

# PHILIPS

Data handbook



Electronic  
components  
and materials

## Components and materials

Part 18

1984

### Direct current motors



# DIRECT CURRENT MOTORS

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## DATA HANDBOOK SYSTEM

Our Data Handbook System is a comprehensive source of information on electronic components, sub-assemblies and materials; it is made up of four series of handbooks each comprising several parts.

ELECTRON TUBES	BLUE
SEMICONDUCTORS	RED
INTEGRATED CIRCUITS	PURPLE
COMPONENTS AND MATERIALS	GREEN

The several parts contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

Where ratings or specifications differ from those published in the preceding edition they are pointed out by arrows. Where application information is given it is advisory and does not form part of the product specification.

If you need confirmation that the published data about any of our products are the latest available, please contact our representative. He is at your service and will be glad to answer your inquiries.

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## ELECTRON TUBES (BLUE SERIES)

The blue series of data handbooks is comprised of the following parts:

- T1** Tubes for r.f. heating
- T2a** Transmitting tubes for communications, glass types
- T2b** Transmitting tubes for communications, ceramic types
- T3** Klystrons, travelling-wave tubes, microwave diodes
- ET3** Special Quality tubes, miscellaneous devices (will not be reprinted)
- T4** Magnetrons
- T5** Cathode-ray tubes  
Instrument tubes, monitor and display tubes, C.R. tubes for special applications
- T6** Geiger-Müller tubes
- T7** Gas-filled tubes  
Segment indicator tubes, indicator tubes, dry reed contact units, thyratrons, industrial rectifying tubes, ignitrons, high-voltage rectifying tubes, associated accessories
- T8** Picture tubes and components  
Colour TV picture tubes, black and white TV picture tubes, colour monitor tubes for data graphic display, monochrome monitor tubes for data graphic display, components for colour television, components for black and white television and monochrome data graphic display
- T9** Photo and electron multipliers  
Photomultiplier tubes, phototubes, single channel electron multipliers, channel electron multiplier plates
- T10** Camera tubes and accessories
- T11** Microwave semiconductors and components
- T12** Vidicons and Newvicons
- T13** Image intensifiers
- T14** Infrared detectors

## SEMICONDUCTORS (RED SERIES)

The red series of data handbooks is comprised of the following parts:

- S1 Diodes**  
Small-signal germanium diodes, small-signal silicon diodes, voltage regulator diodes (< 1,5 W), voltage reference diodes, tuner diodes, rectifier diodes
- S2 Power diodes, thyristors, triacs**  
Rectifier diodes, voltage regulator diodes (> 1,5 W), rectifier stacks, thyristors, triacs
- S3 Small-signal transistors**
- S4a Low-frequency power transistors and hybrid modules**
- S4b High-voltage and switching power transistors**
- S5 Field-effect transistors**
- S6 R.F. power transistors and modules**
- S7 Microminiature semiconductors for hybrid circuits**
- S8 Devices for optoelectronics**  
Photosensitive diodes and transistors, light-emitting diodes, displays, photocouplers, infrared sensitive devices, photoconductive devices.
- S9 Power MOS transistors**
- S10 Wideband transistors and wideband hybrid IC modules**

## INTEGRATED CIRCUITS (PURPLE SERIES)

The purple series of data handbooks is comprised of the following parts:

- IC1** Bipolar ICs for radio and audio equipment
- IC2** Bipolar ICs for video equipment
- IC3** ICs for digital systems in radio, audio and video equipment
- IC4** Digital integrated circuits  
CMOS HE4000B family
- IC5** Digital integrated circuits – ECL  
ECL10 000 (GX family), ECL100 000 (HX family), dedicated designs
- IC6** Professional analogue integrated circuits
- IC7** Signetics bipolar memories
- IC8** Signetics analogue circuits
- IC9** Signetics TTL logic
- IC10** Signetics Integrated Fuse Logic (IFL)
- IC11** Microprocessors, microcomputers and peripheral circuitry



## COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks is comprised of the following parts:

- C1 Assemblies for industrial use**  
PLC modules, PC20 modules, HN1L FZ/30 series, NORbits 60-, 61-, 90-series, input devices, hybrid ICs
- C2 Television tuners, video modulators, surface acoustic wave filters**
- C3 Loudspeakers**
- C4 Ferroxcube potcores, square cores and cross cores**
- C5 Ferroxcube for power, audio/video and accelerators**
- C6 Synchronous motors and gearboxes**
- C7 Variable capacitors**
- C8 Variable mains transformers**
- C9 Piezoelectric quartz devices**  
Quartz crystal units, temperature compensated crystal oscillators, compact integrated oscillators, quartz crystal cuts for temperature measurements
- C10 Connectors**
- C11 Non-linear resistors**  
Voltage dependent resistors (VDR), light dependent resistors (LDR), negative temperature coefficient thermistors (NTC), positive temperature coefficient thermistors (PTC)
- C12 Variable resistors and test switches**
- C13 Fixed resistors**
- C14 Electrolytic and solid capacitors**
- C15 Film capacitors, ceramic capacitors**
- C16 Permanent magnet materials**
- C17 Stepping motors and electronics**
- C18 D.C. motors**
- C19 Piezoelectric ceramics**



TYPE SELECTION

type	nominal voltage V	speed at nominal torque rev/min	nominal torque mNm	direction of rotation	remarks	dia. mm	length of housing mm	catalogue number	page
iron rotor	4,8	2000	1	reversible	special purpose	32,2	25	4322 010 71660	15
	6,7	2000	1	reversible	special purpose	32,2	25	71670	15
	5,5	2400	1	c.c.w.		27	21	72190	19
	5,5	2400	1	c.w.		27	21	72320	19
	7,5	2400	1,3	c.w.		27	21	72360	19
	7,5	2400	1,3	c.c.w.		27	21	72370	19
	12	5900	5	reversible		□ 34	40	09601	103
	6	330	25	reversible	with reduction	□ 39	64	52402	107
	6	60	125	reversible	with reduction	□ 39	64	52405	107
	6	23	125	reversible	with reduction	□ 39	64	52407	107
	6	8,2	125	reversible	with reduction	□ 39	64	52409	107
	12	330	25	reversible	with reduction	□ 39	64	52602	107
	12	60	125	reversible	with reduction	□ 39	64	52605	107
	12	23	125	reversible	with reduction	□ 39	64	52607	107
	12	8,2	125	reversible	with reduction	□ 39	64	52609	107
	24	330	25	reversible	with reduction	□ 39	64	52702	107
	24	60	125	reversible	with reduction	□ 39	64	52705	107
	24	23	125	reversible	with reduction	□ 39	64	52707	107
	24	8,2	125	reversible	with reduction	□ 39	64	52709	107
	ironless rotor	24	2850	10	reversible		40	40	4322 010 74080
12		2850	10	reversible		40	40	74090	25
24		2815	10	reversible		40	40	75060	29
12		2815	10	reversible		40	40	75110	29
15		3000	22	reversible		40	40	75130	33
30		3000	22	reversible		40	40	75300	33
24		2800	10	reversible	with tachogen.	40	50	75140	39
24		2800	10	reversible		40	40	75180	45
24		2800	10	reversible		40	40	75210	51
12		3200	5	reversible		29	40	76000	55
12		3000	5	reversible		29	40	76050	61
12		3900	5	reversible		29	40	76060	67
24		3900	5	reversible		29	40	76080	67
12		3000	5	reversible	with tachogen.	29	48	76130	73
24		3000	5	reversible		29	40	76150	61
9		3500	5	reversible		29	40	76200	79
9		5430	0,3	c.c.w.		19	15	77000	85
7,5		4500	0,3	reversible		20	12,5	77010	91
30		2150	100	reversible		66	64	78010	97



## INTRODUCTION

Our direct current motors are available in two basic types:

- iron rotor motors, having high efficiency and low cost;
- ironless rotor motors, having much better speed control properties such as shorter acceleration times and lower wow and flutter levels.

### APPLICATION EXAMPLES

#### **Iron rotor motors**

cassette recorders;  
record players;  
calculators;  
dictating machines;  
telephone answering equipment;  
weather balloons;  
rotating lights for vehicles;  
car headlamp wipers.

#### **Ironless rotor motors**

hi-fi reel-to-reel recorders;  
hi-fi cassette recorders;  
educational recorders;  
video recorders;  
video long play and compact disc drives;  
floppy disc and computer cassette drives;  
recording measuring equipment;  
computer and calculator printer drives;  
ribbon transport in computer printers;  
punched-card readers.



## DESIGN PRINCIPLES

### IRON ROTOR MOTORS (Fig. 1)

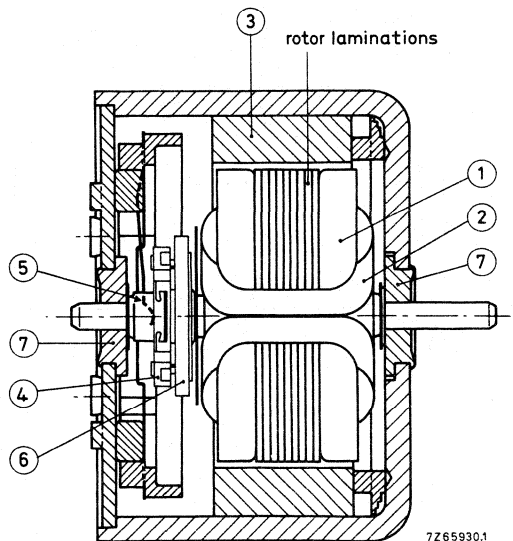
These motors have a three-pole laminated iron rotor and a flat commutator. A disc VDR (voltage dependent resistor) mounted between the commutator and coils suppresses interference and considerably increases brush life. All motors have two-leaf metal brushes except those of the 9904 120 52 . . . series which have carbon brushes. The stator consists of a Ferroxdure ring and the magnet circuit is closed by the motor housing or a steel ring.

The materials of commutator and metal brushes are chosen to ensure optimum commutation for electronic speed control. Low contact resistance ensures a problemless start, even after long rest periods. Owing to their low power consumption, these motors are suitable for operation from a battery supply. They are used as the drive in tape recorders and record players, for which speed stability, low electrical and mechanical noise and high reliability are required.

Several types have radio frequency interference suppression or magnetic shielding or both. Types with built-in integrated circuit or tachogenerator for accurate speed control are also available.

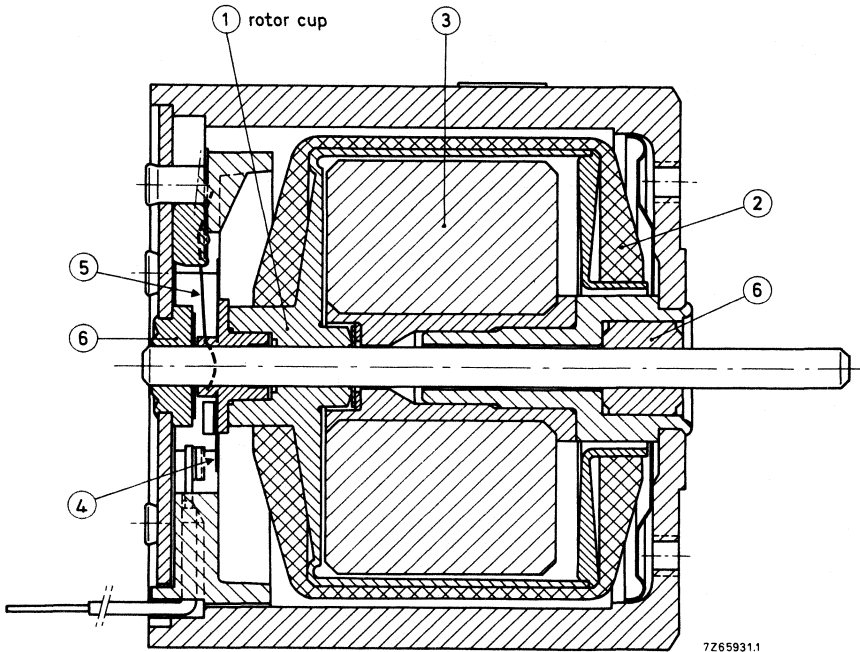
Fig. 1

- 1 = rotor
- 2 = rotor winding
- 3 = stator magnet
- 4 = commutator
- 5 = brush
- 6 = VDR
- 7 = bearing



**IRONLESS ROTOR MOTORS** (Fig. 2)

The rotor consists of a coil-former fixed to the spindle, upon which the coils are wound. The flat commutator is plated with a precious metal. Voltage peaks during commutation are so small in this type of motor that, generally, no radio frequency interference suppression is necessary. The stator is a steel alloy cylindrical magnet located inside the rotor. During assembly, a spigot in the housing is pressed into the stator magnet ring, leaving the rotor free to rotate in its bearings. The motor housing completes the magnet circuit. The brushes have three or four leaves each. The commutators of some types are equipped with zener diodes or capacitors for heavy duty applications or extended life. The ironless rotor motors are characterized by their excellent acceleration, mechanical time constant, starting torque and low-speed stability. Therefore, they are very suitable as the drive in hi-fi and video recorders and in professional equipment.



7265931.1

Fig. 2      1 = rotor                      4 = commutator  
              2 = rotor winding        5 = brush  
              3 = stator magnet       6 = bearing



TACHOGENERATOR

Several motor types are provided with a frequency tachogenerator for very accurate speed control independent of changes in motor characteristics due to ambient conditions.

The frequency tachogenerator has a toothed rotor (72 teeth) mounted on the protruding part of the motor spindle. The stator consists of a coil, a deep-drawn steel housing and a strip magnet of plastic-bonded ceramic magnetized with 72 pole pairs. The alternating flux produced as the toothed wheel rotates in the magnetic field is enclosed by the coil in which the tachogenerator voltage is generated. The frequency of the tachogenerator voltage is determined by the speed of the motor (and by the number of pole pairs of the tachogenerator).

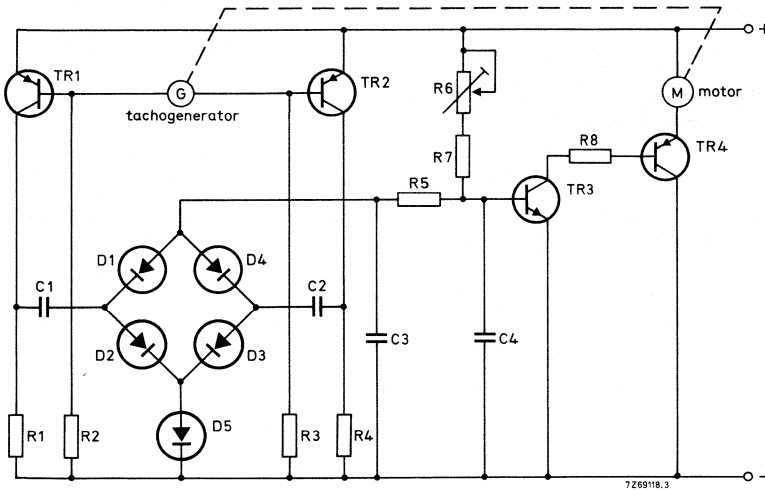


Fig. 3 Example of an electronic speed control system.  
G = frequency tachogenerator, M = direct current motor.

## MOUNTING

Most of the motors are front mounted using screws. Refer to the data sheets for individual details.

### Mounting a pulley or pinion

This can be done in three ways:

- by *pressing* the pulley or pinion onto the motor spindle. This is only allowed if the other end of the spindle is supported so that parts inside the motor are not subjected to axial force. The required hole in the pulley or pinion is given in the table below for spindle diameters of 2 mm and 3 mm.

spindle diameter	$l_{max}$	hole diameter	
		$d_1$	$d_2$
2	2,5	2 P7	2 H7
3	3,5	3 P7	3 H7

Here, P7 denotes a tolerance  $-0,006$  to  $-0,016$

H7 denotes a tolerance  $0$  to  $+0,010$

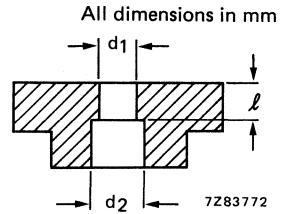


Fig. 4  $d_2$  is a guide hole.

- by *heating* the pulley or pinion and then sliding it onto the spindle; temperature can be calculated from the expansion coefficient of the material used. At room temperature, hole dimensions are the same as for press fitting.
- by *glueing* with a self-curing adhesive. The gap between pulley, or pinion, and spindle depends upon the glue used. Pulley eccentricity will be larger than that for the two preceding methods because of the gap.

## QUALITY

Quality is our constant aim, from the moment the idea for a motor design is born to the last day of operation. Quality control, therefore, is probably the most important aspect of the entire marketing activity.

To achieve the highest possible standard a procedure of many checks is carried out:

- during development, prior to Release for Development Sample production;
- during the pilot production, to optimize conditions for mass production;
- during series production, after Release for Production.

