

Carbon Brushes for Industrial and Railway Application

Physical data of the principal grades

To characterize carbon and graphite materials used for carbon brushes, it is sufficient to state the following material characteristics:

- Specific electrical resistance
- Hardness
- Bending strength and Bulk density

For metal-graphite grades, we additionally state the metal content. All data are average values.

Information on the test methods and equipment is given in IEC Publication 413, the recommendations of which have been generally adopted.

As an indicator of the running performance of carbon brushes, voltage drop and coefficient of friction can be looked at. These two parameters are, however, affected by numerous environment influences and the operating

conditions, so that they are subject to relatively high fluctuations.

A statement which is generally valid is therefore only possible by stating

ranges, in which experience shows these values to lie.

The following summary shows the ranges selected in each case and the corresponding symbols:

| Classification | Symbol | Voltage drop between two carbon brushes connected in series U _ü (V) | Coefficient of friction μ |
|----------------|--------|--|-------------------------------|
| Very low | vl | < 1.5 | < 0.08 |
| Low | l | 1.5 - 2.2 | 0.08 - 0.15 |
| Medium | m | 2.2 - 3.0 | 0.15 - 0.22 |
| High | h | > 3.0 | > 0.22 |

The grades are classified into the selected ranges on the basis of measurements under test conditions 1 - 7, which are explained in the following table.

On request we are able to supply detailed technical data sheets of our grades, which also contain information regarding other operating conditions.

| No. | Current density A/cm ² | Peripheral speed m/s | Brush pressure cN/cm ² | Collector temperature °C | Related to the following fields of application of the carbon brushes |
|-----|-----------------------------------|----------------------|-----------------------------------|--------------------------|--|
| 1 | 12 | 30 | 250 | 90 | Stationary D.C. machines with and without commutation aids |
| 2 | 12 | 50 | 250 | 90 | Traction motors |
| 3 | 10 | 30 | 200 | 90 | Three-phase commutator motors |
| 4 | 6 | 60 | 160 | 90 | Turbogenerators and turbomotors |
| 5 | 20 | 30 | 200 | 90 | Slip-ring machines and low-voltage machines |
| 6 | 16 | 30 | 200 | 90 | Slip-ring machines and low-voltage machines |
| 7 | 12 | 30 | 200 | 90 | Slip-ring machines and low-voltage machines |

Physical data of the principal grades

| Grade | Material type | Voltage drop | Coefficient of friction | Test conditions | Resistivity $\mu\Omega\text{m}$ | Rockwell HR 10/40 | HR 5/40 | Bending strength N/mm ² | Bulk density g/cm ³ | Metal content % |
|--------|-----------------------|--------------|-------------------------|-----------------|------------------------------------|----------------------|------------|---------------------------------------|-----------------------------------|--------------------|
| A12S | Copper-graphite | vl | l | 6 | 0.25 | 90 | - | - | 4.00 | 70 |
| A16 | Copper-graphite | vl | m | 5 | 0.15 | 70 | - | - | 5.00 | 85 |
| A20 | Copper-graphite | vl | m | 7 | 2.0 | 85 | - | - | 2.90 | 50 |
| A24 | Copper-graphite | l | l | 7 | 3.5 | 85 | - | - | 2.60 | 40 |
| A30 | Copper-graphite | l | l | 7 | 8.0 | 85 | - | - | 2.25 | 25 |
| A41 | Copper-graphite | m | m | 6 | 5.0 | 100 | - | - | 2.80 | 37 |
| B14Z1 | Bronze-graphite | vl | l | 5 | 0.1 | 100 | - | - | 5.30 | 90 |
| B20 | Bronze-graphite | vl | l | 5 | 0.08 | 75 | - | - | 5.45 | 90 |
| B24 | Bronze-graphite | vl | l | 5 | 0.1 | 105 | - | - | 5.70 | 90 |
| B25 | Bronze-graphite | vl | l | 5 | 0.3 | 95 | - | - | 5.50 | 90 |
| B26 | Bronze-graphite | vl | l | 5 | 0.15 | 90 | - | - | 5.90 | 95 |
| C16 | Metal-graphite | l | l | 6 | 1.0 | 100 | - | - | 3.00 | 45 |
| C40 | Bronze-graphite | vl | l | 6 | 0.3 | 80 | - | - | 4.05 | 75 |
| C40Z3 | Bronze-graphite | vl | l | 6 | 0.3 | 100 | - | - | 4.10 | 75 |
| C50 | Bronze-graphite | vl | l | 6 | 0.4 | 100 | - | - | 5.65 | 92 |
| C72 | Bronze-graphite | l | l | 7 | 5.0 | 85 | - | - | 2.30 | 25 |
| K14Z3 | Copper-graphite | vl | l | 6 | 1.0 | 110 | - | - | 3.35 | 62 |
| S11 | Silver-graphite | vl | m | - | 0.05 | - | 70 | - | 7.00 | 95 |
| S13 | Silver-graphite | vl | l | - | 8.0 | 75 | - | - | 3.35 | 60 |
| S14 | Silver-graphite | vl | l | - | 3.0 | 85 | - | - | 3.20 | 53 |
| S15 | Silver-graphite | vl | l | - | 1.0 | 100 | - | - | 4.50 | 75 |
| F17 | Copper-graphite | l | l | 6 | 30 | 90 | - | 18 | 2.20 | 20 |
| F19 | Graphite | m | l | 4 | 9 | - | - | 7 | 1.40 | - |
| HG2634 | Graphite | m | l | 4 | 15 | - | - | 10 | 1.30 | - |
| HG5634 | Graphite | m | l | 4 | 18 | - | - | 10 | 1.25 | - |
| F40 | Resin-bonded graphite | h | l | 3 | 110 | 100 | - | 35 | 1.75 | - |
| F46 | Resin-bonded graphite | h | l | 3 | 300 | 105 | - | 35 | 1.75 | - |
| F49 | Resin-bonded graphite | h | l | 3 | 350 | 105 | - | 30 | 1.70 | - |
| F51 | Resin-bonded graphite | h | l | 3 | 300 | 100 | - | 25 | 1.70 | - |
| F61 | Resin-bonded graphite | h | l | 3 | 250 | 100 | - | 30 | 1.70 | - |
| F63 | Resin-bonded graphite | h | l | 3 | 210 | 70 | - | 12 | 1.60 | - |
| E29 | Electrographite | m | l | 2 | 35 | - | 90 | 25 | 1.60 | - |
| E43 | Electrographite | m | l | 7 | 20 | 100 | - | 30 | 1.70 | - |
| E43Z3 | Electrographite | m | l | 7 | 20 | - | 105 | 38 | 1.80 | - |
| E46 | Electrographite | m | m | 1 | 22 | 65 | - | 10 | 1.50 | - |
| E46F3 | Electrographite | m | m | 4 | 22 | 65 | - | 10 | 1.50 | - |
| E46X | Electrographite | m | m | 1 | 22 | 90 | - | 20 | 1.60 | - |
| E468 | Electrographite | m | m | 1 | 20 | 65 | - | 10 | 1.50 | - |

