

PRODUCTION TOOLS

**BOSCH**  
Ideas that work.



TOP  
PERFORMANCE WITH THE  
LOWEST POSSIBLE  
ENERGY CONSUMPTION.



CATALOGUE 2004/2005

HIGH-FREQUENCY POWER TOOLS  
FOR INDUSTRY

[www.boschproductiontools.com](http://www.boschproductiontools.com)

# HIGH-FREQUENCY POWER TOOLS: INEXPENSIVE POWER APPLICATION.

In spite of increasing automation in industrial production, the use of hand-held tools has advantages in many work operations. These tools must fulfil several requirements: robustness, powerful and a long service life, but they must also be easy to manage with high operating comfort.



## Better performance through higher frequency

Because their carbon brushes are subject to wear, universal motors of conventional power tools are unable to satisfy these requirements. On the other hand, the brushless asynchronous motor is ideally suited. The current frequency it is supplied with determines its rotational speed, which, in turn, determines the output that can be achieved. A higher frequency therefore means a higher speed and a higher output.

## High power at a constant speed

In continuous operation at 300 Hz, Bosch high-frequency tools have a power output of up to 400 Watts per kg machine weight. In the short term, peak performances of up to 2.5 times this value are possible. The speed remains almost constant – irrespective of whether the tool is being operated at idle or full load.

## Unique economy

A further argument in favour of high-frequency tools: their economy. Their efficiency and thus their power consumption means that they have unrivalled economy. Their long service life and low maintenance requirements and power consumption offer an economic solution for every type of application.

## Distinct environmental consciousness

Environmental thinking plays a central role in all Bosch products: from the initial development of the idea and energy saving products, to environmentally friendly packaging and disposal. If a Bosch high-frequency tool is irreparably damaged, Bosch will take back the old tool. They are collected centrally in the service centre and passed on for careful recycling.

## Special power saving measures

Bosch is also innovative in the area of power saving and places an emphasis on future-oriented technology: The heat recovery system in the Murrhard plant, for example, produces savings of over half a million litres of heating oil a year.

## Information from the Internet

Bosch now offers users and others interested in industrial tools all current product information on the Internet. Here you will find a free online catalogue illustrating in text and pictures all the common cordless, air and high-frequency tools for industrial use. More information on Page 4.

**CE Conformity**  
All of the air tools listed in this catalogue meet the following standards or norm documents EN 792, EN 50144, in accordance with the regulations of Directives 89/392/EEC.

 Certified in accordance with ISO 9001

Certificate no. FM 30078

All weight data in this catalogue corresponds to the EPTA Procedure 01/2003.

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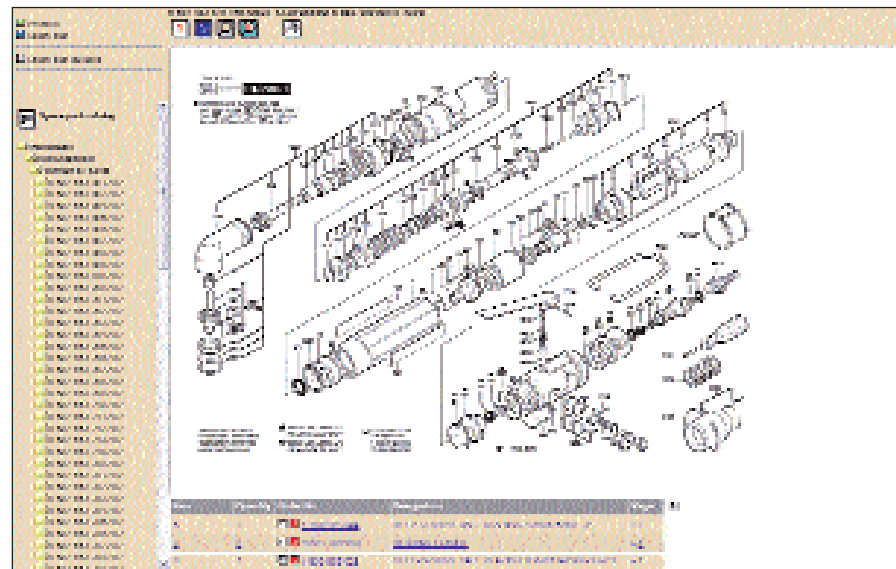


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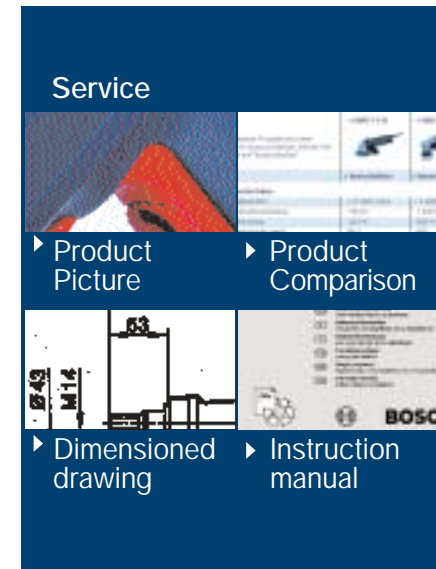
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## AN OVERVIEW WITH A SINGLE CLICK: ALL INDUSTRIAL TOOLS ONLINE.

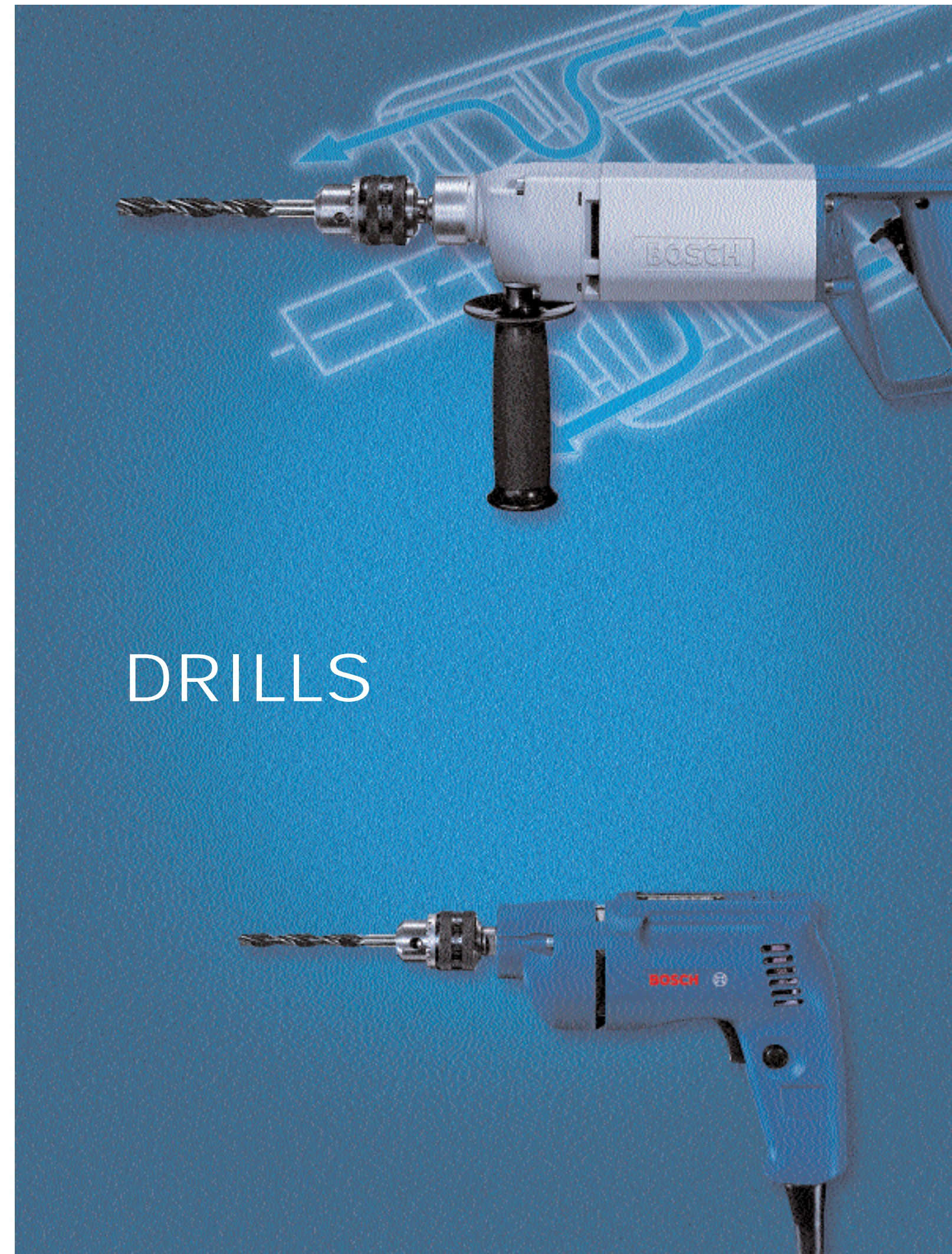
Everything the user needs to know can now be found on the Internet: under [www.boschproductiontools.com](http://www.boschproductiontools.com) the user has an extensive online catalogue to find which products are available and how they can be applied. The selection of tools is made easier by the possibilities to run comparisons between tools. Users, for example, can display all high-frequency sanders and compare their respective data such as output or rotational speed. Furthermore, they find out the latest news about measurement data, innovations and new developments from the area of Bosch Industrial Tools. Within a short time, this provides users with all the relevant information they need to select the correct production tools.



A spare parts service informs users about which spare parts they need – and where they can order them.



Operating instructions, pictures and exploded drawings can be downloaded directly from the Internet.



# DRILLS

# SELECTION GUIDE FOR DRILLS.

Selection of the right drill depends mainly on the following two points:






- drill bit diameter and
- the recommended cutting speed of the material to be processed.

In the table, the preferred bit sizes are assigned to the individual drill types for some common materials. The table shows the drill bit sizes with which the individual types are able to reach the recommended cutting speeds. However, the feed of hand-held tools cannot be increased arbitrarily with increasing bit diameter, since the necessary feed force can no longer be applied. For this reason, the maximum bit diameters for steel and aluminium are allocated to the individual types on page 6. These maximum diameters were determined by tests, unlike the information in the table. In order to achieve a sufficient cutting speed with normal hand pressure, some materials should be predrilled for the following bit diameters:

- steel up to 600 N/mm<sup>2</sup> as of 8 mm
- steel up to 600 N/mm<sup>2</sup> as of 6 mm
- cast iron up to 180 N/mm<sup>2</sup> as of 10 mm
- cast iron up to 300 N/mm<sup>2</sup> as of 8 mm

Note: If only one bit diameter is specified in the table, it refers to the lower limit of the recommended cutting speed. If nothing is specified, the recommended bit diameter is outside the clamping range of the standard chuck.

	Order number	Speed [rpm]	Frequency
<b>Cutting speed [m/min]:</b>			
	0 602 120 101 / ...104 / ...107	2450	200
	0 602 120 104	3700	300
	0 602 121 101 / ...104 / ...107	1350	200
	0 602 121 104	2000	300
	0 602 131 101 / ...104 / ...107	1350	200
	0 602 131 104	2050	300
	0 602 133 101 / ...104	690	200
	0 602 133 107	1000	200
	0 602 133 104	1030	300
	0 602 134 101	3300	200
	0 602 135 001 / ...004	1600	200
		2400	200
	0 602 135 101 / ...104	900	200
		1500	200
	0 602 135 104	1500	300
		2200	300
	0 602 117 001 / ...004 / ...008	510	200
	0 602 117 004	760	300
	0 602 119 001 / ...004 / ...008	216	200
		512	200
	0 602 119 004	328	300
		775	300

	Steel up to 600 N/mm <sup>2</sup>	Steel over 600 N/mm <sup>2</sup>	Cast iron up to 180 N/mm <sup>2</sup>	Cast iron up to 300 N/mm <sup>2</sup> plastic	Brass, copper, bronze	Silumin	Aluminium
Cutting speed [m/min]:	20 to 25	15 to 20	20 to 30	10 to 20	50 to 60	30 to 40	80 to 120
Drill diameter (mm)	2 4 6 8 10 12 14 16 18 20 22 24						
	2-10	2-10	2-10	2-10	2-10	2-10	2-10
	2-10	2-10	2-10	2-10	2-10	2-10	2-10
	2-10	2-10	2-10	2-10	2-10	2-10	2-10
	2-10	2-10	2-10	2-10	2-10	2-10	2-10
	2-10	2-10	2-10	2-10	2-10	2-10	2-10

# DRILLS.

- The suitable drills for a very wide variety of materials
- Drill at constant speed for optimised operational life
- Motors with extremely long service lives for economical work

	Order number	Voltage (V)	Frequency (Hz)	Max. bit-φ in steel (mm)
	0 602 120 101	265	200	3
	0 602 120 104	135	200	3
	0 602 120 107	72	200	3
	0 602 120 104	200	300	2
	0 602 121 101	265	200	6
	0 602 121 104	135	200	6
	0 602 121 107	72	200	6
	0 602 121 104	200	300	4

	Order number	Voltage (V)	Frequency (Hz)	Max. bit-φ in steel (mm)
	0 602 131 101	265	200	6
	0 602 131 104	135	200	6
	0 602 131 107	72	200	6
	0 602 131 104	200	300	4
	0 602 133 101	265	200	9
	0 602 133 104	135	200	9
	0 602 133 107	72	200	8
	0 602 133 104	200	300	8
	0 602 134 101	265	200	2

	Order number	Voltage (V)	Frequency (Hz)	Max. bit-φ in steel (mm)
	0 602 135 001	265	200	5/3
	0 602 135 004	135	200	5/3
	0 602 135 101	265	200	8/5
	0 602 135 104	135	200	8/5
	0 602 135 104	200	300	5/4

	Order number	Voltage (V)	Frequency (Hz)	Max. bit-φ in steel (mm)
	0 602 117 001	265	200	13
	0 602 117 004	135	200	13
	0 602 117 008	72	200	13
	0 602 117 004	200	300	10

	Order number	Voltage (V)	Frequency (Hz)	Max. bit-φ in steel (mm)
	0 602 119 001	265	200	16/12
	0 602 119 004	135	200	16/12
	0 602 119 008	72	200	16/12
	0 602 119 004	200	300	16/18

	Max. bit-φ in aluminium (mm)	Idling speed (min <sup>-1</sup> )	Nominal power consumption (W)	Nominal power output (W)	Nominal current (A)	Weight, without cable (kg)	Output drive tool holding fixture	Motor size (mm)	Speed settings	Remarks	Accessories supplied	Accessory order number
7	2450	260	150	0.9	1.7	1/2"-20 UNF	55	1	1-speed drill with three-jaw chuck	Chuck with key Clamping range 1–10 mm	3 608 571 001	
7	2450	260	150	1.7	1.7	1/2"-20 UNF	55	1				
7	2450	260	150	3.2	1.7	1/2"-20 UNF	55	1				
7	3700	400	230	1.7	1.7	1/2"-20 UNF	55	1				
9	1350	260	140	0.9	1.7	1/2"-20 UNF	55	1				
9	1350	260	140	1.7	1.7	1/2"-20 UNF	55	1				
9	1350	260	140	3.2	1.7	1/2"-20 UNF	55	1				
9	2000	400	230	1.7	1.7	1/2"-20 UNF	55	1				
10	1350	470	310	1.6	2.0	1/2"-20 UNF	57	1	1-speed drill with three-jaw chuck	Chuck with key Clamping range 1–10 mm	3 608 571 001	
10	1350	470	310	3.3	2.0	1/2"-20 UNF	57	1				
10	1350	470	310	6.1	2.0	1/2"-20 UNF	57	1				
10	2050	600	400	3.3	2.0	1/2"-20 UNF	57	1				
10	690	470	310	1.6	2.0	1/2"-20 UNF	57	1				
10	690	470	310	3.3	2.0	1/2"-20 UNF	57	1				
10	1000	400	310	6.1	2.0	1/2"-20 UNF	57	1				
10	1030	700	460	3.3	2.0	1/2"-20 UNF	57	1				
6	3300	400	270	1.6	2.0	M 13 x 1	57	1	1-speed drill with keyless chuck		3 608 571 004	
10/8	1600/2400	400	270	1.6	2.0	1/2"-20 UNF	57	2	2-speed drill with three-jaw chuck	Chuck with key Clamping range 1–10 mm	3 608 571 001	
10/8	1600/2400	400	270	3.3	2.0	1/2"-20 UNF	57	2				
10/8	900/1500	400	270	1.6	2.0	1/2"-20 UNF	57	2				
10/8	900/1500	400	270	3.3	2.0	1/2"-20 UNF	57	2				
10/8	1500/2200	600	400	3.3	2.0	1/2"-20 UNF	57	2				
13	510	600	440	1.6	2.8	Taper B 16	65	1	1-speed drill with speed handle. Three-jaw chuck can be ordered as a special accessory.	Chuck Clamping range 1.5–13 mm Additional handle	1 608 571 027 1 602 025 022	
13	510	600	440	3.3	2.8	Taper B 16	65	1				
13	510	600	440	5.9	2.8	Taper B 16	65	1				
13	760	900	630	3.3	2.8	Taper B 16	65	1				
23	216/512	950	700	2.8	5.6	Morse Taper 2	77	2	2-speed drill with cross handle. Without chuck. Suitable for bits with morse taper 2. Three-jaw chuck can be ordered as a special accessory.	Tubular handlef (M 27 x 2) Drill drift	1 600 763 010 3 601 030 002	
23	216/512	950	700	5.5	5.6	Morse Taper 2	77	2				
23	216/512	950	700	10.0	5.6	Morse Taper 2	77	2				
23	328/775	1450	1050	5.5	5.6	Morse Taper 2	77	2				

The machines come equipped with a special 4-m-long cable without plug.

Your specialist dealer can provide you with information on the complete set of quality accessories.

# RECOMMENDED SPEEDS FOR HSS TWIST DRILL BITS.

Up to drill- $\phi$ (mm)	Steel up to 600 N/mm <sup>2</sup>	Steel over 600 N/mm <sup>2</sup>	Cast iron up to 180 N/mm <sup>2</sup>	Cast iron up to 300 N/mm <sup>2</sup>	Brass, copper, bronze	Silumin	Aluminium
Cutting speed (m/min):	20 to 25	15 to 20	20 to 35	10 to 20	50 to 60	30 to 40	80 to 120
4	2380	1600	2200	1200	4400	2800	8000
5	1900	1270	1800	950	3500	2200	6400
6	1600	1060	1500	800	2900	1850	5300
7	1360	910	1300	680	2500	1600	4550
8	1200	800	1100	600	2200	1400	4000
9	1060	700	1000	530	1900	1200	3540
10	950	640	890	480	1700	1100	3200
11	860	580	810	430	1600	1000	2900
12	800	530	740	400	1500	930	2660
13	730	490	680	370	1350	860	2450
14	680	450	640	340	1250	800	2270
15	630	420	600	320	1150	740	2120
16	600	400	560	300	1100	700	2000
17	560	380	520	280	1050	660	1870
18	530	350	500	260	1000	620	1770
19	500	330	470	250	950	590	1680
20	480	320	450	240	900	560	1600
23	410	280	390	210	760	480	1380
30	310	210	300	160	580	370	1060

# ACCESSORIES FOR DRILLS.

	Order number	Packing unit
Morse taper MK2 on B 16 for using drill chucks with clamping diameters up to 16 mm, B16.	1 603 115 002	1

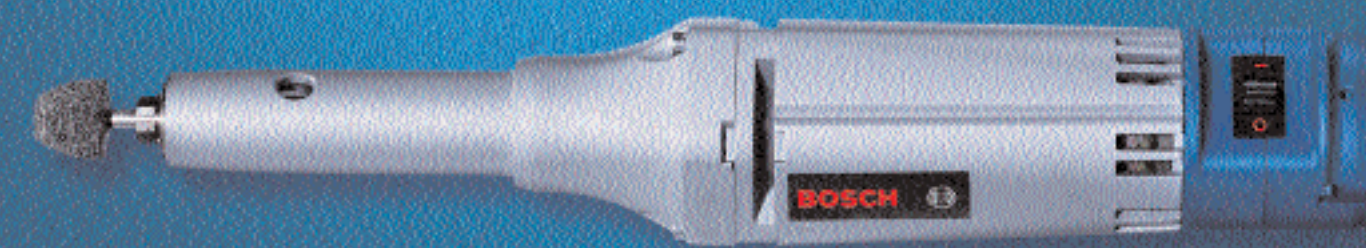
Please consult your stockist for information on the complete range of quality accessories.

