NO 27-13.5 HF       | 0.27                       | 13.5                    | 33                      | 60                        | 420                         | 500                      | 11                      |
| NO 35-17 HF         | 0.35                       | 17.0                    | 43                      | 70                        | 420                         | 500                      | 11                      |

Max. width: 1,000 mm. <sup>1)</sup>Adjustments to magnetic and mechanical properties possible after consultation.

### NO grade delivery types

|                              |                      |             |
|------------------------------|----------------------|-------------|
| <b>Pancake coils</b>         |                      |             |
| Width                        | in mm                | 20 - 1,000  |
| Coil weight                  | in kg/mm strip width | max. 20     |
| Inner diameter               | in mm                | 508         |
| <b>Oscillate-wound coils</b> |                      |             |
| Strip width                  | in mm                | max. 59     |
| Coil weight                  | in kg                | max. 3,500  |
| Coil width                   | in mm                | max. 550    |
| Inner diameter               | in mm                | 400         |
| <b>Cut-to-length sheets</b>  |                      |             |
| Width of sheets              | in mm                | 400 - 1,000 |
| Length of sheets             | in mm                | 400 - 2,500 |

### Tolerances according to DIN EN 1030

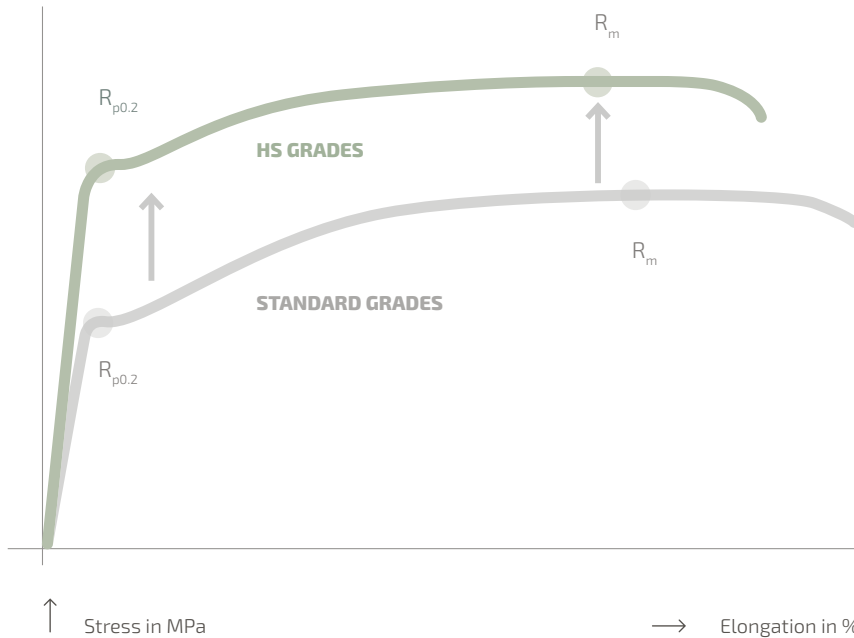
|                                                                    |       |           |           |           |           |           |           |           |
|--------------------------------------------------------------------|-------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>Thickness</b>                                                   |       |           |           |           |           |           |           |           |
| Nominal thickness                                                  | in mm | 0.10      | 0.15      | 0.20      | 0.25      | 0.27      | 0.30      | 0.35      |
| Deviation from nominal thickness                                   | in mm | +/- 0.010 | +/- 0.015 | +/- 0.020 | +/- 0.025 | +/- 0.027 | +/- 0.030 | +/- 0.030 |
| Thickness deviation over strip width (measurement 30 mm from edge) | in mm | 0.01      | 0.02      | 0.02      | 0.02      | 0.02      | 0.02      | 0.02      |

Special thicknesses and special tolerances upon request.

|                              |       |          |               |
|------------------------------|-------|----------|---------------|
| <b>Width</b>                 |       |          |               |
| Nominal width                | in mm | ≤ 150    | > 150 / ≤ 500 |
| Deviation from nominal width | in mm | + 0.4/-0 | + 0.6/-0      |
|                              |       |          | + 1.5/-0      |

|                             |                                            |
|-----------------------------|--------------------------------------------|
| <b>Steel sheet</b>          |                                            |
| Deviation from sheet length | in %                                       |
|                             | + 0.5/- 0 of the nominal value (max. 6 mm) |

# HS grades



## High-strength. For extreme mechanical stress.

Increasingly high motor speeds of up to 25,000 rpm require electrical steel strip that exhibits exceptional mechanical strength. Through a special alloy, we increase the tensile strength of our NO grades and achieve yield strengths of over 500 MPa. This is why our HS (high-strength) grades can be found, for example, in high-frequency automotive drives systems.

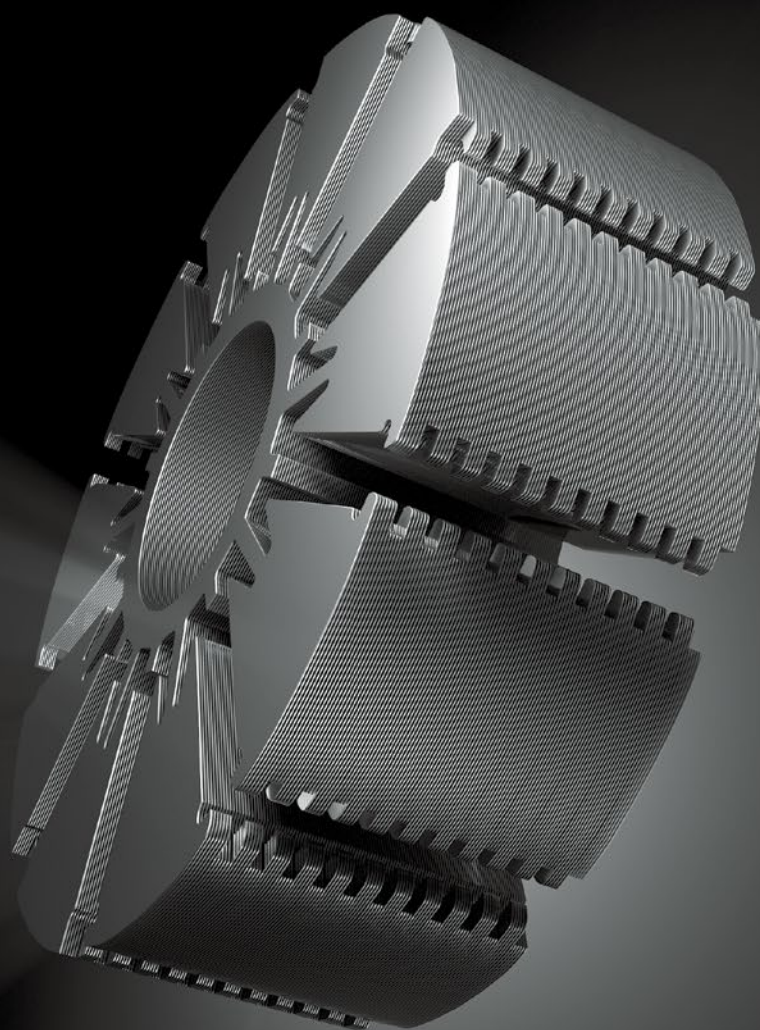
**01** Stress-strain diagram: HS grades are suitable for high-speed applications due to their robustness.