With this procedure optimum quality assurance is realized.

### DEVELOPMENT

The examination during development includes material inspection and verification of the development specification.

Quality checks on development samples include:

- visual inspection, including operational noise due to friction;
- dimensional checks on critical dimensions and spindle deviation;
- mechanical and electrical tests, e.g. on directional stability of rotation, torque, current;
- safety tests, both on insulation resistance and dielectric strength;
- climatic tests;
- life and endurance tests.

### PILOT PRODUCTION

Once the product has passed this development stage, a pilot production should prove the reproducibility.

The mechanical tests are based on performance during operation. Special conditions can be simulated, also upon customer's demand. Besides, batch tests of packed motors are carried out (dropping and bounce tests) as well as vibration and shock tests on motors mounted on a frame.

The climatic tests include functional checks at  $-20^{\circ}\text{C}$  unless otherwise specified, temperature cycle tests,  $-40$  to  $+85^{\circ}\text{C}$  (5 cycles, total 30 h), damp heat cycle tests (6 days) and dry heat storage tests at the maximum specified storage temperature (96 h).

The life tests are accelerated tests during 2000 h under extreme conditions of load and temperature and continuous tests under normal operating conditions.

### SERIES PRODUCTION

Products which pass all these tests during the pilot production stage are released for factory production. Production lots are submitted to lot acceptance tests according to MIL-STD-105D procedure. Unless otherwise specified, inspection level I and an AQL of 1% for major defects are set as limit. During series production a process control carried out at various stages reduces the error initiation to a great extent.

### RELIABILITY

Apart from tests on specified zero hour properties mentioned above, life tests\* are carried out on statistically representative samples. Life expectancy is derived from a Weibull Life Probability Chart (Fig. 5), a plot of cumulative failures as a function of time.

The cumulative failure percentage is

$$n = (i - 0,3)/(n + 0,4) \times 100$$

where  $i$  = sequence number of failure

$n$  = number in sample

#### Example:

Out of a sample of 20 motors, 5 failed after respectively 1750, 2000, 2525, 2600 and 2815 hours of operation.

sequence number	failed at h	cumulative failure percentage $\eta$
1	1750	$(1 - 0,3)/(20 + 0,4) = 3,4\%$
2	2000	$(2 - 0,3)/(20 + 0,4) = 8,3\%$
3	2525	$(3 - 0,3)/(20 + 0,4) = 13,2\%$
4	2600	$(4 - 0,3)/(20 + 0,4) = 18,1\%$
5	2815	$(5 - 0,3)/(20 + 0,4) = 23,0\%$

Plotting these points on the graph and drawing the best straight line through them (the population line) gives a B10-life (time for 10% of the population to fail) of 2200 h. This means 90% of the population has a life longer than 2200 h.

The characteristic life is read at  $\eta = 63\%$  and is here 4000 h. So the Mean Time Between Failures (MTBF) is 4000 h and the failure rate  $\lambda$  ( $= 1/\text{MTBF}$ ) is  $250 \times 10^{-6}/\text{h}$ .

\* Unless otherwise specified the tests are carried out with a duty cycle of 3 h on/1 h off, motor operating in preferred direction of rotation as indicated in the relevant mechanical drawing.

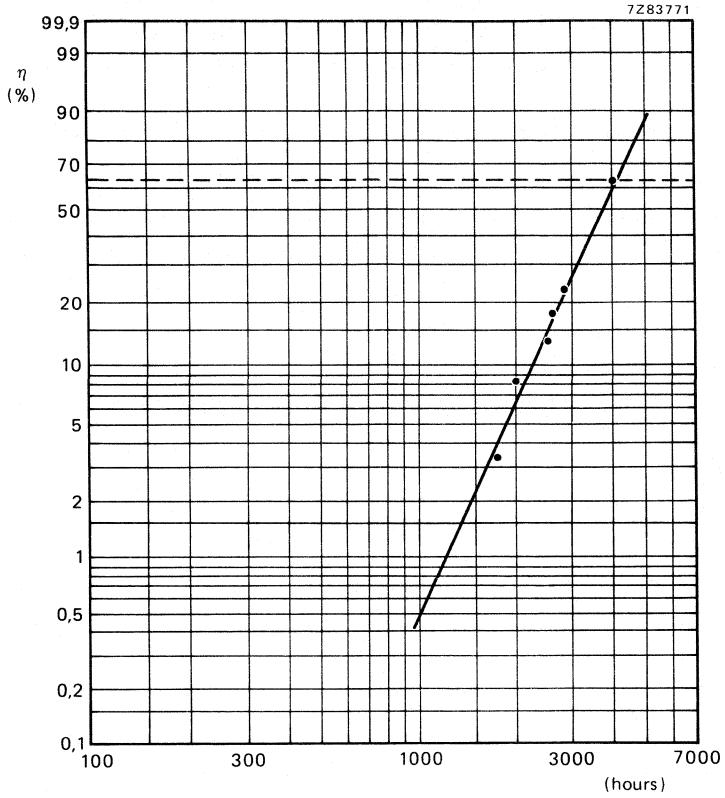


Fig. 5 Weibull Life Probability Chart.

**ADDITIONAL INFORMATION TO  
MOTOR SPECIFICATIONS**

**TERMINOLOGY** (in alphabetical order)

**Mechanical time constant**

The time the unloaded motor at a constant voltage needs, starting from rest to reach 63% of the final speed at that voltage.

**Nominal speed**

The speed at nominal voltage and nominal torque.

**Nominal torque**

The output torque of the motor without radial load, at nominal voltage and nominal speed. (With a radial load the output torque is reduced.)

**Nominal voltage**

The voltage at which the nominal torque and the nominal speed are specified.

**Rotor inductance**

The inductance measured between the terminals of the motor at 1000 Hz, motor at rest and no coils short-circuited by the brushes.

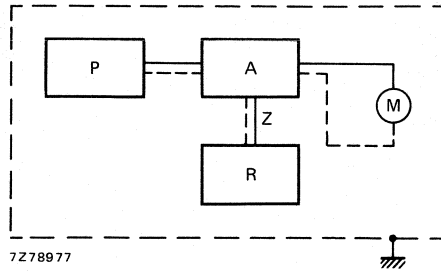
**Rotor resistance**

The resistance measured between the motor terminals at  $+22 \pm 5$  °C, motor at rest and no coils short-circuited by the brushes.

**RADIO INTERFERENCE**

In the data sheets of motors for applications requiring low interference, e.g. cassette recorders, a curve is given showing the maximum interference level with respect to  $1 \mu V$  as a function of frequency. The curve is measured using the circuit shown in Fig. 6.

Fig. 6



P = interference-free power supply

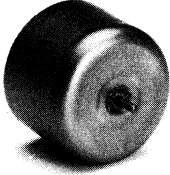
A = artificial network  $50 \Omega // 5 \mu\text{H}$ , according to CISPR, recommendation 53 (0,1 to 100 MHz)

R = interference measuring receiver (FSME 1515 of Schwarzbeck)

M = motor, nominal torque, nominal speed

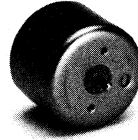
Z =  $50 \Omega$  coaxial cable

8307 11-01-08



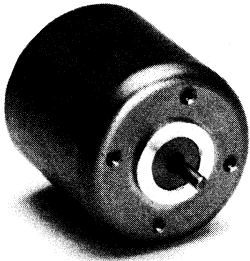
4322 010 71 ...

8307 11-01-11



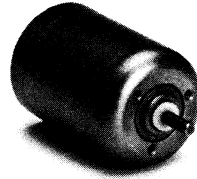
4322 010 72 ...

8307 11-01-01



4322 010 74/75 ...

8307 11-01-07



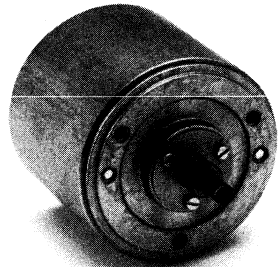
4322 010 76 ...

8307 11-01-12



4322 010 77 ...

8307 11-01-06



4322 010 78 ...



## DIRECT CURRENT MOTORS

iron rotor, special purpose

### QUICK REFERENCE DATA

Catalogue number	4322 010 71660	4322 010 71670	
Nominal voltage (d.c.)	4,8	6,7	V
Nominal speed	2000	2000	rev/min
Nominal torque	1	1	mNm

### APPLICATION

These motors are for applications which require low noise level, smooth running and accurate speed control by an electronic speed control unit. Examples: cassette recorders and players; record players; telephone answering equipment; dictating machines; echo sounders.

### DESCRIPTION

The motors are equipped with a deep-drawn steel housing and have a circular permanent magnet for maximum power performance and minimum holding torque (cogging). A gold-plated commutator with three segments and two-piece silver brushes render optimum commutation. Together with a built-in VDR for spark suppression this ensures a long commutator life. Two solder tags are for electrical connection.

### TECHNICAL DATA

#### Outlines

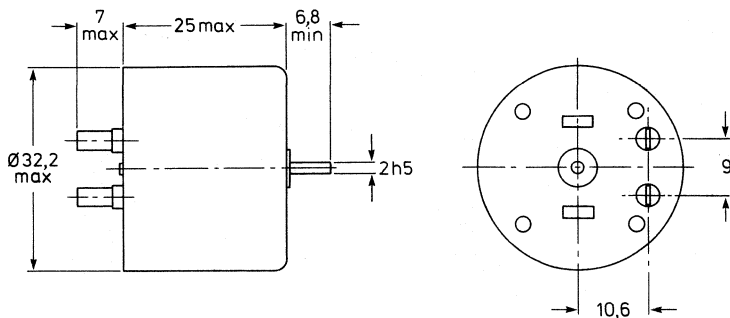


Fig. 1.

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The minus termination is internally connected to mass.

The direction of rotation is given in connection with the polarity.

**Mass** approximately 61 g

**Options** (at additional cost): longer spindle, i.e. 9,8 or 14,8 mm instead of 6,8 mm; two mounting holes M2 at a pitch of 20 mm; aluminium shielding, f.m. interference suppression.

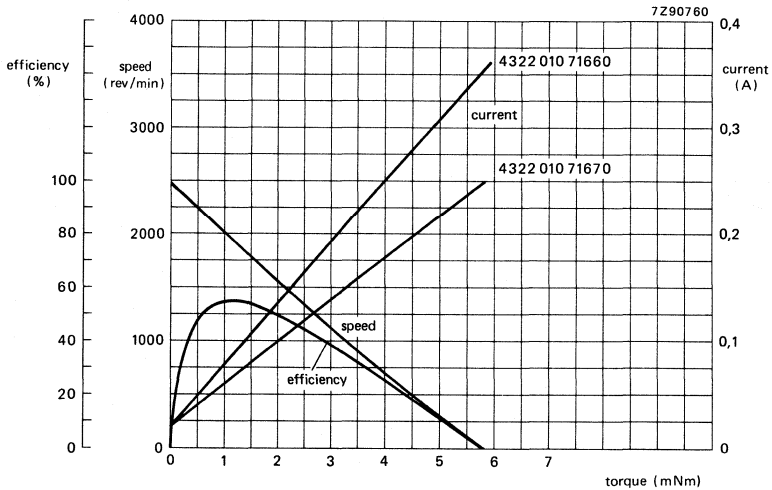


Fig. 2 Typical curves of motor 4322 010 71660 at 4,8 V and of motor 4322 010 71670 at 6,7 V.  $T_{amb} = 20\text{ }^{\circ}\text{C}$ .

**Limiting conditions**

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

	4322 010 71660	4322 010 71670	
Voltage	9	12	V
Torque	2	2	mNm
Current	120	90	mA
Repetitive peak current, 10 ms, 1 Hz	480	400	mA
Speed	3500	3500	rev/min
Output power	0,5	0,5	W
Continuous blocking permitted at	5	6,6	V
Radial force	2,5	2,5	N
Axial force, pressing	0,3	0,3	N

The values given below apply to an ambient temperature of  $22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

Catalogue number	4322 010 71660	4322 010 71670	
Nominal voltage (d.c.)	4,8	6,7	V
Nominal torque	1	1	mNm
Speed	2000	2000	rev/min
Bearings	slide	slide	
Climatic category (IEC 68)	10/060/21	10/C60/21	
E.M.F. at 3000 rev/min	4,95 to 6,1	6,9 to 8,55	
Rotor resistance	$13 \pm 10\%$	$26 \pm 10\%$	$\Omega$
Current at nominal speed			
at nominal torque	max. 94	max. 70	mA
at no load	max. 30	max. 23	mA
at a radial force of 1,5 N at 8 mm from mounting plane	max. 50	max. 3,7	mA
Insulation between terminals and housing	min. 2	min. 2	M $\Omega$
Test voltage (50 Hz) between terminals and housing, for 1 minute	250	250	V
Torque constant	e.m.f./100 $\pi$	e.m.f./100 $\pi$	Nm/A
Starting torque at nominal voltage	4,5 to 7,6	4,4 to 7,5	mNm
Rotor inductance	18	38	mH
Rotor moment of inertia	10	10	gcm <sup>2</sup>
Mechanical time constant	typ. 48	typ. 48	ms
Audio interference	see Fig. 4	see Fig. 4	
Ambient temperature range			
operating	-10 to +60	-10 to +60	°C
storage	-40 to +70	-40 to +70	°C
Temperature coefficient of rotor resistance	0,4	0,4	%/K
e.m.f.	-0,2	-0,2	%/K

**AUDIO INTERFERENCE**

**Measuring procedure**

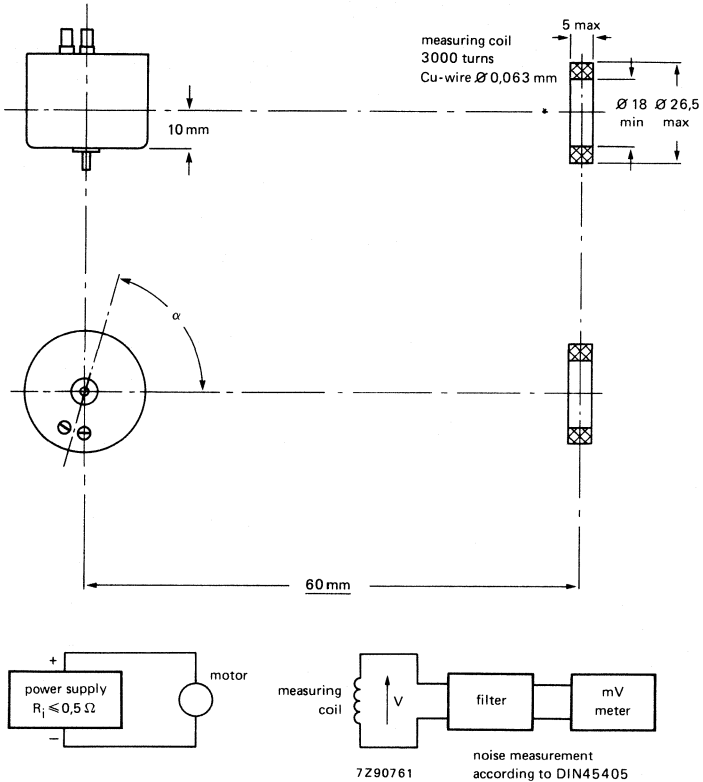


Fig. 3.

Motor speed 2000 rev/min

Nominal torque

$\alpha$  is varied until maximum voltage is obtained

$$V_{p-p} = \max. 140 \times 2\sqrt{2}$$

**CATALOGUE NUMBERS**

4322 01. 71660

4322 01. 71670

0 stamped on motor, **not to be used** for ordering  
3 for bulk packing, to be used for ordering\*

\* Minimum packing quantity 170 items per cardboard box.

**DIRECT CURRENT MOTOR**

iron rotor type

**QUICK REFERENCE DATA**

Clockwise rotation	4322 010 72320	4322 010 72360
Counterclockwise rotation	4322 010 72190	4322 010 72370
Nominal voltage (d.c.)	5,5 V	7,5 V
Nominal speed	2400 rev/min	2400 rev/min
Nominal torque	1 mNm	1,3 mNm

**APPLICATION**

These motors have been designed for applications which require low noise level, smooth running, small size and accurate electronic speed control.

Examples:

- cassette recorders and players
- portable dictating machines
- telephone answering equipment
- arrival and departure boards, e.g. at airports and railway stations

**DESCRIPTION**

The motors have a permanent magnet stator system, consisting of plastic-bonded ceramic material, with which a very low holding torque has been obtained.

The gold-plated flat commutator and silver-plated brushes ensure optimum commutation, thus making the motors suitable for accurate electronic speed control. This commutator-brush construction and the sintered bearings, ensure smooth running and long life.

The built-in spark suppressor (VDR) minimizes interference and considerably increases the commutator and brush life.

The motors have a nickel-plated, deep drawn, steel housing.