# DIMENSIONAL DRAWINGS: DRILLS.

Size in mm	Order number
	0 602 120 101
	0 602 120 104
	0 602 120 107
	0 602 121 101
	0 602 121 104
	0 602 121 107
	0 602 131 101
	0 602 131 104
	0 602 131 107
	0 602 133 101
	0 602 133 104
	0 602 133 107
	0 602 134 101
	0 602 135 001
	0 602 135 004
	0 602 135 101
	0 602 135 104
	0 602 117 001
	0 602 117 004
	0 602 117 008
	0 602 119 001
	0 602 119 004
	0 602 119 008



# GRINDERS





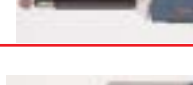
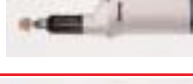
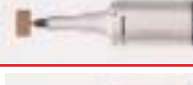
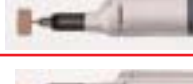

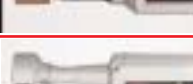
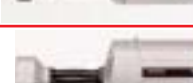

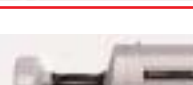
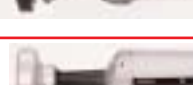
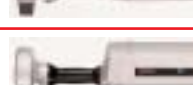














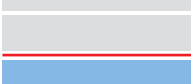




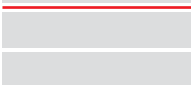





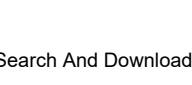

# SELECTION GUIDE FOR GRINDERS.

In order to select the correct grinding machine, you must take the area of application and specific circumstances into consideration. That is to say, selection of a grinding point predetermines selection of the suitable grinder. In both tables – one for straight grinders and one for angle grinders – the machines have been ordered to the grinding tasks or grinding points for which they are appropriate. The more powerful the machine, the larger the amount of material that is removed. Because of the great variety in individual working conditions and spatial considerations, these recommendations can, however, only serve as guidelines. In any case, when selecting a grinder, you should take other product features into consideration in addition to performance.

- optimally suited for this application
- well suited for this application
- suited for this for this application

Please observe manufacturer's information regarding grinding material.

	Order number	Idle speed (rpm)
	0 602 225 1... / 2...	50 000
	0 602 233 2... / 3...	50 000
	0 602 226 2...	30 500
	0 602 227 2...	29 000
	0 602 228 2... / 3...	12 000
	0 602 228 2... / 3...	18 000
	0 602 229 1...	12 000
	0 602 229 1...	18 000
	0 602 238 1...	12 000
	0 602 238 1...	18 000
	0 602 207 0...	23 400
	0 602 208 0...	18 300
	0 602 208 0...	27 400
	0 602 209 1...	12 000
	0 602 209 1...	18 000
	0 602 210 0...	3 100
	0 602 210 0...	4 700
	0 602 211 0...	12 000
	0 602 211 0...	18 000
	0 602 245 0...	18 000
	0 602 211 1...	12 000
	0 602 211 1...	18 000
	0 602 243 1...	10 700
	0 602 212 1...	9 000
	0 602 242 1...	8 600
	0 602 242 1...	6 800
	0 602 242 4...	6 800
	0 602 213 1...	6 800
	0 602 240 1...	5 700
	0 602 240 0...	10 200
	0 602 239 1...	4 800

	With grinding points	With fan-shaped abrasives	With grinding points	With tapered grinding wheels	With straight grinding wheels	With tapered grinding wheels
	Form grinding and deburring		Interior processing		Coarse grinding	
						
						
						
						
						
						
						
						
						
						
						
						
						
						
						
						
						
						
						
						










# STRAIGHT GRINDERS.

- The optimised straight grinders in all power classes for the widest possible variety of applications
- The ideal structural shape for ergonomic work
- Constant speed, even at extremely high loads
- Efficient work with longest possible service life
- Robust motors with long service lives and low maintenance costs
- Extremely favourable weight-performance ratio

for grinding points  
8 to 50 mm in diameter

	Order number	Voltage (V)	Frequency (Hz)	Admissible grinding point- $\phi$
<b>HGS 44/8</b> 	0 602 225 101	265	200	8
	0 602 225 104	135	200	8
	0 602 225 107	72	200	8
	0 602 225 204	200	300	8
	0 602 225 211	72	300	8
<b>HGS 55/8</b> 	0 602 233 201	265	200	8
	0 602 233 204	135	200	8
	0 602 233 207	72	200	8
	0 602 233 304	200	300	8
<b>HGS 55/25</b> 	0 602 226 201	265	200	25
	0 602 226 204	135	200	25
	0 602 226 207	72	200	25
	0 602 227 204	200	300	25
	0 602 227 211	72	300	25
<b>HGS 55/50</b> 	0 602 228 201	265	200	50
	0 602 228 204	135	200	50
	0 602 228 207	72	200	50
	0 602 228 204	200	300	50
	0 602 228 211	72	300	50
<b>HGS 55/50</b> 	0 602 229 101	265	200	50
	0 602 229 104	135	200	50
	0 602 229 104	200	300	50

No load speed (rpm)	Nominal power consumption (W)	Nominal power Output (W)	Nominal current (A)	Weight without cable (kg)	Toolholding fixture Collet chuck (mm)	Switch type	Remarks	Comes complete with	Accessory part number
50 000	80	40	0.2	0.7	3	Slide switch	Bar handle, offset output drive	Collet chuck 3 mm	2 608 570 019
50 000	80	40	0.5	0.7	3			Open-ended spanner SW 9	1 907 950 503
50 000	80	40	0.9	0.7	3			Open-ended spanner SW 11	1 907 950 505
								Auxiliary handle	3 602 025 002
50 000	125	65	0.5	0.7	3				
50 000	125	65	1.4	0.7	3				
50 000	260	150	0.9	1.7	3	Slide switch	Bar handle, offset output drive	Collet chuck 3 mm	2 608 570 019
50 000	260	150	1.7	1.7	3			Open-ended spanner SW 9	1 907 950 503
50 000	260	150	3.2	1.7	3			Open-ended spanner SW 11	1 907 950 505
								Auxiliary handle	3 602 025 002
50 000	400	230	1.7	1.7	3				
30 500	260	150	0.9	1.6	6	Slide switch	Bar handle, offset output drive	Collet chuck 6 mm	2 608 570 079
30 500	260	150	1.7	1.6	6			2 open-ended spanner SW 17	2 607 950 511
30 500	260	150	3.2	1.6	6				
29 000	400	230	1.7	1.6	6				
29 000	400	230	4.6	1.6	6				
12 000	260	150	0.9	1.6	6	Slide switch	Bar handle, central output drive	Collet chuck 6 mm	2 608 570 079
12 000	260	150	1.7	1.6	6			open-ended spanner SW 17	2 607 950 511
12 000	260	150	3.2	1.6	6				
18 000	400	230	1.7	1.6	6				
18 000	400	230	4.6	1.6	6				
12 000	260	150	0.9	1.3	6	Slide switch	Bar handle, central output drive, short spindle for tight spaces	Collet chuck 6 mm with nut	2 608 570 079
12 000	260	150	1.7	1.3	6			open-ended spanner SW 17	2 607 950 511
18 000	400	230	1.7	1.3	6				






The machines come equipped with a special 4-m-long cable without plug.

Your specialist dealer can provide you with information on the complete set of quality accessories.

# STRAIGHT GRINDERS.

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- The ideal structural shape for ergonomic work
- Constant speed, even at extremely high loads
- Efficient work with longest possible service life
- Robust motors with long service lives and low maintenance costs
- Extremely favourable weight-performance ratio

for grinding points  
27 to 50 mm in diameter

	Order number	Voltage (V)	Frequency (Hz)	Admissible grinding point- $\phi$ (mm)
	0 602 228 361	265	200	50
	0 602 228 364	135	200	50
	0 602 228 364	200	300	50
	0 602 228 371	265	200	50
	0 602 228 374	135	200	50
	0 602 228 377	72	200	50
	0 602 228 374	200	300	40
	0 602 238 101	265	200	50
	0 602 238 104	135	200	50
	0 602 238 107	72	200	50
	0 602 238 134	200	300	50
	0 602 238 111	72	300	50
	0 602 207 001	265	200	32
	0 602 207 004	135	200	32
	0 602 207 008	72	200	32
	0 602 208 001	135	200	50
	0 602 208 001	200	300	27
	0 602 209 101	265	200	50
	0 602 209 104	135	200	50
	0 602 209 107	72	200	50
	0 602 209 134	200	300	50
	0 602 209 111	72	300	50

No load speed (rpm)	Nominal power consumption (W)	Nominal power Output (W)	Nominal current (A)	Weight without cable (kg)	Toolholding fixture Collet chuck (mm)	Switch type	Remarks	Comes complete with	Accessory part number
12 000	260	150	0.9	1.6	6	ON/OFF switch	Bar handle, central output drive with eccentric clamping	Collet chuck $\phi$ 6 mm Offset screwdriver	1 608 570 025
12 000	260	150	1.7	1.6	6				1 607 950 001
18 000	400	230	1.7	1.6	6				
12 000	260	150	0.9	1.6	6	Pressure switch with lock	Pistol handle, with eccentric clamping	Collet chuck $\phi$ 6 mm Offset screwdriver	1 608 570 025
12 000	260	150	1.7	1.6	6				1 607 950 001
12 000	260	150	3.2	1.6	6				
18 000	400	230	1.7	1.6	6				
12 000	400	270	1.6	2.1	6	Pressure switch with lock	Post handle, central output drive Spindle length up to 480 mm optional.	Collet chuck $\phi$ 6 mm Open-ended spanner SW 12 Open-ended spanner SW 15	1 608 570 025
12 000	400	270	3.3	2.1	6				1 907 950 506
12 000	400	270	6.1	2.1	6				1 907 950 509
18 000	600	400	3.3	2.1	6				
18 000	600	400	9.2	2.1	6				
23 400	600	440	1.6	2.4	6	Toggle	Post handle, central output drive	Collet chuck $\phi$ 6 mm Open-ended spanner SW 12 Open-ended spanner SW 15	1 608 570 025
23 400	600	440	3.3	2.4	6				1 907 950 506
23 400	600	440	5.9	2.4	6				1 907 950 509
18 300	600	440	3.3	2.4	6				
27 400	900	630	3.3	2.4	6				
12 000	600	440	1.6	2.5	6	Toggle	Post handle, central output drive	Collet chuck $\phi$ 6 mm Open-ended spanner SW 12 Open-ended spanner SW 15	1 608 570 025
12 000	600	440	3.3	2.5	6				1 907 950 506
12 000	600	440	5.9	2.5	6				1 907 950 509
18 000	900	630	3.3	2.5	6				
18 000	900	630	8.8	2.5	6				




The machines come equipped with a special 4-m-long cable without plug.

Your specialist dealer can provide you with information on the complete set of quality accessories.

# STRAIGHT GRINDERS.

- The optimised straight grinders in all power classes for the widest possible variety of applications
- The ideal structural shape for ergonomic work
- Constant speed, even at extremely high loads
- Efficient work with longest possible service life
- Robust motors with long service lives and low maintenance costs
- Extremely favourable weight-performance ratio

## for grinding points 40 to 50 mm in diameter

	Order number	Voltage (V)	Frequency (Hz)	Admissible grinding point- $\phi$ (mm)
	0 602 210 001	265	200	50
	0 602 210 004	135	200	50
	0 602 210 004	200	300	50
	0 602 211 004	265	200	50
	0 602 211 010	135	200	50
	0 602 211 017	72	200	50
	0 602 211 010	200	300	50
	0 602 211 018	72	300	50
	0 602 245 034	200	300	40
	0 602 245 011	72	300	40

No load speed (rpm)	Nominal power consumption (W)	Nominal power Output (W)	Nominal current (A)	Weight without cable (kg)	Toolholding fixture Collet chuck (mm)	Switch type	Remarks	Comes complete with	Accessory part number
3100	600	440	1.6	2.5	6	Toggle	Post handle, offset drive for polishing heads with low circumference velocity	Collet chuck $\phi$ 6 mm	1 608 570 025
3100	600	440	3.3	2.5	6			Open-ended spanner SW 12	1 907 950 506
								Open-ended spanner SW 15	1 907 950 509
4700	900	630	3.3	2.5	6				
12 000	950	700	2.8	4.3	8	Toggle	Post handle, central output drive	Collet chuck $\phi$ 8 mm	2 608 570 009
12 000	950	700	5.5	4.3	8			Open-ended spanner SW 14	1 607 950 511
12 000	950	700	10.0	4.3	8			Open-ended spanner SW 22	1 607 950 505
18 000	1450	1050	5.5	4.3	8				
18 000	1450	1050	15.2	4.3	8				
18 000	1800	1500	6.4	4.7	Spindle M 14	Toggle	Post handle, central output drive for grinding wheels with internal thread	Open-ended spanner SW 27	3 607 950 004
18 000	1800	1500	17.7	4.7	Spindle M 14	Lever switch with lock			


The machines come equipped with a special 4-m-long cable without plug.

Your specialist dealer can provide you with information on the complete set of quality accessories.

# STRAIGHT GRINDERS.

- The optimised straight grinders in all power classes for the widest possible variety of applications
- The ideal structural shape for ergonomic work
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- Extremely favourable weight-performance ratio

for grinding wheels  
50 to 80 mm in diameter

	Order number	Voltage (V)	Frequency (Hz)	Admissible grinding point-φ (mm)
	0 602 211 101	265	200	75 mm φ
	0 602 211 107	135	200	45 m/s
	0 602 211 116	72	200	circumference
				velocity
	0 602 211 134	200	300	50 mm φ
				45 m/s
				circumference
				velocity
	0 602 212 101	265	200	100 mm φ
	0 602 212 104	135	200	45 m/s
	0 602 212 107	72	200	circumference
				velocity
	0 602 242 101	265	200	100 mm φ
	0 602 242 104	265	200	45 m/s
	0 602 242 107	72	200	circumference
				velocity
	0 602 242 134	200	300	100 mm φ
				45 m/s
				circumference
				velocity
	0 602 242 436	200	300	125 mm φ
			45 m/s	
			circumference	
			velocity	

No load speed (rpm)	Nominal power consumption (W)	Nominal power Output (W)	Nominal current (A)	Weight without cable (kg)	Toolholding fixture Collet chuck (mm)	Switch type	Remarks	Comes complete with	Accessory part number
12 000	950	700	2.8	4.7	Mounting flanges M 14 for grinding wheels with bore-φ 20 mm	Toggle	The machine must not be operated without a protective guard.	Open-ended spanner SW 32	3 607 950 005
12 000	950	700	5.5	4.7				Pin sparrer	3 607 950 006
12 000	950	700	10.0	4.7				Protective guard	3 605 510 025
								Mounting flange	3 605 703 028
								Collet flange	3 605 703 074
18 000	1450	1050	5.5	4.7	Mounting flanges M 14 for grinding wheels with bore-φ 20 mm	Lever with lock	The machine must not be operated without a protective guard.	Open-ended spanner SW 32	3 607 950 005
								Pin sparrer	3 607 950 006
								Protective guard	3 605 510 025
								Mounting flange	3 605 703 028
								Collet flange	3 605 703 074
9000	950	700	2.8	5.1	Mounting flanges M 14 for grinding wheels with bore-φ 20 mm	Toggle	The machine must not be operated without a protective guard.	Open-ended spanner SW 32	3 607 950 005
9000	950	700	5.5	5.1				Pin sparrer	3 607 950 006
9000	950	700	10.1	5.1				Protective guard	3 605 510 019
								Mounting flange	3 605 703 028
								Collet flange	3 605 703 074
8600	1200	1000	3.3	5.5	Mounting flanges M 14 for grinding wheels with bore-φ 20 mm	Lever with lock	The machine must not be operated without a protective guard.	Open-ended spanner SW 32	3 607 950 005
8600	1200	1000	3.3	5.5				Pin sparrer	3 607 950 006
8600	1200	1000	11.8	5.5				Protective guard	3 605 510 019
								Mounting flange	3 605 703 028
								Collet flange	3 605 703 074
8600	1800	1500	6.4	5.5	Mounting flanges M 14 for grinding wheels with bore-φ 20 mm	Lever with lock	The machine must not be operated without a protective guard.	Open-ended spanner SW 32	3 607 950 005
								Pin sparrer	3 607 950 006
								Protective guard	3 605 510 019
								Mounting flange	3 605 703 028
								Collet flange	3 605 703 074
6800	1800	1500	6.4	5.5	Mounting flanges M 14 for grinding wheels with bore-φ 20 mm	Toggle	The machine must not be operated without a protective guard.	Open-ended spanner SW 32	3 607 950 010
								Pin sparrer	1 607 950 061

The machines come equipped with a special 4-m-long cable without plug.

Your specialist dealer can provide you with information on the complete set of quality accessories.