**02** Rotor stack

### Examples of electrical steel strip HS grades

| Grade <sup>1)</sup> | Nominal thickness<br>in mm | Max. core loss at      |                         |                           | Min. mechanical properties |                 |                  | Min. magnetic polarization at<br>2,500 A/m<br>in T |
|---------------------|----------------------------|------------------------|-------------------------|---------------------------|----------------------------|-----------------|------------------|----------------------------------------------------|
|                     |                            | 1.5 T/50 Hz<br>in W/kg | 1.0 T/400 Hz<br>in W/kg | 1.0 T/1,000 Hz<br>in W/kg | $R_{p0.2}$<br>in MPa       | $R_m$<br>in MPa | $A_{80}$<br>in % |                                                    |
| NO 20-20 HS         | 0.20                       | /                      | 20                      | 63                        | 500                        | 590             | 16               | 1.47                                               |
| NO 25-25 HS         | 0.25                       | /                      | 25                      | 72                        | 490                        | 590             | 18               | 1.50                                               |
| NO 35-28 HS         | 0.35                       | /                      | 28                      | 100                       | 530                        | 600             | 18               | 1.50                                               |
| M530-65A HS         | 0.65                       | 5.30                   | /                       | /                         | 500                        | 590             | 16               | 1.47                                               |

<sup>1)</sup> More high-strength variations available upon request.



Centrifugal forces exert enormous levels of stress on rotor blades, especially in the area around the teeth. This is why high-speed electric motors require electrical steel strip grades that exhibit high yield strengths through the use of strength-increasing alloys.

# HP grades

HP grades (High-Permeability/-Polarization) are used for high-performance electric drives that require a high degree of polarization. Thanks to their high level of permeability, these exhibit excellent magnetizability. They are also particularly efficient to use, as they allow significantly higher levels of polarization compared to standard grades with the same energy input. The high thermal conductivity of HP grades offers an advantage when it comes to the dissipation of operating heat, especially in the case of high-performance electric motors.

## Magnetic properties of HP grades

| Grade | Min. magnetic polarization<br>at 2,500 A/m according to<br>DIN EN 10106 | Waelzholz | Typ.<br>yield strength $R_{p0.2}$ | Typ.<br>tensile strength $R_m$ | Typ.<br>elongation $A_{80}$ | Typ.<br>hardness HV5 | Thermal<br>conductivity $\lambda$ |
|-------|-------------------------------------------------------------------------|-----------|-----------------------------------|--------------------------------|-----------------------------|----------------------|-----------------------------------|
|       | in T                                                                    | in T      | in MPa                            | in MPa                         | in %                        |                      | in W/mK                           |

### Nominal thickness: 0.50 mm

|             |      |      |     |     |    |     |      |
|-------------|------|------|-----|-----|----|-----|------|
| M350-50A HP | 1.50 | 1.56 | 340 | 470 | 29 | 160 | 24.5 |
| M400-50A HP | 1.53 | 1.58 | 340 | 470 | 29 | 160 | 24.5 |
| M470-50A HP | 1.54 | 1.59 | 300 | 430 | 30 | 135 | 30.3 |
| M530-50A HP | 1.56 | 1.61 | 300 | 430 | 30 | 135 | 30.3 |
| M600-50A HP | 1.57 | 1.62 | 295 | 415 | 34 | 130 | 34.6 |
| M700-50A HP | 1.60 | 1.65 | 295 | 415 | 34 | 130 | 34.6 |
| M800-50A HP | 1.60 | 1.65 | 295 | 415 | 34 | 130 | 34.6 |
| M940-50A HP | 1.62 | 1.66 | 295 | 415 | 34 | 130 | 34.6 |

### Nominal thickness: 0.65 mm

|              |      |      |     |     |    |     |      |
|--------------|------|------|-----|-----|----|-----|------|
| M400-65A HP  | 1.52 | 1.57 | 335 | 460 | 30 | 165 | 24.5 |
| M470-65A HP  | 1.53 | 1.58 | 340 | 470 | 30 | 165 | 24.5 |
| M530-65A HP  | 1.54 | 1.59 | 340 | 470 | 30 | 165 | 24.5 |
| M600-65A HP  | 1.56 | 1.61 | 300 | 430 | 32 | 140 | 30.3 |
| M700-65A HP  | 1.57 | 1.62 | 295 | 415 | 34 | 130 | 34.6 |
| M800-65A HP  | 1.60 | 1.66 | 295 | 415 | 34 | 130 | 34.6 |
| M1000-65A HP | 1.61 | 1.66 | 295 | 415 | 34 | 130 | 34.6 |

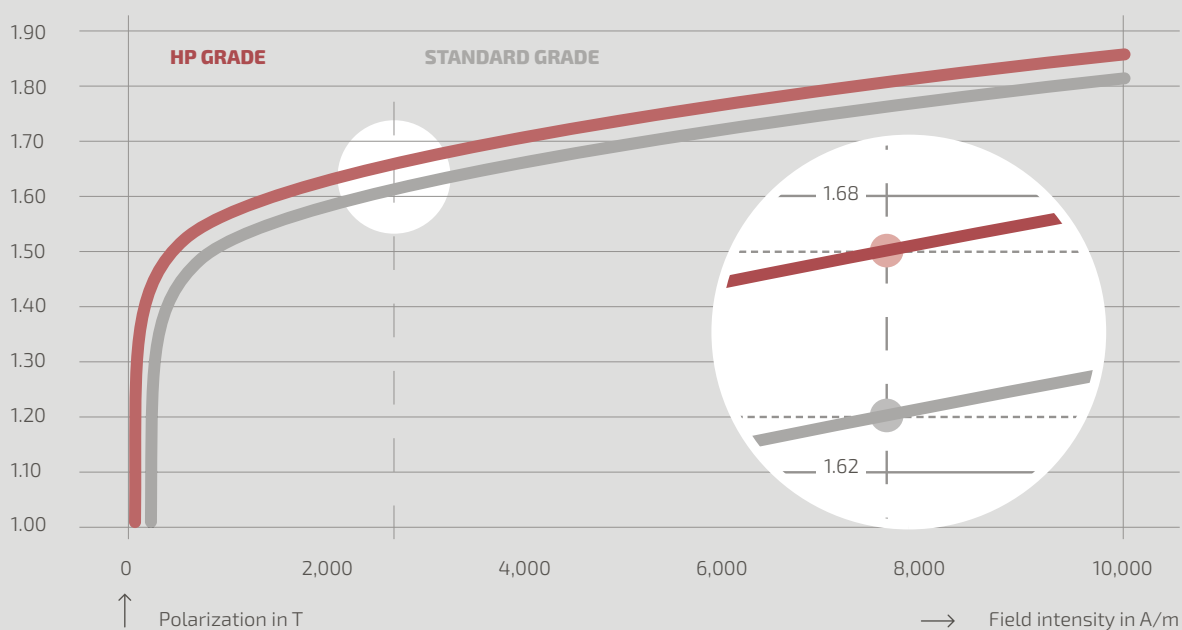
### Nominal thickness: 1.00 mm

|               |      |      |     |     |    |     |      |
|---------------|------|------|-----|-----|----|-----|------|
| M1400-100A HP | 1.60 | 1.66 | 295 | 415 | 34 | 130 | 34.6 |
|---------------|------|------|-----|-----|----|-----|------|

## More torque. Thanks to highly permeable materials.

Thanks to their excellent polarization properties, HP grades are used in applications that require higher levels of torque, for example.

