TECHNICAL DATA SHEET

DIMENSIONS OF CARBON BRUSHES

The I.E.C. (International Electrotechnical Commission) has published several standards concerning carbon brushes and brush-holders, particularly their nomenclature and dimensions.

Mersen brushes and brush-holders have 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 that our customers conform as far as possible to following tables in which are indicated the Mersen specifications for the standard dimensions and tolerances as applied to carbon brushes.

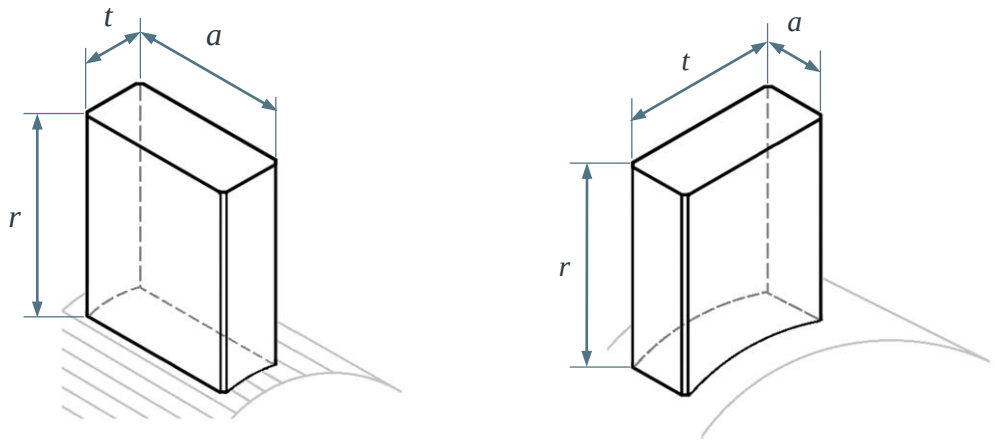
If not elsewhere specified, the unit is millimeter (mm). For dimension in inches (within international yard and pound system) please contact us.

01 - NOMENCLATURE OF PRINCIPAL DIMENSIONS OF CARBON BRUSHES

In accordance with IEC 60276 and IEC 60136:

These dimensions are expressed with the following sequence: *t* x *a* x *r* [1] and in millimeters, where:

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



a - Orientation on a commutator

b - Orientation on a slip ring

Fig. 1 - Nomenclature of brush dimensions

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).

[1] The sign “x” is in between letters (it is not a multiplication sign)

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

According to IEC 60136 we currently use following standard dimensions:

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*

Note:
The norm also specifies recommended combinations of *t*, *a* and *r*.

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.

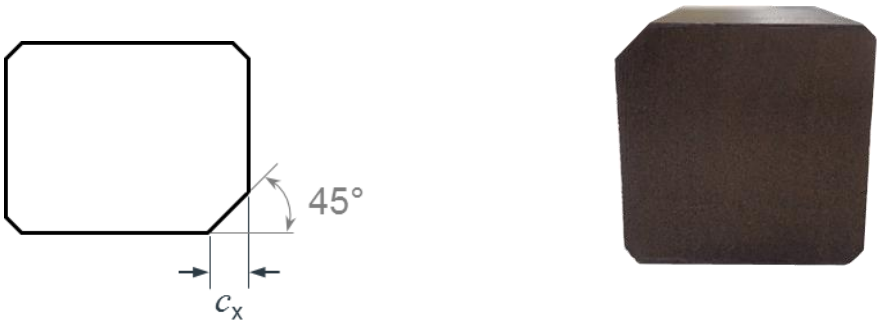


Fig. 2 - Brush with non-reversing chamfer

03 - TOLERANCES ON *t*, *a* AND *r* DIMENSIONS (in mm, according to IEC 60136)

The brush shall be guided along a sufficient height with a suitable clearance to avoid either sticking or rocking. The tolerances of brush-holder boxes shall be in accordance with the standard E10 of *ISO286-2*. The IEC 60136 specifies clearances between the brush and the brush-holder according to their nominal dimensions, and the corresponding tolerances on *t* and *a*.

Mersen applies these tolerances and clearances between the brush and the brush-holder (reported in table 2). Brushes machined within tolerances of table 2 are fitted with acceptable clearances in brush-holders manufactured to old standards (NF, DIN…).

Standard brushes

The table 2 below shows specifications on *t* and *a* for monobloc and split brushes [2] (brush assembly with 2 or more wafers - see *TDS-01*) manufactured in metric system, clearance with the brush-holder cage (when in accordance with E10) and tolerances on *r*.

Nominal values of *t*, *a* and *r*	Tolerances on t and a				Clearance on *t* or *a* between brush and brush-holder (monobloc brushes)		Tolerances on *r*
	Monobloc brushes		Split brushes [2]				
	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

[2] The maximum value of the tolerance is increased by 0.02 mm to allow the wafers to slide along each other

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 generally applied by Mersen for metal-graphite brushes, based on the recommendations of our experts.