# STRAIGHT GRINDERS.

- The optimised straight grinders in all power classes for the widest possible variety of applications
- The ideal structural shape for ergonomic work
- Constant speed, even at extremely high loads
- Efficient work with longest possible service life
- Robust motors with long service lives and low maintenance costs
- Extremely favourable weight-performance ratio

## for grinding wheels 125 to 180 mm in diameter

	Order number	Voltage (V)	Frequency (Hz)	Admissible grinding wheels- $\phi$ (mm)
	0 602 213 104	200	300	125 mm $\phi$
				45 m/s circumference velocity
	0 602 240 104	135	200	150 mm $\phi$
	0 602 240 107	72	200	45 m/s circumference velocity
	0 602 240 134	200	300	150 mm $\phi$
				45 m/s circumference velocity
	0 602 240 034	200	300	150 mm $\phi$
	0 602 240 035	200	300	80 m/s circumference velocity
	0 602 239 104	135	200	180 mm $\phi$
	0 602 239 107	72	200	45 m/s circumference velocity
	0 602 239 134	200	300	180 mm $\phi$
				45 m/s circumference velocity

No load speed (rpm)	Nominal power consumption (W)	Nominal power Output (W)	Nominal current (A)	Weight without cable (kg)	Toolholding fixture Collet chuck (mm)	Switch type	Remarks	Comes complete with	Accessory part number
6800	1450	1050	5.5	5.2	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 20 mm	Toggle	The machine must not be operated without a protective guard.	Open-ended spanner SW 32 Pin spanner Protective guard Mounting flange Collet flange	3 607 950 010 1 607 950 061 3 605 510 014 3 605 703 068 3 605 703 077
5700	1950	1500	10.0	7.7	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 20 mm	Lever with lock	The machine must not be operated without a protective guard.	Open-ended spanner SW 32 Pin spanner Protective guard Mounting flange Collet flange	3 607 950 010 1 607 950 061 3 605 510 018 3 605 703 068 3 605 703 077
5700	1950	1500	18.0	7.7					
5700	2900	2200	10.0	7.7	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 20 mm	Lever with lock	The machine must not be operated without a protective guard.	Open-ended spanner SW 32 Pin spanner Protective guard Mounting flange Collet flange	3 607 950 010 1 607 950 061 3 605 510 018 3 605 703 068 3 605 703 077
10 200	2900	2200	10.0	7.7	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 20 mm	Lever with lock	The machine must not be operated without a protective guard.	Open-ended spanner SW 32 Pin spanner Protective guard Mounting flange Collet flange	3 607 950 010 1 607 950 061 3 605 510 031 3 605 703 068 3 605 703 077
10 200	2900	2200	10.0	7.7		Lever without lock			
4800	1950	1500	10.0	7.9	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 20 mm	Lever with lock	The machine must not be operated without a protective guard.	Open-ended spanner SW 32 Pin spanner Protective guard Mounting flange Collet flange	3 607 950 010 1 607 950 061 3 605 510 035 3 605 703 068 3 605 703 077
4800	1950	1500	18.0	7.9					
4800	2900	2200	10.0	7.9	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 20 mm	Lever with lock	The machine must not be operated without a protective guard.	Open-ended spanner SW 32 Pin spanner Protective guard Mounting flange Collet flange	3 607 950 010 1 607 950 061 3 605 510 035 3 605 703 068 3 605 703 077




The machines come equipped with a special 4-m-long cable without plug.

Your specialist dealer can provide you with information on the complete set of quality accessories.

# ANGLE GRINDERS.



for grinding wheels  
100 to 180 mm in diameter

	Order number	Voltage (V)	Frequency (Hz)	Admissible grinding wheels- $\phi$ (mm)
<b>HWS 5265/125</b> 	0 602 324 301	265	200	125
	0 602 324 304	135	200	125
	0 602 324 307	72	200	125
<b>HWS 5265/125</b> 	0 602 324 341	265	200	125
	0 602 324 344	135	200	125
	0 602 324 347	72	200	125
	0 602 324 324	200	300	125
	0 602 324 331	72	300	125
<b>HWS 65/125</b> 	0 602 301 201	265	200	125
	0 602 301 204	135	200	125
	0 602 301 207	72	200	125
	0 602 301 204	200	300	125
	0 602 327 001	265	200	100
<b>HWS 65/125</b> 	0 602 326 104	200	300	125
<b>HWS 77/100 for wet grinding</b> 	0 602 305 010	42	200	125
<b>HWS 77/175</b> 	0 602 305 001	265	200	175
	0 602 305 004	135	200	175
	0 602 305 008	72	200	175
	0 602 306 034	200	300	175
<b>HWS 77/180</b> 	0 602 304 001	265	200	180
	0 602 304 004	135	200	180
	0 602 304 009	72	200	180
	0 602 304 034	200	300	180
	0 602 304 010	72	300	180

- The correct grinder/sander for every application
- Extremely robust and maintenance-friendly motors
- Constant speeds throughout the whole power range for top economy and longest possible service lives
- Robust angular gear with high operational performance

No load speed (rpm)	Nominal power consumption (W)	Nominal power Output (W)	Nominal current (A)	Weight without cable (kg)	Toolholding fixture chuck (mm)	Switch type	Remarks	Comes complete with	Accessory part number
4800	520	360	1.6	2.0	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 22.3 mm	Slide-switch	For fibre-sanding discs with spindle locking. SDS-clic available as special accessory	Pin-type wrench Auxiliary handle Pin-type wrench Mounting flange	1 607 950 052
4800	520	360	3.2	2.0					1 602 025 031
4800	520	360	6.1	2.0					1 603 345 043 2 605 703 014
5800	520	360	1.6	2.2	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 22.3 mm	Slide-switch	For light grinding work	Protective guard $\phi$ 125 mm Pin-type wrench Auxiliary handle Pin-type wrench Mounting flange	1 605 510 155
5800	520	360	3.2	2.2					1 607 950 052
5800	520	360	6.1	2.2					1 602 025 031 1 603 345 043 2 605 703 014
7300	800	550	3.2	2.2			For fan-type discs		
7300	800	550	8.7	2.2					
4100	600	440	1.6	3.0	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 22.3 mm	Toggle	For fibre-sanding	Open-ended spanner SW 17 Auxiliary handle Pin-type wrench	2 607 950 511
4100	600	440	3.3	3.0					1 602 025 022
4100	600	440	5.9	3.0					1 607 950 052
6150	900	630	3.3	3.0					
2550	600	410	1.6	3.0					
9000	900	630	3.3	3.2	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 22.3 mm	Toggle	For light grinding work	Protective guard $\phi$ 125 mm Pin-type wrench Open-ended spanner SW 17 Auxiliary handle Pin-type wrench	1 605 510 155
									1 607 950 052
									2 607 950 511 1 602 025 022 1 603 345 043
1750	950	700	17.5	4.5	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 22.3 mm	Toggle	For wet grinding	Open-ended spanner SW 17 Auxiliary handle Pin-type wrench Mounting flange Pin-type wrench	2 607 950 511
									1 602 025 022
									1 607 950 061 2 605 703 014 1 603 345 043
1750	950	700	2.8	4.4	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 22.3 mm	Toggle	For polishing work	Open-ended spanner SW 17 Auxiliary handle	2 607 950 511
1750	950	700	5.5	4.4					1 602 025 022
1750	950	700	10.0	4.4					
1650	1450	1050	5.5	4.4					
5700	950	700	2.8	4.6	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 22.3 mm	Toggle	For medium-heavy grinding work	Protective guard $\phi$ 180 mm Mounting flange Pin-type wrench Pin-type wrench Open-ended spanner SW 17 Auxiliary handle	1 605 510 176
5700	950	700	5.5	4.6					2 605 703 014
5700	950	700	10.0	4.6					1 603 345 043 1 607 950 061 2 607 950 511 1 602 025 022
8600	1450	1050	5.5	4.6					
8600	1450	1050	15.2	4.6					

The machines come equipped with a special 4-m-long cable without plug.

Your specialist dealer can provide you with information on the complete set of quality accessories.

# ANGLE GRINDERS.

- The correct grinder/sander for every application
- Extremely robust and maintenance-friendly motors
- Constant speeds throughout the whole power range for top economy and longest possible service lives
- Robust angular gear with high operational performance

for grinding wheels  
180 to 230 mm in diameter

	Order number	Voltage (V)	Frequency (Hz)	Admissible grinding wheels- $\phi$ (mm)
	HWS 85/180			
	0 602 329 001	265	200	180
	0 602 329 004	135	200	180
	0 602 329 007	72	200	180
	0 602 329 034	200	300	180
	0 602 329 011	72	300	180
	0 602 329 036	200	300	180

	Order number	Voltage (V)	Frequency (Hz)	Admissible grinding wheels- $\phi$ (mm)
	HWS 88/180			
	0 602 331 001	265	200	180
	0 602 331 004	135	200	180
	0 602 331 007	72	200	180
	0 602 331 003	265	200	180
	0 602 331 034	200	300	180
	0 602 331 036	200	300	180

	Order number	Voltage (V)	Frequency (Hz)	Admissible grinding wheels- $\phi$ (mm)
	HWS 88/230			
	0 602 332 001	265	200	230
	0 602 332 011	200	300	230
	0 602 332 034	200	300	230
	0 602 332 003	265	200	230
	0 602 332 036	200	300	230
	0 602 332 005	135	200	230

No load speed (rpm)	Nominal power consumption (W)	Nominal power Output (W)	Nominal current (A)	Weight without cable (kg)	Toolholding fixture chuck (mm)	Switch type	Remarks	Comes complete with	Accessory part number	
8500	1200	1000	3.3	5.6	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 2,3 mm	Lever with lock	For medium-heavy grinding work. SDS-clic available as special accessory.	Protective guard $\phi$ 180 mm	1 605 510 176	
8500	1200	1000	6.4	5.6				Mounting flange	2 605 703 014	
8500	1200	1000	11.8	5.6				Round nut	1 603 345 043	
								Pin-type wrench	1 607 950 061	
								Open-ended spanner SW 17	2 607 950 511	
								Auxiliary handle	1 602 025 022	
8500	1800	1500	6.4	5.6						
8500	1800	1500	17.7	5.6						
8500	1800	1500	6.4	5.6				Toggle		
8500	1950	1500	5.0	6.5	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 2,3 mm	Lever with lock	For medium-heavy grinding work. SDS-clic available as special accessory.	Protective guard $\phi$ 180 mm	1 605 510 176	
8500	1950	1500	10.0	6.5				Mounting flange	2 605 703 014	
8500	1950	1500	18.0	6.5				Round nut	1 603 345 043	
								Pin-type wrench	1 607 950 061	
								Open-ended spanner SW 17	2 607 950 511	
								Auxiliary handle	1 602 025 022	
8500	1950	1500	5.0	6.5				Toggle		
8500	2900	2200	10.0	6.5				Lever with lock		
8500	2900	2200	10.0	6.5				Toggle		
6600	1950	1500	5.0	7.0	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 2,3 mm	Lever with lock	For medium-heavy grinding work. SDS-clic available as special accessory.	Protective guard $\phi$ 180 mm	1 605 510 173	
6600	2900	2200	10.0	7.0				Mounting flange	2 605 703 014	
6600	2900	2200	10.0	7.0				Round nut	1 603 345 043	
								Pin-type wrench	1 607 950 061	
								Open-ended spanner SW 17	2 607 950 511	
								Auxiliary handle	1 602 025 022	
6600	1950	1500	5.0	7.0				Toggle		
6600	2900	2200	10.0	7.0						
6600	1950	1500	10.0	7.0				Lever with lock		

The machines come equipped with a special 4-m-long cable without plug.

Your specialist dealer can provide you with information on the complete set of quality accessories.




# ANGLE GRINDERS

- The correct grinder/sander for every application
- Extremely robust and maintenance-friendly motors
- Constant speeds throughout the whole power range for top economy and longest possible service lives
- Robust angular gear with high operational performance

for grinding wheels  
230 to 300 mm in diameter

	Order number	Voltage (V)	Frequency (Hz)	Admissible grinding wheels- $\phi$ (mm)
HWS 810/230	0 602 334 101	265	200	230
	0 602 334 107	72	200	230
	0 602 334 134	200	300	230
	0 602 334 136	200	300	230

	Order number	Voltage (V)	Frequency (Hz)	Admissible grinding wheels- $\phi$ (mm)
HWS 810/300	0 602 335 001	265	200	300
	0 602 335 004	135	200	300
	0 602 335 007	72	200	300
	0 602 335 034	200	300	300
	0 602 335 036	200	300	300

No load speed (rpm)	Nominal power consumption (W)	Nominal power Output (W)	Nominal current (A)	Weight without cable (kg)	Toolholding fixture chuck (mm)	Switch type	Remarks	Comes complete with	Accessory part number
6600	2500	2000	6.7	8.5	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 22,3 mm	Lever with lock	For heavy grinding work. SDS-click available as special accessory.	Protective guard $\phi$ 230 mm	1 605 510 173
6600	2500	2000	24.7	8.5				Mounting flange	2 605 703 014
								Round nut	1 603 345 043
						Lever with lock		Pin-type wrench	1 607 950 061
						Toggle		Open-ended spanner SW 17	2 607 950 511
								Auxiliary handle	1 602 025 022
<hr/>									
4700	2500	2000	6.7	10.0	Mounting flanges M 14 for grinding wheels with bore- $\phi$ 22,3 mm	Lever with lock	For cutting work.	Protective guard $\phi$ 300 mm	1 605 510 212
4700	2500	2000	13.2	10.0				Mounting flange	2 605 703 011
								Round nut	1 603 345 043
								Mounting flange	2 605 703 022
								Internal hexagon key	1 907 950 007
						Lever with lock		Pin-type wrench	1 607 950 061
						Toggle		Open-ended spanner SW 17	2 607 950 511
								Auxiliary handle	1 602 025 022




The machines come equipped with a special 4-m-long cable without plug.

Your specialist dealer can provide you with information on the complete set of quality accessories.

# DISC SANDERS AND RANDOM ORBIT SANDERS.

- The correct sander for all surfaces
- Best sanding results, even on large surfaces
- Robust motors with an extremely long service life
- Small random orbit sander with very high performance

disc sanders and random orbit sanders for sanding discs with 180 mm diameter

	Order number	Voltage (V)	Frequency (Hz)	Admissible grinding wheels-φ (mm)
<b>HTS 75/180</b> 	0 602 373 004	135	200	180
	0 602 373 004	200	300	180
<b>HTS 86/180</b> 	0 602 370 101	265	200	180
	0 602 370 104	135	200	180
	0 602 370 107	72	200	180
<b>HEX 5265/150</b> 	0 602 370 301	265	200	150
	0 602 370 304	135	200	150
	0 602 370 307	72	200	150
	0 602 370 311	72	300	150
	0 602 370 334	200	300	150

No load speed (rpm)	Nominal power consumption (W)	Nominal Power Output (W)	Nominal current (A)	Weight without cable (kg)	Toolholding fixture Collet chuck (mm)	Switch type	Remarks	Comes complete with	Accessory part number
3600	850	580	2.2	3.7	Threaded mounting M 14	Toggle	For fibre-sanding discs	Open-ended spanner SW 17 Auxiliary handle Ringscrew Spring Gloves	2 607 950 511 1 602 025 022 2 912 521 237 2 916 680 011 2 601 329 036
5400	1300	900	4.5	3.7					
6000	1000	800	3.4	4.7	Threaded mounting M 14	Toggle	For fibre-sanding discs	Open-ended spanner SW 24 Open-ended spanner SW 19 Auxiliary handle Gloves	1 907 950 513 1 907 950 511 1 602 025 022 2 601 329 036
6000	1000	800	6.0	4.7					
6000	1000	800	12.8	4.7					
5800	520	360	1.6	2.7		Fastener	Slide switch	Auxiliary Handle Dust bag Screw-on connector Allen key	2 602 025 067 2 605 411 046 2 605 702 009 1 907 950 007
5800	520	360	3.2	2.7					
5800	520	360	6.1	2.7					
7300	800	550	6.1	2.7					
7300	800	550	3.2	2.7					

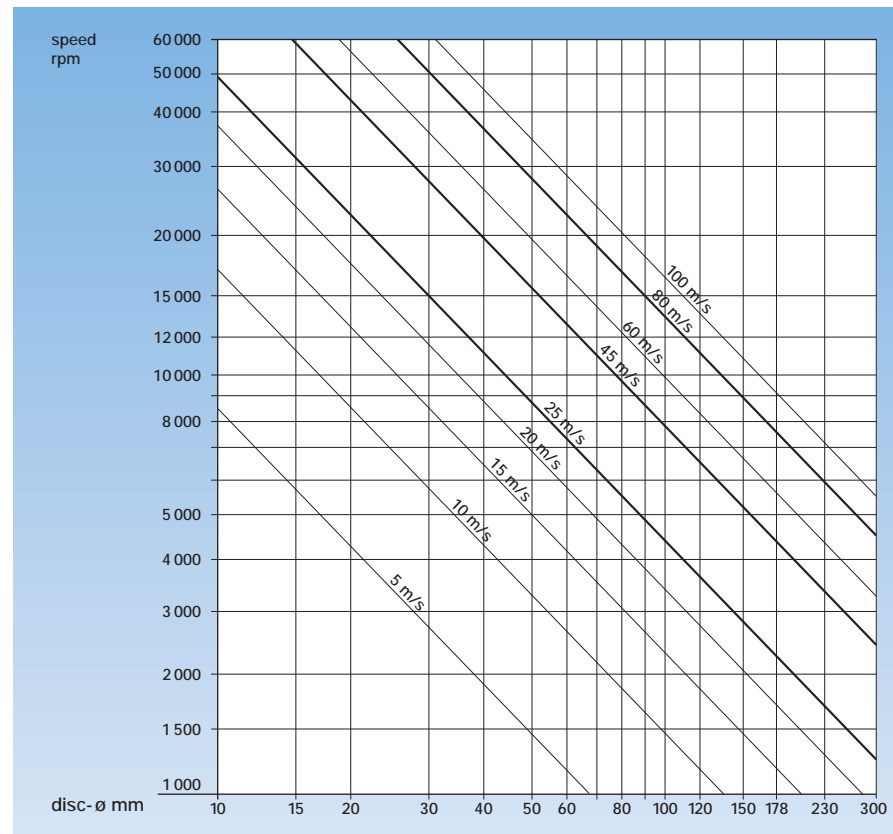
The machines come equipped with a special 4-m-long cable without plug.

Your specialist dealer can provide you with information on the complete set of quality accessories.

## SELECTION GUIDE FOR GRINDERS.

### Admissible working speed

Observe the following with grinding stones: Permissible speeds (rpm) depend on abrasive wheel diameter and length, as well as shank diameter and clamping length as per DIN 69170.



The table shows the relationship between the permissible diameter of the grinding wheel and the speed.

## ACCESSORIES FOR ANGLE GRINDERS.

	Order number	Working ø (mm)
Protective guard	1 605 510 110	180
Flange for straight grinding wheels	1 605 703 028	
Flange for tapered grinding wheels	1 600 501 006	
Locking nut	1 603 345 004	
SDS quick clamping flange	1 603 340 031	

## ACCESSORIES FOR STRAIGHT GRINDERS.

	0 602 225 ...101/...204/...211	0 602 236 ...007	0 602 237 004 ...201/...204/...207	0 602 226 ...201/...204/...207	0 602 227 ...201/...204/...211	0 602 228 ...201/...204/...211	0 602 229 ...101/...104	0 602 228 ...361/...374/...377	0 602 238 ...101/...104/...111	0 602 207 ...001/...008	0 602 208 001 ...101/...104/...111	0 602 210 ...001/...004	0 602 211 ...004/...010/...018
<b>Collets-ø</b>													
3 mm	1 608 570 0312	608 570 077	-	-									
1/8"	-2 608 570 078	-	-										
4 mm	1 608 570 033	-	-										
6 mm	1 608 570 0372	608 570 079	2 608 570 118	-									
1/4"	-2 608 570 080	-	2 608 570 014										
8 mm	-2 608 570 081	2 608 570 0162	608 570 009										
10 mm	-	-	2 608 570 017										

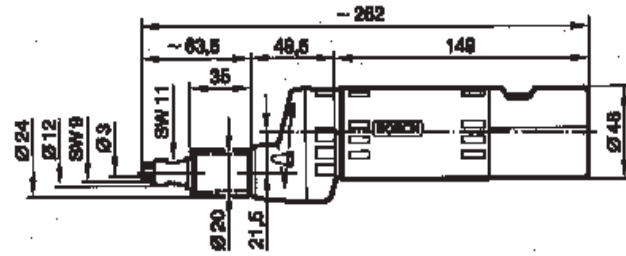
	0 602 221 ... and 243 ...	0 602 212 ... and 242 ...	0 602 213 ...	0 602 240 ...	0 602 240 ...	0 602 239 ...
<b>Accessories for conical grinding wheels</b>						
	45 and 80 m/s up to 80 mm ø	45 and 80 m/s up to 100 mm ø	45 m/s up to 125 mm ø	45 m/s up to 150 mm ø	80 m/s up to 150 mm ø	45 m/s up to 180 mm ø
Wheel guards	3 605 510 025	3 605 510 030	3 605 510 031	3 605 510 018	3 605 510 017	3 605 510 016
Mounting flange	3 605 703 028	3 605 703 028	3 605 703 068	3 605 703 068	3 605 703 068	3 605 703 068
Collet flange	3 605 703 074	3 605 703 074	3 605 703 077	3 605 703 077	3 605 703 070	3 605 703 077
admissible grinding point width (mm)	20/25	20/25	20/25	20/25	20/25	20

	Order number	Product type for model 0 602 ...	Length in mm
<b>Spindle extension</b>	3 606 120 031	... 238 101 - 234	150
	3 606 120 032	... 238 101 - 234	300
<b>Auxiliary handle</b>	3 602 025 008	... 225 ...	46

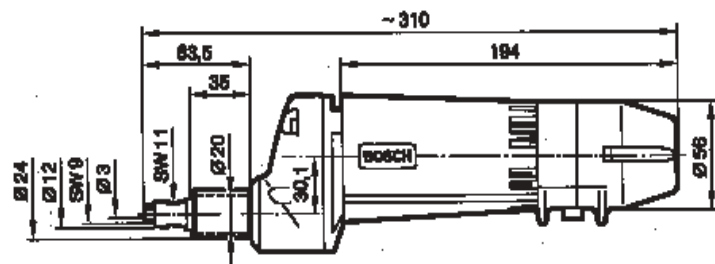
# DIMENSIONAL DRAWINGS: STRAIGHT GRINDERS.