- 01** Greater efficiency: Our HP grades' higher levels of polarization compared to standard grades offer our customers excellent magnetizability and, as a result, greater performance with the same energy input.



# Electrical steel strip

(according to DIN EN 10106)

## Electrical steel strip according to DIN EN 10106

| Grade          |                | Max. core loss at      |                                      | Min. magnetic polarization at |                   |                    | Waelzholz production averages |                          |     | Density <sup>1)</sup><br><br>in kg/dm <sup>3</sup> |
|----------------|----------------|------------------------|--------------------------------------|-------------------------------|-------------------|--------------------|-------------------------------|--------------------------|-----|----------------------------------------------------|
|                |                | 1.5 T/50 Hz<br>in W/kg | 1.0 T/50 Hz <sup>2)</sup><br>in W/kg | 2,500 A/m<br>in T             | 5,000 A/m<br>in T | 10,000 A/m<br>in T | R <sub>p0.2</sub><br>in MPa   | R <sub>m</sub><br>in MPa | HV5 |                                                    |
| DIN EN 10027-1 | DIN EN 10027-2 |                        |                                      |                               |                   |                    |                               |                          |     |                                                    |

### Nominal thickness: 0.35 mm

|                        |        |      |      |      |      |      |     |     |     |      |
|------------------------|--------|------|------|------|------|------|-----|-----|-----|------|
| M210-35A <sup>3)</sup> | 1.0802 | 2.10 | 0.90 | 1.49 | 1.60 | 1.70 | 410 | 530 | 200 | 7.65 |
| M235-35A <sup>3)</sup> | 1.0890 | 2.35 | 0.95 | 1.49 | 1.60 | 1.70 | 420 | 540 | 200 | 7.60 |
| M250-35A <sup>3)</sup> | 1.0800 | 2.50 | 1.00 | 1.49 | 1.60 | 1.70 | 360 | 510 | 200 | 7.60 |
| M270-35A <sup>3)</sup> | 1.0801 | 2.70 | 1.10 | 1.49 | 1.60 | 1.70 | 350 | 500 | 190 | 7.65 |
| M300-35A               | 1.0804 | 3.00 | 1.20 | 1.49 | 1.60 | 1.70 | 345 | 490 | 170 | 7.65 |
| M330-35A               | 1.0803 | 3.30 | 1.30 | 1.49 | 1.60 | 1.70 | 335 | 480 | 155 | 7.65 |

### Nominal thickness: 0.50 mm

|                        |        |      |      |      |      |      |     |     |     |      |
|------------------------|--------|------|------|------|------|------|-----|-----|-----|------|
| M230-50A <sup>3)</sup> | 1.0837 | 2.30 | 1.00 | 1.49 | 1.60 | 1.70 | 410 | 530 | 200 | 7.65 |
| M250-50A <sup>3)</sup> | 1.0891 | 2.50 | 1.05 | 1.49 | 1.60 | 1.70 | 420 | 540 | 200 | 7.60 |
| M270-50A <sup>3)</sup> | 1.0806 | 2.70 | 1.10 | 1.49 | 1.60 | 1.70 | 360 | 510 | 200 | 7.60 |
| M290-50A <sup>3)</sup> | 1.0807 | 2.90 | 1.15 | 1.49 | 1.60 | 1.70 | 350 | 500 | 190 | 7.60 |
| M310-50A               | 1.0808 | 3.10 | 1.25 | 1.49 | 1.60 | 1.70 | 345 | 490 | 180 | 7.65 |
| M330-50A               | 1.0809 | 3.30 | 1.35 | 1.49 | 1.60 | 1.70 | 335 | 480 | 160 | 7.65 |
| M350-50A               | 1.0810 | 3.50 | 1.50 | 1.50 | 1.60 | 1.70 | 330 | 475 | 155 | 7.65 |
| M400-50A               | 1.0811 | 4.00 | 1.70 | 1.53 | 1.63 | 1.73 | 325 | 465 | 150 | 7.70 |
| M470-50A               | 1.0812 | 4.70 | 2.00 | 1.54 | 1.64 | 1.74 | 320 | 460 | 145 | 7.70 |
| M530-50A               | 1.0813 | 5.30 | 2.30 | 1.56 | 1.65 | 1.75 | 315 | 450 | 140 | 7.70 |
| M600-50A               | 1.0814 | 6.00 | 2.60 | 1.57 | 1.66 | 1.76 | 310 | 440 | 135 | 7.75 |
| M700-50A               | 1.0815 | 7.00 | 3.00 | 1.60 | 1.69 | 1.77 | 300 | 430 | 130 | 7.80 |
| M800-50A               | 1.0816 | 8.00 | 3.60 | 1.60 | 1.70 | 1.78 | 295 | 420 | 125 | 7.80 |
| M940-50A               | 1.0817 | 9.40 | 4.20 | 1.62 | 1.72 | 1.81 | 280 | 400 | 120 | 7.85 |

### Nominal thickness: 0.65 mm

|                        |        |       |      |      |      |      |     |     |     |      |
|------------------------|--------|-------|------|------|------|------|-----|-----|-----|------|
| M310-65A <sup>3)</sup> | 1.0892 | 3.10  | 1.25 | 1.49 | 1.60 | 1.70 | 420 | 540 | 200 | 7.60 |
| M330-65A <sup>3)</sup> | 1.0819 | 3.30  | 1.35 | 1.49 | 1.60 | 1.70 | 350 | 500 | 190 | 7.60 |
| M350-65A               | 1.0820 | 3.50  | 1.50 | 1.49 | 1.60 | 1.70 | 345 | 485 | 175 | 7.60 |
| M400-65A               | 1.0821 | 4.00  | 1.70 | 1.52 | 1.62 | 1.72 | 340 | 480 | 160 | 7.65 |
| M470-65A               | 1.0823 | 4.70  | 2.00 | 1.53 | 1.63 | 1.73 | 335 | 475 | 155 | 7.65 |
| M530-65A               | 1.0824 | 5.30  | 2.30 | 1.54 | 1.64 | 1.74 | 325 | 465 | 150 | 7.70 |
| M600-65A               | 1.0825 | 6.00  | 2.60 | 1.56 | 1.66 | 1.76 | 315 | 450 | 140 | 7.75 |
| M700-65A               | 1.0826 | 7.00  | 3.00 | 1.57 | 1.67 | 1.76 | 310 | 440 | 135 | 7.75 |
| M800-65A               | 1.0827 | 8.00  | 3.60 | 1.60 | 1.70 | 1.78 | 300 | 430 | 130 | 7.80 |
| M1000-65A              | 1.0829 | 10.00 | 4.40 | 1.61 | 1.71 | 1.80 | 280 | 400 | 120 | 7.80 |

### Nominal thickness: 1.00 mm

|            |        |       |      |      |      |      |     |     |     |      |
|------------|--------|-------|------|------|------|------|-----|-----|-----|------|
| M600-100A  | 1.0893 | 6.00  | 2.60 | 1.53 | 1.63 | 1.72 | 340 | 485 | 180 | 7.60 |
| M700-100A  | 1.0894 | 7.00  | 3.00 | 1.54 | 1.64 | 1.73 | 330 | 475 | 160 | 7.65 |
| M800-100A  | 1.0895 | 8.00  | 3.60 | 1.56 | 1.66 | 1.75 | 320 | 460 | 150 | 7.70 |
| M1000-100A | 1.0896 | 10.00 | 4.40 | 1.58 | 1.68 | 1.76 | 295 | 420 | 125 | 7.80 |
| M1300-100A | 1.0897 | 13.00 | 5.80 | 1.60 | 1.70 | 1.78 | 280 | 400 | 120 | 7.80 |

<sup>1)</sup> Density can be calculated on the basis of the chemical composition of the alloy. <sup>2)</sup> Not obligatory acc. to DIN EN 10106. <sup>3)</sup> Max. width: 1,000 mm.

