Carbon brushes for fractional motors

Materials – Physical values

Location SKT

L-materials: carbon – graphite, pressing direction: tangentially or axially

Grade	Contact Voltage	Coeffi-cient of Friction	Resis-tivity	Rockwell Hardness HR			Bending Strength	Bulk Density	Metal Content	Allowed Peri-pheral Speed	Max. Constant Current Density
	$U_{ü}$	μ	μΩm	5/7	5/40	10/40	N/mm²	g/cm³	%	m/s	A/cm²
-L24-	h	m	700	–	–	108	23	1.54	–	50	14
-L25-	h	m	1250	–	–	105	22	1.58	–	50	10
-L26-	h	l	1100	–	85	–	24	1.60	–	50	10
-L28-	h	m	250	–	85	–	28	1.60	–	50	16
-L29-	h	m	1000	–	–	100	21	1.54	–	50	12
-L41-	m	l	80	–	98	–	25	1.65	–	40	20
-L42-	h	l	225	–	95	–	22	1.60	–	40	16
-L43-	h	m	500	–	90	–	22	1.60	–	40	14
-L45-	h	m	580	–	–	102	18	1.56	–	50	14
-L48-	h	l	950	–	–	105	30	1.60	–	50	14
-L53-	h	l	1400	–	–	90	18	1.48	–	50	10
-L55-	h	m	750	–	–	95	18.5	1.60	–	50	14
-L62-	h	m	375	–	–	105	24	1.60	–	50	16
-L63-	h	m	725	–	80	–	22	1.60	–	50	14
-L64-	h	m	1400	–	–	85	14	1.58	–	50	10
-L71-	m	m	45	–	100	–	35	1.57	–	30	20
-L73-	h	m	725	–	90	–	25	1.50	–	50	14
-L74-	h	m	1700	–	85	–	22	1.53	–	50	10
-L75-	h	m	2400	–	–	95	18	1.40	–	50	10
-L82-	h	m	375	–	85	–	25	1.58	–	50	16
-L83-	h	m	725	–	85	–	22	1.60	–	50	12
-L84-	h	m	1250	–	–	100	18	1.55	–	50	10
-L85-	h	m	975	–	–	95	17	1.55	–	50	12
-L86-	h	m	375	–	90	–	18	1.62	–	50	14
-L87-	h	m	725	–	85	–	18	1.65	–	50	14
-L88-	h	m	400	–	–	85	24	1.60	–	50	14
-L89-	h	m	1900	–	–	83	13	1.55	–	50	10
-L93-	h	m	725	–	93	–	25	1.63	–	50	12
-L94-	h	m	1250	–	–	105	17	1.60	–	50	10
-L95-	h	m	1100	–	–	100	16	1.58	–	50	10
-L97-	h	m	675	–	–	105	20	1.60	–	50	14
-L98-	h	m	1100	–	–	95	16	1.60	–	50	10

All specifications above are typical average values and are based upon measurements with new carbon brushes and ideal conditions.
The figures are standard values without liability.
Measuring method, see brochure 13.12.

Location HOS

HP-materials: carbon – graphite, pressing direction: tangentially or axially

Grade	Contact Voltage $U_{ü}$	Coefficient of Friction μ	Resistivity μΩm	Rockwell Hardness HR 5/7	Rockwell Hardness HR 5/40	Rockwell Hardness HR 10/40	Bending Strength N/mm²	Bulk Density g/cm³	Metal Content %	Allowed Peripheral Speed m/s	Max. Constant Current Density A/cm²
-HP3221-	h	l	250	–	–	85	20	1.65	–	40	18
-HP3223-	h	l	250	–	–	85	20	1.65	–	40	18
-HP3251-	h	l	800	–	–	80	20	1.58	–	40	16
-HP3356-	h	l	800	–	–	80	17	1.70	–	40	14

All specifications above are typical average values and are based upon measurements with new carbon brushes and ideal conditions.
The figures are standard values without liability.
Measuring method, see brochure 13.12.