Dimensions mm

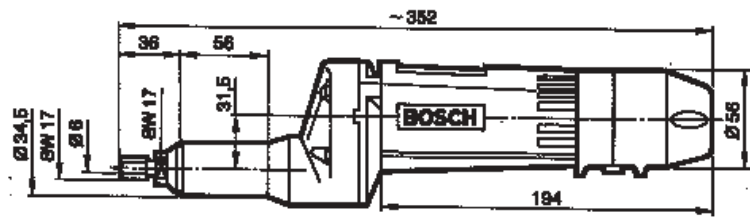
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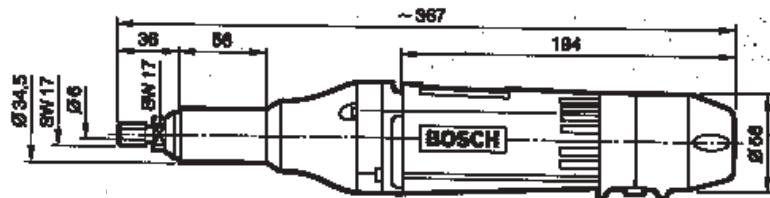
- 0 602 225 101
- 0 602 225 104
- 0 602 225 107
- 0 602 225 204
- 0 602 225 211



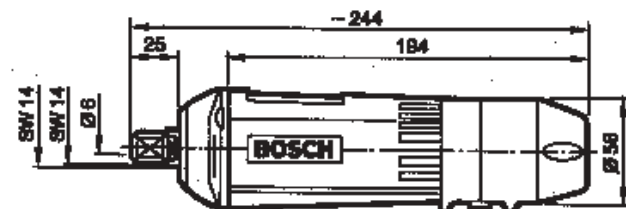
- 0 602 233 201
- 0 602 233 204
- 0 602 233 207
- 0 602 233 304



- 0 602 226 201
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- 0 602 228 201
- 0 602 228 204
- 0 602 228 207
- 0 602 228 211

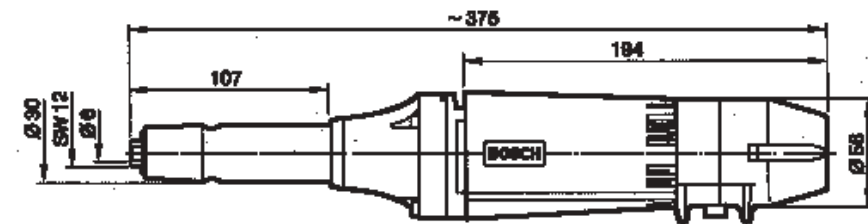


- 0 602 229 101
- 0 602 229 104

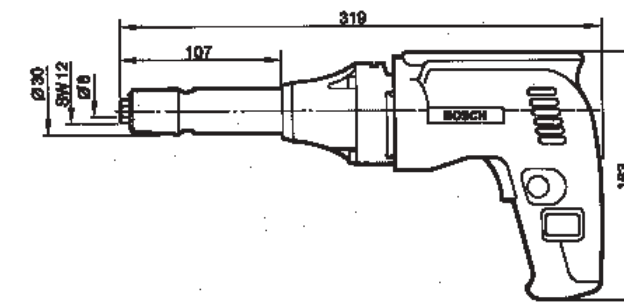
# DIMENSIONAL DRAWINGS: STRAIGHT GRINDERS.

Dimensions mm

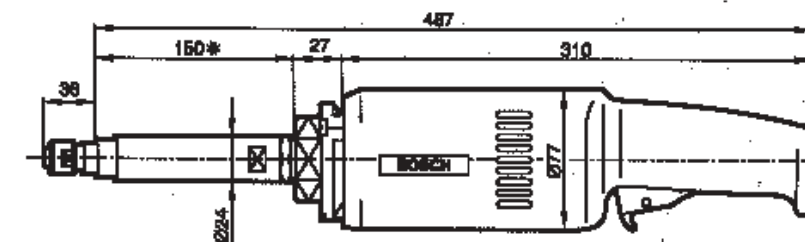
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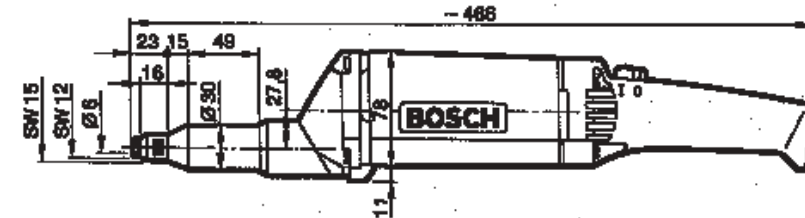
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- 0 602 228 364



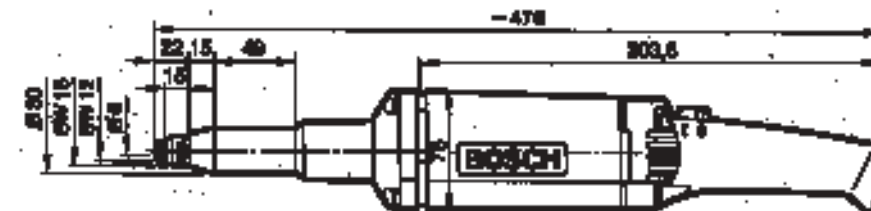
- 0 602 228 371
- 0 602 228 374
- 0 602 228 377



- 0 602 238 101
- 0 602 238 104
- 0 602 238 107
- 0 602 238 111
- 0 602 238 134



- 0 602 207 001
- 0 602 207 004
- 0 602 207 008
- 0 602 208 001



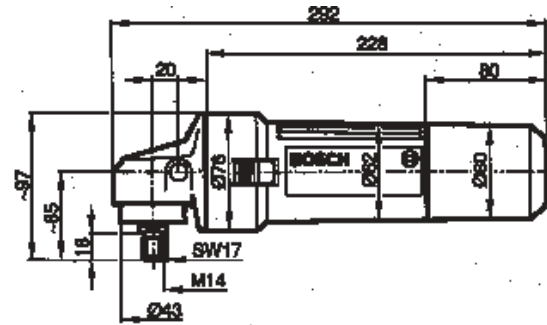
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- 0 602 209 104
- 0 602 209 107
- 0 602 209 111
- 0 602 209 134



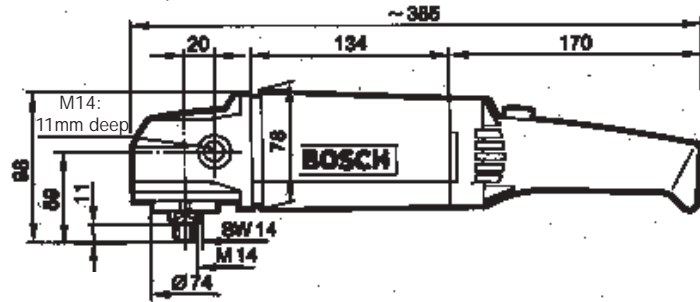
# DIMENSIONAL DRAWINGS: ANGLE GRINDERS.

Dimensions mm

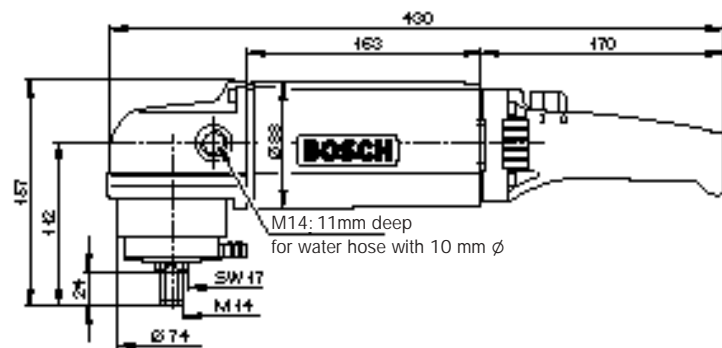
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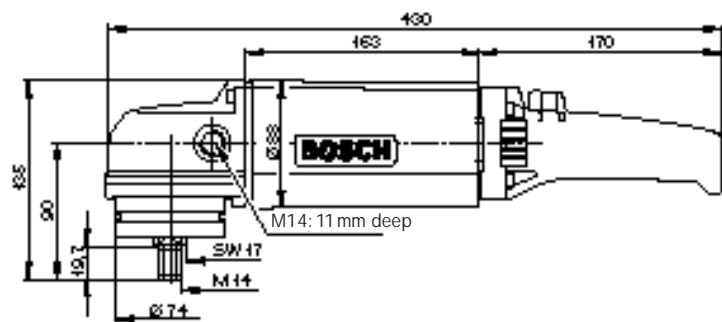
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- 0 602 324 307
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- 0 602 324 344
- 0 602 324 347
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- 0 602 301 201
- 0 602 301 204
- 0 602 301 207
- 0 602 301 104
- 0 602 327 001



- 0 602 305 010

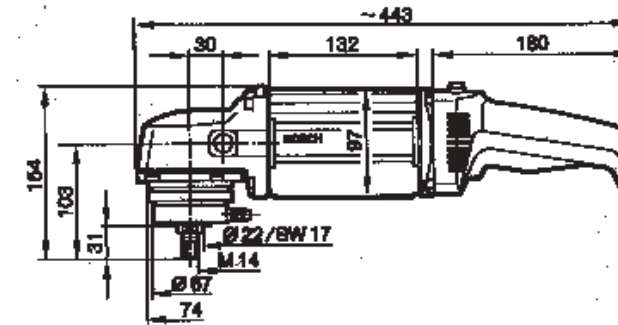


- 0 602 304 001
- 0 602 304 004
- 0 602 304 009
- 0 602 304 010
- 0 602 304 034
- 0 602 305 001
- 0 602 305 004
- 0 602 305 008
- 0 602 306 034

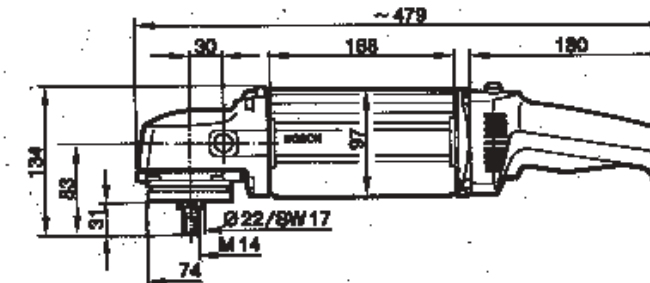
# DIMENSIONAL DRAWINGS: ANGLE GRINDERS.

Dimensions mm

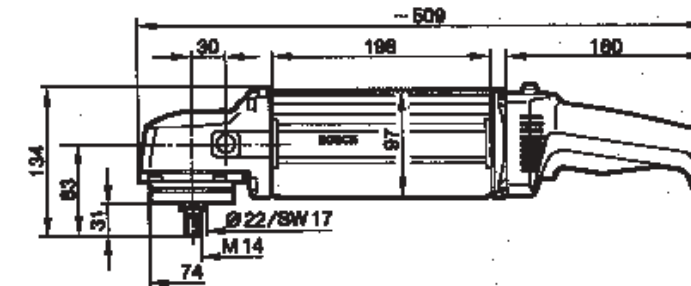
Order number



- 0 602 329 001
- 0 602 329 004
- 0 602 329 007
- 0 602 329 011
- 0 602 329 034
- 0 602 329 036



- 0 602 331 001
- 0 602 331 003
- 0 602 331 004
- 0 602 331 007
- 0 602 331 034
- 0 602 331 036
- 0 602 332 001
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- 0 602 332 007
- 0 602 332 011
- 0 602 332 034
- 0 602 332 036

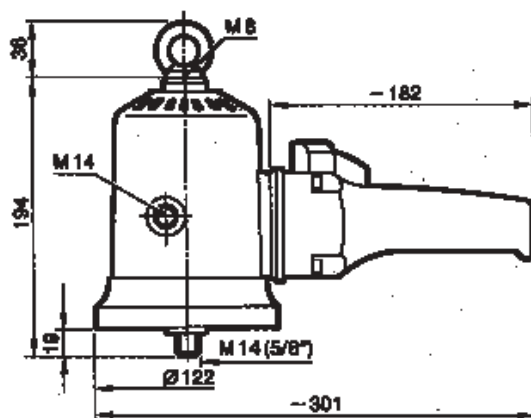


- 0 602 334 101
- 0 602 334 107
- 0 602 334 134
- 0 602 334 136
- 0 602 335 001
- 0 602 335 004
- 0 602 335 007
- 0 602 335 034
- 0 602 335 036

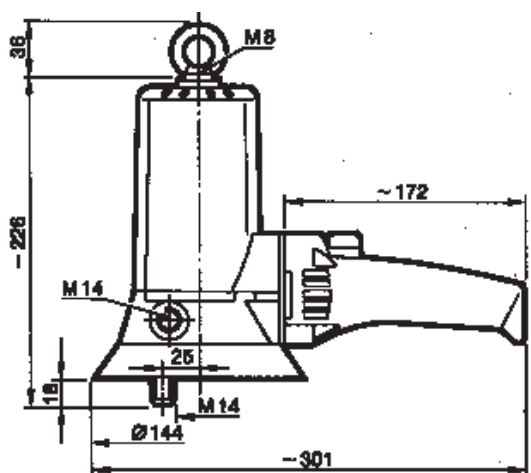
# DIMENSIONAL DRAWINGS: DISC SANDERS AND RANDOM ORBIT SANDERS.

Dimensions mm

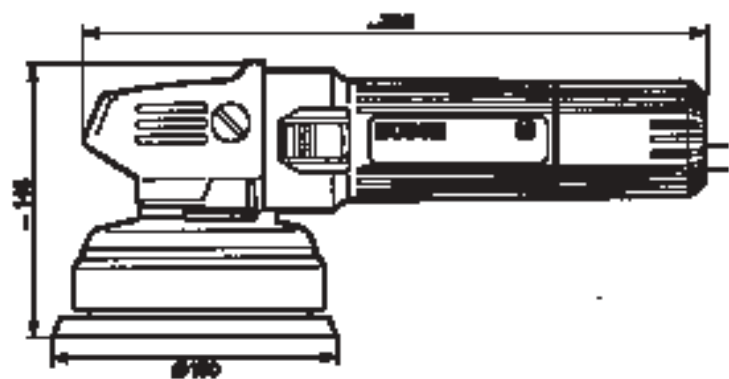
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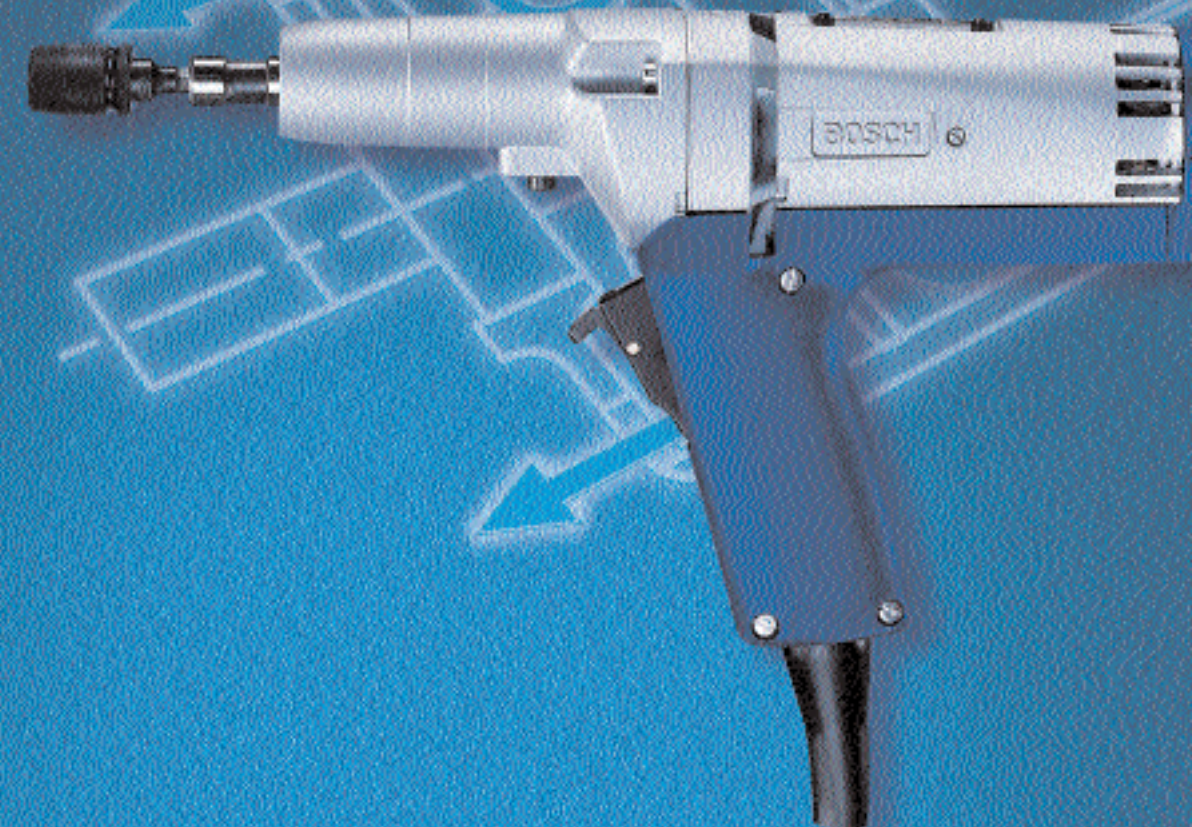
- 0 602 370 101
- 0 602 370 104
- 0 602 370 107