Nominal values of *t* and *a*	Tolerances on *t* and *a*		Clearance on *t* or *a* between brush and brush-holder (monobloc brushes)	
	Monobloc brushes			
	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

04 - MARKING OF CARBON BRUSHES

When specifying dimensions of a brush block, the unit of measurement imperial and metric units may be easily confused, particularly when the measurement tool is not accurate.

For example “around 12.5” could be interpreted as being 12.5 mm as a nominal or could correspond to 12.7 mm, that is to say ½ in.

To avoid any confusion between these systems, and in accordance with *IEC 60136*, brushes shall be marked with the following corresponding symbol:

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

In addition it is recommended to engrave additional markings as per below, when possible at the same location as the unit symbol:

- a mark corresponding to the brush reference, for instance the grade of the block or the brush drawing
- a traceability reference (genetic code, manufacturing date, etc…)
- a logotype to identify Mersen: Mersen logotype, or (letter C + Lorraine cross), representing the Carbone Lorraine brand, Carbone Lorraine being Mersen’s previous name

Opposite figure 3 is an example of a brush with such marking.

Fig. 3 – Example of marking

05 - CHAMFERS ON CARBON BRUSHES

Brushes are generally 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 and a	Chamfer dimension *c*		
	Nominal value	Minimum tolerance	Maximum tolerance
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

06 - ANGLES FOR TOP AND BOTTOM BEVELS

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

Contact bevel angle α:

The brush can be straight (radial) or set at an angle on the commutator / the ring. In that last case, the brush bottom (foot) is bevelled, at an α angle, as shown in figure 4.

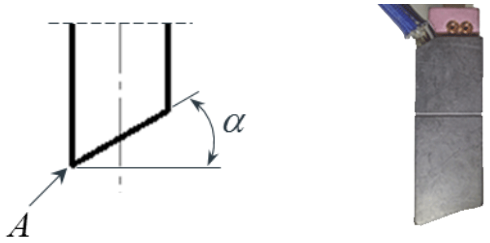


Fig. 4 – Definition of contact bevel angle α and flat edge *A*

Following values are recommended for the contact angle α (or foot angle)

α	0° - 7.5° - 15° - 22.5°

Table 5 - Standard dimensions for α

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:

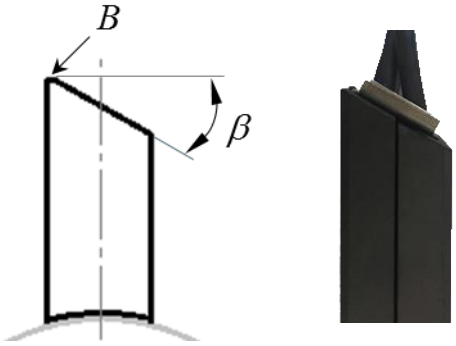


Fig. 5 – Definition of Top bevel angle β and flat edge B

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

β	0° - 7.5° - 15° - 22.5°

Table 6 - Standard dimensions for β

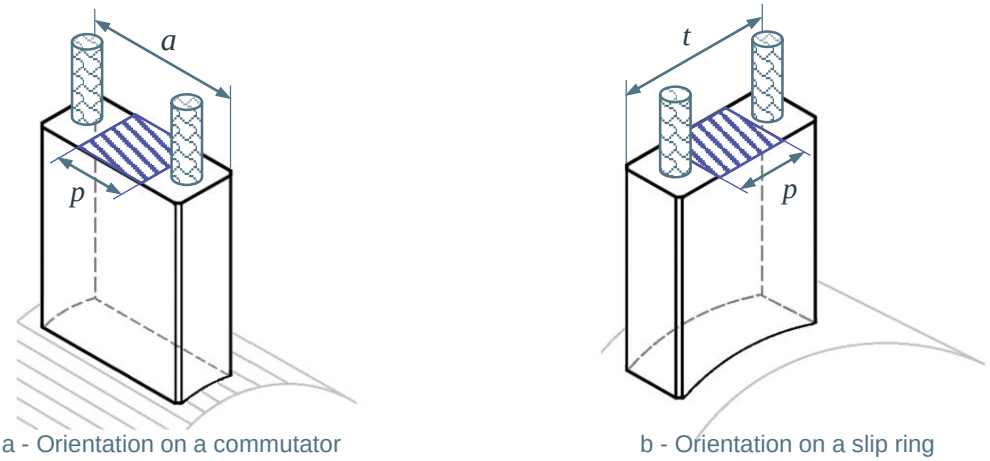
Note: When β is over 15° a flat edge B of 1 mm width may be machined on the top of the brush.

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

07 - WIDTH *p* AVAILABLE FOR APPLICATION OF PRESSURE

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

Figure 6 represents brushes for which the pressure system is applied at their median portion (center axis).



a - Orientation on a commutator b - Orientation on a slip ring

Fig. 6 – Definition of width ρ for application of pressure

In most cases **the *p* width is equal to one-half of the dimension**, among *t* and *a*, which is parallel to *p* (as represented on fig. 6).