L/HP-materials can be used in universal motors for household appliances and for hand-held electric power tools. Their versatility makes them ideal for solving special problems. The essential characteristics for these non-metallic materials are:

- good commutation
- low radio interference level
- long brush life
- usable in high-performance motors

To increase the efficiency of the materials, it is basically possible to perform a subsequent impregnation treatment with F7, F10, F12, F13, F20, F25, F101, F131, S, ZP as well as special impregnations. The impregnation KVP is applicable especially for improved carbon brush bedding. Because the values for the contact voltage ($U_{ü}$) and the coefficient of friction (μ) depend very much on the measuring conditions, they should be considered only as recommended values. The symbols represent the following ranges:

Classification	Symbol	Contact Voltage Drop for 2 Brushes (V)	Coefficient of Friction
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

Measurement Conditions:		
	Peripheral Speed of Commutator	20 m/s
	Specific Contact Pressure	400 cN/cm²
	Current Density	6 A/cm²

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Location SKT

L-materials: carbon – graphite, pressing direction: radially

Grade	Contact Voltage $U_{ü}$	Coefficient of Friction μ	Resistivity μΩm	Rockwell Hardness HR 2.5/7	Rockwell Hardness HR 5/40	Rockwell Hardness HR 10/40	Bending Strength N/mm²	Bulk Density g/cm³	Metal Content %	Allowed Peripheral Speed m/s	Max. Constant Current Density A/cm²
-L252-	h	m	2600	66	–	–	–	1.58	–	50	10
-L262-	h	m	1700	74	–	–	–	1.60	–	50	10
-L412-	m	l	90	77	–	–	–	1.59	–	50	20
-L422-	m	m	300	77	–	–	–	1.60	–	50	16
-L732-	h	m	1100	80	–	–	–	1.50	–	50	10
-L742-	h	m	2200	70	–	–	–	1.53	–	50	10
-L752-	h	m	2800	55	–	–	–	1.40	–	50	10
-L822-	h	m	550	72	–	–	–	1.58	–	50	16
-L842-	h	m	1700	57	–	–	–	1.55	–	50	10
-L852-	h	m	1600	60	–	–	–	1.55	–	50	10
-L872-	h	m	1250	65	–	–	–	1.65	–	50	10
-L892-	h	m	2900	47	–	–	–	1.55	–	50	10
-L942-	h	m	1800	65	–	–	–	1.60	–	50	10

All specifications above are typical average values and are based upon measurements with new carbon brushes and ideal conditions.
The figures are standard values without liability.
Measuring method, see brochure 13.12.

L-materials can be used in universal motors for household appliances and for hand-held electric power tools. Their versatility makes them ideal for solving special problems. The essential characteristics for these non-metallic materials are:

- good commutation
- low radio interference level
- long brush life
- usable in high-performance motors

To increase the efficiency of the materials, it is basically possible to perform a subsequent impregnation treatment with F7, F10, F12, F13, F20, F25, F101, F131, S, ZP as well as special impregnations. The impregnation KVP is applicable especially for improved carbon brush bedding. Because the values for the contact voltage ($U_{ü}$) and the coefficient of friction (μ) depend very much on the measuring conditions, they should be considered only as recommended values. The symbols represent the following ranges:

Classification	Symbol	Contact Voltage Drop for 2 Brushes (V)	Coefficient of Friction
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

Measurement Conditions:		
	Peripheral Speed of Commutator	20 m/s
	Specific Contact Pressure	400 cN/cm²
	Current Density	6 A/cm²

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Carbon brushes for fractional motors

Materials – Physical values

Location SKT

E-materials: electrographite
F-materials: phenolic resin bonded graphite and carbonized
G-materials: epoxy resin bonded graphite
H-materials: carbon
pressing direction: tangentially or axially

Grade	Contact Voltage $U_{ü}$	Coeffi-cient of Friction μ	Resis-tivity μΩm	Rockwell Hardness HR 5/7	Rockwell Hardness HR 5/40	Rockwell Hardness HR 10/40	Bending Strength N/mm²	Bulk Density g/cm³	Metal Content %	Allowed Peri-pheral Speed m/s	Max. Constant Current Density A/cm²
-E43-	vl	m	20	–	–	100	30	1.60	–	50	20
-E105-	m	l	55	–	70	–	18	1.54	–	50	20
-F14-	l	m	14	–	–	87	–	1.85	2.5	30	20
-F17-	l	m	30	–	–	90	–	2.25	20	30	20
-F21-	l	m	12	–	–	102	30	2.00	10	30	20
-F25-	l	l	110	–	–	97	–	2.16	20	50	20
-F34-	l	m	100	–	–	100	–	2.00	10	30	7
-F35-	l	m	100	–	–	105	30	2.05	10	30	7
-F37-	h	l	300	68*	–	–	23	1.72	–	30	7
-F70-	h	m	425	42	–	–	16	1.48	–	50	10
-G11-	h	l	550	65	–	–	16	1.65	–	60	14
-G15-	h	l	750	52	–	–	18	1.54	–	60	14
-G40-	h	l	400	62	–	–	15	1.60	–	60	10
-G60-	h	n	950	60	–	–	21	1.63	–	60	10
-H18-	m	m	250	–	110	–	40	1.73	–	30	12

