TECHNICAL DATA SHEET

DIMENSIONS *t*, *a*, AND *r* OF CARBON BRUSHES AND BRUSH-HOLDERS

The I.E.C. (International Electrotechnical Commission) has published standards concerning carbon brushes dimensions and various fitting elements.

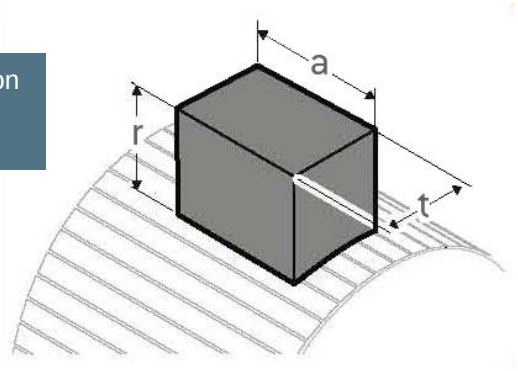
Mersen brushes and brush-holders has been developed in partnership with electrical machines manufacturers.

Technical developments and costs of labor make the execution of "specials" more and more unusual at the present time. We strongly recommend to our Customers to conform as far as possible with the following tables in which are indicated the Mersen specifications for the standard dimensions and tolerances as applied to carbon brushes and brush-holders.

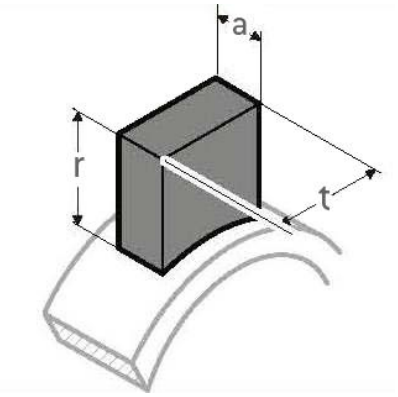
If not elsewhere specified, the unit is millimeter (mm).

01 - NOMENCLATURE OF PRINCIPAL DIMENSIONS OF CARBON BRUSHES *t*, *a* AND *r*

t: tangential dimension
a: axial dimension
r: radial dimension



Recommended orientation of a carbon brush on a commutator



Recommended orientation of a carbon brush on a slip ring

Figure 1 - Nomenclature of brush dimensions (in accordance with IEC 60276 and IEC 60136)

These dimensions are expressed with the following sequence: *t* x *a* x *r* and in millimeters.

Note: The *r* dimension of Mersen carbon brushes does not consider elements or parts of elements, which take part in the pressure application (in another words "*r*" corresponds to the carbon block length).

02 - SERIES OF STANDARD DIMENSIONS *t* AND *a*

The following values are recommended for *t* and *a* dimensions (according to IEC 60136):

t or a	1,6 - 2 - 2,5 - 3,2 - 4 - 5 - 6,3 - 8 - 10 - 12,5 - 16 - 20 - 25 - 32 - 40 - 50 - 64 - 80

Table 1 - Standard dimensions for *t* and *a*

(For imperial dimensions (see section 4) please contact us.

Note: For several reasons, in particular for brush material grain orientation the use of **square brushes** where t=a is **strongly discouraged**. However if such combination is used Mersen recommends the use of a brush fitted with a non-reversing chamfer and a suitable brush-holder.

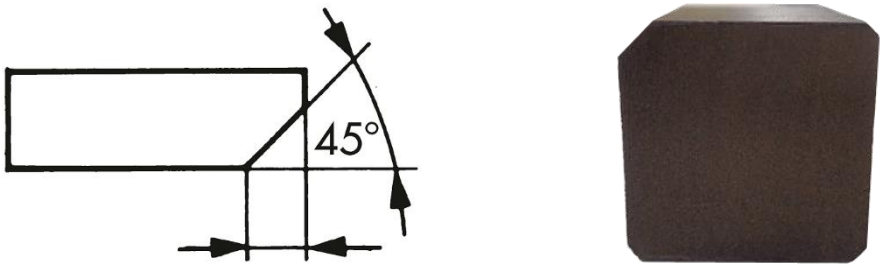


Figure 2 - Brush with non-reversing chamfer

03 - TOLERANCES ON *t*, *a* AND *r* DIMENSIONS

Brushes

The brush shall be guided along a sufficient height with a suitable clearance to avoid either sticking of rocking. Therefore Mersen applies tolerances and clearances which are defined in IEC 60136 and reported on table 2 (all dimensions are in mm).