## Classic precision. And even more precise on request.

Our range of grades of DIN EN 10106-compliant non-grain oriented electrical steel strip extends from low-alloy steels with good permeability and thermal conductivity to high-alloy steels with low core losses. The dimensional tolerances correspond to the specifications of EN 10106, but can also be fine-tuned to meet your requirements. HS versions (High Strength) of these grades are available on request.

### Comparison of standards

| Max. core loss at          |                         | Denomination of grades according to common international standards |                       |                     |                        |                        |                |                    |
|----------------------------|-------------------------|--------------------------------------------------------------------|-----------------------|---------------------|------------------------|------------------------|----------------|--------------------|
| 1.5 T/50 Hz<br>in W/kg     | 1.5 T/60 Hz<br>in W/lbs | DIN EN 10106<br>(2024)                                             | IEC 404-8-4<br>(1998) | JIS C2552<br>(2000) | GOST 21427.2<br>(1983) | ASTM A677-07<br>(2007) | AISI<br>(1983) | GB/T2521<br>(1996) |
| Nominal thickness: 0.35 mm |                         |                                                                    |                       |                     |                        |                        |                |                    |
| 2.10                       | 1.20                    | M210-35A                                                           | M210-35A 5            | 35A210              |                        |                        |                |                    |
| 2.35                       | 1.35                    | M235-35A                                                           |                       | 35A230              |                        |                        |                | 35W230             |
| 2.50                       | 1.42                    | M250-35A                                                           | 250-35A5              | 35A250              | 2413                   | 36F145                 | M-15           | 35W250             |
| 2.70                       | 1.52                    | M270-35A                                                           | 270-35A5              | 35A270              | 2412                   | 36F155                 | M-19           | 35W270             |
| 3.00                       | 1.70                    | M300-35A                                                           | 300-35A5              | 35A300              | 2411                   | 36F175                 | M-22           | 35W300             |
| 3.30                       | 1.87                    | M330-35A                                                           | 330-35A5              |                     |                        | 36F185                 | M-36           | 35W330             |
| Nominal thickness: 0.50 mm |                         |                                                                    |                       |                     |                        |                        |                |                    |
| 2.30                       | 1.34                    | M230-50A                                                           | M230-50A 5            | 50A230              |                        |                        |                |                    |
| 2.50                       | 1.46                    | M250-50A                                                           |                       |                     |                        |                        |                | 50W250             |
| 2.70                       | 1.57                    | M270-50A                                                           | 270-50A5              | 50A270              | 2414                   | 47F165                 | M-15           | 50W270             |
| 2.90                       | 1.68                    | M290-50A                                                           | 290-50A5              | 50A290              | 2413                   | 47F180                 | M-19           | 50W290             |
| 3.10                       | 1.79                    | M310-50A                                                           | 310-50A5              | 50A310              | 2412                   | 47F190                 | M-22           | 50W310             |
| 3.30                       | 1.90                    | M330-50A                                                           | 330-50A5              | 50A330              |                        | 47F200                 | M-27           | 50W330             |
| 3.50                       | 2.02                    | M350-50A                                                           | 350-50A5              | 50A350              | 2411                   | 47F210                 | M-36           | 50W350             |
| 4.00                       | 2.31                    | M400-50A                                                           | 400-50A5              | 50A400              | 2216                   | 47F240                 | M-43           | 50W400             |
| 4.70                       | 2.68                    | M470-50A                                                           | 470-50A5              | 50A470              | 2214                   | 47F280                 |                | 50W470             |
| 5.30                       | 3.02                    | M530-50A                                                           | 530-50A5              |                     | 2212                   |                        | M-45           | 50W540             |
| 6.00                       | 3.41                    | M600-50A                                                           | 600-50A5              | 50A600              | 2112                   |                        |                | 50W600             |
| 7.00                       | 3.99                    | M700-50A                                                           | 700-50A5              | 50A700              | 2111                   | 47F400                 | M-47           | 50W700             |
| 8.00                       | 4.56                    | M800-50A                                                           | 800-50A5              | 50A800              | 2011                   | 47F450                 |                | 50W800             |
| 9.40                       | 5.37                    | M940-50A                                                           |                       | 50A1000             |                        |                        |                | 50W1000            |
| Nominal thickness: 0.65 mm |                         |                                                                    |                       |                     |                        |                        |                |                    |
| 3.10                       | 1.85                    | M310-65A                                                           |                       |                     |                        |                        |                | 65W600             |
| 3.30                       | 1.95                    | M330-65A                                                           |                       |                     |                        | 64F200                 |                | 65W700             |
| 3.50                       | 2.07                    | M350-65A                                                           | 350-65A5              |                     |                        | 64F210                 | M-19           | 65W800             |
| 4.00                       | 2.36                    | M400-65A                                                           | 400-65A5              |                     |                        | 64F235                 | M-27           | 65W1000            |
| 4.70                       | 2.78                    | M470-65A                                                           | 470-65A5              |                     |                        | 64F275                 | M-43           | 65W1300            |
| 5.30                       | 3.10                    | M530-65A                                                           | 530-65A5              |                     | 2312                   | 64F320                 |                | 65W1600            |
| 6.00                       | 3.50                    | M600-65A                                                           | 600-65A5              |                     | 2212                   |                        | M-45           |                    |
| 7.00                       | 4.07                    | M700-65A                                                           | 700-65A5              |                     | 2212                   |                        |                |                    |
| 8.00                       | 4.65                    | M800-65A                                                           | 800-65A5              | 65A800              | 2122                   | 64F500                 | M-47           |                    |
| 10.00                      | 5.79                    | M1000-65A                                                          | 1000-65A5             | 65A1000             |                        | 64F550                 |                |                    |
| Nominal thickness: 1.00 mm |                         |                                                                    |                       |                     |                        |                        |                |                    |
| 6.00                       | 3.69                    | M600-100A                                                          |                       |                     |                        |                        |                |                    |
| 7.00                       | 4.25                    | M700-100A                                                          |                       |                     |                        |                        |                |                    |
| 8.00                       | 4.85                    | M800-100A                                                          |                       |                     |                        |                        |                |                    |
| 10.00                      | 6.07                    | M1000-100A                                                         |                       |                     |                        |                        |                |                    |
| 13.00                      | 7.86                    | M1300-100A                                                         |                       |                     |                        |                        |                |                    |

## Tolerances according to DIN EN 10106

### Thickness

|                                                                       |       |          |          |          |          |
|-----------------------------------------------------------------------|-------|----------|----------|----------|----------|
| Nominal thickness                                                     | in mm | 0.35     | 0.50     | 0.65     | 1.00     |
| Deviation from nominal thickness                                      | in %  | +/- 8    | +/- 8    | +/- 6    | +/- 6    |
|                                                                       | in mm | +/- 0.03 | +/- 0.04 | +/- 0.04 | +/- 0.06 |
| Thickness deviation over strip width<br>(measurement 30 mm from edge) | in mm | + 0.02   | + 0.02   | + 0.03   | + 0.03   |