**Options**

Each type of motor can be made available (if a sufficient quantity is ordered) with:

- mu-metal shield (for optimum interference suppression)
- pulley or pinion
- other spindle length
- other supply voltage
- other lead length and colour
- other preferred direction of rotation

TECHNICAL DATA

Outlines

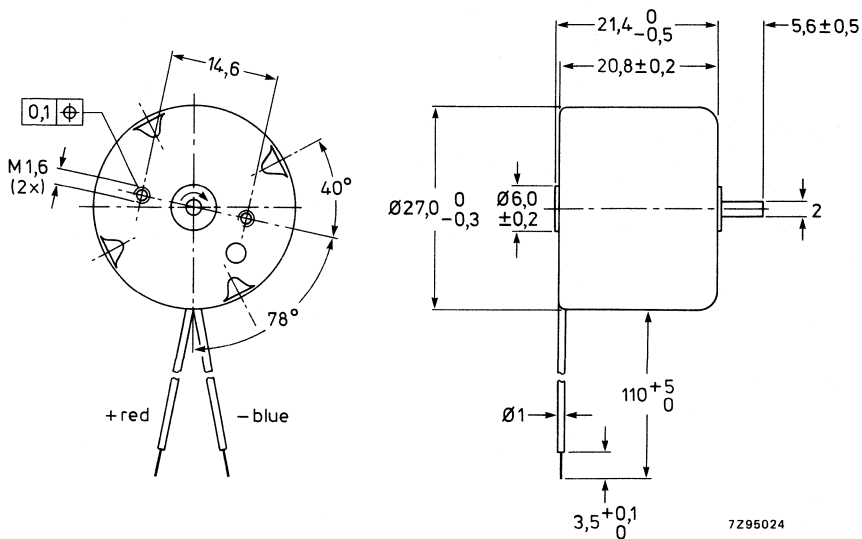


Fig. 1.

**Axial play of rotor** min. 0,1 mm, max. 0,7 mm

**Mass** 44 g approximately

**Mounting**

The motors are provided with two holes for front mounting by means of M1,6 screws; maximum permissible screw insertion 1,7 mm.

Maximum permissible pulling force on connecting leads 3 N.

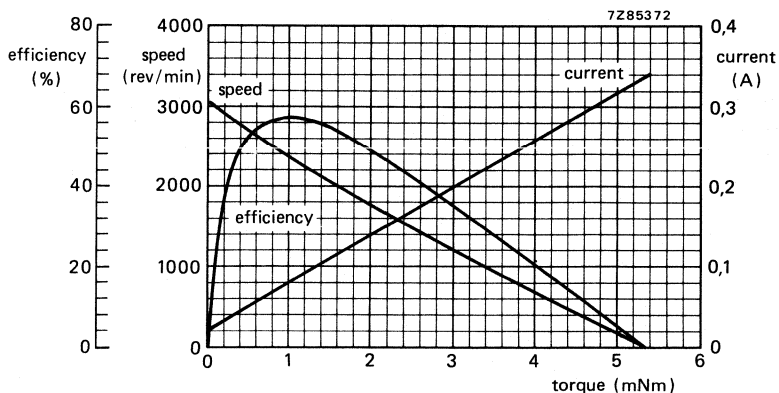


Fig. 2 Typical curves of the 5,5 V motors,  $T_{amb} = 22 \text{ }^\circ\text{C}$ .

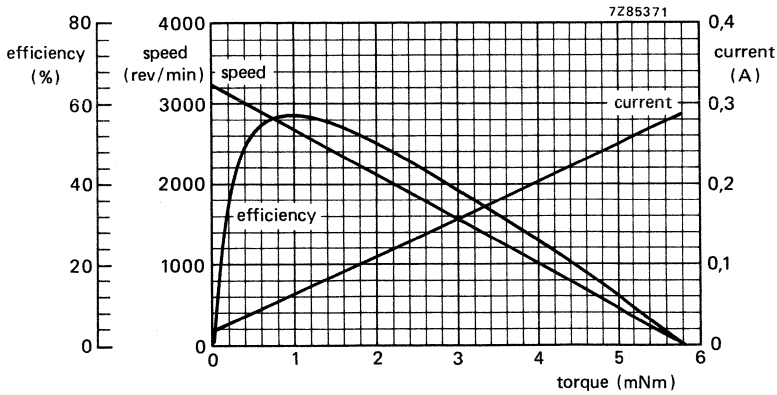


Fig. 3 Typical curves of the 7,5 V motors,  $T_{amb} = 22 \text{ }^{\circ}\text{C}$ .

**Limiting conditions**

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

Catalogue numbers	4322 010 72320	4322 010 72360	
	4322 010 72190	4322 010 72370	
Voltage	8	14	V
Torque	2	2	mNm
Current	150	120	mA
Repetitive peak current, 10 ms, 1 Hz	600	470	mA
Speed	4200	4200	rev/min
Output power	0,5	0,65	W
Continuous blocking permitted at	3,8	5,6	V
Radial force	2,5	2,5	N
Axial force			
pressing	0,5	0,5	N
pulling	0,2	0,2	N

The values given below apply to an ambient temperature of  $22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

	4322 010 72320	4322 010 72360	
	4322 010 72190	4322 010 72370	
Clockwise rotation	4322 010 72320	4322 010 72360	
Counterclockwise rotation	4322 010 72190	4322 010 72370	
Nominal voltage (d.c.)	5,5	7,5	V
Nominal torque	1	1,3	mNm
Speed	see Fig. 2	see Fig. 3	
Bearings	slide	slide	
Climatic category (IEC 68)	20/070/21	20/070/21	
E.M.F. at 3000 rev/min	4,6 - 5,6	5,75 - 7,35	V
Rotor resistance	$16 \pm 10\%$	$25,6 \pm 10\%$	$\Omega$
Current at nominal voltage			
at nominal torque	71 - 100	69 - 98	mA
at no load	max. 34	max. 27	mA
at a radial force of 1,5 N at 8 mm from mounting plane	max. 50	max. 40	mA
Insulation between terminals and housing	min. 2	min. 2	M $\Omega$
Test voltage (50 Hz) between terminals and housing, for 1 minute	250	250	V
Torque constant	e.m.f./100 $\pi$	e.m.f./100 $\pi$	Nm/A
Starting torque at nominal voltage	min. 4,1	min. 4,4	mNm
Rotor inductance	16	27	mH
Rotor moment of inertia	9	9	gcm <sup>2</sup>
Mechanical time constant	34	34	ms
Audio interference	see Fig. 4	see Fig. 4	
Ambient temperature range			
operating	-20 to +70*	-20 to +70*	°C
storage	-40 to +90	-40 to +90	°C
Temperature coefficient of rotor resistance	0,4	0,4	%/K
e.m.f.	-0,2	-0,2	%/K

\* +85 °C for maximum 24h.



**AUDIO INTERFERENCE**

**Measuring procedure**

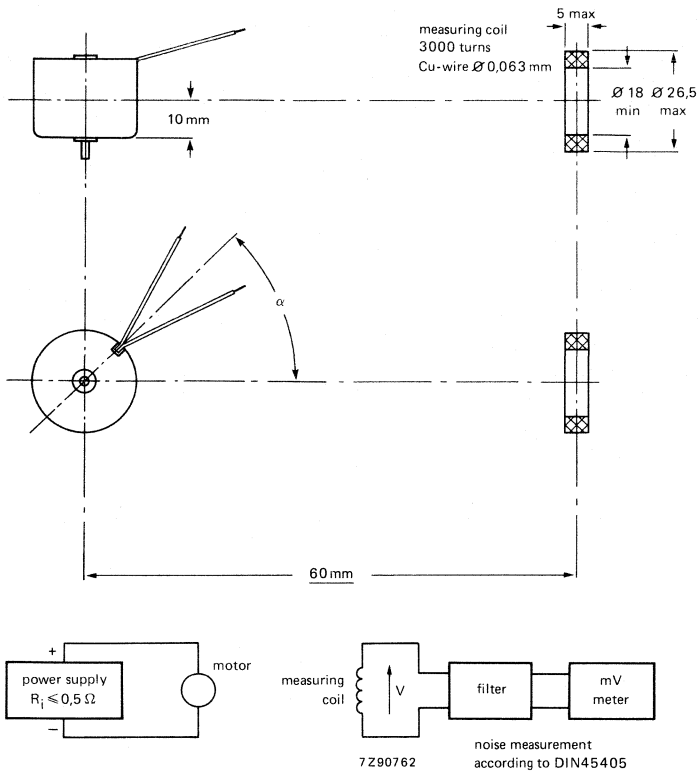


Fig. 4.

Motor speed 2400 rev/min

Nominal torque

$\alpha$  is varied until maximum voltage is obtained

$$V_{p-p} = \text{max. } 28 \times 2\sqrt{2}$$

**CATALOGUE NUMBERS**

4322 01. 72190

4322 01. 72320

4322 01. 72360

4322 01. 72370

0 stamped on motor, **not to be used** for ordering  
3 for bulk packing, to be used for ordering\*

\* Minimum packing quantity 170 items per cardboard box.



## DIRECT CURRENT MOTORS

ironless rotor type

### QUICK REFERENCE DATA

---

Nominal voltage (d.c.)	
motor 4322 010 74080	24 V
motor 4322 010 74090	12 V
Nominal speed	2850 rev/min
Nominal torque	10 mNm

---

### APPLICATION

These motors have been designed for applications which require high acceleration, high efficiency and smooth running. No magnetic holding torque. Examples:

- digital cassette and cartridge recorders
- card readers
- printers (paper feed and head position)
- recording measuring instrument
- videorecorder

### DESCRIPTION

The motors owe their special characteristics to the following design:

- Ironless rotor with oblique windings.
- Mechanical time constant of only 19,6 ms.
- High starting torque of 65 mNm.
- Precious-metal plated commutator with 9 segments and three silver-plated brushes ensure optimum commutation making the motor suitable for accurate electronic speed control or optimum functioning as a servo motor or d.c. tachogenerator.
- High efficiency due to a powerful cylindrical ticonal magnet.
- Protruding rear shaft, which can easily be supported when pinion or pulley has to be fitted on front shaft.
- The combination of the above commutator/brush construction with sintered slide bearings ensures a long life, smooth running and low noise.

TECHNICAL DATA

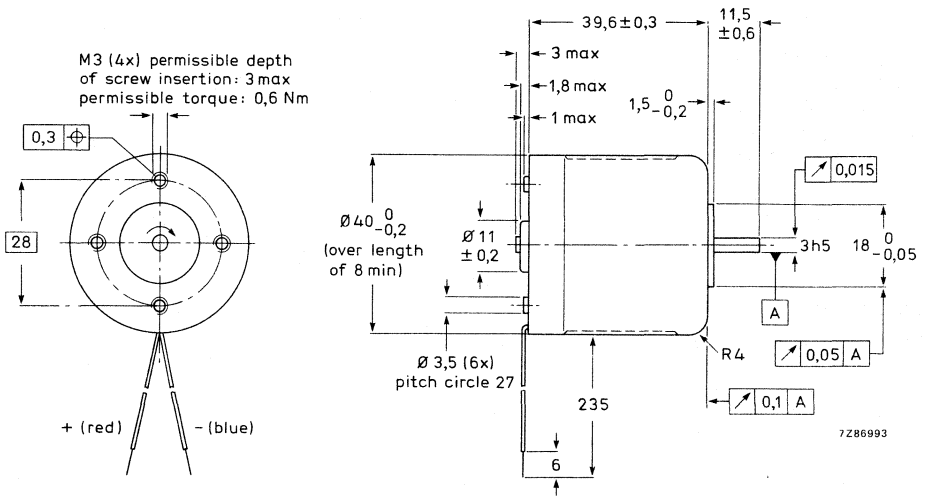


Fig. 1.

The direction of rotation is given in connection with the polarity.

Axial play of rotor: 0,2 + 0,4 mm.

Mass 205 g

The values given below apply to an ambient temperature of + 22 ± 5 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

	4322 010 74080	4322 010 74090	
Nominal voltage (d.c.)	24	12	V
Nominal torque	10	10	mNm
Speed	see Fig. 1	see Fig. 2	
Bearings	slide	slide	
Direction of rotation	reversible	reversible	
Climatic category (IEC 68)	05/060/21	05/060/21	
E.M.F. at 3000 rev/min	18,9 - 24,9	9,5 - 12,5	V
Rotor resistance	24,5 ± 10%	6,2 ± 10%	Ω
Current at nominal voltage			
at nominal torque	180	365	mA
at no load	max. 15	max. 30	mA
at a radial force of 5 N at 10 mm from mounting plane	max. 78	max. 156	mA

	4322 010 74080	4322 010 74090	
Insulation between terminals and housing	min. 2	min. 2	MΩ
Test voltage (50 Hz) between terminals and housing, for 1 minute	250	250	V
Torque constant	e.m.f./100π	e.m.f./100π	Nm/A
Starting torque at nominal voltage	min. 65	min. 65	mNm
Rotor inductance	3,3	0,8	mH
Rotor moment of inertia	3,9 × 10 <sup>-6</sup>	3,9 × 10 <sup>-6</sup>	kg m <sup>2</sup>
Mechanical time constant	19,6	19,6	ms
Ambient temperature range			
operating	-10 to +60	-10 to +60	°C
storage	-40 to +70	-40 to +70	°C
Temperature coefficient of rotor resistance	0,4	0,4	%/K
e.m.f.	-0,02	-0,02	%/K

**Limiting conditions**

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

	4322 010 74080	4322 010 74090	
Voltage	30	15	V
Torque	20	20	mNm
Current	275	550	mA
Repetitive peak current, 10 ms, 1 Hz	1200	2400	mA
Speed	4000	4000	rev/min
Output power	5	5	W
Radial force	7	7	N
Axial force	0,5	0,5	N

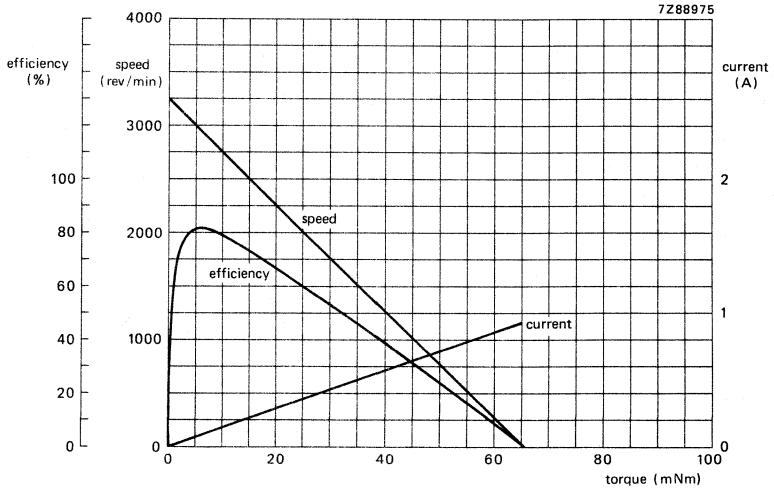


Fig. 2 Typical curves of motor 4322 010 74080 at 24 V,  $T_{amb} = 22\text{ }^{\circ}\text{C}$ .

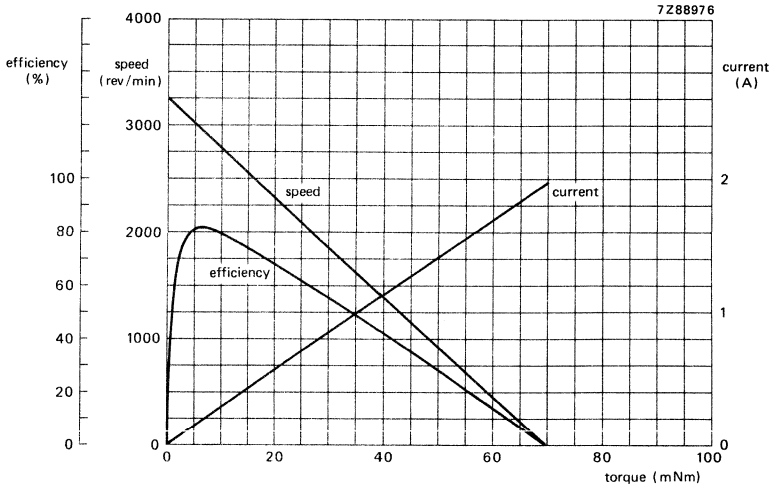


Fig. 3 Typical curves of motor 4322 010 74090 at 12 V,  $T_{amb} = 22\text{ }^{\circ}\text{C}$ .