All specifications above are typical average values and are based upon measurements with new carbon brushes and ideal conditions.
The figures are standard values without liability. Measuring method, see brochure 13.12.
* Rockwell Hardness HR 2.5/7

The materials E, F (very soft) and H (very hard) are reserved for special fields of application with various levels of load. It is basically possible to perform a subsequent impregnation treatment with F7, F10, F12, F13, F20, F25, F101, F131, S, ZP as well as special impregnations. The material G can be impregnated with F10, F12 and F13.

Because the values for the contact voltage ($U_{ü}$) and the coefficient of friction (μ) depend very much on the measuring conditions, they should be considered only as recommended values. The symbols represent the following ranges:

Classification	Symbol	Contact Voltage Drop for 2 Brushes (V)	Coefficient of Friction
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

Measurement Conditions:		
	Peripheral Speed of Commutator	20 m/s
	Specific Contact Pressure	400 cN/cm²
	Current Density	6 A/cm²

Location HOS

HK-materials: phenolic resin bonded graphite and carbonized
HG-materials: epoxy resin bonded
pressing direction: tangentially or axially

Grade	Contact Voltage $U_{ü}$	Coefficient of Friction μ	Resistivity μΩm	Rockwell Hardness HR 5/7	Rockwell Hardness HR 5/40	Rockwell Hardness HR 10/40	Bending Strength N/mm²	Bulk Density g/cm³	Metal Content %	Allowed Peripheral Speed m/s	Max. Constant Current Density A/cm²
-HK11-	l	m	60	–	–	–	15	1.65	–	40	20
-HK12-	m	m	300	–	–	–	20	1.60	–	40	20
-HG22-	h	m	1100	–	–	–	12	1.48	–	60	16
-HG23-	m	m	400	–	–	–	23	1.60	–	60	16
-HG24-	h	m	800	–	–	–	18	1.60	–	50	14
-HG25-	m	m	400	–	–	–	23	1.65	–	60	16
-HG26-	m	m	350	–	–	–	23	1.60	–	60	16
-HG27-	m	m	450	–	–	–	17	1.60	–	50	16
-HG28-	m	m	300	–	–	–	22	1.65	–	50	18
-HG29-	h	m	800	–	–	–	20	1.60	–	50	14
-HG30-	m	m	350	–	–	–	14	1.70	–	60	16

All specifications above are typical average values and are based upon measurements with new carbon brushes and ideal conditions.
The figures are standard values without liability.
Measuring method, see brochure 13.12.

Current density and allowed peripheral speed are to be considered as recommended values. The materials can be impregnated for special fields of application; in order to achieve optimal bedding conditions (faster motor bedding, less commutator sparking, better radio interference, better motor performance), it is also possible to impregnate only the running surface of the brush with a treatment called “KVP”.

Classification	Symbol	Contact Voltage Drop for 2 Brushes (V)	Coefficient of Friction
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

Measurement Conditions:		
	Peripheral Speed of Commutator	20 m/s
	Specific Contact Pressure	400 cN/cm²
	Current Density	6 A/cm²

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Location SKT

F-materials: phenolic resin bonded graphite and carbonized
pressing direction: radially

Grade	Contact Voltage $U_{ü}$	Coeffi-cient of Friction μ	Resis-tivity μΩm	Rockwell Hardness HR 5/7	Rockwell Hardness HR 5/7	Rockwell Hardness HR 10/40	Bending Strength N/mm²	Bulk Density g/cm³	Metal Content %	Allowed Peri-pheral Speed m/s	Max. Constant Current Density A/cm²
-F212-	l	m	24	70	–	–	–	1.96	10	30	20
-F217-	l	m	20	–	–	102	–	2.07	10	30	20
-F218-	l	m	22	–	–	102	–	2.10	10	30	20
-F352-	l	m	375	–	75	–	–	2.05	10	30	7

All above specifications are typical average values and are based upon measurements with new carbon brushes and ideal conditions.
The figures are standard values without liability.
Measuring method, see brochure 13.12.