Special thicknesses and special tolerances upon request

### Width

|                              |       |       |               |               |                 |         |
|------------------------------|-------|-------|---------------|---------------|-----------------|---------|
| Nominal width                | in mm | < 150 | ≥ 150 / ≤ 300 | > 300 / ≤ 600 | > 600 / ≤ 1,000 | > 1,000 |
| Deviation from nominal width | in mm | + 0.2 | + 0.3         | + 0.5         | +1.0            | +1.5    |
|                              |       | - 0   | - 0           | - 0           | - 0             | - 0     |

### Steel sheet

|                             |      |                                            |
|-----------------------------|------|--------------------------------------------|
| Deviation from sheet length | in % | + 0.5/- 0 of the nominal value (max. 6 mm) |
|-----------------------------|------|--------------------------------------------|

## DIN EN 10106 grade delivery types

### Pancake coils

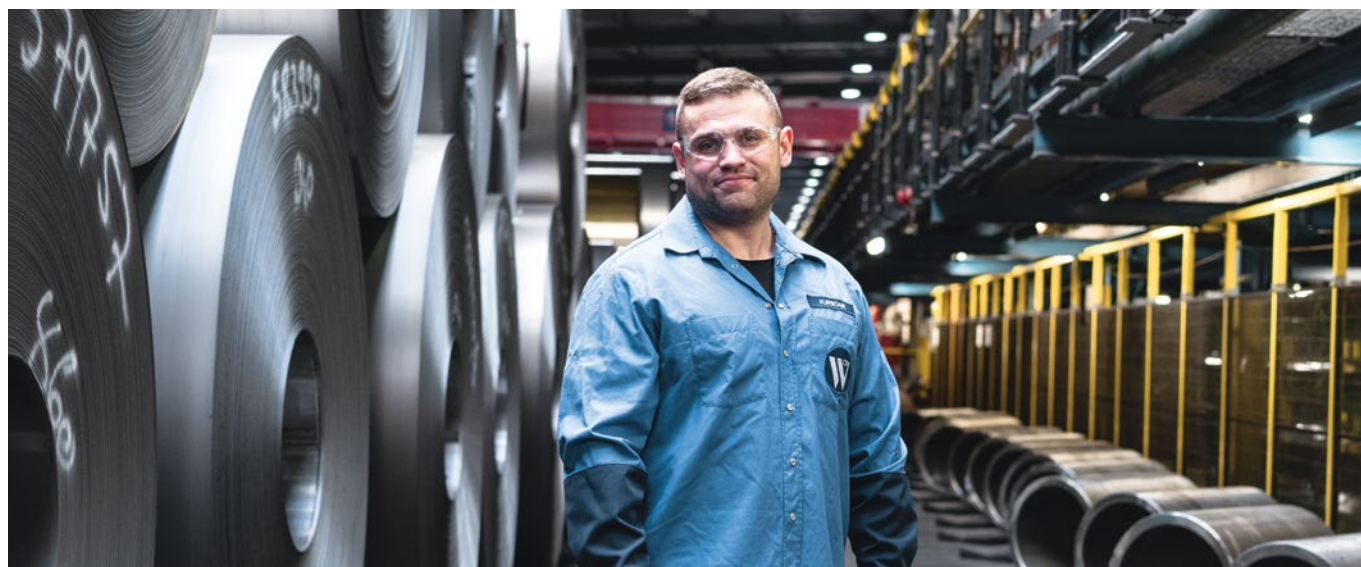
|                |                      |            |
|----------------|----------------------|------------|
| Width          | in mm                | 20 - 1,270 |
| Coil weight    | in kg/mm strip width | max. 20    |
| Inner diameter | in mm                | 508        |

### Oscillate-wound coils

|                |       |            |
|----------------|-------|------------|
| Strip width    | in mm | max. 59    |
| Coil weight    | in kg | max. 3,500 |
| Coil width     | in mm | max. 550   |
| Inner diameter | in mm | 400        |

### Cut-to-length sheets

|                  |       |             |
|------------------|-------|-------------|
| Width of sheets  | in mm | 400 - 1,250 |
| Length of sheets | in mm | 400 - 2,500 |



# Pole sheets and soft magnetic iron

## Defined properties. Tailor-made for your application.

Pole sheets according to DIN EN 10265 are characterized by high degrees of polarization and thus strong magnetic fields combined with high yield strengths. We offer a wide range of these standard materials with precisely defined properties.

For the use in electrical switching systems, we also manufacture mild magnetic steel in various grades (RFe grades) according to DIN 17405 and DIN EN 10304. These possess defined levels of coercivity.

### Pole sheets according to DIN EN 10265

| Grade          | Material number | Min. yield strength  | Min. tensile strength | Min. elongation  | Min. magnetic polarization at |                    |
|----------------|-----------------|----------------------|-----------------------|------------------|-------------------------------|--------------------|
|                |                 | $R_{p0.2}$<br>in MPa | $R_m$<br>in MPa       | $A_{80}$<br>in % | 5,000 A/m<br>in T             | 15,000 A/m<br>in T |
| 250-100-TF 183 | 1.0280          | 250                  | 375                   | 16               | 1.60                          | 1.83               |
| 300-100-TF 182 | 1.0281          | 300                  | 390                   | 15               | 1.55                          | 1.82               |
| 350-100-TF 181 | 1.0282          | 350                  | 440                   | 13               | 1.52                          | 1.81               |
| 400-100-TF 180 | 1.0283          | 400                  | 460                   | 10               | 1.50                          | 1.80               |

### Mild magnetic steel (RFe grades)

| Grade according to |              | Material number | Max. coercive field strength<br>after reference annealing<br>in A/m | Max.<br>hardness<br>in HV | Min. magnetic polarization<br>at 500 A/m<br>in T | Delivery<br>condition |
|--------------------|--------------|-----------------|---------------------------------------------------------------------|---------------------------|--------------------------------------------------|-----------------------|
| DIN 17405          | DIN EN 10304 |                 |                                                                     |                           |                                                  |                       |
| RFe 120            | M120         | 1.1012          | 120                                                                 | 150                       | 1.30                                             | GT / GB               |
| RFe 100            | M100         | 1.1013          | 100                                                                 | 150                       | 1.30                                             | GT / GB               |
| RFe 80             | M80          | 1.1014          | 80                                                                  | 150                       | 1.30                                             | GT / GB               |
| RFe 40             | M40          | 1.1016          | 40                                                                  | 150                       | 1.35                                             | GT / GB               |

# INSULATE, PROTECT, CONNECT. OUR COATING SYSTEMS.

We have developed a wide range of coating systems for our customers. These include classic insulating varnishes, bonding varnish, combination coatings, and other special solutions. The coating systems combine different benefits with regard to further processing and the use of electrical steel strip. One of our main areas of expertise is combining the right electrical steel strip and coating system for your application. Contact us to find out what benefits we can achieve for you with our coating systems.