## DIRECT CURRENT MOTORS

ironless rotor type

### QUICK REFERENCE DATA

---

Nominal voltage (d.c.)	
motor 4322 010 75060	24 V
motor 4322 010 75110	12 V
Nominal speed	2815 rev/min
Nominal torque	10 mNm

---

### APPLICATION

These motors have been designed for applications which require high acceleration, high efficiency and smooth running. No magnetic holding torque. Examples:

- hi-fi reel-to-reel recorders (capstan and reel drive);
- hi-fi cassette recorders (reel drive);
- video recorders (capstan, reel and drum drive);
- digital cassette and cartridge recorders;
- card readers;
- printers (paper transport and head positioner);
- recording measuring instruments.

### DESCRIPTION

The motors owe their special characteristics to the following design:

- ironless rotor with oblique windings;
- mechanical time constant of only 19,6 ms;
- high starting torque of 70 mNm;
- precious-metal plated commutator with 9 segments and three silver-plated brushes ensure optimum commutation making the motor suitable for accurate electronic speed control or optimum functioning as a servo motor or d.c. tachogenerator;
- high efficiency due to a powerful cylindrical ticonal magnet;
- the combination of the above commutator/brush construction with sintered slide bearing ensures a long life, smooth running and low noise.

**TECHNICAL DATA**

**Outlines**

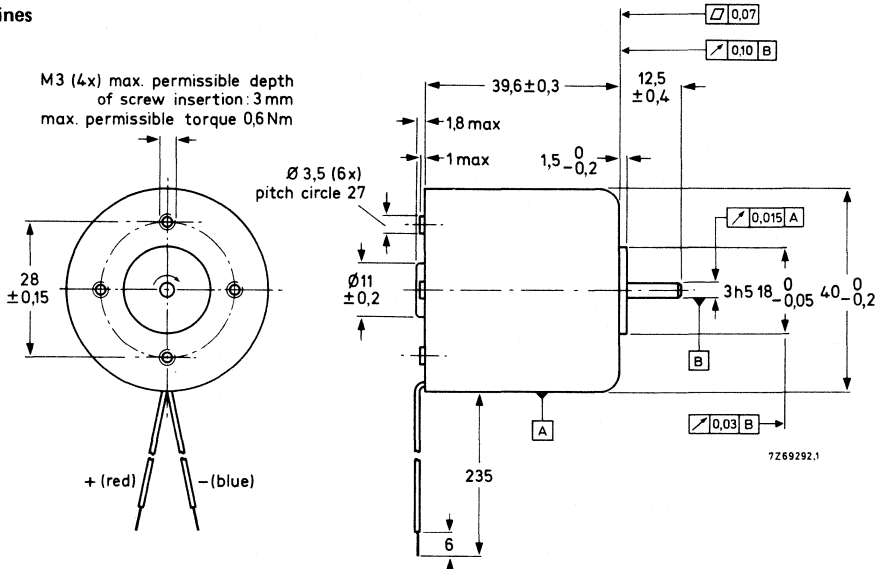


Fig. 1.

The direction of rotation is given in connection with the polarity.

**Mass** approx. 205 g

The values given below apply at an ambient temperature of 22 ± 5 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

	4322 010 75110	4322 010 75060	
Nominal voltage (d.c.)	12	24	V
Nominal torque	10	10	mNm
Speed at nominal load	2815 ± 385	2815 ± 385	rev/min
at no load	3310 ± 460	3310 ± 460	rev/min
Current at nominal load	max. 365	max. 180	mA
at no load	max. 30	max. 15	mA
Starting torque	70 ± 17	70 ± 17	mNm
Input power	max. 4,3	max. 4,3	W
Specific input current	25,1 to 33,1	12,5 to 16,6	mA/mNm
Induced voltage	3,17 to 4,17	6,33 to 8,33	mV per rev/min
Rotor resistance	6,2 ± 10%	24,5 ± 10%	Ω
Direction of rotation	reversible	reversible	
Ambient temperature range	-5 to + 70	-5 to + 70	°C
Rotor moment of inertia	39,2	39,2	gcm <sup>2</sup>
Motor constant	typ. 19,6	typ. 19,6	ms



	4322 010 75110	4322 010 75060	
Bearings	slide bearings	slide bearings	
Maximum radial force 8 mm from mounting plane	5	5	N
Maximum axial force*	0,5	0,5	N
Maximum axial play	0,6	0,6	mm
Housing material	steel	steel	

**Limiting conditions**

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

	4322 010 75110	4322 010 75060	
Maximum voltage (d.c.)	15	30	V
Maximum permissible load	20	20	mNm
Maximum permissible current	550	275	mA
Maximum speed	4000	4000	rev/min
Maximum output power	5	5	W
Locked rotor	max. 2 min at 12 V	max. 2 min at 24 V	

\* Directed towards the connections.

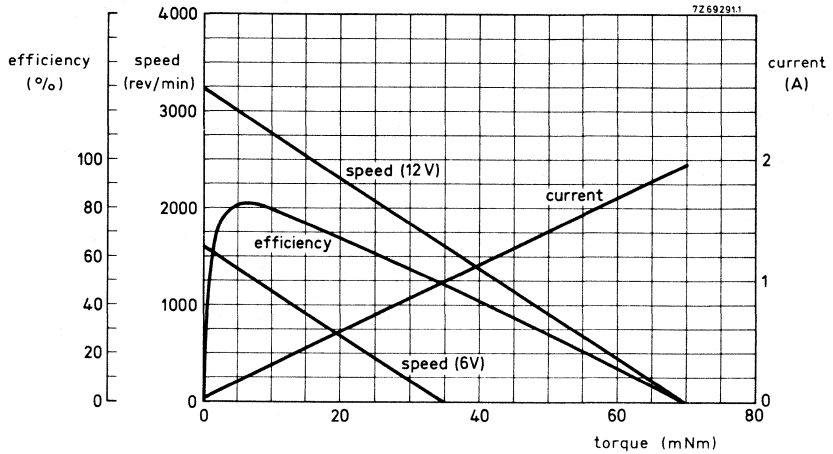


Fig. 2 Typical curves of motor 4322 010 75110 at 12 V and 6 V,  $T_{amb} = 20\text{ }^{\circ}\text{C}$ .

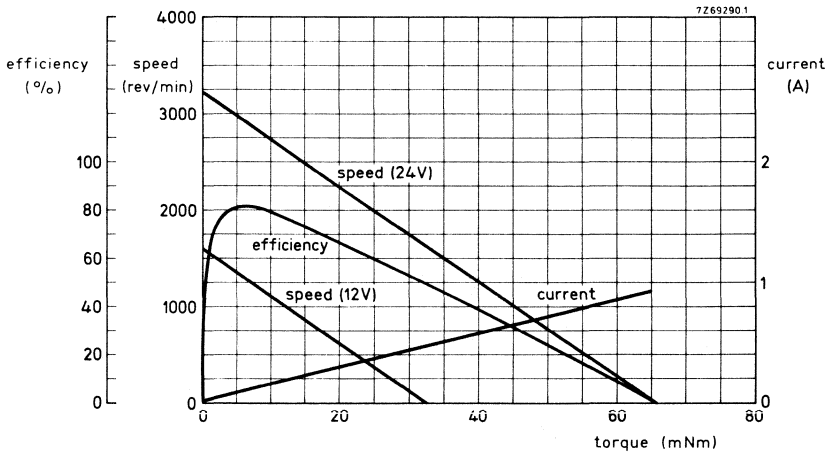


Fig. 3 Typical curves of motor 4322 010 75060 at 24 V and 12 V,  $T_{amb} = 20\text{ }^{\circ}\text{C}$ .

## DIRECT CURRENT MOTORS

ironless rotor type

### QUICK REFERENCE DATA

---

Nominal voltage (d.c.)	
motor 4322 010 75130	15 V
motor 4322 010 75300	30 V
Nominal speed	3000 rev/min
Nominal torque	22 mNm

---

### APPLICATION

These motors have been designed for heavy duty applications which require high acceleration and many start/stops. There is no magnetic holding torque thus the motors are extremely smooth running.

Examples:

- digital cassette and cartridge recorders;
- printers (head drive, head positioner, paper drive etc.);
- recording measuring instruments.

### DESCRIPTION

The motors owe their special characteristics to the following design:

- ironless rotor with oblique winding;
- the low moment of inertia and the high starting torque yield a time constant of no more than 22 ms;
- the robust commutator/brush construction (silver-palladium-plated commutator with 9 segments and silver-plated brushes) and the built-in interference suppression system make the motor suitable for heavy duty applications;
- the commutator/brush construction together with the sintered slide bearings with extra oil reservoirs, ensure a long life, smooth running and a low audible and electrical noise level.

Motor 4322 010 75130 has a spindle at both sides.

TECHNICAL DATA

Outlines

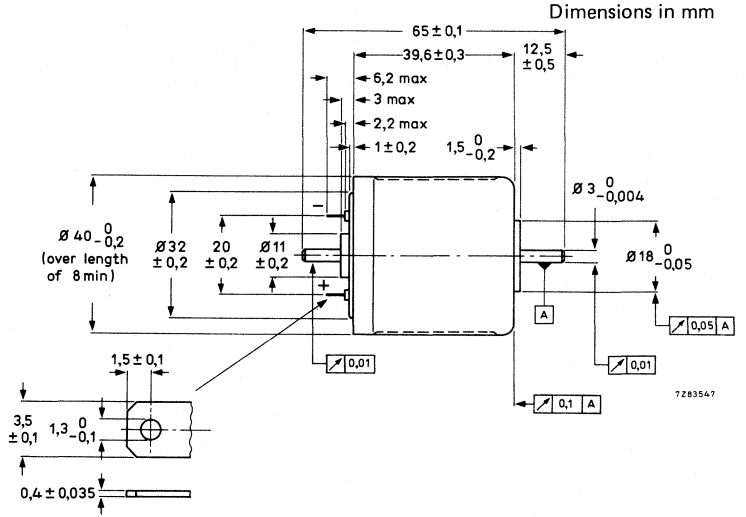
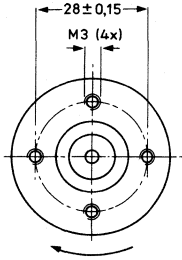


Fig. 1 Type 4322 010 75130.

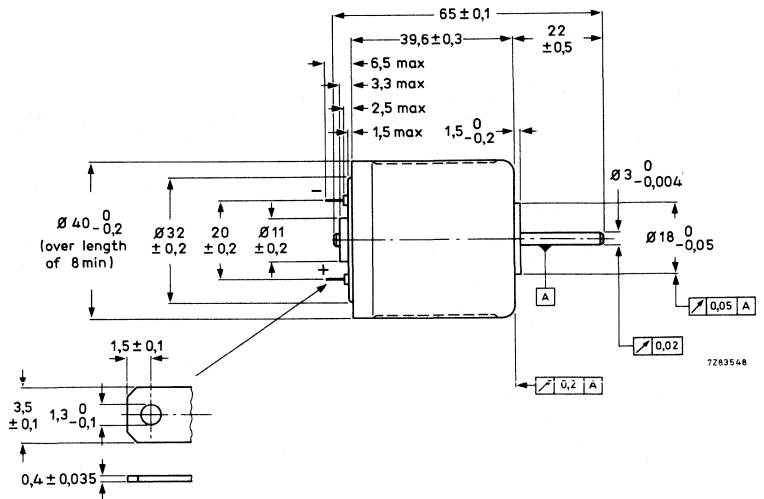
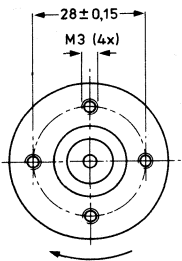


Fig. 2 Type 4322 010 75300.

The direction of rotation is given in connection with the polarity.

Mass approximately 200 g.

**Mounting**

The motor is front mounted by means of four M3 screws. Permissible depth of screw insertion maximum 3 mm. Maximum permissible torque 0,6 Nm.

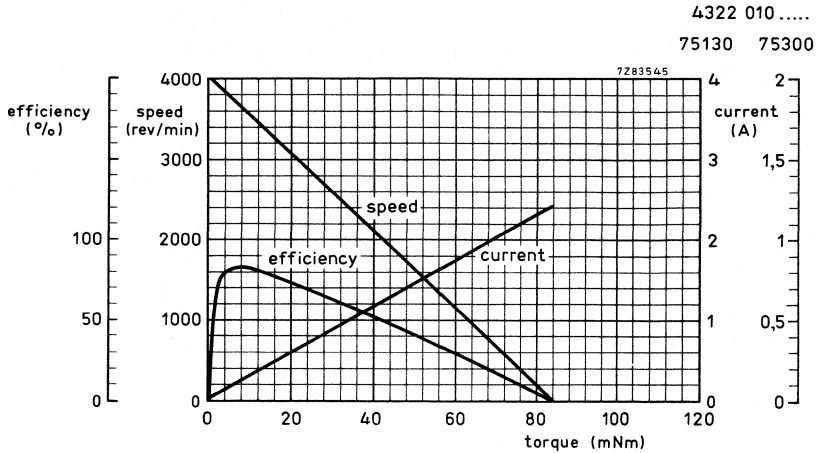


Fig. 3 Typical curves at 15 V (4322 010 75130) and 30 V (4322 010 75300),  $T_{amb} = 22\text{ }^{\circ}\text{C}$ .

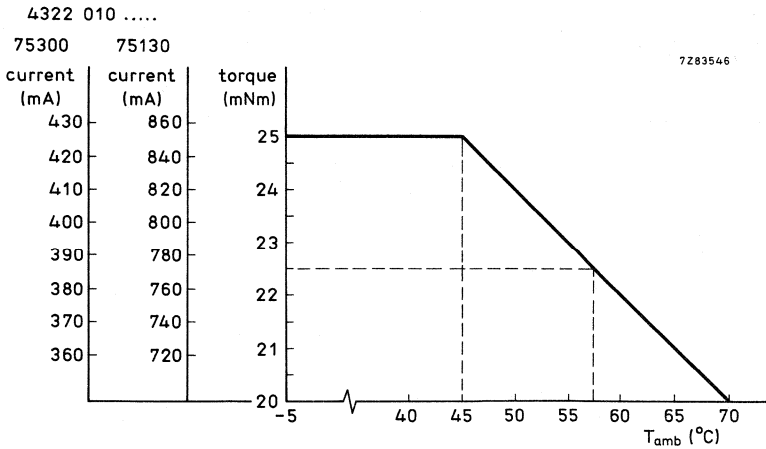


Fig. 4 Maximum permissible torque and current versus ambient temperature, motor mounted on a heatsink.

The values given below apply to an ambient temperature of  $+ 22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

	4322 010 75130	4322 010 75300	
Nominal voltage (d.c.)	15	30	V
Nominal torque	22	22	mNm
Speed	see Fig. 3	see Fig. 3	
Bearings	slide	slide	
Direction of rotation	reversible	reversible	
Climatic category (IEC 68)	05/060/21	05/060/21	
E.M.F. at 3000 rev/min	9,5 to 12,5	19 to 25	V
Rotor resistance	$6,2 \pm 10\%$	$24,5 \pm 10\%$	$\Omega$
Current at nominal voltage			
at nominal torque	565-770	280-385	mA
at no load	max. 40	max. 20	mA
at a radial force of 5 N at 10 mm from mounting plane	max. 156	max. 78	mA
Insulation between terminals and housing	min. 2	min. 2	M $\Omega$
Test voltage (50 Hz) between terminals and housing, for 1 minute	250	250	V
Torque constant	e.m.f./100 $\pi$	e.m.f./100 $\pi$	Nm/A
Starting torque at nominal voltage	min. 65	min. 65	mNm
Rotor inductance	0,8	3,3	mH
Rotor moment of inertia	$4,33 \times 10^{-6}$	$4,33 \times 10^{-6}$	kg m <sup>2</sup>
Mechanical time constant	22	22	ms
Radio interference	see section General		
Ambient temperature range			
operating	-5 to + 60	-5 to + 60	°C
storage	-40 to + 70	-40 to + 70	°C
Temperature coefficient of rotor resistance	0,4	0,4	%/K
e.m.f.	-0,02	-0,02	%/K

**Limiting conditions**

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

	4322 010 75130	4322 010 75300	
Voltage	18	36	V
Torque	see Fig. 4	see Fig. 4	
Current	see Fig. 4	see Fig. 4	
Repetitive peak current, 10 ms, 1 Hz	2500	1250	mA
Speed	4000	4000	rev/min
Output power	8,5	8,5	W
Continuous blocking, mounted on heatsink of 150 x 150 x 3 mm permitted at	6,7	13,4	V
Radial force	7	7	N
Axial force	0,5	0,5	N





## DIRECT CURRENT MOTOR with frequency tachogenerator

### QUICK REFERENCE DATA

Motor		Tachogenerator	
Nominal voltage (d.c.)	24 V	Number of pole pairs	72
Nominal speed	2800 rev/min	Generated voltage at 3000 rev/min	≥ 650 mV
Nominal torque	10 mNm	Frequency wobble at 3150 Hz	≤ 0,11 %

### APPLICATION

This motor-tachogenerator combination has been designed for applications which require a direct current drive system the speed of which can be controlled in a very accurate and reliable way, and where high acceleration, high efficiency and smooth running are preferred.