For split brushes (a brush assembly with 2 or more wafers - see TDS-01), the maximum value of the tolerance is increased by 0.02mm to allow the wafers to slide together.

Brush-holders

The tolerances of brush-holders shall be in accordance with the standard E10 of ISO286-2. Table 2 gives clearances between the brush and the brush-holder.

Brushes machined within tolerances of table 2 are fitted with acceptable clearances in brush-holders manufactured to old standards (NF, DIN…).

Nominal values of *t*, *a* or *r*	Tolerances on t or a				Clearance on *t* or *a* between brush and brush-holder (monobloc brush)		Tolerances on *r*
	monobloc brush		split brush				
	minimum	maximum	minimum	maximum	minimum	maximum	
1.6 2 2.5	-0.03	-0.09	-	-	0.044	0.144	±0.3
3.2					0.050	0.158	
4 5	-0.03	-0.11	-0.03	-0.13	0.050	0.178	±0.3
6.3 8 10					0.055	0.193	
12.5 16	-0.04	-0.13	-0.04	-0.15	0.072	0.232	±0.5
20 25					0.080	0.254	
32 40 50	-0.05	-0.15	-0.05	-0.17	0.100	0.300	±0.8
64 80					0.110	0.330	
100 125	-	-	-	-	-	-	±1

Table 2 - Tolerances and clearances on brushes and brush-holders

Metal-graphite brushes

These brushes sometimes work under difficult conditions (machines without filters, closed motors, high temperature, etc.) which might harm their ability to slide in the brush holders. The IEC 60136 standard, in these particular cases, recommends a clearance increase, while keeping the nominal values. Table 3 presents tolerances and clearances for metal-graphite brushes.

This is applied at the user's request, or upon Mersen experts' recommendation.

Nominal values of *t* or *a*	Tolerances on *t* or *a*		Clearance on *t* or *a* between brush and brush-holder (monobloc brush)	
	monobloc brush			
	minimum	maximum	minimum	maximum
1.6 2 2.5	-0.06	-0.12	0.074	0.174
3.2 4 5	-0.07	-0.15	0.090	0.218
6.3 8 10	-0.08	-0.17	0.105	0.253
12.5 16	-0.15	-0.26	0.182	0.362
20 25	-0.16	-0.29	0.200	0.414
32 40	-0.17	-0.33	0.220	0.480
50	-0.18	-0.34	0.230	0.490
64	-0.19	-0.38	0.250	0.560
80	-0.20	-0.39	0.260	0.570

Table 3 - Tolerances on brushes and brush-holders when using a metal-graphite grade, in mm

04 - MARKING OF CARBON BRUSHES

When specifying the unit of measurement imperial and metric units may be easily confused.

To avoid any confusion between these systems, brushes shall be marked with the following corresponding symbol (according to *IEC 60136*):

- for dimensions in **metric system** (millimeters) : **square** □
- for dimensions in **imperial system** (inches) : **triangle** Δ

When possible the grade of the brush is engraved on the same face as the unit symbol.

05 - CHAMFERS ON CARBON BRUSHES

Generally brushes are machined with chamfers at each edge to avoid chipping during handling and running. The chamfer dimension *c* and tolerances are reported in table 4. A 45° angle is recommended for the chamfer of brushes (according to IEC 60136).