Location HOS

HK-materials: phenolic resin bonded graphite and carbonized
HG-materials: epoxy resin bonded graphite
pressing direction: radially

Grade	Contact Voltage $U_{ü}$	Coeffi-cient of Friction μ	Resis-tivity μΩm	Rockwell Hardness HR 5/7	Rockwell Hardness HR 5/40	Rockwell Hardness HR 10/40	Bending Strength N/mm²	Bulk Density g/cm³	Metal Content %	Allowed Peri-pheral Speed m/s	Max. Constant Current Density A/cm²
-HK11-	m	m	120	–	–	–	10	1.65	–	40	20
-HG13-	h	m	1000	–	–	–	10	1.60	–	40	14
-HG24-	h	m	2000	–	–	–	7	1.60	–	50	14
-HG31-	h	m	2500	–	–	–	7	1.55	–	40	14
-HG8989-	h	m	1200	–	–	–	12	1.65	–	40	16

All specifications above are typical average values and are based upon measurements with new carbon brushes and ideal conditions.
The figures are standard values without liability.
Measuring method, see brochure 13.12.

Current density and allowed peripheral speed are to be considered as recommended values. The materials can be impregnated for special fields of application; in order to achieve optimal bedding conditions (faster motor bedding, less commutator sparking, better radio interference, better motor performance), it is also possible to impregnate only the running surface of the brush with a treatment called “KVP”.

Classification	Symbol	Contact Voltage Drop for 2 Brushes (V)	Coefficient of Friction
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

Measurement Conditions:		
	Peripheral Speed of Commutator	20 m/s
	Specific Contact Pressure	400 cN/cm²
	Current Density	6 A/cm²

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Carbon brushes for fractional motors

Materials – Physical values

Location SKT

A-materials: copper – graphite resin bonded
K-material: copper – graphite pitch bonded
S-material: silver – graphite pitch bonded

Grade	Contact Voltage	Coeffi-cient of Friction	Resis-tivity	Rockwell Hardness HR			Bending Strength	Bulk Density	Metal Content	Allowed Peri-pheral Speed	Max. Constant Current Density
	$U_{ü}$	μ	μΩm	5/7	5/40	10/40	N/mm²	g/cm³	%	m/s	A/cm²
-A20-	vl	m	2.5	–	–	85	–	2.90	50	30	20
-A24-	l	l	3.5	–	–	85	–	2.60	40	30	20
-A41-	vl	l	5	–	–	100	–	2.80	39	30	25
-A413-	–	–	10	–	–	95	–	2.75	39	–	–
-A433-	vl	l	2.5	–	–	95	–	2.70	36.5	30	25
-A44(3)-	vl	l	5	–	–	100	–	2.65	36.5	30	25
-A473-	vl	l	2.5	–	–	85	–	2.48	29.5	30	25
-A513-	vl	m	2	–	–	95	–	3.05	50	30	25
-A528-	–	–	3.5	–	–	90	–	3.20	53	–	–
-A52-	vl	m	4	–	–	90	–	3.00	53	30	25
-A533-	vl	l	1.5	–	–	95	–	3.10	53	30	20
-A553-	vl	l	1.5	–	–	90	–	3.00	50	30	20
-A62-	l	l	8.5	–	–	93	–	2.48	30	–	–
-K177-	vl	l	2.5	–	–	90	–	3.20	60	25	25
-S13-	vl	m	2.6	–	–	90	25	3.60	60	–	–

All specifications above are typical average values and are based upon measurements with new carbon brushes and ideal conditions.
The figures are standard values without liability. Measuring method, see brochure 13.12.

The materials A, K and S are distinguished by metal additives. The fields of application for these materials are: low-voltage motors, micro motors, and motors for toys.

A third number behind the material description A and S indicates the production method and design.

Because the values for the contact voltage ($U_{ü}$) and the coefficient of friction (μ) depend very much on the measuring conditions, they should be considered only as recommended values. The symbols represent the following ranges:

Classification	Symbol	Contact Voltage Drop for 2 Brushes (V)	Coefficient of Friction
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

Measurement Conditions:		
	Peripheral Speed of Commutator	20 m/s
	Specific Contact Pressure	400 cN/cm²
	Current Density	6 A/cm²

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