Examples:

- hi-fi reel-to-reel recorders (capstan drive);
- video recorders (capstan, reel and drum drive);
- digital cassette and cartridge recorders;
- card readers;
- recording measuring instruments.

### DESCRIPTION

The motor has an ironless rotor with oblique winding. The low moment of inertia ( $41 \text{ gcm}^2$ ) and the high starting torque (69 mNm) yield a time constant of no more than 20 ms.

A gold-plated commutator with 9 segments and three-piece silver-plated brushes ensure optimum commutation, thus making the motor suitable for accurate electronic control and optimum functioning as a servo motor or tachogenerator. The powerful cylindrical steel permanent magnet, around which the rotor rotates, makes for high efficiency. The commutator/brush construction together with the sintered slide bearings ensures a long life, smooth running and low noise level.

The frequency tachogenerator has a gearwheel rotor (72 teeth) which is mounted on the protruding spindle of the motor. The stator consists of a deep drawn steel housing, a magnet strip of plastic-bonded ceramic material which has been magnetized with 72 pole pairs and a coil. The alternating flux, which arises by rotation of the gearwheel in the magnetic field, is enclosed by the coil in which the tachogenerator voltage is generated. The frequency of this tachogenerator voltage is determined by the speed of the motor and the number of pole pairs of the tachogenerator.

**TECHNICAL DATA**

Outlines

Dimensions in mm

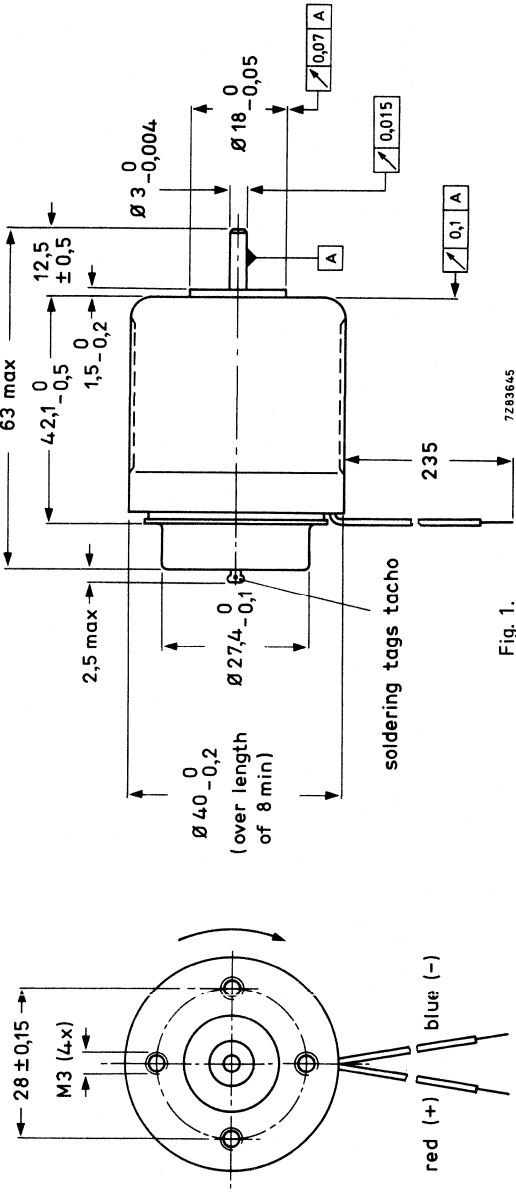


Fig. 1.

The direction of rotation is given in connection with the polarity (clockwise in Fig. 1). Axial play is  $0,2 + 0,4$  mm. Position of leads/soldering tags and fixing holes is arbitrary.

The motor is available with other spindle lengths.

Mass approximately 223 g

**Mounting**

The motor is front mounted by means of four M3 screws. Permissible depth of screw insertion maximum 3 mm. Maximum permissible torque 0,6 Nm.

The values given below apply to an ambient temperature of  $+22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

Nominal voltage (d.c.)	24 V
Nominal torque	10 mNm
Speed	see Fig. 2
Bearings	slide
Direction of rotation	reversible
Climatic category (IEC 68)	10/060/21
E.M.F. at 3000 rev/min	19 to 25 V
Rotor resistance	$24,5 \Omega \pm 10\%$
Current at nominal voltage	
at nominal torque	max. 180 mA
at no load	max. 14,5 mA
at a radial force of 5 N at 8 mm from mounting plane	max. 68 mA
Insulation between terminals and housing	min. 2 M $\Omega$
Test voltage (50 Hz) between terminals and housing, for 1 minute	250 V
Torque constant	e.m.f./ $100\pi$ Nm/A
Starting torque at nominal voltage	69 mNm
Rotor inductance	3,3 mH
Rotor moment of inertia	41 gcm <sup>2</sup>
Mechanical time constant	20 ms
Audio interference	see Fig. 5
Ambient temperature range	
operating	-10 to +60 °C
storage	-40 to +70 °C
Temperature coefficient of rotor resistance	0,4 %/K
e.m.f.	-0,02 %/K

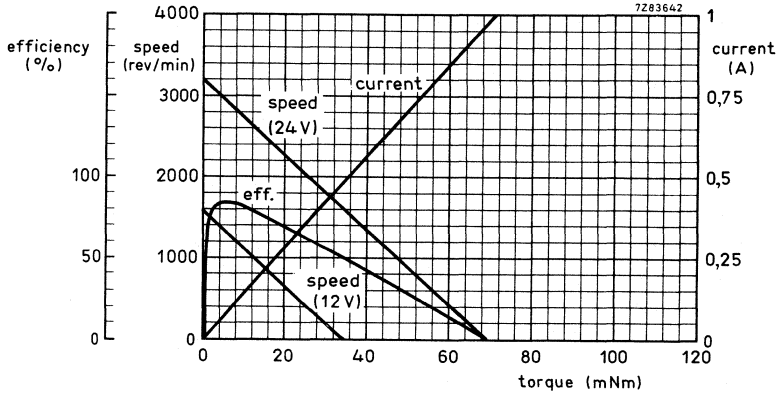


Fig. 2 Typical curves at 24 V,  $T_{amb} = 22\text{ }^{\circ}\text{C}$ .

#### Limiting conditions

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

Voltage	30 V
Torque	20 mNm
Current	275 mA
Repetitive peak current	1200 mA, 10 ms, 1 Hz
Speed	4000 rev/min
Output power	5 W
Continuous blocking permitted at	10,5 V
Radial force 8 mm from mounting plane	5 N
Axial force	
pressing	0,5 N
pulling	0,5 N

**Tachogenerator**

Number of pole pairs	72
Generated voltage (r.m.s.) at 3000 rev/min	min. 650 mV, see also Fig. 4
Amplitude variation for 1 revolution ( $E_{l.f.}/E_p \times 100\%$ ) (see Fig. 3)	max. 15%
Frequency	$72n/60$ Hz ( $n$ = number of rev/min)
Frequency wobble at 3150 Hz	max. 0,11%
Resistance	775 $\Omega$
Inductance	0,5 H

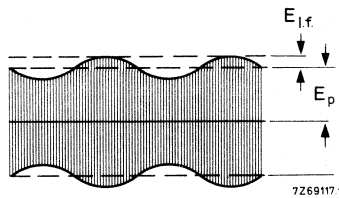


Fig. 3.

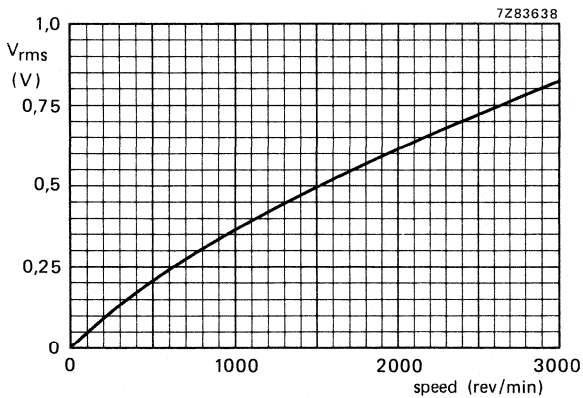


Fig. 4 Tachogenerator voltage as a function of the speed.

\* Measured with EMT measuring instrument type 424 (position "linear") or equivalent. For additional information see section "General".

**AUDIO INTERFERENCE**

**Measuring procedure**

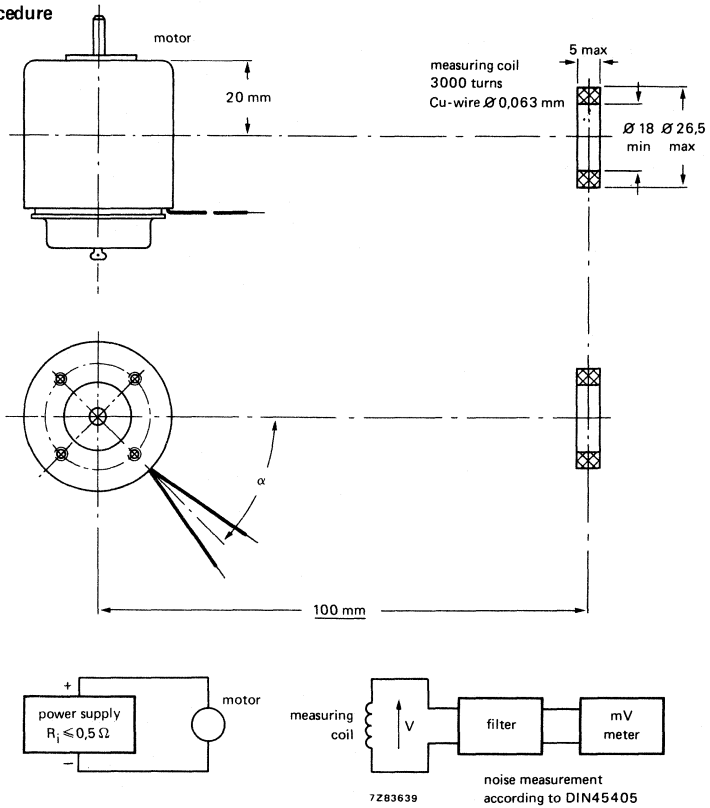


Fig. 5.

Motor voltage 24 V

Preferred direction of rotation (positive voltage to + terminal)

Torque 10 mNm

$\alpha$  is varied until maximum voltage is obtained

→  $V_{p-p} = \text{max. } 8 \times 2\sqrt{2} \text{ mV}$

**CATALOGUE NUMBERS**

4322 01 . 75140

- 0 stamped on motor, **not to be used** for ordering
- 3 for bulk packing, to be used for ordering\*

\* Minimum packing quantity 170 items per cardboard box.

## DIRECT CURRENT MOTOR

ironless rotor type

### QUICK REFERENCE DATA

---

Nominal voltage (d.c.)	24 V
Nominal speed	2800 rev/min
Nominal torque	10 mNm

---

### APPLICATION

These motors have been designed for applications which require low noise level, smooth running and accurate speed control by an electronic speed control unit.

Examples:

- hi-fi-cassette recorders
- video cassette recorders
- digital cassette and cartridge recorders
- recording measuring instruments
- telephone answering equipment
- dictating machines
- echo sounders
- printers

### DESCRIPTION

The motors have an ironless rotor with oblique windings. The low moment of inertia and the high starting torque yield a mechanical time constant of no more than 20 ms.

A commutator with 9 segments and four-finger brushes ensure optimum commutation by applying a good combination of precious metals, thus making the motor suitable for accurate electronic control and optimum functioning as a servo motor or tachogenerator. The powerful cylindrical steel permanent magnet, around which the rotor rotates, makes for high efficiency.

The above mentioned commutator/brush construction together with the ball bearings ensures a long life, smooth running and low noise level, even under severe climatic conditions and high radial load.

**TECHNICAL DATA**

**Outlines**

Dimensions in mm

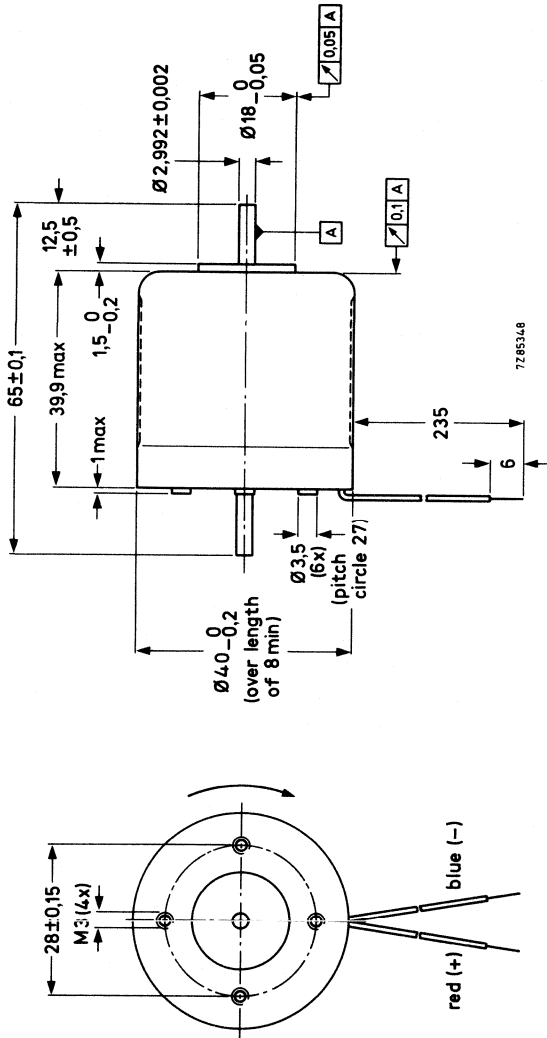


Fig. 1.

The direction of rotation is given in connection with the polarity (clockwise in Fig. 1); Position of leads and fixing holes is arbitrary. The motor is available with other spindle lengths.

**Mass** approximately 205 g

**Mounting**

The motor is front mounted by means of four M3 screws. Permissible depth of screw insertion maximum 3 mm. Maximum permissible torque 0,6 Nm.



The values given below apply to an ambient temperature of  $+22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

Nominal voltage (d.c.)	24 V
Nominal torque	10 mNm
Speed	see Fig. 2
Bearings	ball
Direction of rotation	reversible
Climatic category (IEC 68)	10/060/21
E.M.F. at 3000 rev/min	19 to 25 V
Rotor resistance	$24,5 \Omega \pm 10\%$
Current at nominal voltage	
at nominal torque	125-181 mA
at no load	max. 13 mA
at a radial force of 5 N at 8 mm from mounting plane	max. 50 mA
Insulation between terminals and housing	min. 2 M $\Omega$
Test voltage (50 Hz) between terminals and housing, for 1 minute	250 V
Torque constant	e.m.f./ $100\pi$ Nm/A
Starting torque at nominal voltage	68 mNm
Rotor inductance	3,3 mH
Rotor moment of inertia	39,2 gcm <sup>2</sup>
Mechanical time constant	20 ms
Audio interference	see Fig. 5
Ambient temperature range	
operating	-10 to + 60 °C
storage	-40 to + 70 °C
Temperature coefficient of rotor resistance	0,4%/K
e.m.f.	-0,02%/K

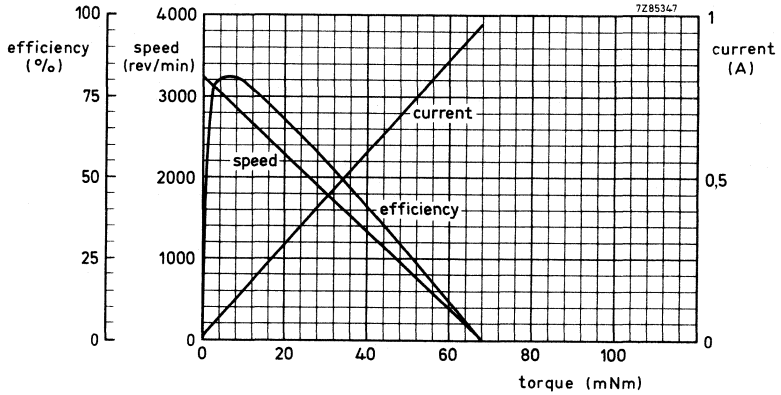


Fig. 2 Typical curves at 24 V,  $T_{amb} = 22\text{ }^{\circ}\text{C}$ .