- 0 602 373 004



- 0 602 370 301
- 0 602 370 304
- 0 602 370 307
- 0 602 370 311
- 0 602 370 334



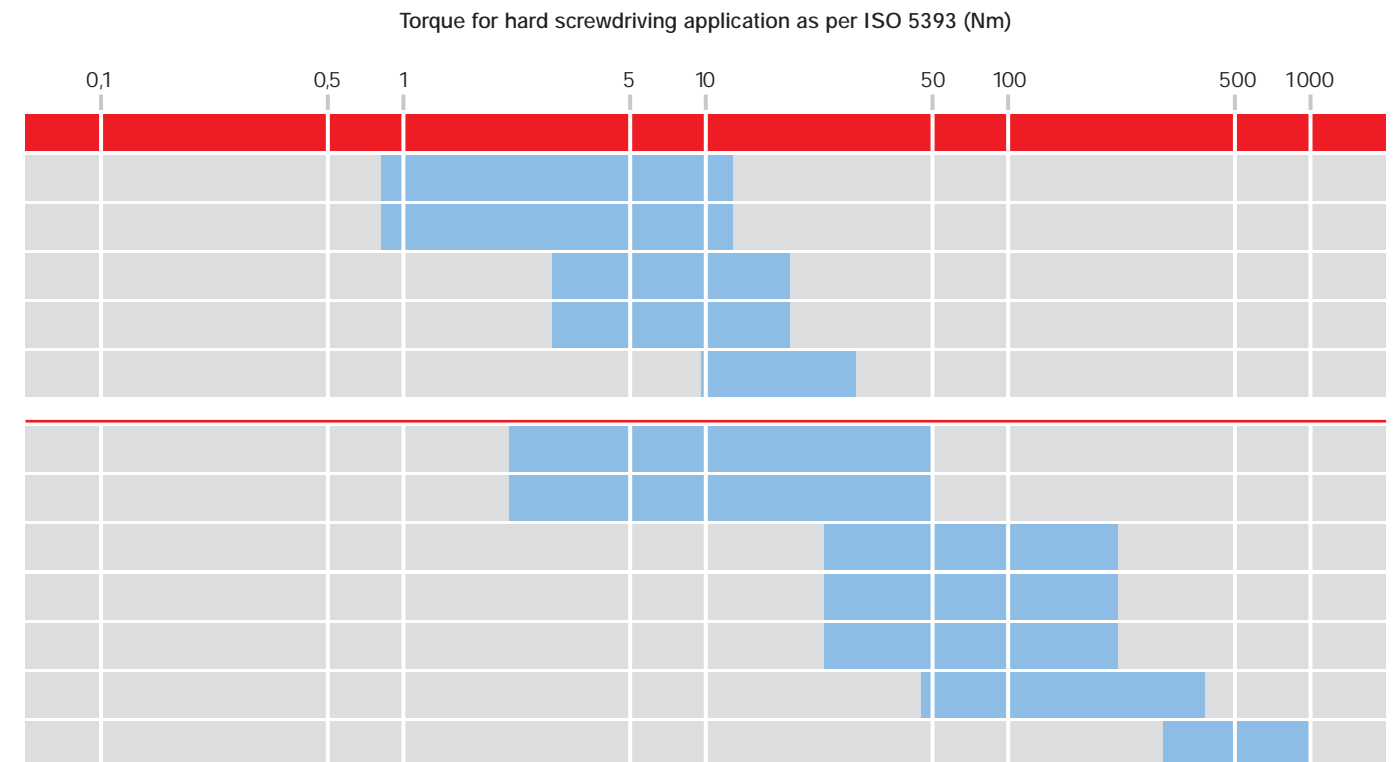
# SCREWDRIVERS TAPPERS



# SELECTION GUIDE FOR SCREWDRIVERS.

Torque is a decisive parameter for controlling the pretension force applied. The table provides an overview of the recommended torques for common bolt and nut sizes. The recommended maximum torques apply to untreated, oil-lubricated screws (coefficient of friction = 0.125). The torques correspond to approx. 62% of the yield point.

	Order number
<b>Screwdrivers with adjustable cut-off clutch</b>	
• For screw connections with high torque accuracy	0 602 485 1..
• Torque upper range limited by reaction torques	0 602 488 1..
• Further advantages: low noise, low wear, long service life, the user has no influence on the torque	0 602 486 2..
	0 602 489 0..
	0 602 487 0..
<b>Impact Wrenches</b>	
• For large screw / bolt diameters with high torque	0 602 442 0..
• Virtually free of reaction torque, therefore no upward limitation	0 602 443 0..
	0 602 440 0..
	0 602 433 1..
	0 602 438 0..
	0 602 435 0..
	0 602 439 0..



## Torque accuracy depending on screwdriver system and screwdriving type

The torque that can be achieved for a screw connection depends on the type of screwdriving / bolting situation. To achieve a balanced basis for assessment, all data on screwdrivers is based on unbending, or "hard" screw connections (30° angle of rotation). In the case of flexible or "soft" screw connections, achievable values are, in part, considerably below the nominal values. Furthermore, torque variance increases. Due to the wide variety of possibilities, specifications with absolute values are not possible. If in doubt, use a trial and error system. The table offers an overview of the advantages and achievable torque accuracy of the individual screwdriver systems with various characteristic screwdriving applications.

Bolting event	Angle of rotation to M <sub>d</sub> max.	Torque accuracy with automatic shut-off	Torque accuracy with overload disengaging clutch	Torque accuracy with percussion mechanism
 Torque vs Rotation	up to approx. 30°	very good	good to very good	satisfactory – depending upon the degree of accuracy required
 Torque vs Rotation	up to approx. 60°	good to very good	good to satisfactory	somewhat unsatisfactory
 Torque vs Rotation	over 60°	good – provided cut-out function is still operative	satisfactory	satisfactory – provided only a low level of accuracy is required
 Torque vs Rotation		good – provided cut-out function is still operative	satisfactory	satisfactory
 Torque vs Rotation	angle of rotation not definable	good – provided cut-out function is still operative	good	satisfactory
 Torque vs Rotation		good – provided cut-out function is still operative	good – provided that the function is still operative	good

## Tightening torque

Guideline values for maximum bolt/screw tightening torques in Nm. Assumed friction below head  $m_{ges.} = 0.12$ , calculated from the stressed cross sections: yield point usage 90%. Valid for shaft screws with standard metric thread as per DIN 13, BL 13; heads as per DIN 931, 933.

When you select a screwdriver, you must consider not only the required torque – as a function of the pretensioning force required from the bolted connection – but also the torque accuracy as a function of the bolting event. This information has been compiled in tables 1 and 2 in order to facilitate the selection from among the various bolting systems. The fixed torque values provided apply to "hard" bolted connections. The maximum values are lower for "soft" bolted connections (e.g. spring washers, rubber washers, etc.)

Hardness class per DIN 267	8.8		10.9	
M 2.5	0.7	1.0		
M 3	1.2	1.7		
M 4	2.9	4		
M 5	5.5	8		
M 6	9.7	13.6		
M 8	23	33		
M 10	47	65		
M 12	80	113		
M 14	130	180		
M 16	196	275		
M 18	270	380		
M 20	385	540		
M 22	510	715		
M 24	650	910		
M 27	960	1345		
M 30	1300	1830		



# CUT-OUT SCREWDRIVERS.

with adjustable cut-out clutch for screws from M 4 to M 10

	Order number	Voltage (V)	Frequency (Hz)	Max. thread size
<b>HSR 44-A</b> 	0 602 485 101	265	200	M 4
	0 602 485 104	135	200	M 4
	0 602 485 118	42	300	M 4
<b>HSR 48-A</b> 	0 602 488 101	265	200	M 6
	0 602 488 104	135	200	M 6
	0 602 488 107	72	200	M 6
	0 602 488 104	200	300	M 6
	0 602 488 118	42	300	M 6
<b>HSR 55-A</b> 	0 602 486 201	265	200	M 6
	0 602 486 204	135	200	M 6
	0 602 486 204	200	300	M 8
<b>HSR 57-A</b> 	0 602 489 001	265	200	M 8
	0 602 489 004	135	200	M 8
	0 602 489 007	72	200	M 8
	0 602 489 004	200	300	M 8
<b>HSR 64-A</b> 	0 602 487 001	265	200	M 10
	0 602 487 004	135	200	M 10
	0 602 487 007	72	200	M 10

Torque (Nm) for hard screwdriving application as per ISO 5393	No load speed (rpm)	Nominal capacity Output (W)	Nominal power output (W)	Nominal current (A)	Weight without cable (kg)	Toolholding fixture Hex. = hexagon	Remarks	Comes complete with	Accessory part number
0.8-2.5	840	80	40	0.2	0.8	1/4" Hex.	Handle grip with ON/OFF and reverse switch	Gib-head key for torque adjustment	1 607 950 037
0.8-2.5	840	80	40	0.5	0.8	1/4" Hex.			
0.9-3.0	1260	125	65	2.4	0.8	1/4" Hex.			
3-6	840	170	85	0.5	1.1	1/4" Hex.	Handle grip with ON/OFF and reverse switch	Gib-head key for torque adjustment	1 607 950 037
3-6	840	170	85	1.0	1.0	1/4" Hex.			
3-6	840	170	85	1.8	1.0	1/4" Hex.			
3.2-6.5	1260	265	135	1.0	1.0	1/4" Hex.			
3.2-6.5	1260	265	135	5.0	1.0	1/4" Hex.			
3.5-12	590	260	140	0.9	2.1	1/4" Hex.	Middle grip with ON/OFF and reverse switch	Gib-head key for torque adjustment	1 607 950 037
3.5-12	590	260	140	1.7	1.7	1/4" Hex.			
4-13	900	400	220	1.7	1.7	1/4" Hex.			
5-17	690	400	270	1.6	2.3	1/4" Hex.	Pistol grip with ON/OFF and reverse switch	Gib-head key for torque adjustment	1 607 950 037
5-17	690	400	270	3.3	2.3	1/4" Hex.			
5-17	690	400	270	6.1	2.3	1/4" Hex.			
6-20	1040	600	400	3.3	2.3	1/4" Hex.			
9-24	780	350	200	1.0	2.8	1/4" Hex.	Middle grip with ON/OFF and reverse switch	Gib-head key for torque adjustment	1 607 950 037
9-24	780	350	200	2.0	2.8	1/4" Hex.			
9-24	780	350	200	3.0	2.8	1/4" Hex.			

The machines come equipped with a special 4-m-long cable without plug.

Your specialist dealer can provide you with information on the complete set of quality accessories.


# IMPACT WRENCHES.

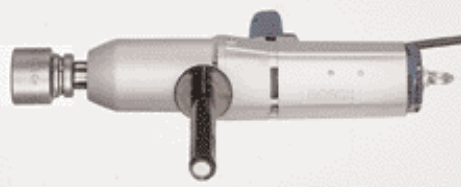
## impact wrenches for screws from M6 to M30

	Order number	Voltage (V)	Frequency (Hz)	Max. thread size
	0 602 442 001	265	200	M 10
	0 602 442 004	135	200	M 10
	0 602 442 007	72	200	M 10
	0 602 443 004	200	300	M 10

	Order number	Voltage (V)	Frequency (Hz)	Max. thread size
	0 602 440 001	265	200	M 12
	0 602 440 004	135	200	M 12

	Order number	Voltage (V)	Frequency (Hz)	Max. thread size
	0 602 433 101	265	200	M 16
	0 602 433 104	135	200	M 16
	0 602 433 107	72	200	M 16
	0 602 438 004	200	300	M 16

	Order number	Voltage (V)	Frequency (Hz)	Max. thread size
	0 602 435 001	265	200	M 22
	0 602 435 004	135	200	M 22
	0 602 435 008	72	200	M 22

	Order number	Voltage (V)	Frequency (Hz)	Max. thread size
	0 602 439 001	265	200	M 30
	0 602 439 004	135	200	M 30
	0 602 439 007	72	200	M 30

Torque (Nm) for hand screwdriving application as per ISO 5393	No load speed (rpm)	Nominal capacity Output (W)	Nominal power output (W)	Nominal current (A)	Weight without cable (kg)	Toolholder Drive Hex. = hexagon Sq. = external square	Remarks	Comes complete with	Accessory part number
30	1650	170	85	0.5	1.1	1/4" Hex.	Handle grip with ON/OFF and reverse switch		
30	1650	170	85	1.0	1.1	1/4" Hex.			
30	1650	170	85	1.8	1.1	1/4" Hex.			
30	1780	265	135	1.0	1.1	1/4" Hex.			
80	1410	260	140	0.9	2.4	1/2" Sq. with spring pin	Handle grip with ON/OFF and reverse switch		
80	1410	260	140	1.7	2.4	1/2" Sq. with spring pin			
190	1100	360	220	1.0	3.0	1/2" Sq. without spring pin	Centre grip with ON/OFF and reverse switch		
190	1100	360	220	2.0	3.0	1/2" Sq. without spring pin			
190	1100	360	220	3.7	3.0	1/2" Sq. without spring pin			
190	1100	550	340	2.0	3.0	1/2" Sq. without spring pin			
350	800	850	580	2.2	5.6	3/4" Sq.	Palm grip with ON/OFF and reverse switch	Auxiliary handle	1 602 025 030
350	800	850	580	4.5	5.6	3/4" Sq.			
350	800	850	580	8.5	5.6	3/4" Sq.			
1000	600	950	700	2.8	8.6	1" Sq.	Two handled grip with ON/OFF and reverse switch		
1000	600	950	700	5.5	8.6	1" Sq.			
1000	600	950	700	10.0	8.6	1" Sq.			

The machines come equipped with a special 4-m-long cable without plug.

Your specialist dealer can provide you with information on the complete set of quality accessories.

# TAPPERS.

tappers for threads up to 8 mm in diameter



HGR 55/10

Order number	Voltage (V)	Frequency (Hz)	Working range thread $\phi$ (mm)	Spacebolt $\phi$ (mm)
0 602 463 101	265	200	8	6
0 602 463 104	135	200	8	6
0 602 463 107	72	200	8	6

Nominal power consumption (W)	No load speed (rpm) forward	Reverse	Nominal power consumption (W)	Nominal power output (W)	Nominal current (A)	Weight without cable (kg)	Toolholding fixture	Remarks	Comes complete with	Accessory part number
3-10	380	750	260	150	0.9	2.3	Cone B 12 DIN 238		Two-jaw drill chuck	3 608 573 000
3-10	380	750	260	150	1.7	2.3	Cone B 12 DIN 238		Fastening key for 3.0 mm high	3 603 111 004
3-10	380	750	260	150	3.2	2.3	Cone B 12 DIN 238		for 3.3 mm high	3 603 111 005
									for 3.6 mm high	3 603 111 003
									Spare key	2 607 950 012

The machines come equipped with a special 4-m-long cable without plug.

Your specialist dealer can provide you with information on the complete set of quality accessories.

## ACCESSORIES FOR SHUT-OFF SCREWDRIVER.

	Order number	0 602 485 ...	0 602 488 ...	0 602 486 ...	0 602 489 ...	Packing unit
Hanging hook	3 604 682 001	•	•			1
	3 604 682 000			•	•	1

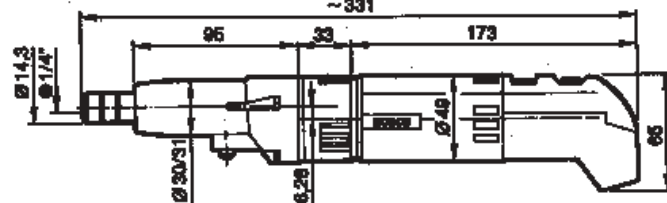
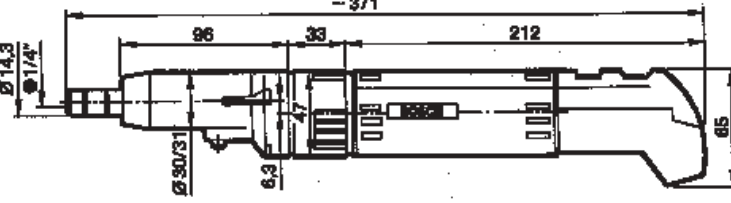
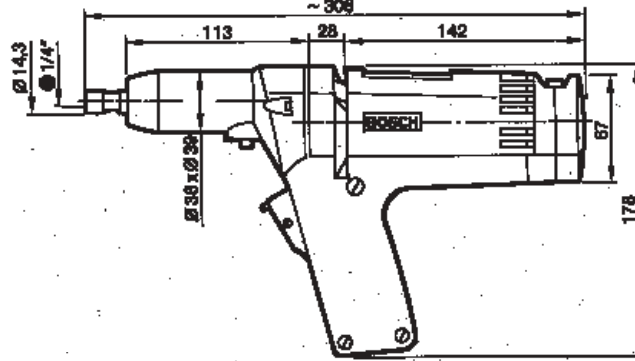
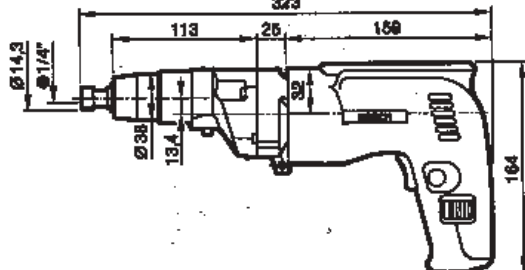
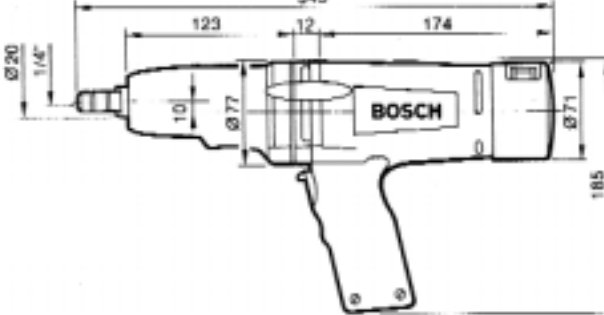
## SPECIAL ACCESSORIES FOR SCREWDRIVERS.

	Order number	0 602 442 ...	0 602 443 ...	0 602 440 ...	0 602 433 ...	Packing unit
Loop hanger	3 604 682 001	•	•	•		1
Cylinder screws for fastening	2 910 021 118	•	•	•		1
Quick-change collet chuck 7/16"	1 606 455 012				•	1

Your specialist dealer can provide you with information on the complete set of quality accessories.

## DIMENSIONAL DRAWINGS: CUT-OUT SCREWDRIVERS.

Dimensions mm

Dimensions mm	Order number
	0 602 485 101
	0 602 485 104
	0 602 485 118
	0 602 488 101
	0 602 488 104
	0 602 488 107
	0 602 488 118
	0 602 486 201
	0 602 486 204
	0 602 489 001
	0 602 489 004
	0 602 489 007
	0 602 487 001
	0 602 487 004
	0 602 487 007





# ACCESSORIES





# BALANCER.



for loads  
from 0.3 to 17 kg

## Balancer

- Robust metal safety hanger including spring hook
- Bowden cable with high-quality distributor valve and safety coupling for uniform pulling out behaviour
- Spring fracture safety device balancers with a load burden greater than 3 kg
- Cable change possible without disassembly of the spring drum
- Simple change of the weight class through modular structure

	Order number
Balancer	0 607 950 920
	
Balancer	0 607 950 921
	0 607 950 922
	0 607 950 923
	0 607 950 931
	0 607 950 937
Balancer	0 607 950 924
	0 607 950 925
	0 607 950 926
Balancer	0 607 950 927
	0 607 950 928

Load min. (kg)	Load max. (kg)	Max. lift (mm)	Weight (kg)	Remarks
0.3	1.2	1200	0.5	Spring balancer with adjustable load range
0.6	1	2000	0.7	Spring balancer with adjustable load range
1	2	2000	0.7	
2	3	2000	0.8	
0.5	2	2000	0.7	Balancer with adjustable load range with lock
1.5	3	2000	0.8	
3	5	2000	3	Spring balancer with adjustable load range
6	8	2000	3.2	
8	10	2000	3.4	
9	14	2000	3.4	Spring balancer with adjustable load range
13	17	2000	3.6	

Your specialist dealer can provide you with information on the complete set of quality accessories.