Nominal values Dimension of t or a	chamfer dimension *c*		
	nominal value	tolerance minimum	tolerance maximum
1.6 – 3.2	0.2	0	+0.1
4 - 8	0.5	0	+0.3
10 – 20	1	0	+0.5
>20	2	0	+0.5

Table 4 - Chamfer dimension and tolerances (in *mm*)

06 - ANGLES FOR TOP AND BOTTOM BEVELS

Inclined brushes are often considered more stable for unidirectional machines. If such a configuration is applied, we recommend a study to be conducted on stability.

Contact bevel angle α:

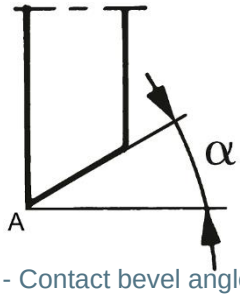


Figure 3 - Contact bevel angle α

Following values are recommended for angle α: 0° - 7.5° - 15° - 22.5°

Note: When α is greater than 15° and t is greater than 8 mm (5/16 in), the sharp edge of angle A may be removed to prevent brush chipping.

Top bevel angle β:

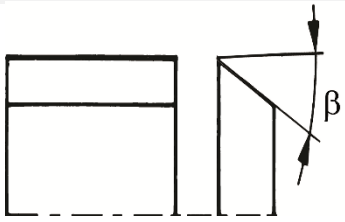


Figure 4 - Top bevel angle β

Following values are recommended for angle β: 0° - 7.5° - 15° - 22.5°

Note: When β is over 15° a flat of 1 mm width may be machined on the top of the brush.

For all these values Mersen applies tolerances of ± 1°.

07 - WIDTH *p* AVAILABLE FOR APPLICATION OF PRESSURE

The center of the brush top shall be left clear of connections for pressure systems to apply the appropriate pressure.

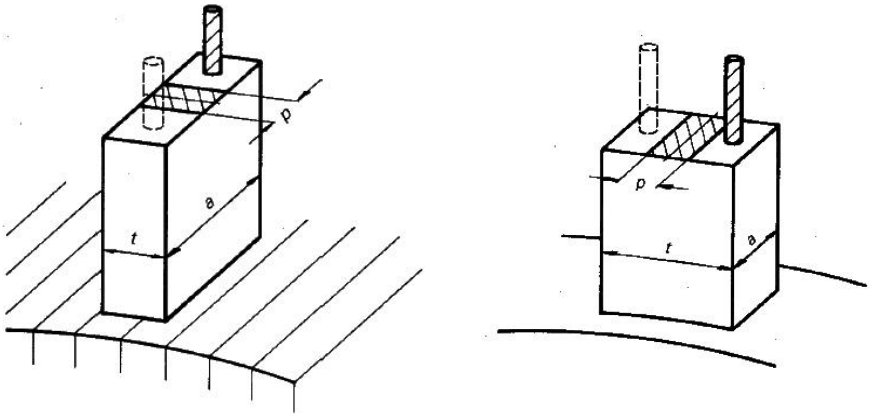


Figure 5 -Width ρ for application of pressure

In most cases the *p* width on the brush top showing the available area for the pressure device of the brush-holder is equal to half the *t* or *a* dimension.

However for brushes where the *t* dimension is only slightly different from the *a* dimension, experience shows that flexible location often requires a larger area on the brush top. In these cases, the reserved area for the pressure device and *p* width are accordingly reduced, usually by about 20 %.

The minimum values of *p* recommended are given in IEC 60136.

08 - FLEXIBLES (SHUNTS) FOR INDUSTRIAL BRUSHES

Flexible length

The length *l* of flexibles (shunts) should be measured between the insertion in the brush block and the axis of the terminal as shown in figure 6.

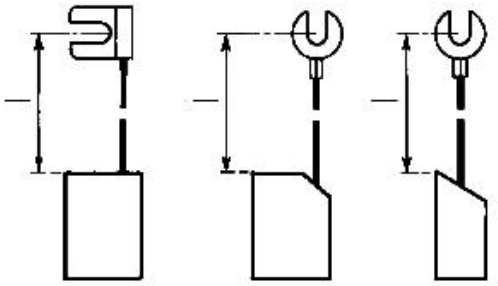


Figure 6 - Measurement of length *l*

Recommended dimensions and tolerances of length *l*, in accordance with IEC 60136, are reported in table 5.