#### Limiting conditions

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

Voltage	30 V
Torque	20 mNm
Current	275 mA
Repetitive peak current	1200 mA, 10 ms, 1 Hz
Speed	4000 rev/min
Output power	5 W
Continuous blocking permitted at	10,5 V
Radial force 8 mm from mounting plane	10 N
Axial force	
pressing	5 N
pulling	5 N

**AUDIO INTERFERENCE**

**Measuring procedure**

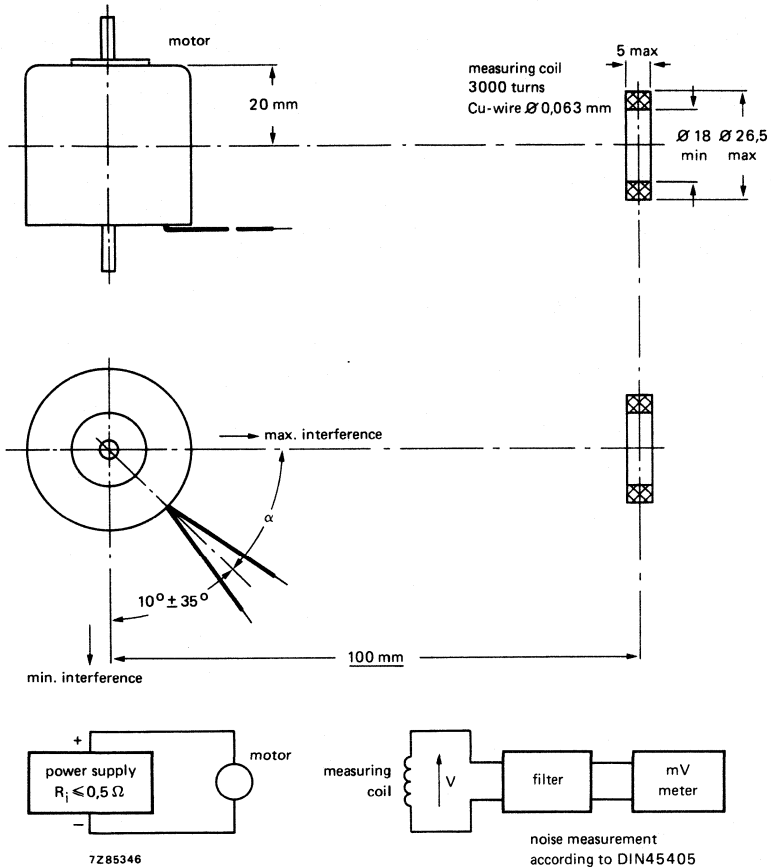


Fig. 3.

Motor speed 3000 rev/min

Preferred direction of rotation (positive voltage to + terminal)

Torque 10 mNm

$\alpha$  is varied until maximum voltage is obtained

$V_{p-p} = \text{max. } 7,0 \times 2\sqrt{2} \text{ mV}$

**CATALOGUE NUMBERS**

4322 01. 75180

- 0 stamped on motor, not to be used for ordering
- 3 for bulk packing, to be used for ordering\*

\* Minimum packing quantity 170 items per cardboard box.



## DIRECT CURRENT MOTOR

ironless rotor type

### QUICK REFERENCE DATA

---

Nominal voltage (d.c.)	24 V
Nominal speed	2800 rev/min
Nominal torque	10 mNm

---

### APPLICATION

This motor has been designed for applications which require high acceleration, high efficiency and smooth running (no magnetic holding torque).

Examples:

- hi-fi reel-to-reel recorders (capstan and reel drive)
- hi-fi cassette recorders (reel drive)
- video recorders (capstan, reel and drum drive)
- digital cassette and cartridge recorders
- card readers
- printers (paper transport and head positioner)
- recording measuring instruments

### DESCRIPTION

The motor owes its special characteristics to the following design:

- ironless rotor with oblique winding;
- the low moment of inertia and the high starting torque yield a time constant of no more than 20 ms;
- a precious-metal-plated commutator with 9 segments and three-piece silver-plated brushes ensure optimum commutation, thus making the motor suitable for accurate electronic control and optimum functioning as a servo motor or tachogenerator;
- the powerful cylindrical steel permanent magnet, around which the rotor rotates, makes for high efficiency;
- the above-mentioned commutator/brush construction together with the sintered slide bearings ensures a long life, smooth running and low noise level.

TECHNICAL DATA

Outlines

Dimensions in mm

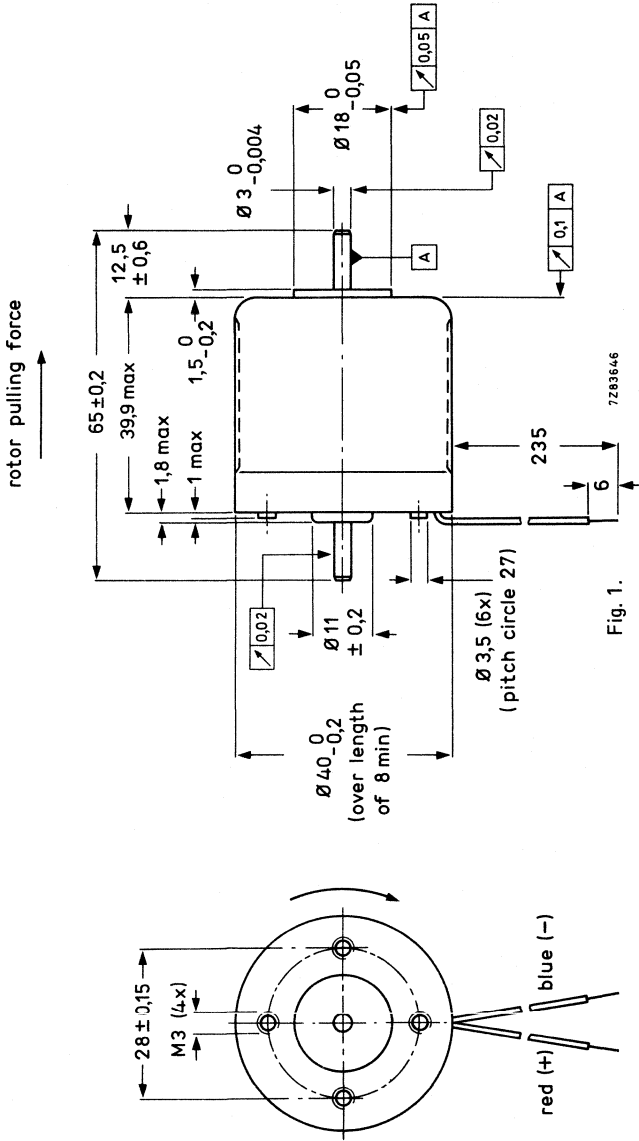


Fig. 1.

The direction of rotation is given in connection with the polarity (clockwise in Fig. 1). Axial play is 0,2 + 0,4 mm. Position of leads and fixing holes is arbitrary.

The motor is available with other spindle lengths.

Mass 205 g approximately.

Mounting

The motor is front mounted by means of four M3 screws. Permissible depth of screw insertion maximum 3 mm. Maximum permissible torque 0,6 Nm.

The values given below apply to an ambient temperature of  $+22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

Nominal voltage (d.c.)	24 V
Nominal torque	10 mNm
Speed	see Fig. 2
Bearings	slide
Direction of rotation	reversible
Climatic category (IEC 68)	10/060/21
E.M.F. at 3000 rev/min	19 – 21,4 V
Rotor resistance	24,5 $\Omega \pm 10\%$
Current at nominal voltage	
at nominal torque	150 – 185 mA
at no load	max. 21 mA
at a radial force of 5 N at 8 mm from mounting plane	max. 80 mA
Insulation between terminals and housing	min. 2 M $\Omega$
Test voltage (50 Hz) between terminals and housing, for 1 minute	250 V
Torque constant	e.m.f./100 $\pi$ Nm/A
Starting torque at nominal voltage	61 mNm
Rotor inductance	3,3 mH
Rotor moment of inertia	39,2 gcm <sup>2</sup>
Mechanical time constant	20 ms
Ambient temperature range	
operating	-10 to +60 °C
storage	-40 to +70 °C
Temperature coefficient of rotor resistance	0,4%/K
e.m.f.	-0,02%/K

**Limiting conditions**

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

Voltage	30 V
Torque	20 mNm
Current	275 mA
Repetitive peak current	1200 mA, 10 ms, 1 Hz
Speed	4000 rev/min
Output power	5 W
Continuous blocking permitted at	10 V
Radial force 8 mm from mounting plane	7 N
Axial force	0,4 N

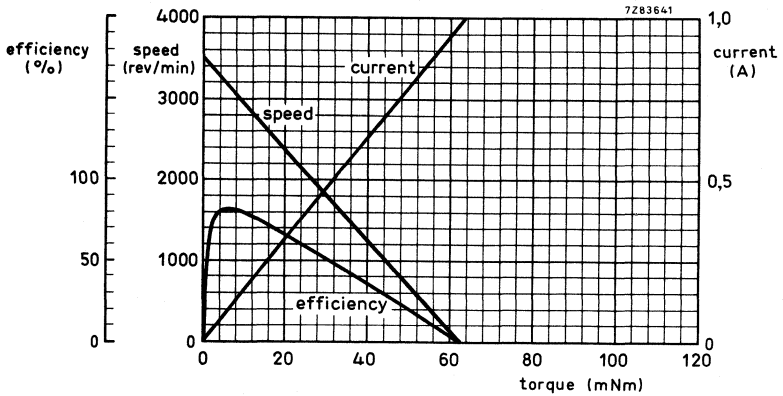


Fig. 2 Typical curves at 24 V,  $T_{amb} = 22 \text{ }^{\circ}\text{C}$ .

**CATALOGUE NUMBERS**

**4322 01. 75210**

- 0 stamped on motor, **not to be used** for ordering
- 3 for bulk packing, to be used for ordering \*

\* Minimum packing quantity 170 items per cardboard box.



## DIRECT CURRENT MOTOR

ironless rotor type

### QUICK REFERENCE DATA

---

Nominal voltage (d.c.)	12 V
Nominal speed	3200 rev/min
Nominal torque	5 mNm

---

### APPLICATION

These motors have been designed for applications which require low noise level, smooth running and accurate speed control by an electronic speed control unit.

Examples:

- hi-fi cassette recorders
- video cassette recorders
- digital cassette and cartridge recorders
- recording measuring instruments
- telephone answering equipment
- dictating machines
- echo sounders
- printers

### DESCRIPTION

The motors have an ironless rotor with oblique windings. The low moment of inertia and the high starting torque yield a mechanical time constant of no more than 12 ms.

A commutator with 9 segments and four-finger brushes ensure optimum commutation by applying a good combination of precious metals, thus making the motor suitable for accurate electronic control and optimum functioning as a servo motor or tachogenerator. The powerful cylindrical steel permanent magnet, around which the rotor rotates, makes for high efficiency.

The above mentioned commutator/brush construction together with the ball bearings ensures a long life, smooth running and low noise level, even under severe climatic conditions.

**TECHNICAL DATA**  
Outlines

Dimensions in mm

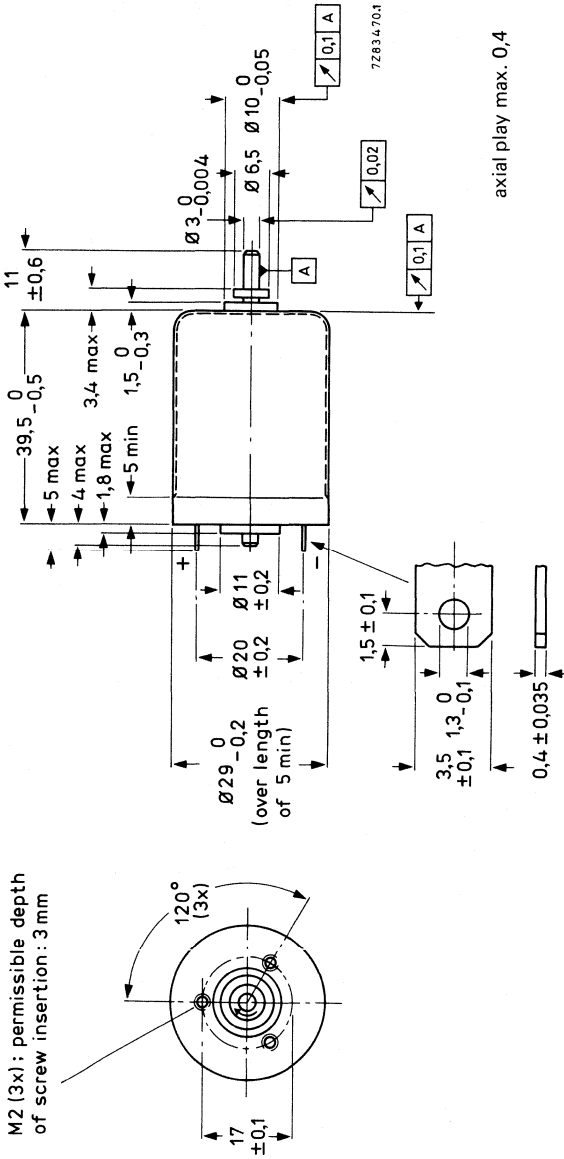


Fig. 1.

The direction of rotation is given in connection with the polarity (clockwise in Fig. 1).

Mass approximately 120 g.

**Mounting**

The motor is front mounted by means of three M2 screws. Permissible depth of screw insertion maximum 3 mm.

The values given below apply to an ambient temperature of  $+22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

Nominal voltage (d.c.)	12 V
Nominal torque	5 mNm
Speed	see Fig. 2
Bearings	ball
Direction of rotation	reversible
Climatic category (IEC 68)	10/060/21
E.M.F. at 3000 rev/min	8,1 – 10,1 V
Rotor resistance	$12 \Omega \pm 10\%$
Current at nominal voltage	
at nominal torque	170 – 230 mA
at no load	max. 50 mA
at a radial force of 3,5 N at 8 mm from mounting plane	max. 70 mA
Insulation between terminals and housing	min. 2 M $\Omega$
Test voltage (50 Hz) between terminals and housing, for 1 minute	250 V
Torque constant	e.m.f./100 $\pi$ Nm/A
Starting torque at nominal voltage	29 mNm
Rotor inductance	1 mH
Rotor moment of inertia	$0,9 \times 10^{-6}$ kgm <sup>2</sup>
Mechanical time constant	12 ms
Audio interference	see Fig. 3
Radio interference	see section General
Ambient temperature range	
operating	–10 to +60 °C
storage	–40 to +70 °C
Temperature coefficient of rotor resistance	0,4 %/K
e.m.f.	–0,02 %/K

**Limiting conditions**

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

Voltage	15 V
Torque	8 mNm
Current	325 mA
Repetitive peak current	1100 mA, 10 ms, 1 Hz
Speed	6000 rev/min
Output power	3 W
Continuous blocking permitted at	6,5 V
Radial force 8 mm from mounting plane	10 N
Axial force	5 N

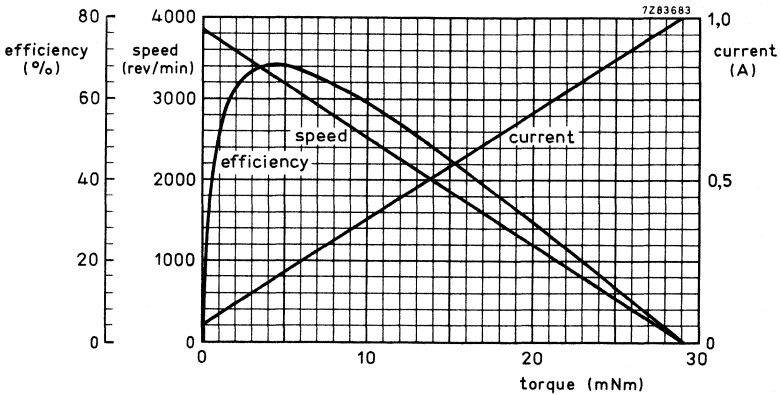


Fig. 2 Typical curves at 12 V,  $T_{amb} = 22\text{ }^{\circ}\text{C}$ .