## Coating systems

| ASTM class | IEC class | Waelzholz coating type                           | Color         | Thickness per side<br><br>in µm | Continuous thermal resistance under air<br><br>IEC 60404-12<br>in °C | Annealing resistance under inert gas<br><br>IEC 60404-12<br>in °C | Surface resistance<br><br>ASTM 717<br>in Ω • cm <sup>2</sup> /lam | Chemical resistance<br><br>DIN 8944 | Weldability<br><br>SEP 1210 |
|------------|-----------|--------------------------------------------------|---------------|---------------------------------|----------------------------------------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------|-------------------------------------|-----------------------------|
| C-3        | EC-3      | PH3                                              | golden yellow | 1 - 7                           | 180                                                                  | -                                                                 | 10 - 200                                                          | resistant                           | -                           |
|            |           | PE75W<br>(bonding varnish)                       | transparent   | 3 - 6                           | 180 <sup>1)</sup>                                                    | -                                                                 | /                                                                 | /                                   | -                           |
|            |           | PE49<br>(bonding varnish)                        | transparent   | 3 - 6                           | 180 <sup>1)</sup>                                                    | -                                                                 | /                                                                 | /                                   | -                           |
|            |           | PE75W-HP<br>(fast-bonding varnish)               | transparent   | 3 - 6                           | 180 <sup>1)</sup>                                                    | -                                                                 | /                                                                 | /                                   | -                           |
|            |           | PE49-Rapid<br>(fast-bonding varnish)             | transparent   | 3 - 6                           | 180 <sup>1)</sup>                                                    | -                                                                 | /                                                                 | /                                   | -                           |
|            |           | PE49-Pulse<br>(media-tight-fast-bonding-varnish) | transparent   | 3 - 6                           | 180 <sup>1)</sup>                                                    | -                                                                 | /                                                                 | /                                   | -                           |
| C-5        | EC-5      | AN50 S                                           | transparent   | 0.5 - 1.5                       | 210                                                                  | 600                                                               | 5 - 50                                                            | resistant                           | ++                          |
|            |           | AN50 V                                           | grey          | 0.5 - 5                         | 210                                                                  | 800                                                               | > 50                                                              | resistant                           | +                           |
|            |           | AN8                                              | grey          | 1 - 4                           | 270                                                                  | 600                                                               | 20 - 200                                                          | resistant                           | +                           |
| C-6        | EC-6      | PH2                                              | grey          | 2 - 7                           | 180                                                                  | 500                                                               | > 10,000                                                          | resistant                           | -                           |
|            |           | PH2 FF                                           | grey          | 2 - 7                           | 180                                                                  | 500                                                               | > 10,000                                                          | resistant                           | -                           |
|            |           | PH20                                             | grey          | 1 - 3                           | 180                                                                  | 500                                                               | > 10,000                                                          | resistant                           | -                           |

<sup>1)</sup> Thermal class acc. to IEC 60404-12

- less suitable    + suitable    ++ extremely suitable

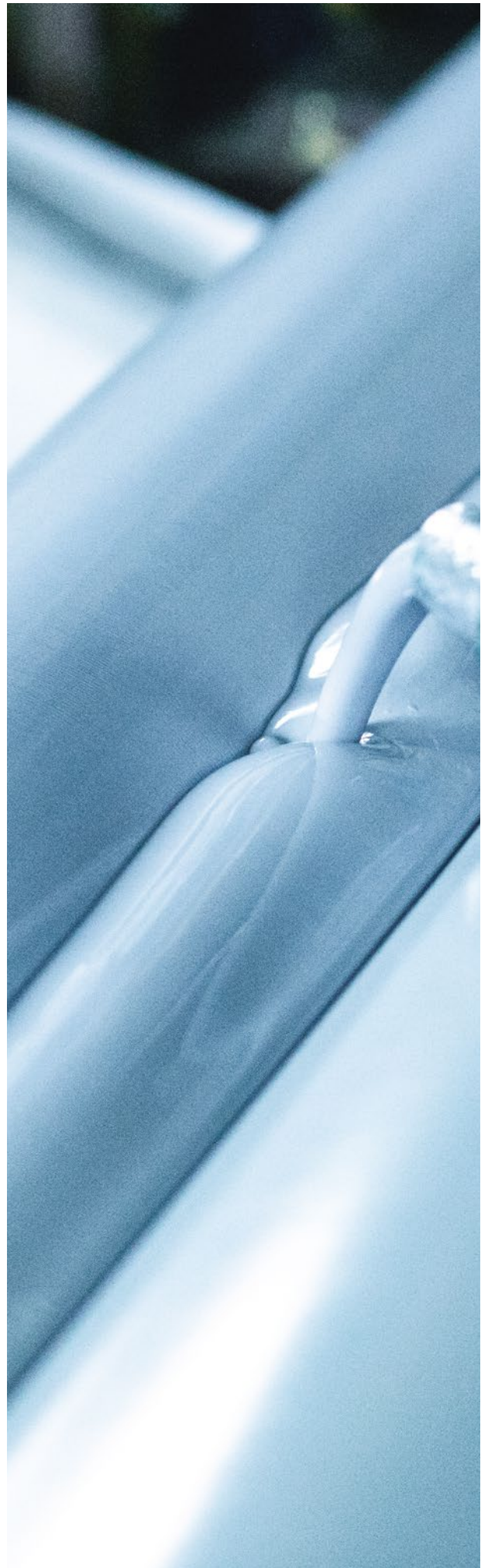
- 01** Precision: Applying a coating to electrical steel strips requires a highly accurate control system to create a homogeneous layer on the surface of the strip.

**Versatile. And precisely tailored to the application.**

Every electrical steel strip application has its own specific requirements. This is why we offer our customers a wide range of insulating varnishes. This allows us to precisely match the choice of insulating coating to the application. In this context, the focus is not only on insulating the electrical steel strips, but also, for example, on corrosion protection, chemical resistance, or thermal stability. Consideration is also given to aspects of further processing such as the steel's ability to be punched or welded. As with our electrical steel strip, you have the choice between the existing standard systems and systems developed specifically for your requirements.

**The environment. Always in mind.**

The focus of our development activities is on a combination of organic and inorganic coatings that we can use to precisely define desired properties. In addition to the high functionality of the coating systems, environmental protection is an important aspect for us in the production of the coatings. That is why we only produce water-soluble coatings.