However in some cases (for example when *t* is only slightly different from *a*) experience shows that the location of flexibles may require a larger area on the brush top. In these cases, the reserved area for the pressure device is 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 7.

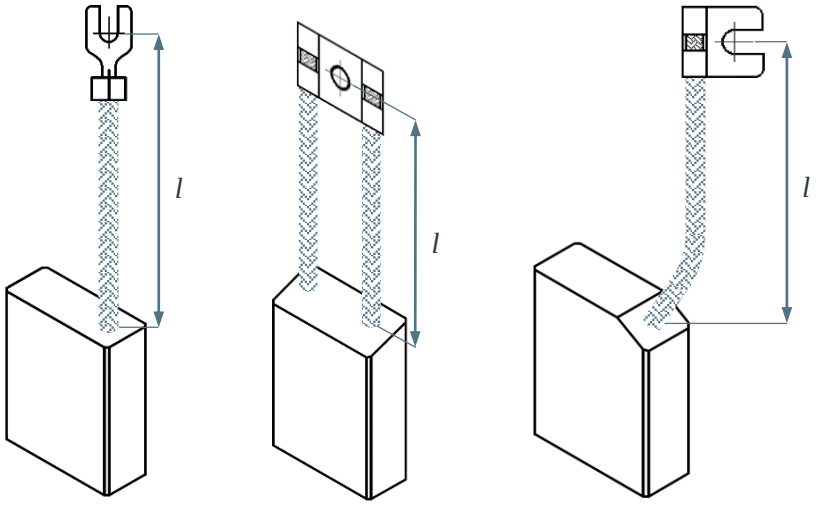


Fig. 7 – Definition of flexible length *l*

Recommended dimensions and tolerances of length *l*, in accordance with IEC 60136, are reported in table 7.

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 7 - Recommended dimensions of *l*, in mm

Flexible diameter and section

The table 8 gives the standard cross-sectional area of flexibles and the corresponding maximum diameter according to IEC 60136.

Nominal cross-sect. area (mm²)	0.25	0.35	0.50	0.75	1	1.25	1.5	2	2.5	3.2	4	5	6	8	10	12.5	16
Maximum diameter (mm)	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.5	2.8	3.2	3.6	4	4.5	5	5,6	6,3

Table 8 - Standard cross-sectional area of flexibles

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

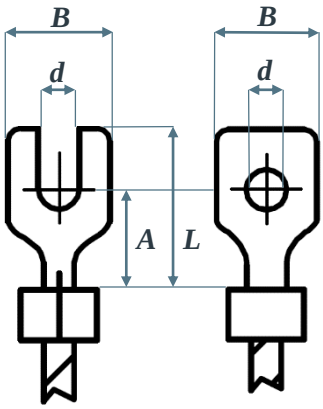
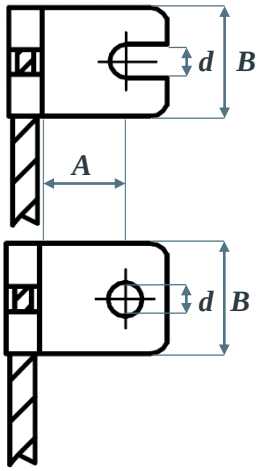
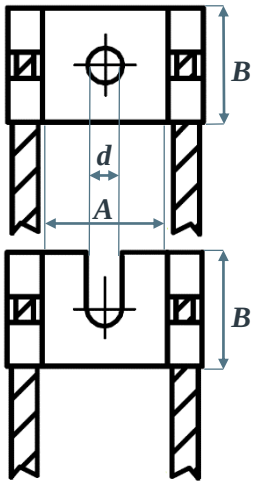
Tolerance on flexible section used by Mersen is ± 0.1mm².

09 - TERMINALS FOR INDUSTRIAL BRUSHES

Terminal part dimensions are standardized in IEC 60136. Table 9 gives standards of:

- terminal opening *d* (hole diameter or slot width)
- distance *A* from the terminal opening axis to the shoe
- width *B* (perpendicular to the flexible axis)
- and length *L* (along flexible's axis)

for standard terminals in use at Mersen (spade, flag and double shoe terminals).

Shape	axial			flag			double shoe	
MERSEN References [3]	A, B, F, M			E, G, H, M			O, T, W	
Definition of dimensions (examples)								
Bolt diameter	Opening diameter *d*	*B*	Minimum *A*	*L*	*B*	Minimum *A*	*B*	Minimum *A*
4	4.3	10	6	18	10	6	12	12
5	5.2	12	7	20	12	7	14	14
6	6.5	14	8.5	25	14	8.5	16	17
8	8.5	18	10.5	32	18	10.5	18	21

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

Table 9 - 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"*

[3] see Mersen's "Carbon brushes for motors and generators" technical guide page 34

Contact: info.ptt@mersen.com