## PLUG CONNECTIONS, LEADS.

CEE plugged connections DIN 49 462/63 and DIN 49 465 for frequencies from 100 to 300 Hz (green housing)

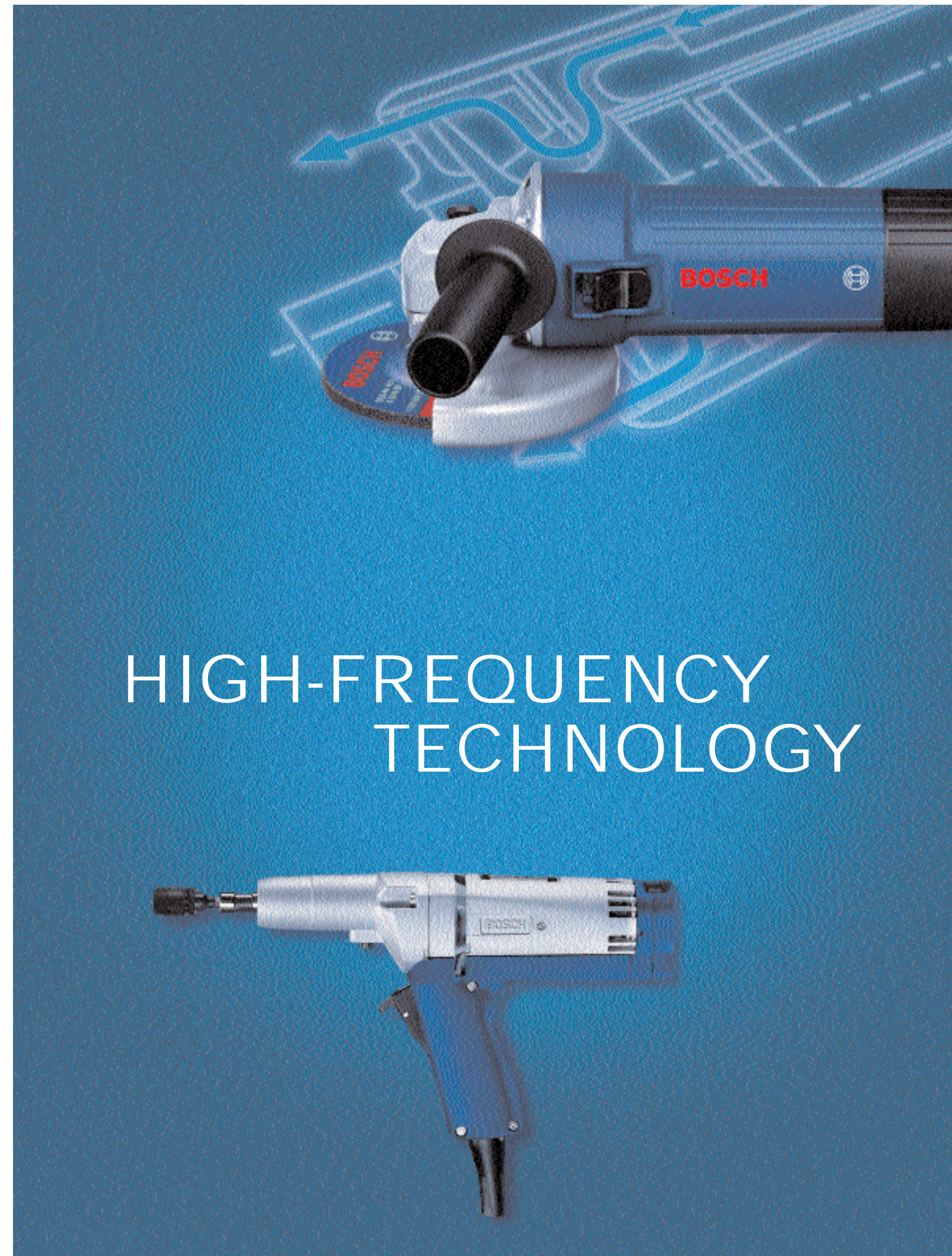
	Order number	Voltage (V)	Load capacity (A)	Packing unit
Connector plug	1 614 482 048	50 – 300	16	1
	1 614 482 049	50 – 300	32	1
	1 614 482 050	to 50	32	1
Coupling socket	1 614 484 010	50 – 300	16	1
	1 614 484 011	50 – 300	32	1
	1 614 484 012	to 50	32	1
Wall socket	1 614 485 024	50 – 300	16	1
	1 614 485 025	50 – 300	32	1
	1 614 485 026	to 50	32	1

### Electrical leads

	Order number	Material number	Lead cross-section (mm <sup>2</sup> )	Outer-Ø (mm)	
4-core cable (length 50 m)	3 604 422 003	6 254 812 403	0.75	8	
	3 604 422 077*	3 604 422 023	1.50	11	
	3 604 422 050*	3 604 422 024	2.50	13	
	working length 4 m (spiral line)	3 604 462 002		0.75	8
	working length 6 m (spiral line)	3 604 462 003		0.75	8
3-core cable (length 50 m) for 42 V operating voltage	3 604 422 004	6 254 811 303	0.75	7	

\*unpacked

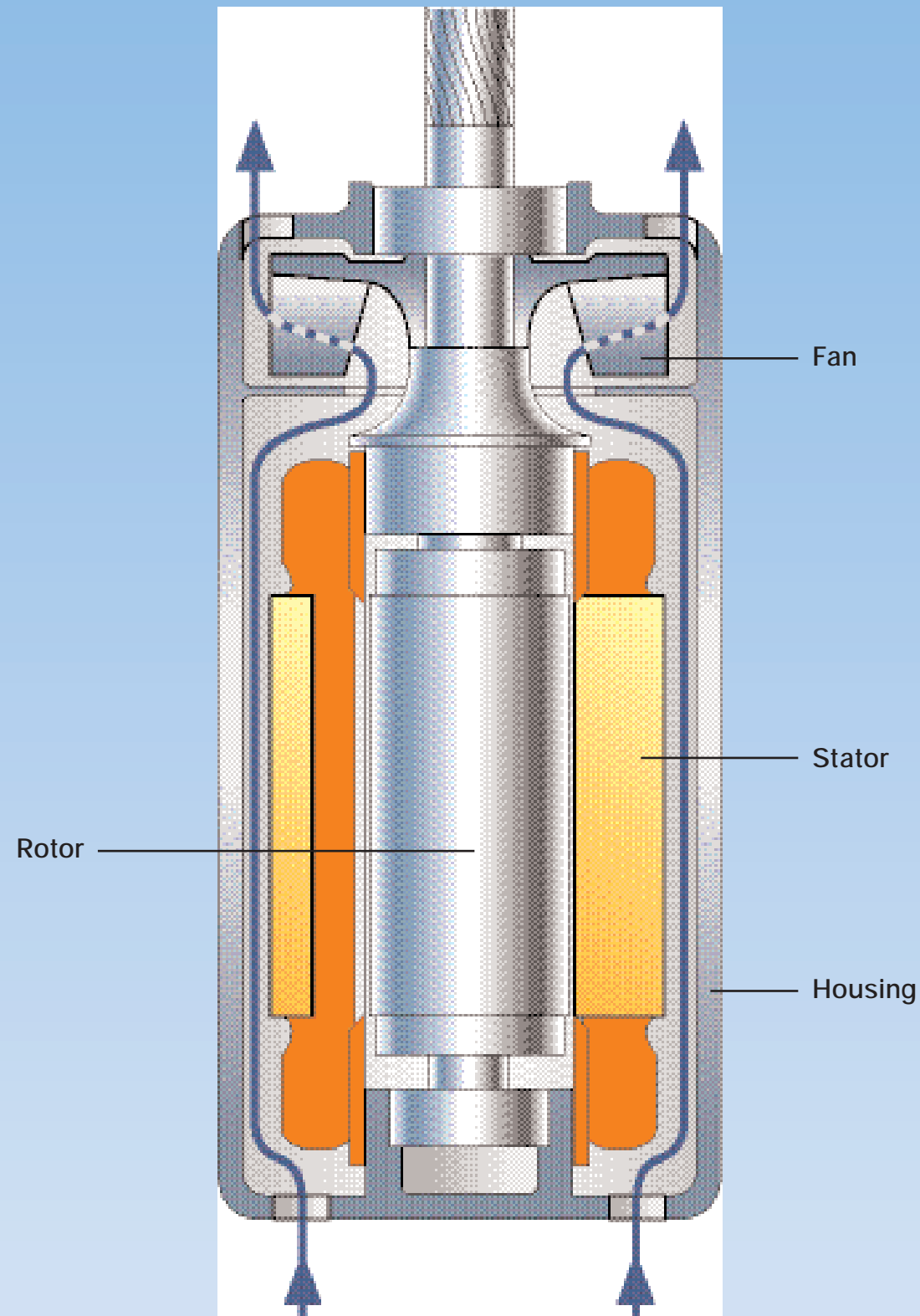
Frequency converters can be obtained from: EME GmbH · Postfach 0306 · D-78257 Ettlingen · Telephone 072 43/32 06 06 · Fax 072 43/32 06 11 or 32 06 12  
Please consult your stockist for information on the complete range of quality accessories.





## ROBUST TECHNOLOGY FOR LONG-TERM HEAVY-DUTY USE.

A high-frequency motor is a three-phase current motor with a short-circuit rotor. Its stator and rotor consist of a laminated sheet-metal bundle. If the stator winding of the motor is connected to the three-phase current supply, a magnetic field is created (rotary field), which runs through the motor due to the arrangement of the winding and which is dependent on number of pole pairs and the frequency.



### A real concept: High-frequency Tools

How a good idea was consistently further developed: The designation 'high-frequency tools' came to be known through the market launch of the tools and was given to those powerful high-frequency tools with asynchronous motors, operated with three-phase current at an increased frequency of 200 or 300 Hz. In a physical sense, there is no real connection between these tools and genuine high-frequency technology, but they still came to be known under this name.

### The operating frequency determines the performance

In hand tools, rotary current at increased frequency of 200 or 300 Hz combines high electrical performance with minimal motor weight. As the frequency of the rotary current increases, there is a proportional increase in motor speed and thus in the performance of asynchronous motors. This is limited by the maximum admissible circumference velocity (operating rotational speed) of the tools. An optimum performance/weight ratio is achieved by high-frequency tools operating at a frequency of 200 to 300 Hz

(Fig. 1). Large differences between motor rotational speed and operating rotational speed require larger gears. This means that weight savings from the rotary current drive are negated by the increased weight from the stepdown gearing. High-frequency installations using exclusively grinders should be operated at 300 Hz. Using rotary current at increased frequency optimally fulfils the demand for light yet high-performance hand tools.

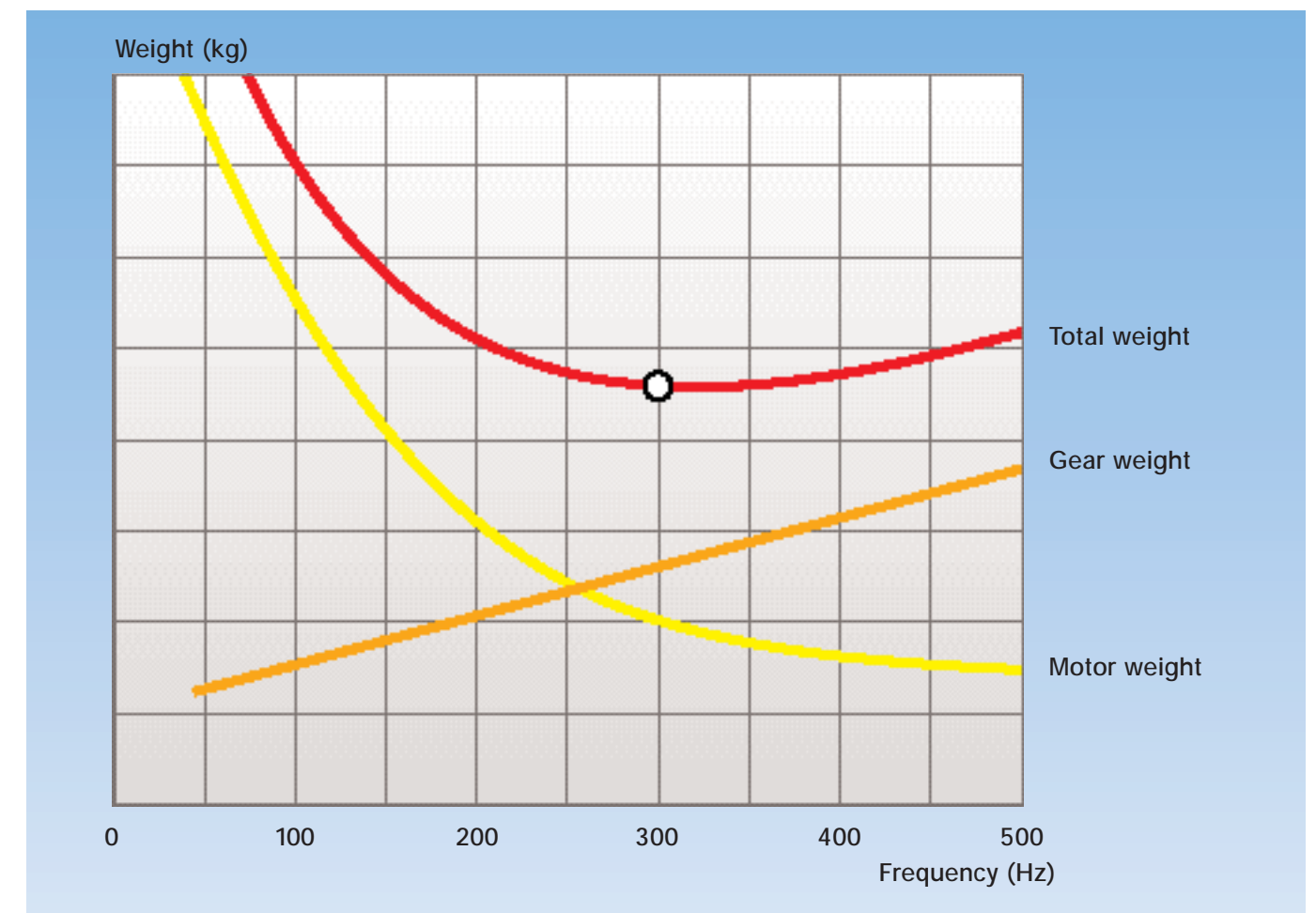


Fig. 1 The graph shows the dependence of motor and gearing weight on frequency at constant motor performance and rated rotational speed. 300 Hz yields an optimum performance/weight ratio.

# RELIABLE THREE-PHASE CURRENT MOTORS WITH A LONG SERVICE LIFE.

A magnetic field forms in a three-phase current motor, which circulates through the motor. This is called a rotary field and is dependent on the number of pole pairs and frequency. When the smallest possible number of pole pairs is used, at a frequency of 50 Hz, for example, a rotary field or rotor speed of 3000 rpm results; at a frequency of 200 Hz: 12000 rpm and at 300 Hz: 18000 rpm.

Due to the short distance between bearings and the stationary stator coil, the motor is both mechanically and electrically very reliable. It is distinguished by steady, low-vibration operation. Speed drop is only approx. 5% at rated load, and peak performance is around 2 1/2 times the rated performance. Short-term overloads are possible as long as they do not result in the admissible coil temperature being exceeded. Since the objective in hand tools is to make them as light as possible with the highest possible performance, Bosch has decided in favour of "dust protection with direct cooling" for its high-frequency motors (Fig. 2). This combines the advantages of both encapsulated and open construction. The flow of cooling air ensures good heat dissipation; at the same time, dust and dirt are prevented from penetrating into the rotating system.

The design concept underlying Bosch high-frequency electric tools offers the user the following advantages:

- Optimum performance in a light-weight tool**  
 During extended operation, Bosch high-frequency electric tools achieve a performance level of up to 400 watts per kilogram machine weight. Short-term peak performance levels reach 2 1/2 times normal operating performance output. These high reserves mean a decisive improvement in work performance.
- Constant rotational speed under load**  
 The speed drop for Bosch high-frequency electric tools is only 3 – 5% at rated load (Fig. 2). This ensures that recommended average speeds can be used to full advantage during grinding and drilling. The constant average speed means that the tools can be employed more efficiently and
- Minimal maintenance cost combined with high load capacity**  
 Bosch high-frequency electric tools offer an easy-to-service construction design and a motor without wear parts. Even when subject to extreme stress conditions (e.g. in foundries), they live up to their reputation for long service life at low maintenance cost.
- Highly effective**  
 Due to their high efficiency levels, Bosch high-frequency electric tools offer economical, environmentally compatible operation under extended operation conditions.

achieve a longer service life.

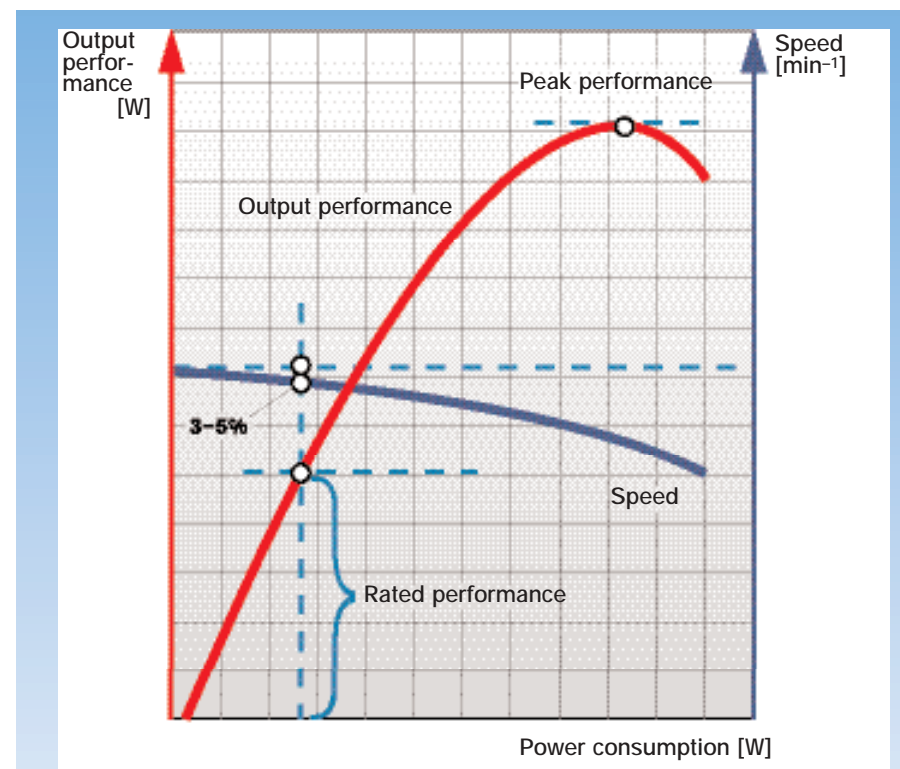


Fig. 2 Output and rotational speed curve as a function of load moment

# ELECTRICAL OPERATING VALUES.

An operating frequency of 300 Hz is to be recommended for a high-frequency electric tool installation. The higher motor rotational speed at 300 Hz is particularly advantageous at today's circumference velocities for grinders. The increased motor rotational speed results in higher machine performance without an increase in weight. In so far as possible, 135 V current should be selected for 200 Hz and 200 V for 300 Hz, regardless of country.