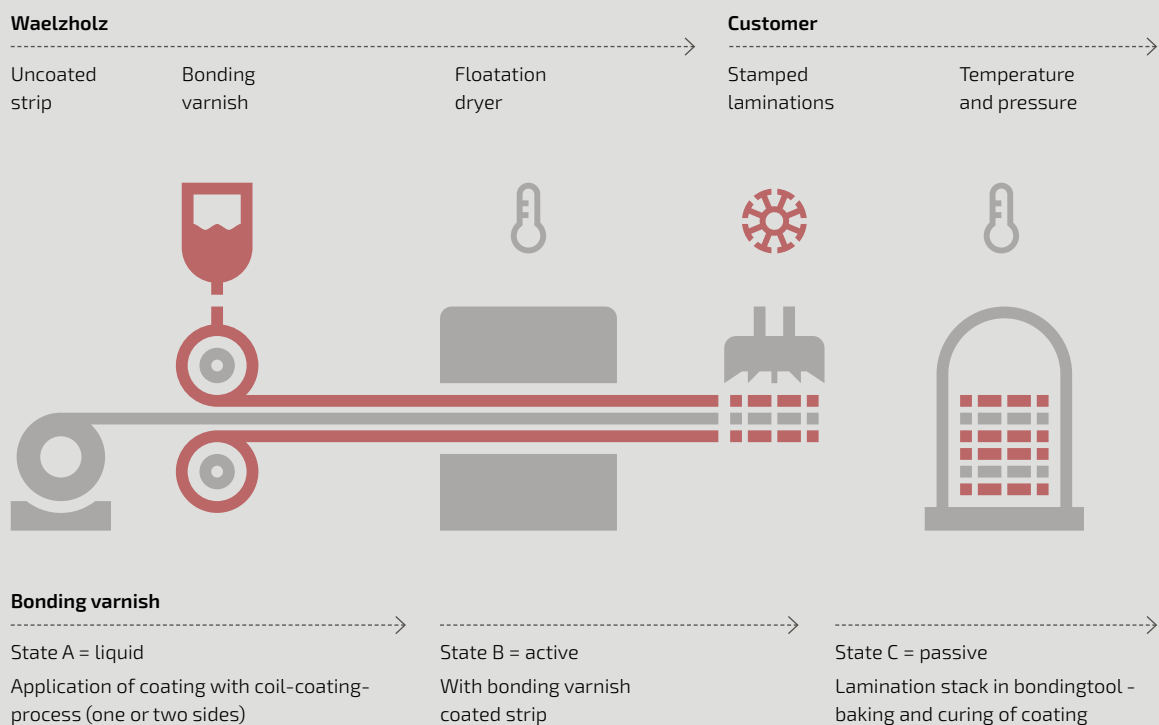
# Bonding varnish

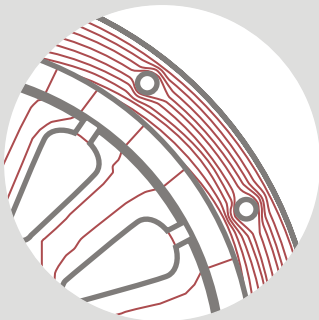
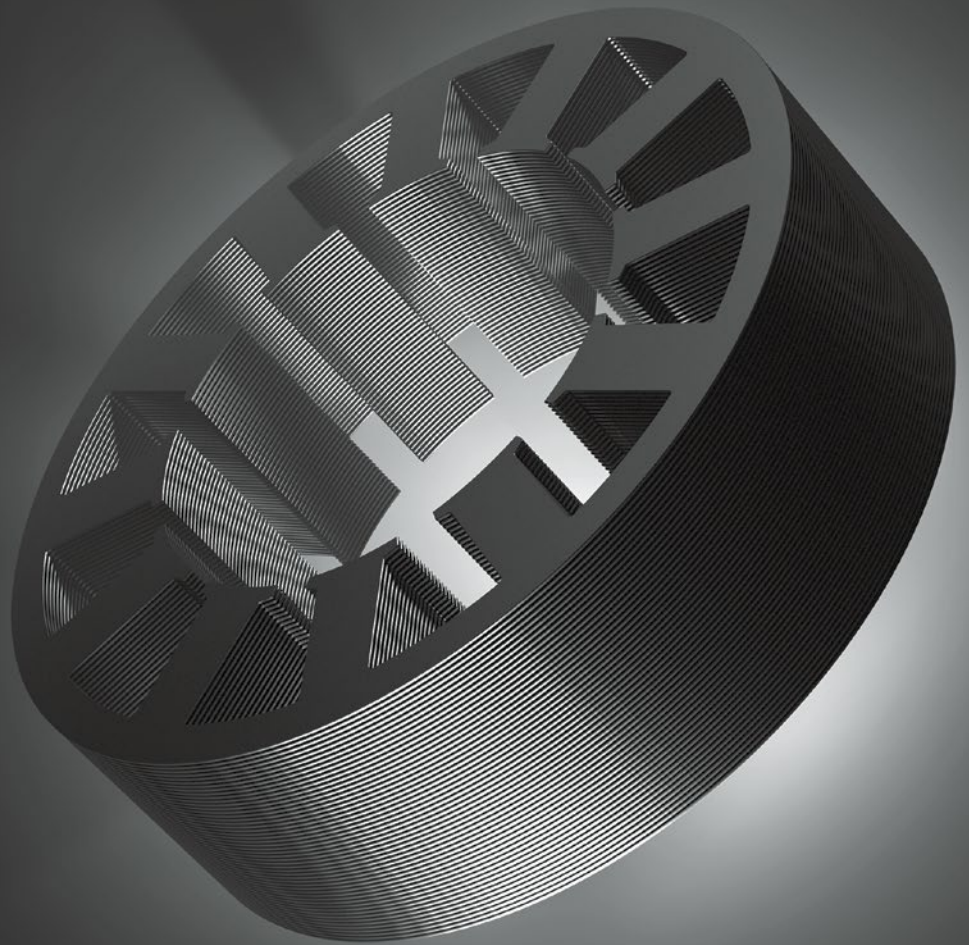
## Failure-free connection. Undisturbed magnetic flux.

The performance of lamination stacks for electric motors and generators is determined by the magnetic flux, among other factors. In order to fully tap the potential of the lamination stack, this needs to be as undisturbed as possible. However, welds, punch stacking, or rivets are all disturbing connections that impair the magnetic flux. But this is not the case when bonding with bonding varnish – here the stacks are simply glued together by the bonding varnish without affecting the electrical steel strip's fundamental material properties.

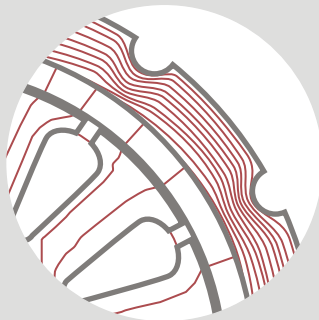
Beyond that, the bonding varnish technology combines a great number of other benefits. With bonding varnish the punchability of the steel strip is improved, which enables the realization of complex geometries. In the baking process, compact and waterproof lamination stacks with no varnish discharge are formed. On top of that, the risk of stack humming during later use, which can occur with the other bonding methods, is eliminated with bonding varnish.

- 01 Lamination stack production process with bonding varnish
- 02 Stator stack with bonding varnish
- 03 Undisturbed magnetic flux with sheets coated with bonding varnish

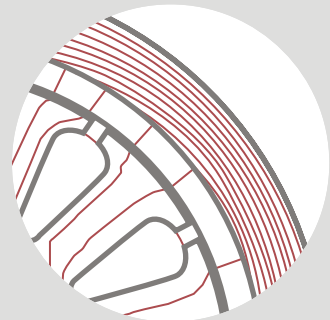




Disturbed magnetic flux  
due to rivets



Disturbed magnetic flux  
due to welds



Bonding varnish:  
Undisturbed magnetic flux  
due to absence of irregularities

# Special Coatings

## **Exact. Tailored to your needs.**

Many projects require individual coating systems that are designed to meet the specific requirements of the area of application. This can include, for example, a special degree of insulation or a certain layer thickness. If necessary, we can develop such a system to meet specific customer needs. In addition, we also combine various coating systems to exploit the respective properties of the individual systems together. An example is the synthesis of insulating varnish and bonding varnish – this custom coating combines excellent insulating properties with the bonding varnish bonding technology. In this case, the common combination of C-6 coating and bonding varnish offers an extremely high degree of insulating resistance with an undisturbed magnetic flux.