**AUDIO INTERFERENCE**

**Measuring procedure**

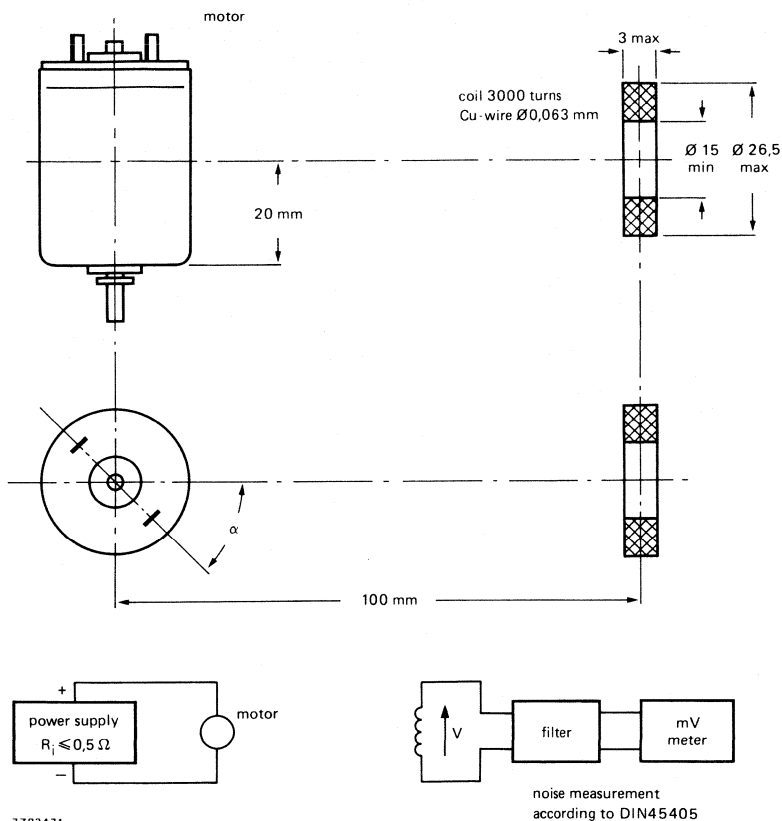


Fig. 3.

Motor speed 3000 rev/min.

Preferred direction of rotation (positive voltage to + terminal).

Current 190 mA.

$\alpha$  is varied until maximum voltage is obtained.

$V_{p-p} = \text{max. } 4,4 \times 2\sqrt{2}$  mV.

**CATALOGUE NUMBERS**

4322 01. 76000

- \_\_\_\_\_ 0 stamped on motor, **not to be used** for ordering
- \_\_\_\_\_ 3 for bulk packing, to be used for ordering \*

\* Minimum packing quantity 170 items per cardboard box.



## DIRECT CURRENT MOTORS

ironless rotor type

### QUICK REFERENCE DATA

---

Nominal voltage (d.c.)	
motor 4322 010 76050	12 V
motor 4322 010 76150	24 V
Nominal speed	3000 rev/min
Nominal torque	5 mNm

---

### APPLICATION

These motors have been designed for applications which require low noise level, smooth running and accurate speed control by an electronic speed control unit.

Examples:

- hi-fi cassette recorders
- video cassette recorders
- digital cassette and cartridge recorders
- recording measuring instruments
- telephone answering equipment
- dictating machines
- echo sounders
- printers

### DESCRIPTION

The motors have an ironless rotor with oblique windings. The low moment of inertia and the high starting torque yield a mechanical time constant of no more than 11 ms.

A commutator with 9 segments and four-finger brushes ensure optimum commutation by applying a good combination of precious metals, thus making the motor suitable for accurate electronic control and optimum functioning as a servo motor or tachogenerator. The powerful cylindrical steel permanent magnet, around which the rotor rotates, makes for high efficiency.

The above mentioned commutator/brush construction together with the sintered slide bearings ensures a long life, smooth running and low noise level, even under severe climatic conditions.

Dimensions in mm

**TECHNICAL DATA**  
Outlines

M2 (3x) : permissible depth  
of screw insertion : 3 mm

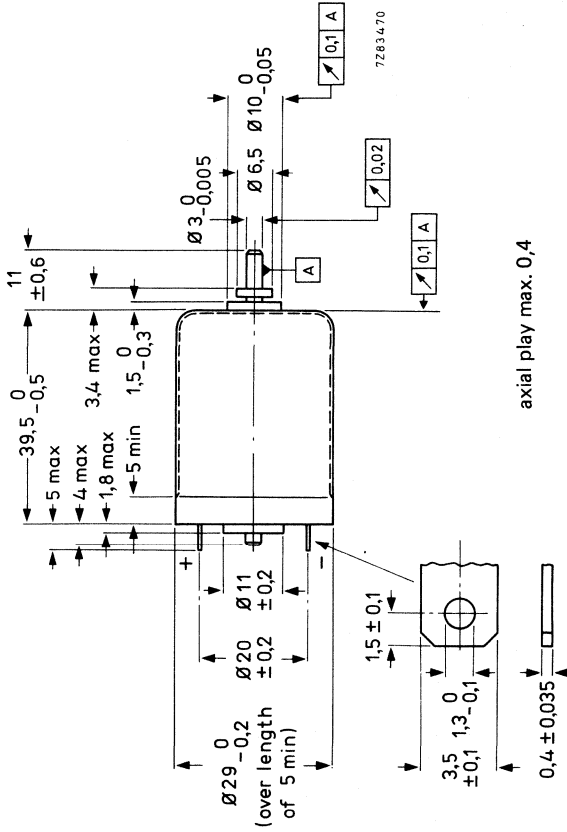
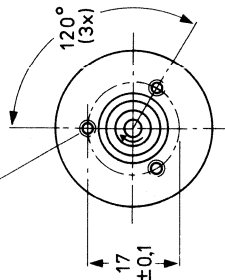


Fig. 1.

The direction of rotation is given in connection with the polarity (clockwise in Fig. 1). The motors can be made available with other spindle lengths.

Mass approximately 120 g.

**Mounting**

The motor is front mounted by means of three M2 screws. Permissible depth of screw insertion maximum 3 mm.



The values given below apply to an ambient temperature of  $22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

	4322 010 76050	4322 010 76150	
Nominal voltage (d.c.)	12	24	V
Nominal torque	5	5	mNm
Speed	see Fig. 2	see Fig. 2	
Bearings	slide	slide	
Direction of rotation	reversible	reversible	
Climatic category (IEC 68)	10/060/21	10/060/21	
E.M.F. at 3000 rev/min	8,4-10,8	16,8-21,6	V
Rotor resistance	$12 \pm 10\%$	$47 \pm 10\%$	$\Omega$
Current at nominal voltage			
at nominal torque	164-238	82-119	mA
at no load	max. 56	max. 28	mA
at a radial force of 3,5 N at 8 mm from mounting plane	max. 110	max. 55	mA
Insulation between terminals and housing	min. 2	min. 2	M $\Omega$
Test voltage (50 Hz) between terminals and housing, for 1 minute	250	250	V
Torque constant	e.m.f./100 $\pi$	e.m.f./100 $\pi$	Nm/A
Starting torque at nominal voltage	30	30	mNm
Rotor inductance	1	4,1	mH
Rotor moment of inertia	$0,9 \times 10^{-6}$	$0,9 \times 10^{-6}$	kg m <sup>2</sup>
Mechanical time constant	11,0	11,0	ms
Audio interference	see Fig. 3	see Fig. 3	
Radio interference	see section General		
Ambient temperature range			
operating	-10 to +60	-10 to +60	°C
storage	-40 to +70	-40 to +70	°C
Temperature coefficient of rotor resistance	0,4	0,4	%/K
E.M.F.	-0,02	-0,02	%/K

**Limiting conditions**

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

	4322 010 76050	4322 010 76150	
Voltage	15	30	V
Torque	8	8	mNm
Current	325	162	mA
Repetitive peak current, 10 ms, 1 Hz	1100	550	mA
Speed	6000	6000	rev/min
Output power	3	3	W
Continuous blocking permitted at	6,2	12,5	V
Radial force	5	5	N
Axial force	0,5	0,5	N

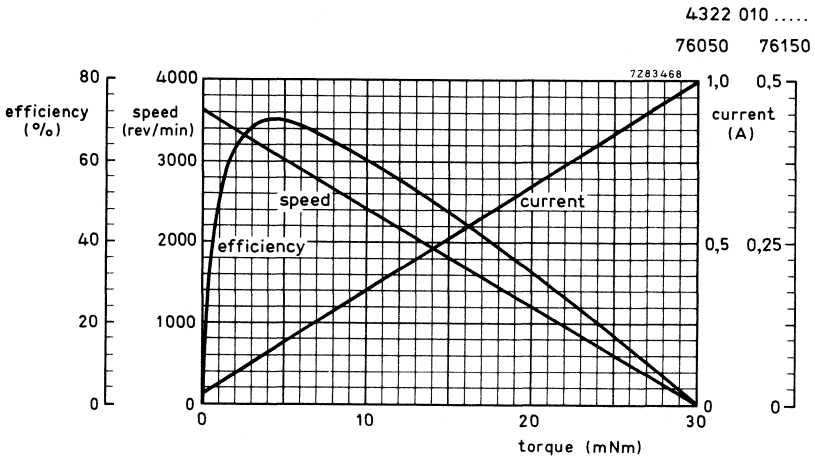


Fig. 2 Typical curves at 12 V (4322 010 76050) and 24 V (4322 010 76150),  $T_{amb} = 22\text{ }^{\circ}\text{C}$ .

**AUDIO INTERFERENCE**

**Measuring procedure**

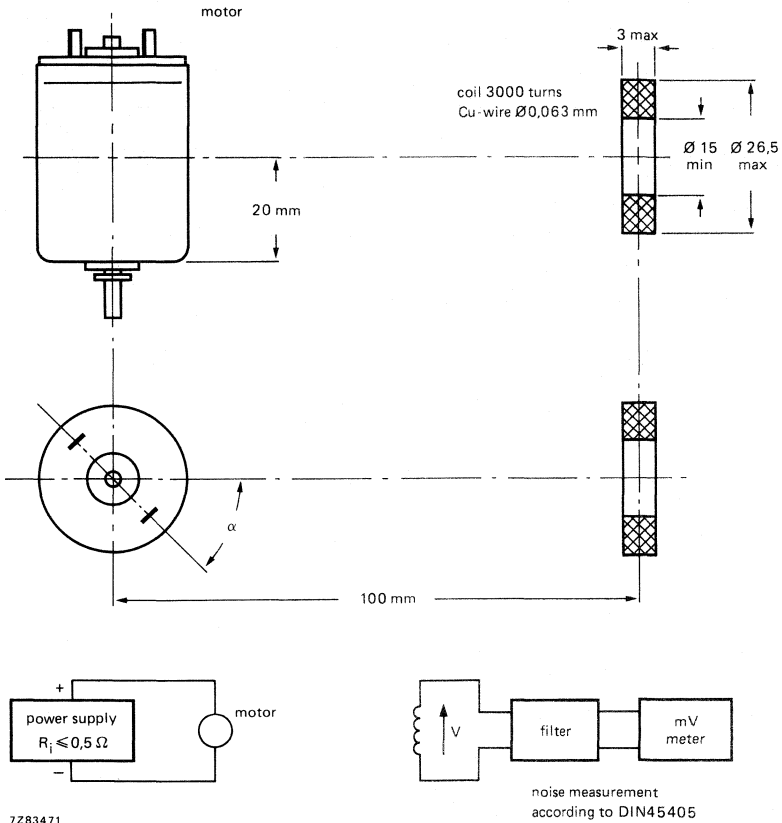


Fig. 3.

Motor speed 3000 rev/min.

Preferred direction of rotation (positive voltage to + terminal).

Current 195 mA (4322 010 76050) or 97 mA (4322 010 76150).

$\alpha$  is varied until maximum voltage is obtained.

$V_{p-p} = \text{max. } 4,4 \times 2\sqrt{2} \text{ mV.}$

**CATALOGUE NUMBERS**

12 V motor: 4322 01. 76050

24 V motor: 4322 01. 76150

- 0 stamped on motor, not to be used for ordering
- 3 for bulk packing, to be used for ordering\*

\* Minimum packing quantity 170 items per cardboard box.





## DIRECT CURRENT MOTOR

ironless rotor type

### QUICK REFERENCE DATA

---

Nominal voltage (d.c.)	
motor 4322 010 76060	12 V
motor 4322 010 76080	24 V
Nominal speed	3900 rev/min
Nominal torque	5 mNm

---

### APPLICATION

These motors have been designed for applications which require low noise level, smooth running and accurate speed control by an electronic speed control unit.

Examples:

- hi-fi cassette recorders
- video cassette recorders
- digital cassette and cartridge recorders
- recording measuring instruments
- telephone answering equipment
- dictating machines
- echo sounders
- printers

### DESCRIPTION

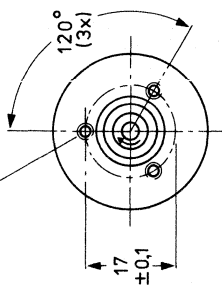
The motors have an ironless rotor with oblique windings. The low moment of inertia and the high starting torque yield a mechanical time constant of no more than 22 ms.

A commutator with 9 segments and four-finger brushes ensure optimum commutation by applying a good combination of precious metals, thus making the motor suitable for accurate electronic control and optimum functioning as a servo motor or tachogenerator. The powerful cylindrical steel permanent magnet, around which the rotor rotates, makes for high efficiency.

The above mentioned commutator/brush construction together with the sintered slide bearings ensures a long life, smooth running and low noise level, even under severe climatic conditions.

**TECHNICAL DATA**  
**Outlines**

M2 (3x) : permissible depth  
of screw insertion : 3 mm



Dimensions in mm

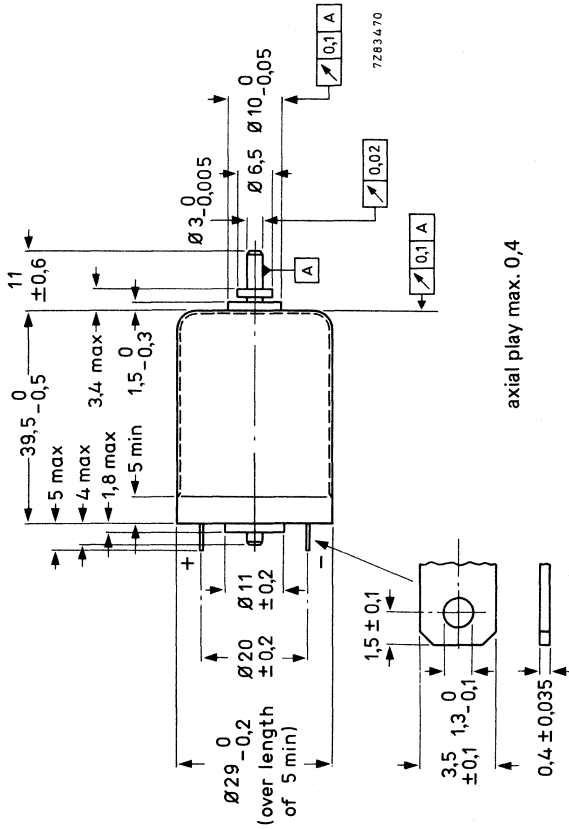


Fig. 1.

The direction of rotation is given in connection with the polarity (clockwise in Fig. 1).

Mass approximately 120 g.

**Mounting**

The motor is front mounted by means of three M2 screws. Permissible depth of screw insertion maximum 3 mm.