The secondary power output of the frequency converter or its size is calculated as follows: The high-frequency electric tools to be used are grouped according to motor size and number so that their rated current consumption can be added together. Multiplying the sum of the rated current values by the operating voltage and the factor  $\sqrt{3}$  results in a calculation for the entire apparent power consumption for the tools. The formula is:

$$S = \sqrt{3} \cdot U \cdot I = 1.73 \cdot U \cdot I$$

Once the apparent power value has been calculated in this way, it must still be multiplied by the simultaneity factor G in order to obtain the secondary power output of the converter. The simultaneity factor G takes into account the degree of use of all of the tools – since the tools are generally not all used at the same time.

For the simultaneity factor G, we have the following experiential values:

automobile body manufacture	0.45
motor manufacture	0.30
appliance manufacture	0.40
tool and form manufacture	0.25
steel manufacture	0.50
foundry work	0.60

In planning for a high-frequency electric tool installation, you must always take into account the need for a certain amount of reserve power in the frequency converter. Particularly for small installations, you must bear in mind that the power output must be at least twice the rated power consumption of the most powerful high-frequency electric tool to be connected. This ensures that the tools will start without trouble. In the event of short-term overload, the voltage drop at the frequency converter will not be too large.

## Network groups

Operating frequencies and operating voltages

Number of work groups	200 Hz	300 Hz
1	265 V	–
2	135 V	200 V
3	72 V	(110 V)
4	–	72 V
7	–	42 V
10	42 V	–

■ Ideal network group is highlighted

## Sample calculation for a high-frequency electric tool installation

A foundry wishes to introduce 3 high-frequency 0 602 332 034 angle grinders with 230 mm diameter cutting discs and 3 high-frequency 0 602 242 134 straight grinders with 100 mm diameter grinding discs.

Calculation:  
(Refer to pages 24 – 25 and 30 – 31 for current and voltage values)

3 grinders, motor size 88	$3 \cdot 10 \text{ A} = 30.0 \text{ A}$
3 grinders, motor size 85	$3 \cdot 6.4 \text{ A} = 19.2 \text{ A}$
Total:	49.2 A

This yields the apparent power:

$$\begin{aligned}
 S &= 1.73 \cdot U \cdot I \\
 &= 1.73 \cdot 200 \text{ V} \cdot 49.2 \text{ A} \\
 &= \text{approx. } 17023 \text{ VA} \\
 &= \text{approx. } 17 \text{ kVA}
 \end{aligned}$$

This value must still be multiplied by the simultaneity factor, G = 0.6 for foundries:

$$\begin{aligned}
 \text{Converter apparent power} &= \\
 S \cdot G &= 17 \text{ kVA} \cdot 0.60 = 10.2 \text{ kVA}
 \end{aligned}$$

In this case, a converter with 11 kVA secondary power is selected so that there are additional power reserves of approx. 10%.

# DESIGNING AN INSTALLATION FOR HIGH-FREQUENCY ELECTRIC TOOLS.

## Frequency converter with synchronic generator

The best solution, technically speaking, in selecting frequency converters is the combination of asynchronous motors with synchronic generators. The converters are single-wave aggregates with an asynchronous motor as drive motor and a brushless innerpole-generator with built-in current generator.

The voltage difference between idling and operation under full load is only approx. 3% for small transformers at  $\cos \phi$  0.6 – 0.9, for large converters, approx. 4%. Synchronic converters are not affected by voltage fluctuations in the primary rotary current mains and, in addition, safeguarded against short circuiting. Assimilation to the rated voltage can be effected by means of a potentiometer. Moreover, the converters are maintenance-free for 20,000 machine hours.

Secondary frequency is calculated according to the following formula:

$$if_2 = f_1 \cdot p_2/p_1$$

- $f_1$  = primary frequency of rotary current mains
- $f_2$  = secondary frequency for high-frequency electric tools
- $p_1$  = pole pair count of the drive motor
- $p_2$  = pole pair count of the generator

Frequency converters with a power output in excess of 4 kVA should generally not be switched into the mains direct but con-

nected by means of star delta switches. When they are switched in directly, a short-term current surge occurs. This surge could overload the lead wires on converters over 4 kVA and trigger the serial fuse. When a star delta switch is used, the current surge is reduced since current flow over the star switch is reduced to one third of what it would be with direct switching.

When a star delta switch is used, the coil of the drive motor is switched from the star (switch-on process) to the delta (operating position). It is imperative that a frequency converter that is to be operated on a 400 V mains line with a star delta switch is laid out for 400 V in the delta. If a converter of this kind is laid out for only 230 V in the delta, it can only be switched in to the 400 V mains directly over the star, that is to say, without star delta switching. When laying out a new installation, it is very important to take this into consideration.

## Parallel operation of frequency converters

In order to increase the economics of the entire installation and to equalize load peaks, frequency converters can be switched in parallel. This results in optimal assimilation to the equipment being used. When frequency converters are linked to synchronic generators, no particular preparations are required to operate equipment in parallel even when power output levels differ.

## Compensating for reactive current

Every inductive consumer is lumbered with a reactive current that performs no effective work, but only loads the electrical wiring. Frequency converters and high-frequency electric tools are also inductive consumers.

Compensation for reactive current on the secondary side of the converter requires considerable expenditure since each tool must be compensated separately. Depending on the number and the performance level of the individual high-frequency electric tools, a total output factor  $\cos \phi$  of 0.5 to 0.85 is to be reckoned with. On the primary side of the frequency converter, the output factor  $\cos \phi$  can be significantly improved if the magnetizing current from the drive motor and generator are compensated. Switching in correspondingly rated capacitors makes it possible to counteract the primary side reactance output of the converter almost entirely when idling and to compensate it under load to such an extent as to yield an output factor larger than  $\cos \phi = 0.9$ .

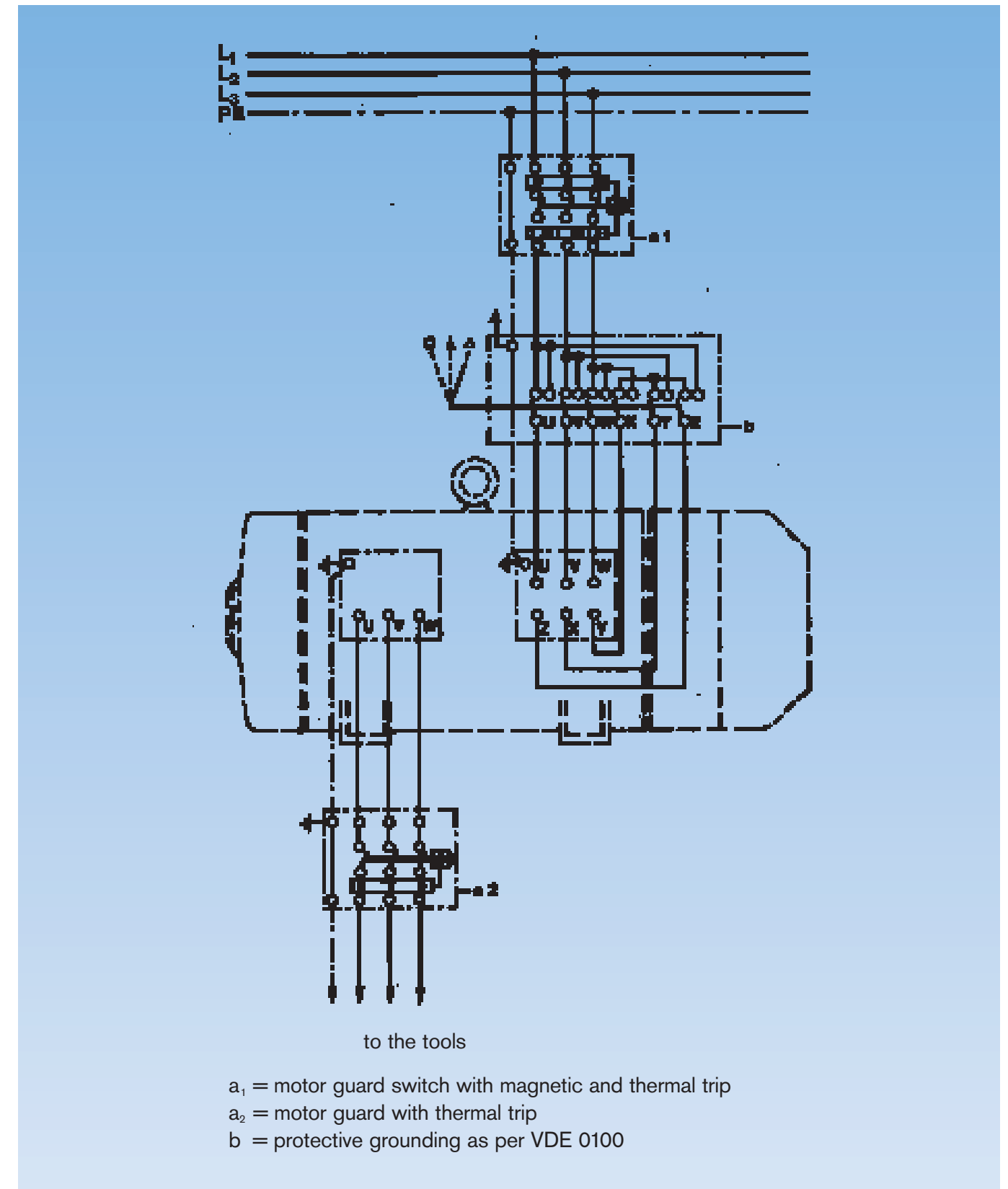


Fig. 3

# ELECTRICAL SAFETY.

For high-frequency electric tools, electrical safety is assured by the protective conductor as per EN 50144 based on protection class I. When the secondary coil of the converter is switched in the star, the star point or neutral point is extended outwards. This neutral point is earthed (earthing resistance  $R_B \leq 2 \text{ ohms}$ ) and connected to the metal housing of the electric tools by way of the protective conductors so that, at an operating voltage of 265 V, the dangerous voltage between phase and earth is only

$$\frac{265 \text{ V}}{1.73} = 153 \text{ V}$$

At operating voltages of 135 V or 72 V, on the other hand, the dangerous voltage is only

$$\frac{135 \text{ V}}{1.73} = 78 \text{ V} \text{ or}$$

$$\frac{72 \text{ V}}{1.73} = 42 \text{ V}$$

The effectiveness of the protective earthing is assured by using correspondingly robust plug fixtures of faultless electrical construction

together with suitably resistant cables. Careful maintenance is equally important. The electric tool itself must, in its construction design, be capable of satisfying the stringent demands of industrial manufacture. Under normal circumstances, the description provided above, e.g. the protection measure "Earthing" as per VDE 0100 - 10 N is adhered to.

The possible protective measures may be classified and subdivided as follows:

- 1.0 protective measures without switching device
- 1.1 protective insulation (VDE 0100 - § 7 N)
- 1.2 low voltage, 42 V (VDE 0100 - § 8 N)
- 1.3 protective separation (VDE 0100 - § 14 N)
- 2.0 protective measures with switching device
- 2.1 protective earthing (VDE 0100 - § 9 N)
- 2.2 reduction to zero voltage (VDE 0100 - § 10 N)

In cases 2.1 and 2.2, switch-off is effected by fuses or corresponding thermo-magnetically triggered station circuit breakers.

The greatest possible degree of protection is reached by using fault current (FI) circuit breakers in addition.

Protective insulation as per 1.1 is not applied to high-frequency electric tools. Low voltage as per 1.2 finds application only in special cases in which, due to existing regulations, it cannot be avoided. Because of the high currents involved, this measure is very problematic with respect to cable cross-section, switches, plugs etc. when applied to the transmission of large outputs. Small screw drivers comprise an exception. In this case, one is better off using protective separation as per 1.3, according to which every tool must have its own separator-converter. Protective separation should be restricted to circumstances in which it is absolutely necessary.

Here we wish to focus on the protective measure "reduction to zero voltage as per 2.2" since it finds application primarily with high-frequency electric tools. The voltage reduction should continuously prevent excessive contact potential on installation parts that do not belong to the operating circuit (see Fig. 5). It requires direct earthing of a mid-point or star point conductor and is effected by connecting the installation parts that are to be protected either to the neutral conductor or to a special protective

conductor that is in turn connected to the neutral conductor.

The protective measure "reduction to zero voltage" thus switches off defective installation parts since the inline fuse directly before the defective location is activated.

If the fuse is really to be activated, certain voltage reduction conditions as per VDE 0100 - § 10 N must be complied with. The most important voltage reduction requirement: The cross-section of the leads from the power

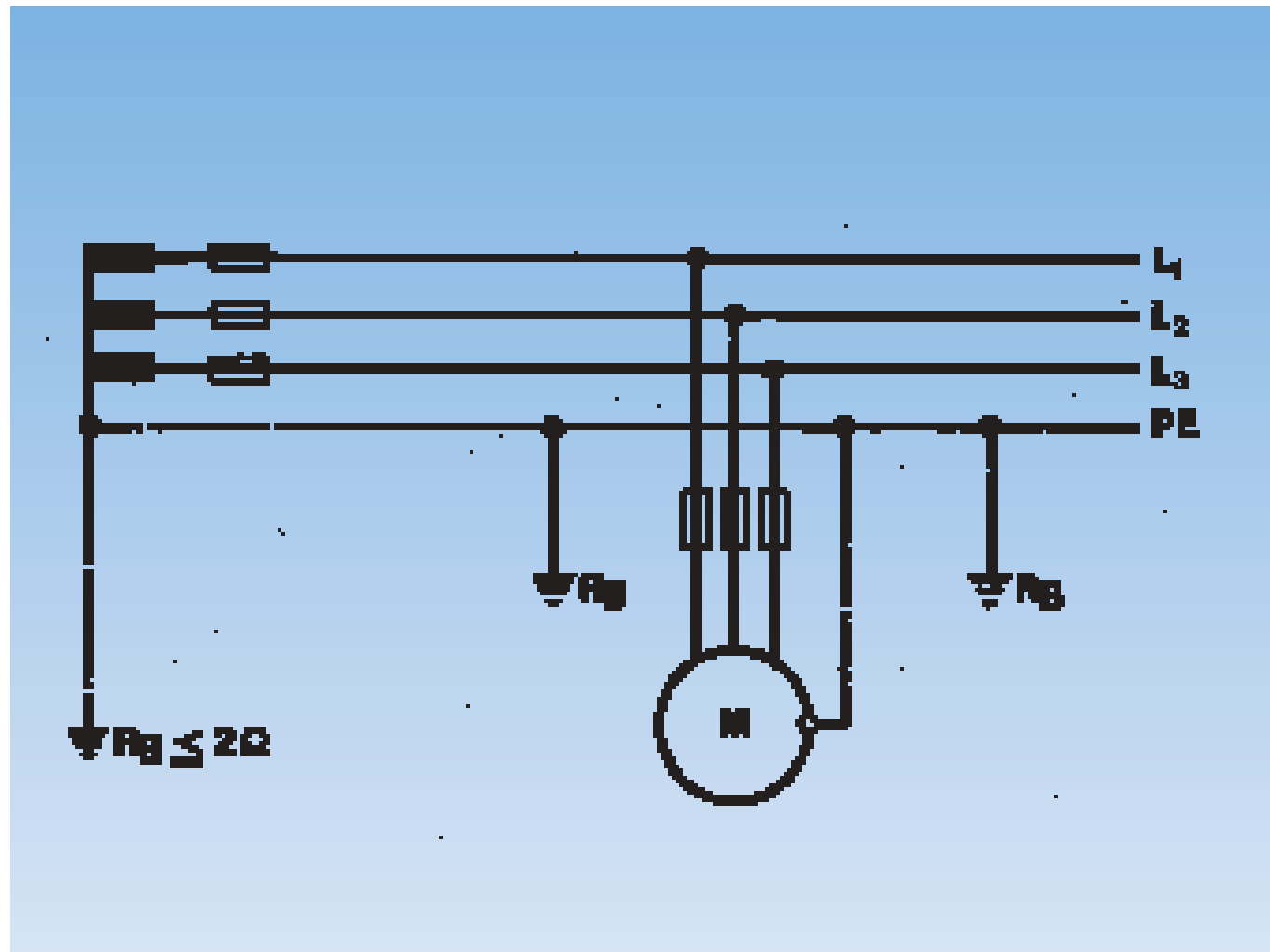


Fig. 4

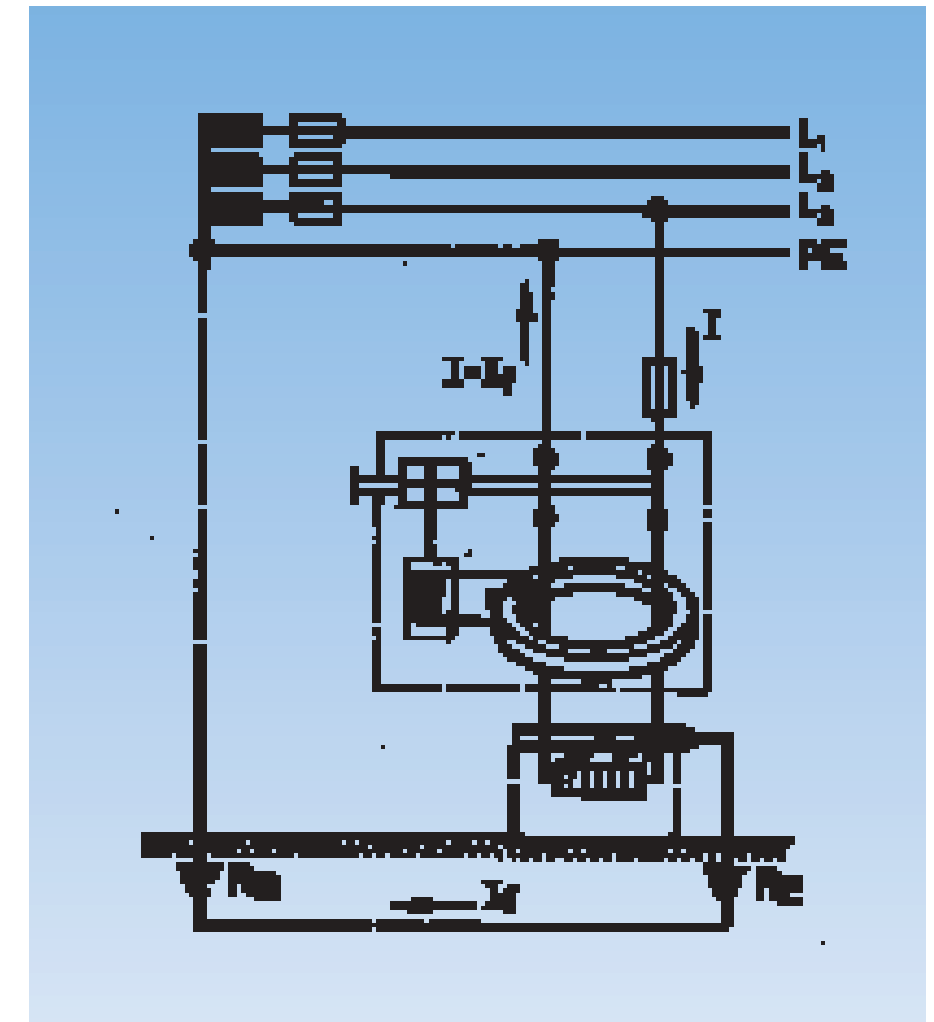


Fig. 5

generator or converter to the power consumer must be rated so that the switch-off current  $I_A$  of the next upline excess voltage protection unit according to table I VDE 0100 – § 9 N will at least be activated whenever a complete short circuit between an outer conductor and the neutral conductor occurs at any point in the circuitry.