Nominal values of *l*	Tolerances on *l*	
	minimum	minimum
16, 20, 25, 32, 40	0	3
50, 56, 63, 71, 80, 90, 100	0	5
112, 125, 140, 160	0	8

Table 5 - Recommended dimensions of *l*, in *mm*

Flexible diameter and section

The table 6 gives the standard cross-sectional area of flexibles and the corresponding maximum diameter according to IEC 60136.

Nominal (mm²)	Maximum diameter (mm)	Nominal (mm²)	Maximum diameter (mm)
0.25	0.8	3.20	2.8
0.35	1.0	4	3.2
0.50	1.2	5	3.6
0.75	1.4	6	4.0
1.00	1.6	8	4.5
1.25	1.8	10	5.0
1.50	2.0	12.5	5.6
2.00	2.2	16	6.3
2.50	2.5		

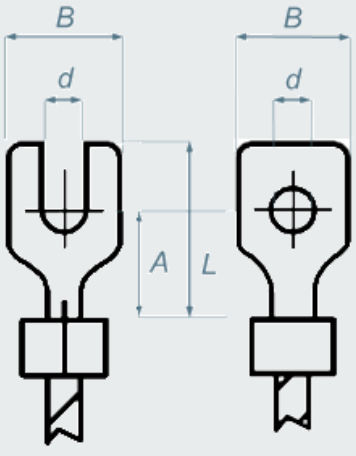
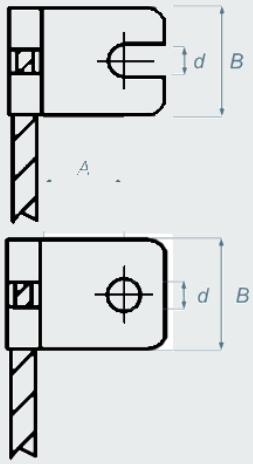
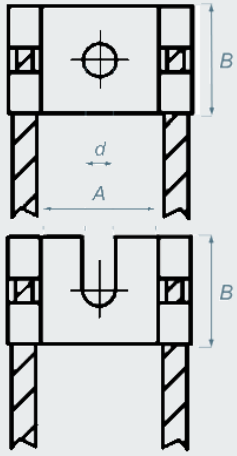
Table 6 - Standard section of flexibles

Tolerance on flexible section used by Mersen is ± 0.1mm².

Note: Flexibles used on small brushes for FHP (Fractional Horse Power) and aeronautical appliances correspond to other standards.

09 - TERMINALS FOR INDUSTRIAL BRUSHES

Terminal part dimensions are standardized in IEC 60136. Table 7 gives standards of opening terminal *d* (hole diameter or slot width) and other dimensions *A*, *B* and *L* of spade, flag and double shoe terminals.

Shape of terminal		Spade terminal			Flag terminal		Double shoe terminal	
Mersen references*		A, B, F, M			E, G, H, M		O, T, W	
Dimensions definition (examples)								
Screw diameter r	Opening of terminal d	B	A minimum	L	B	A minimum	B	A minimum
4	4.3	10	6	8	10	6	12	12

Tolerances on opening of terminal *d* are +0 to +0.3mm.

Table 7 - Standard dimensions of terminals. For other shapes please consult us

Bibliographic data:
IEC 60276 : Carbon brushes, brush holders, commutators and slip rings – Definitions and nomenclature
IEC 60136 : Dimensions of brushes and brush-holders for electrical machinery
ISO 286-2 : Geometrical product specifications (GPS) -- ISO code system for tolerances on linear sizes -- Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts
Mersen technical guide "Carbon brushes for motors and generators"

* see Mersen's "Carbon brushes for motors and generators" technical guide page 34

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