# CONVERSION TABLE

| SIZE                     | UNIT<br>FROM           | TO                     | CONVERSION<br>FACTOR  |
|--------------------------|------------------------|------------------------|-----------------------|
| Magnetic polarization    | $T = Wb/m^2 = Vs/m^2$  | $Wb/cm^2 = Vs/cm^2$    | $10^{-4}$             |
|                          | T                      | G                      | $10^4$                |
|                          | T                      | lines/square inch      | $6.45 \times 10^4$    |
|                          | $Vs/cm^2$              | T                      | $10^4$                |
|                          | G                      | T                      | $10^{-4}$             |
|                          | lines/square inch      | T                      | $1.55 \times 10^{-5}$ |
| Magnetic field intensity | A/m                    | A/cm                   | 0.01                  |
|                          | A/m                    | Oe                     | 0.0126                |
|                          | A/m                    | ampere-turns/inch      | 0.0254                |
|                          | A/cm                   | A/m                    | 100                   |
|                          | Oe                     | A/m                    | 79.6                  |
|                          | ampere-turns/inch      | A/m                    | 39.4                  |
| Core loss                | W/kg                   | W/lb                   | 0.454                 |
|                          | W/lb                   | W/kg                   | 2.2046                |
|                          | W/kg (50 Hz)           | W/kg (60 Hz)           | 1.266                 |
|                          | W/kg (60 Hz)           | W/kg (50 Hz)           | 0.79                  |
|                          | W/kg (50 Hz)           | W/lb (60 Hz)           | 0.574                 |
|                          | W/lb (60 Hz)           | W/kg (50 Hz)           | 1.737                 |
| Tensile strength         | MPa                    | kp/mm <sup>2</sup>     | 0.102                 |
|                          | MPa                    | psi                    | 145                   |
|                          | kp/mm <sup>2</sup>     | MPa                    | 9.81                  |
|                          | psi                    | MPa                    | $6.90 \times 10^{-3}$ |
| Force                    | N = kgm/s <sup>2</sup> | kp                     | 0.102                 |
|                          | kp                     | N = kgm/s <sup>2</sup> | 9.81                  |
| Weight                   | g                      | ounce                  | 0.0353                |
|                          | kg                     | pound                  | 2.2046                |
|                          | ounce                  | g                      | 28.4                  |
|                          | pound                  | kg                     | 0.454                 |
| Length                   | mm                     | inch                   | 0.0394                |
|                          | inch                   | mm                     | 25.4                  |
| Area                     | cm <sup>2</sup>        | square inch            | 0.155                 |
|                          | square inch            | cm <sup>2</sup>        | 6.45                  |
| Volume                   | cm <sup>3</sup>        | cubic inch             | 0.061                 |
|                          | cubic inch             | cm <sup>3</sup>        | 16.387                |
| Temperature              | °C                     | °F                     | $1.8 + 32$            |
|                          | °F                     | °C                     | $0.556 - 17.8$        |



# MORE THAN ELECTRICAL STEEL STRIP AND COATING SYSTEMS

**Discover our wide range of tailor-made steel materials  
and our worldwide services.**

High-quality electrical steel strip from Waelzholz forms the basis of many of our customers' sophisticated products. Our goal has been and continues to be the provision of customized steel materials in this sector. If nothing else, we achieve this through our comprehensive expertise in the development and production of our wide range of materials for highly diverse applications.

As a technology leader for sophisticated steel strip solutions, we rely on uncompromising premium quality. Solution-oriented engineering and services for all phases of the value-added chain make us a reliable partner worldwide.

➤ For further information visit  
[waelzholz.com/company](https://waelzholz.com/company)

# OUR MATERIALS AT A GLANCE

| PRODUCT GROUP                     | VARIATIONS                                                                                                                                                        | CUSTOMER BENEFIT                                                                                                                                                                                            |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cold rolled steel strip           | DC-grade steel, micro-alloyed steel, case-hardening steel, steel for hardening and tempering, spring steel or fine blanking grades: alloyed or as standard grades | Unparalleled dimensional accuracy, good formability, suitable for heat treatment, high elasticity, optimal combination of tensile strength and formability                                                  |
| Hardened and tempered steel strip | Martensite, bainite, sorbite                                                                                                                                      | Hardness, homogeneity, spring properties, high resistance to wear, substitution of piece hardening                                                                                                          |
| High-strength steel strip         | High-strength, micro-alloyed fine grained steel                                                                                                                   | High resistance to wear and good formability at the same time                                                                                                                                               |
| Surface-coated steel strip        | With a phosphate layer refined case-hardening or DC-grade steel                                                                                                   | Implementation of complex, multi-stage forming operations, prolonged service life of the forming tool                                                                                                       |
| Profiles                          | Over 250 different profile shapes made of steel strip or wire                                                                                                     | Tailored geometries, cross-sections tailored to customer products and processes                                                                                                                             |
| Electrical steel strip            | NO grades, HF grades, HS grades, HP grades, DIN EN 10106, DIN EN 10303, bonding varnish, fast-bonding varnish or insulating varnish                               | Thermal conductivity, low core losses, high magnetic polarization, high mechanical durability at high speeds, undisturbed magnetic flux due to elimination of imperfections, improved insulation resistance |
| Flat wire products                | Wide range of materials from spring steel to hardened and tempered steel strip                                                                                    | Prolonged service life thanks to a mill edge, high tensile strength and even bending properties                                                                                                             |
| Stainless precision steel strip   | Corrosion-resistant steel, upon request with special alloys                                                                                                       | Resistance to corrosion, acids or heat                                                                                                                                                                      |

# Customized materials for your industry

Our customers develop future-oriented products in the key industries of today and tomorrow. Here, innovative material solutions are an essential foundation. We know and understand our customers' industries and their requirements – from mobility to energy to multifaceted industrial applications..



We combine this industry expertise with our excellent engineering competence and fine-tuned production processes. Our extensive range of production lines in combination with state-of-the-art and intelligently networked measuring and control technology allows us to produce materials with outstanding properties and to reliably achieve reproducible quality in all areas. This is how we develop and produce one thing in particular for our customers: Unparalleled quality..

↗ For further information visit  
[waelzholz.com/steel-materials](https://waelzholz.com/steel-materials)

An international orientation has characterized the successful development of our company since the very start. Today 2,300 employees in Europe, North and South America, and Asia produce more than 780,000 tons of high-quality steel strip and profiles annually.

## **First choice when it comes to the future of cold rolled steel strip. Worldwide.**

Personal relationships, the digital networking of our production sites and consistently high process standards are what counts when it comes to providing our customers with engineering, production and supply chain management expertise in unparalleled high-quality. Regardless of time and place, anywhere in the world.

This is how we pursue our long-term strategy: continuing consequently our journey as a medium-sized, independent, family-owned company with the development of customized material solutions. So that in the tradition of long-term partnerships we will remain our customers' first choice when it comes to the future of cold rolled steel strip.

➤ For further information visit  
[waelzholz.com/contact-partner](https://waelzholz.com/contact-partner)

# WELL POSITIONED



|                                       |                                                           |
|---------------------------------------|-----------------------------------------------------------|
| Locations worldwide                   | 13 locations in Europe, North and South America, and Asia |
| Employees worldwide                   | 2,300                                                     |
| Sales volume steel materials          | 780,000 tons/year                                         |
| Share of production outside of Europe | 33 %                                                      |
| International share of sales          | 65 %                                                      |