One can also use fault current circuit breakers in addition, as shown in Fig. 6 (illustrated, for the sake of simplicity, for single-phase current). The FI circuit breaker receives its impulse from a current transformer through which all of the lead wires inclusive neutral conductor pass. The secondary coil of the current transformer supplies the activation current for the relay coil of the FI circuit breaker. The wires surrounded by the current transformer generate an alternating magnetic field in the core of the transformer if all of the currents do not neutralize each other in sum total (Fig. 7). During fault-free condition of the FI circuit breaker, the current flowing to the consumer is of exactly the same magnitude as that flowing back from it. Thus the two currents neutralize each other. There is no resulting induction onto the secondary coil of the current transformer, and the relay coil of the FI circuit breaker remains currentless (Fig. 6).

If there is a fault condition at the FI circuit breaker, a fault current flows off through the earth; the currents in the current transformer are no longer all mutually neutralized and induction results. Voltage is induced on the secondary side of the transformer.

The relay coil in the FI circuit breaker is activated (Fig. 7). 45 mA FI circuit breakers are available for 265 V/200 Hz rotary current. FI circuit breakers for rotary current at other voltage and frequency levels must be specially requested from appropriate manufacturers.

A schematic representation of an FI circuit breaker is provided in Fig. 8. In order to accommodate the regulations and specific conditions in other countries, Bosch offers high-frequency electric tools for various operating

voltages (265 V, 135 V, 72 V, 42 V at 200 Hz; 200 V, 72 V, 42 V at 300 Hz). At the lower voltages, however, only a few high-frequency electric tools should be used in close proximity to the associated frequency converter. This is because the currents arising at high power levels and low voltage require cable cross-sections that would be too large.

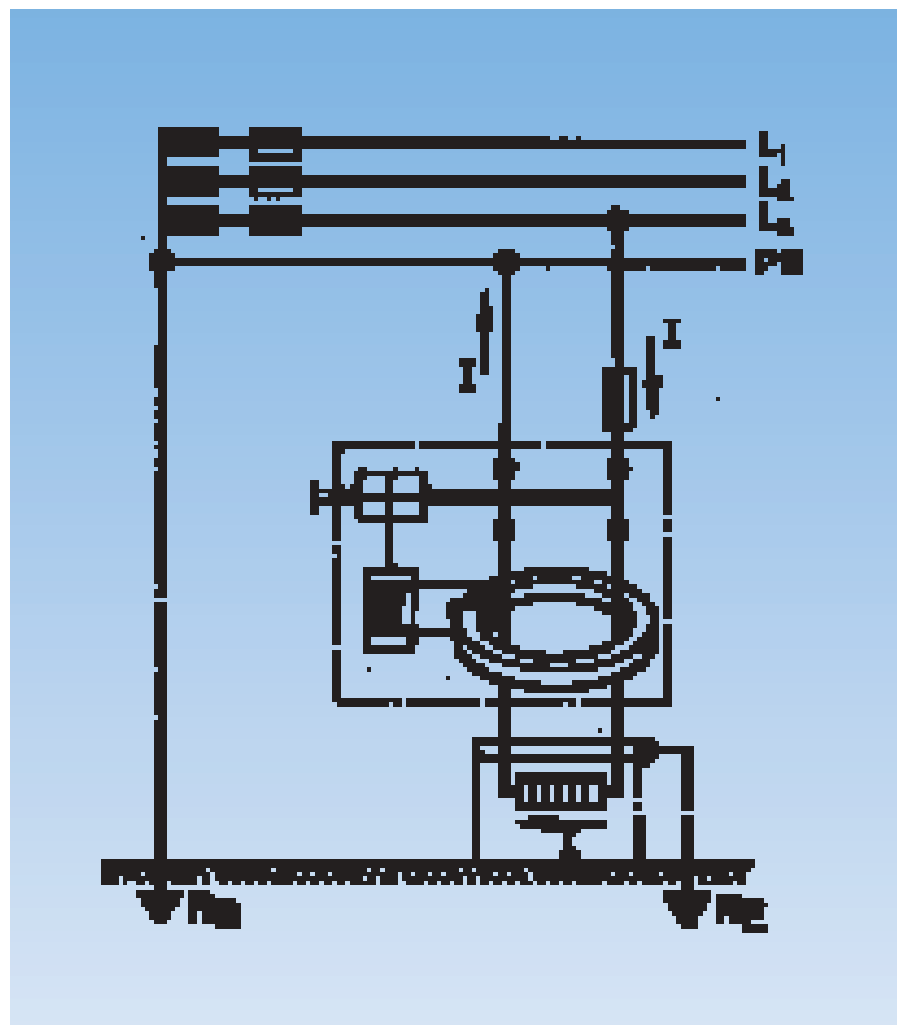


Fig. 7

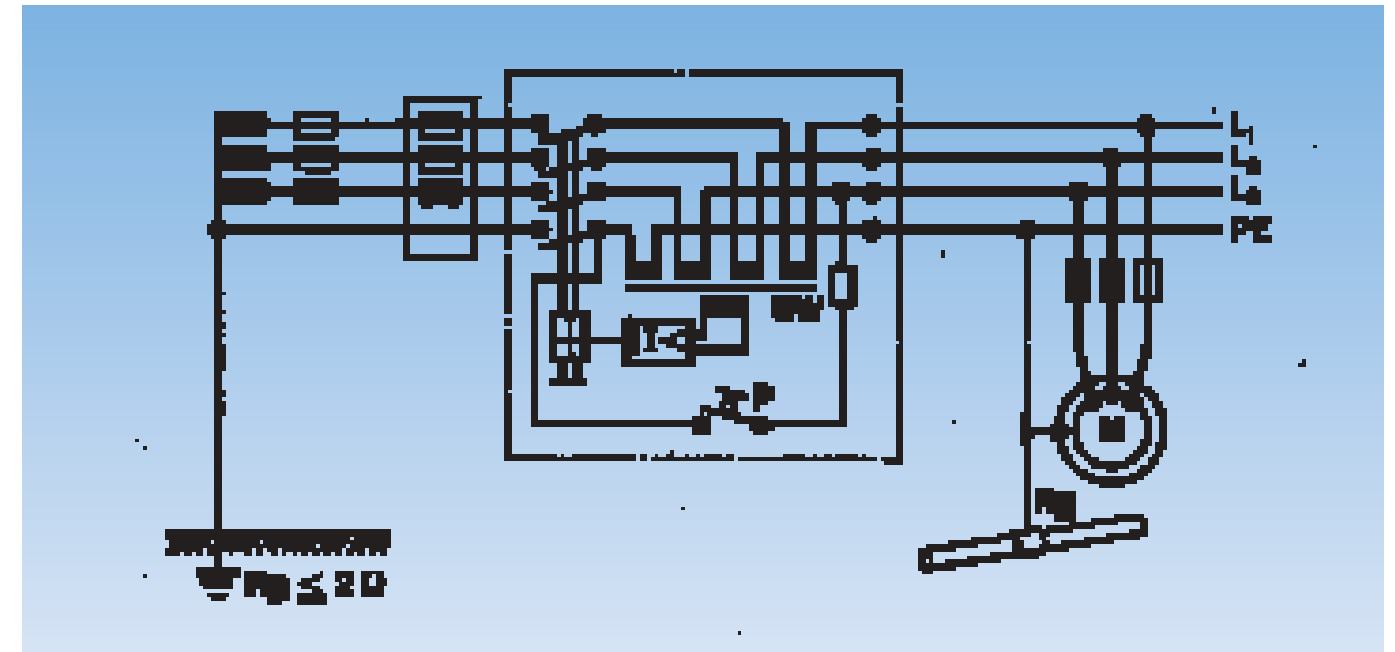


Fig. 6

## THE DISTRIBUTION NETWORK.

The distribution network must not have any connection with the existing 50 Hz supply mains. For this reason, special CEE plugged connections as per DIN 49462/63 and DIN 49465 are prescribed for frequencies between 100 and 300 Hz. The housings for the plug, coupling box and wall socket are all green. The different shape of these plugged connections prevents existing 50 Hz plug units from being combined with either the plugs or the coupling boxes. Depending on practical requirements, either movable or fixed leads may be used for the distribution network between the

frequency converter and the individual high-frequency electric tools. The transmission of high power levels at low voltage is uneconomical in broadly distributed installations. There will either be high installation costs due to the large lead cross-sections required or else transformers will be needed to reduce the higher voltage at the place of tool operation. Presupposing a constant level of power transmission, predefined voltage drop and equal lead length, the lead cross-section is inversely proportional to the square of the voltage, i.e. half the

voltage will require a lead cross-section that is four times larger. The required distribution network cross-section can easily be determined by referring to Figs. 9 to 12. The admissible voltage drop of 5 % from ohmic resistance, the admissible temperature increase and the voltage drop from inductive resistance are all taken into account in calculating lead cross-sections. The illustrations are to be read as follows:

Fig. 8:  
Cable cross-section as a function of voltage and lead length

Move horizontally from the left or the right, depending on the type of current, with the value of the power to be transmitted until the row intersects with the column for the voltage. Next, move vertically downwards until you intersect with the line for the lead length (simple length), then move horizontally again to the left or the right.

Fig. 9:  
Cable cross-section as a function of voltage and performance factor  
The cross-section calculated in Fig. 9 is now tested for temperature rise. Move horizontally from the left with the value of the power to be transmitted until you intersect with the column for the voltage. Next, move vertically downwards until you intersect with the line for the output factor  $\cos \varphi$ ; finally, move horizontally to the right to find the cross-section for the type of lead you are using.

Fig. 10:  
Cable cross-section as a function of frequency and inductive resistance  
If the cross-section for rotary current resulting from Figs. 9 and 10 exceeds  $10 \text{ mm}^2$ , you must then apply the precise calculated value to Fig. 10 in order to take the inductive voltage drop into account. Next, move vertically upwards from the horizontal

base line until you intersect with the frequency curve. Then move horizontally to the left or right. The larger of the calculated values for the cable cross-section is decisive in determining the lead.

Inductive resistance is significant for large cross-sections. These, in turn, are necessary at low voltages or high frequencies. Calculation of the curve in Fig. 11 was based on an assumed output factor  $\cos \varphi$  of 0.7 for the consumer.

For single phase alternating current installations with an output factor  $\cos \varphi = 1$ , inductive resistance can be ignored even for large cable cross-sections.

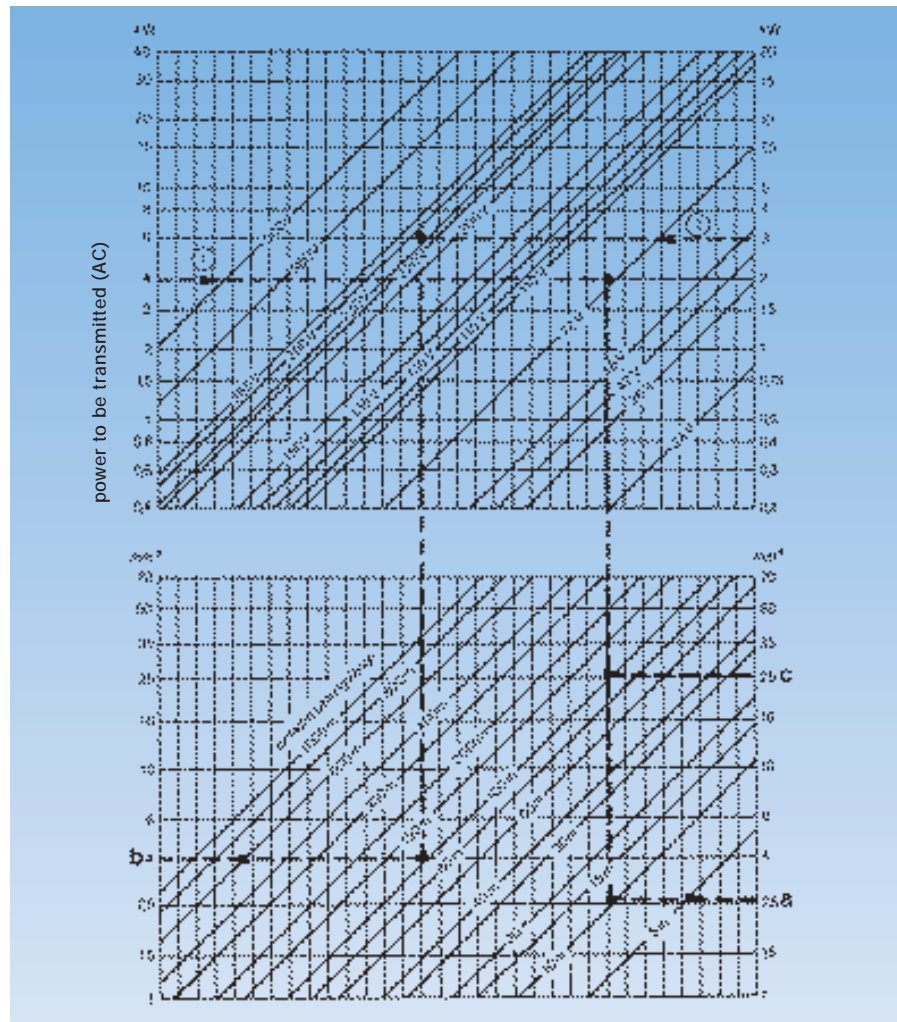


Fig. 8

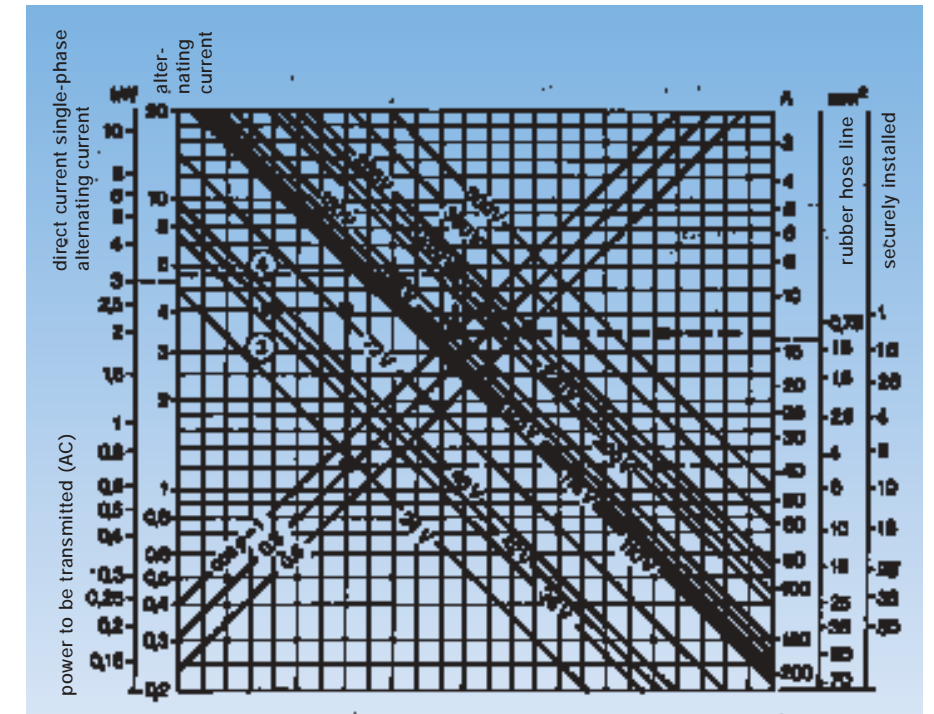


Fig. 9

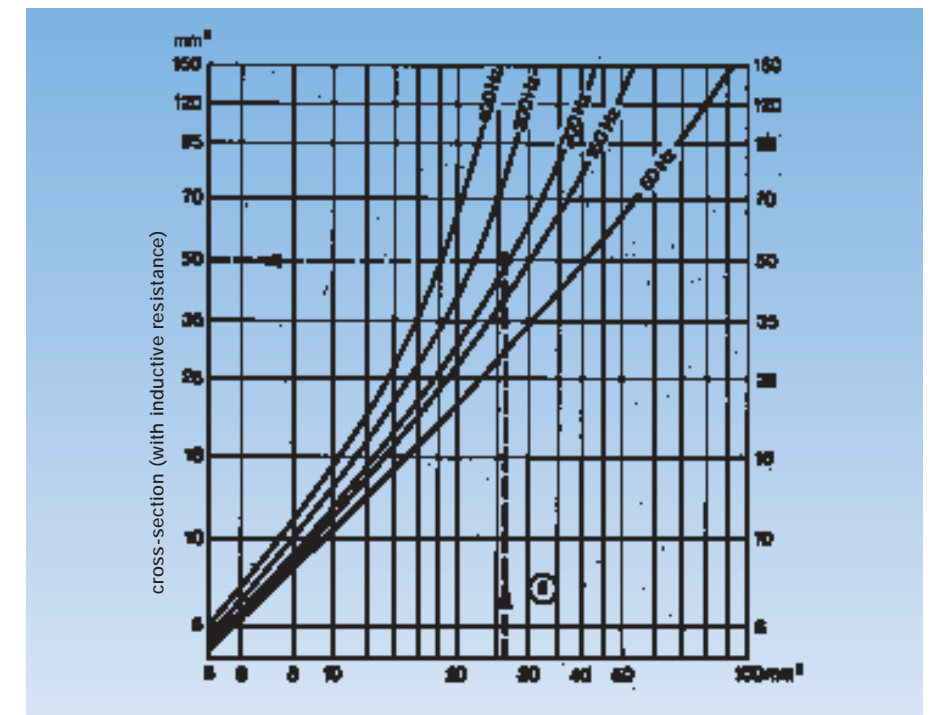


Fig. 10

**Example a:**  
Transmission of 4 kW, 72 V rotary current,  $\cos \varphi = 0.8$ , lead length (simple) 10 m. Cable cross-section calculated in accordance with Fig. 9:  $2.75 \text{ mm}^2$ . Cable cross-section calculated in accordance with Fig. 10:  $4.8 \text{ mm}^2$  (selected cross-section:  $6 \text{ mm}^2$ ) The cable cross-section of  $2.75 \text{ mm}^2$  calculated on the basis of Figs. 9 and 10 is not sufficient; the cable would get too hot. Testing in accordance with Fig. 11 is not necessary since the cross-section is less than  $10 \text{ mm}^2$ .

**Example b:**  
Transmission of 3 kW, 220 V single-phase alternating current,  $\cos \varphi = 0.9$ , lead length (simple): 100 m. Cable cross-section calculated in accordance with Fig. 9:  $4 \text{ mm}^2$ . Cable cross-section calculated in accordance with Fig. 10:  $0.9 \text{ mm}^2$ . According to Fig. 9, a cross-section of  $4 \text{ mm}^2$  is required. This value is decisive since Fig. 10 yields a value of only  $0.9 \text{ mm}^2$  and there is no danger of overheating.

**Example c:**  
As in "Example a", but at 200 Hz rotary current with lead length of 100 m. The cable cross-section calculated in accordance with Fig. 9 is  $27 \text{ mm}^2$ . This value must be tested in accordance with Fig. 11. In this example, the larger cross-section of  $50 \text{ mm}^2$  must be selected.

Bosch Customer Support Services is always available to answer questions on the use of high frequency tools and the area of high frequency technology in general.

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