Physical data of the principal grades

| Grade | Material type | Voltage drop | Coefficient of friction | Test conditions | Resistivity $\mu\Omega\text{m}$ | Rockwell HR 10/40 | HR 5/40 | Bending strength N/mm ² | Bulk density g/cm ³ | Metal content % |
|-------|-----------------|--------------|-------------------------|-----------------|------------------------------------|----------------------|------------|---------------------------------------|-----------------------------------|--------------------|
| E49 | Electrographite | h | l | 1 | 55 | - | 90 | 16 | 1.60 | - |
| E49X | Electrographite | h | l | 1 | 55 | - | 105 | 30 | 1.70 | - |
| E498 | Electrographite | h | l | 1 | 55 | - | 90 | 16 | 1.60 | - |
| E50 | Electrographite | h | l | 1 | 100 | - | 105 | 25 | 1.60 | - |
| E50X | Electrographite | h | l | 2 | 100 | - | 115 | 35 | 1.70 | - |
| E55 | Electrographite | m | l | 1 | 20 | - | 90 | 28 | 1.75 | - |
| E558 | Electrographite | m | l | 1 | 20 | - | 90 | 28 | 1.75 | - |
| E64Z4 | Electrographite | m | m | 2 | 35 | - | 90 | 28 | 1.70 | - |
| E79X | Electrographite | m | m | 1 | 35 | 90 | - | 16 | 1.65 | - |
| E79Z1 | Electrographite | m | m | 2 | 35 | 100 | - | 23 | 1.65 | - |
| E84S | Electrographite | m | l | 2 | 32 | - | 110 | 35 | 1.70 | - |
| E841 | Electrographite | m | l | 2 | 32 | - | 110 | 38 | 1.72 | - |
| E88 | Electrographite | m | l | 2 | 40 | - | 105 | 30 | 1.70 | - |
| E88X | Electrographite | m | l | 2 | 40 | - | 115 | 40 | 1.75 | - |
| E888 | Electrographite | m | l | 2 | 38 | - | 105 | 30 | 1.70 | - |
| E94 | Electrographite | m | l | 2 | 40 | - | 100 | 30 | 1.65 | - |
| E101 | Electrographite | m | l | 1 | 40 | - | 95 | 30 | 1.60 | - |
| E101X | Electrographite | m | l | 1 | 40 | - | 105 | 35 | 1.65 | - |
| E104 | Electrographite | m | m | 4 | 28 | - | - | 5 | 1.30 | - |
| E105 | Electrographite | m | l | 1 | 43 | - | 75 | 18 | 1.54 | - |
| E106 | Electrographite | m | l | 1 | 55 | - | 80 | 23 | 1.60 | - |
| E108 | Electrographite | m | l | 1 | 40 | - | 95 | 30 | 1.60 | - |
| E141 | Electrographite | m | l | 2 | 40 | - | 115 | 35 | 1.78 | - |
| E151 | Electrographite | h | l | 2 | 90 | - | 115 | 35 | 1.70 | - |
| E160 | Electrographite | l | m | 2 | 18 | 105 | - | 28 | 1.70 | - |
| E190 | Electrographite | m | l | 2 | 40 | - | 90 | 20 | 1.56 | - |
| E200 | Electrographite | m | m | 4 | 13 | 50 | - | 12 | 1.45 | - |
| E220 | Electrographite | m | l | 2 | 65 | 100 | - | 22 | 1.70 | - |
| E231 | Electrographite | m | l | 2 | 40 | - | 100 | 25 | 1.66 | - |
| L300 | Carbon-graphite | h | m | 7 | 28 | 95 | - | 18 | 1.62 | - |
| L310 | Carbon-graphite | h | m | 7 | 28 | 90 | - | 20 | 1.70 | - |
| L320 | Carbon-graphite | h | m | 7 | 25 | 95 | - | 24 | 1.65 | - |

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