The values given below apply to an ambient temperature of  $22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

	4322 010 76060	4322 010 76080	
Nominal voltage (d.c.)	12	24	V
Nominal torque	5	5	mNm
Speed	see Fig. 2	see Fig. 2	
Bearings	slide	slide	
Direction of rotation	reversible	reversible	
Climatic category (IEC 68)	10/060/21	10/060/21	
E.M.F. at 3000 rev/min	6,0-7,85	12,0-15,7	V
Rotor resistance	$12 \pm 10\%$	$47 \pm 10\%$	$\Omega$
Current at nominal voltage			
at nominal torque	222-326	111-163	mA
at no load	max. 74	max. 37	mA
at a radial force of 3,5 N at 8 mm from mounting plane	max. 138	max. 72	mA
Insulation between terminals and housing	min. 2	min. 2	M $\Omega$
Test voltage (50 Hz) between terminals and housing, for 1 minute	250	250	V
Torque constant	e.m.f./100 $\pi$	e.m.f./100 $\pi$	Nm/A
Starting torque at nominal voltage	22	22	mNm
Rotor inductance	1	4,1	mH
Rotor moment of inertia	$0,9 \times 10^{-6}$	$0,9 \times 10^{-6}$	kg m <sup>2</sup>
Mechanical time constant	22	22	ms
Audio interference	see Fig. 3	see Fig. 3	
Radio interference	see section General		
Ambient temperature range			
operating	-10 to +60	-10 to +60	°C
storage	-40 to +70	-40 to +70	°C
Temperature coefficient of rotor resistance	0,4	0,4	%/K
e.m.f.	-0,02	-0,02	%/K

**Limiting conditions**

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

	4322 010 76060	4322 010 76080	
Voltage	13,5	27	V
Torque	6,5	6,5	mNm
Current	375	190	mA
Repetitive peak current, 10 ms, 1 Hz	1100	570	mA
Speed	6000	6000	rev/min
Output power	2,5	2,5	W
Continuous blocking permitted at	6,2	12,5	V
Radial force	5	5	N
Axial force	0,5	0,5	N

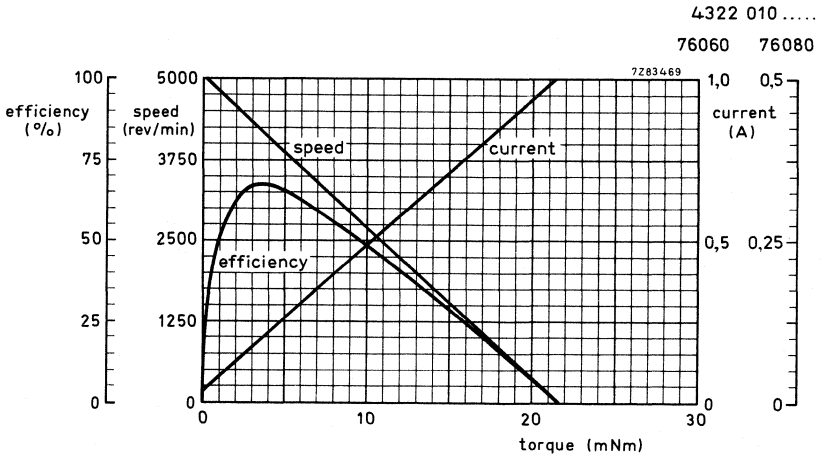
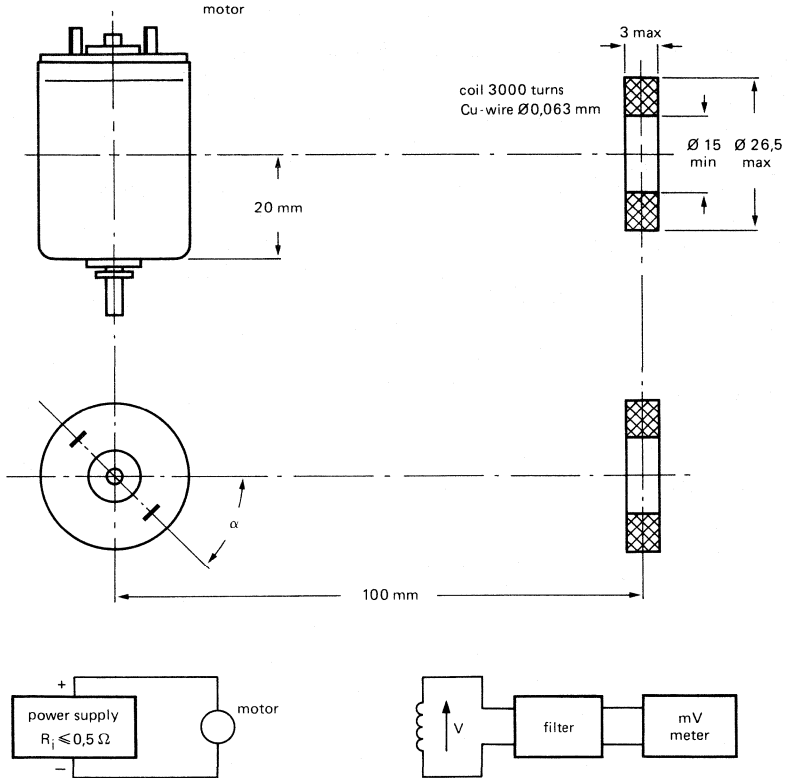


Fig. 2 Typical curves at 12 V (4322 010 76060) and 24 V (4322 010 76080),  $T_{amb} = 22\text{ }^{\circ}\text{C}$ .



**AUDIO INTERFERENCE**

**Measuring procedure**



7283471

**Fig. 3.**

noise measurement according to DIN45405

Motor speed 3900 rev/min.

Preferred direction of rotation (positive voltage to + terminal).

Current 260 mA (4322 010 76060) or 130 mA (4322 010 76080).

$\alpha$  is varied until maximum voltage is obtained.

$$V_{p-p} = \max. 4,2 \times 2\sqrt{2} \text{ mV.}$$

**CATALOGUE NUMBER**

12 V motor: 4322 01. 76060

24 V motor: 4322 01. 76080

- 0 stamped on motor, not to be used for ordering
- 3 for bulk packing, to be used for ordering\*

\* Minimum packing quantity 170 items per cardboard box.



## DIRECT CURRENT MOTOR

ironless rotor type, with frequency tachogenerator

### QUICK REFERENCE DATA

Motor		Tachogenerator	
Nominal voltage (d.c.)	12 V	Number of pole pairs	72
Nominal speed	3000 rev/min	Generated voltage at 3000 rev/min	$\geq 650$ mV
Nominal torque	5 mNm	Frequency wobble at 3150 Hz	$\leq 0,2$ %

### APPLICATION

This motor-tachogenerator combination has been designed for applications which require a direct current drive system the speed of which can be controlled in a very accurate and reliable way, and where high acceleration, high efficiency and smooth running are preferred.

Examples:

- hi-fi reel-to-reel recorders (capstan drive)
- video recorders (capstan, reel and drum drive)
- digital cassette and cartridge recorders
- card readers
- recording measuring instruments

### DESCRIPTION

The motors have an ironless rotor with oblique windings. The low moment of inertia and the high starting torque yield a mechanical time constant of no more than 13 ms.

A commutator with 9 segments and four-finger brushes ensure optimum commutation by applying a good combination of precious metals, thus making the motor suitable for accurate electronic control and optimum functioning as a servo motor. The powerful cylindrical steel permanent magnet, around which the rotor rotates, makes for high efficiency.

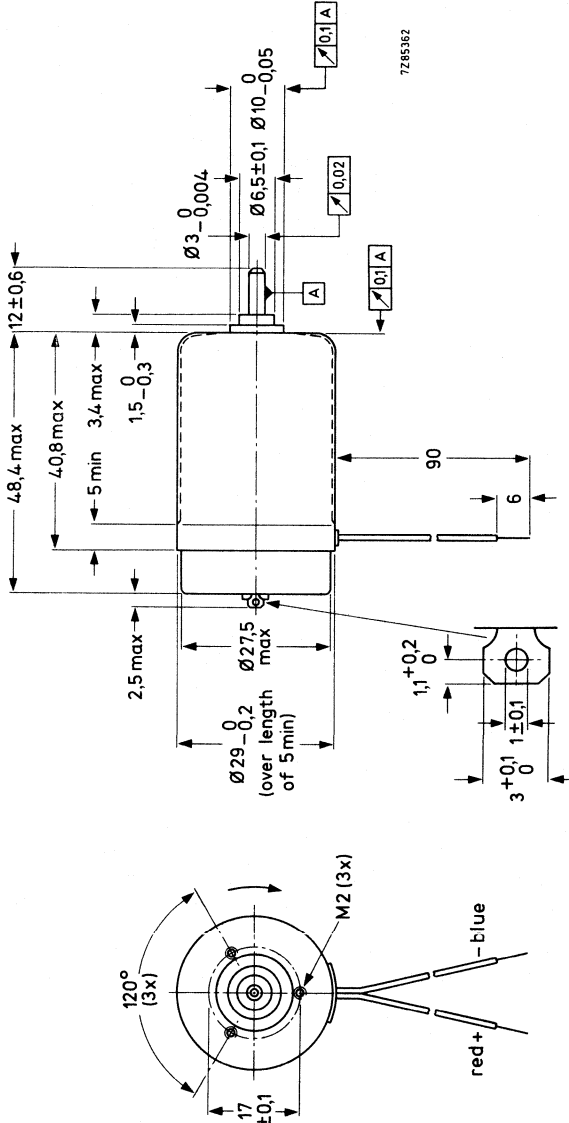
The above mentioned commutator/brush construction together with the sintered slide bearings ensures a long life, smooth running and low noise level, even under severe climatic conditions.

The frequency tachogenerator has a gearwheel rotor (72 teeth) which is mounted on the protruding spindle of the motor. The stator consists of a deep drawn steel housing, a magnet strip of plastic-bonded ceramic material which has been magnetized with 72 pole pairs and a coil. The alternating flux, which arises by rotation of the gearwheel in the magnetic field, is enclosed by the coil in which the tachogenerator voltage is generated. The frequency of this tachogenerator voltage is determined by the speed of the motor and the number of pole pairs of the tachogenerator.

**TECHNICAL DATA**

Outlines

Dimensions in mm



The direction of rotation is given in connection with the polarity (clockwise in Fig. 1). Axial play is 0.2 + 0.3 mm. Position of leads, soldering tags and fixing holes is arbitrary.

The motor is available with other spindle lengths.

**Mass** approximately 140 g

**Mounting**

The motor is front mounted by means of three M2 screws. Permissible depth of screw insertion maximum 3 mm.

The values given below apply to an ambient temperature of  $+22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

Nominal voltage (d.c.)	12 V
Nominal torque	5 mNm
Speed	see Fig. 2
Bearings	slide
Direction of rotation	reversible
Climatic category (IEC 68)	10/060/21
E.M.F. at 3000 rev/min	8,1 – 10,1 V
Rotor resistance	$12 \Omega \pm 10\%$
Current at nominal voltage	
at nominal torque	175 – 250 mA
at no load	max. 58 mA
at a radial force of 5 N at 8 mm from mounting plane	max. 145 mA
Insulation between terminals and housing	min. 2 M $\Omega$
Test voltage (50 Hz) between terminals and housing, for 1 minute	250 V
Torque constant	e.m.f./ $100\pi$ Nm/A
Starting torque at nominal voltage	28 mNm
Rotor inductance	1 mH
Rotor moment of inertia	10,4 gcm <sup>2</sup>
Mechanical time constant	13 ms
Audio interference	see Fig. 5
Ambient temperature range	
operating	-10 to +60 °C
storage	-40 to +70 °C
Temperature coefficient of rotor resistance	0,4 %/K
e.m.f.	-0,02 %/K

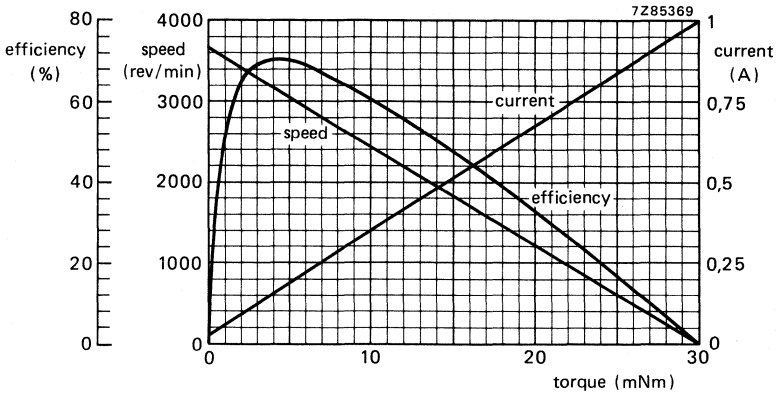


Fig. 2 Typical curves at 12 V,  $T_{amb} = 22\text{ °C}$ .

**Limiting conditions**

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

Voltage	15 V
Torque	8 mNm
Current	325 mA
Repetitive peak current	1100 mA, 10 ms, 1 Hz
Speed	6000 rev/min
Output power	3 W
Continuous blocking permitted at	6,5 V
Radial force 8 mm from mounting plane	5 N
Axial force	
pressing	0,5 N
pulling	0,5 N

**Tachogenerator**

Number of pole pairs	72
Generated voltage (r.m.s.) at 3000 rev/min	min. 650 mV, see also Fig. 4
Amplitude variation for 1 revolution ( $E_{l.f.}/E_p \times 100\%$ ) (see Fig. 3)	max. 15%
Frequency	72n/60 Hz (n = number of rev/min)
Frequency wobble at 3150 Hz *	max. 0,2%
Resistance	775 $\Omega$
Inductance	0,5 H

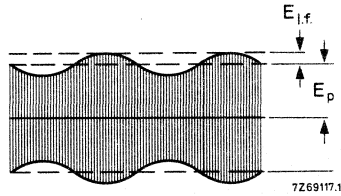


Fig. 3.

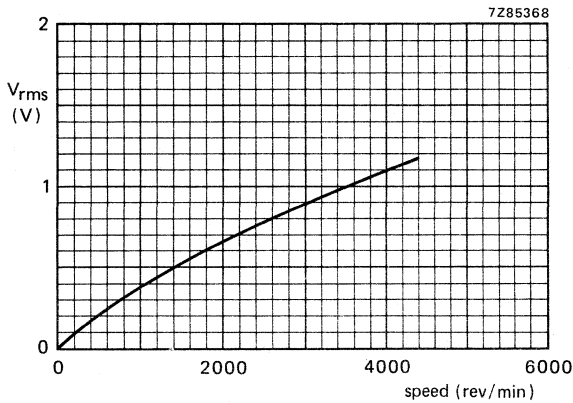


Fig. 4 Tachogenerator voltage as a function of the speed.

For additional information see general section of chapter "Direct current motors".

\* Measured with EMT measuring instrument type 424 (position "linear") or equivalent.

**AUDIO INTERFERENCE**

**Measuring procedure**

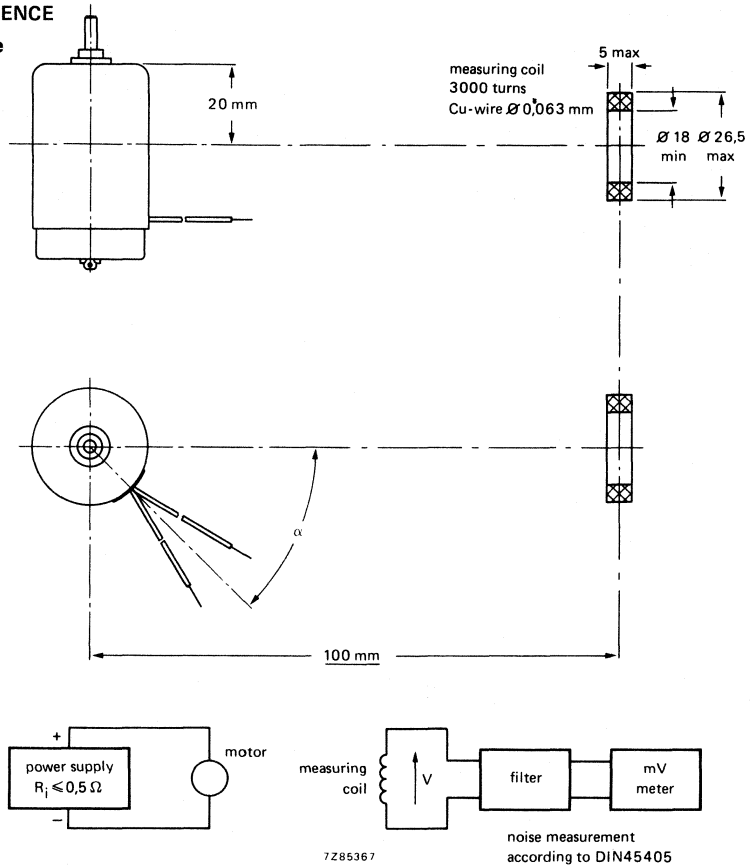


Fig. 5.

Motor speed 3000 rev/min

Preferred direction of rotation (positive voltage to + terminal)

Torque 5 mNm

$\alpha$  is varied until maximum voltage is obtained

$V_{p-p} = \text{max. } 4,4 \times 2\sqrt{2} \text{ mV}$

**CATALOGUE NUMBERS**

4322 01. 76130

- 0 stamped on motor, **not to be used** for ordering
- 3 for bulk packing, to be used for ordering \*

\* Minimum packing quantity 170 items per cardboard box.



## DIRECT CURRENT MOTOR

ironless rotor type

### QUICK REFERENCE DATA

---

Nominal voltage (d.c.)	9 V
Nominal speed	3500 rev/min
Nominal torque	5 mNm

---

### APPLICATION

These motors have been designed for applications which require low noise level, smooth running and accurate speed control by an electronic speed control unit.

Examples:

- hi-fi cassette recorders
- video cassette recorders
- digital cassette and cartridge recorders
- recording measuring instruments
- telephone answering equipment
- dictating machines
- echo sounders
- printers

### DESCRIPTION

The motors have an ironless rotor with oblique windings. The low moment of inertia and the high starting torque yield a mechanical time constant of no more than 13 ms.

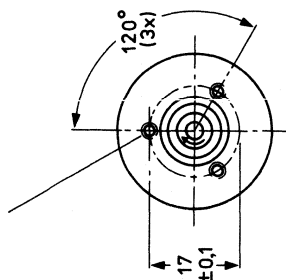
A commutator with 9 segments and four-finger brushes ensure optimum commutation by applying a good combination of precious metals, thus making the motor suitable for accurate electronic control and optimum functioning as a servo motor or tachogenerator. The powerful cylindrical steel permanent magnet, around which the rotor rotates, makes for high efficiency.

The above mentioned commutator/brush construction together with the sintered slide bearings ensures a long life, smooth running and low noise level, even under severe climatic conditions.

**TECHNICAL DATA**

**Outlines**

M2 (3x); permissible depth of screw insertion: 3 mm



Dimensions in mm

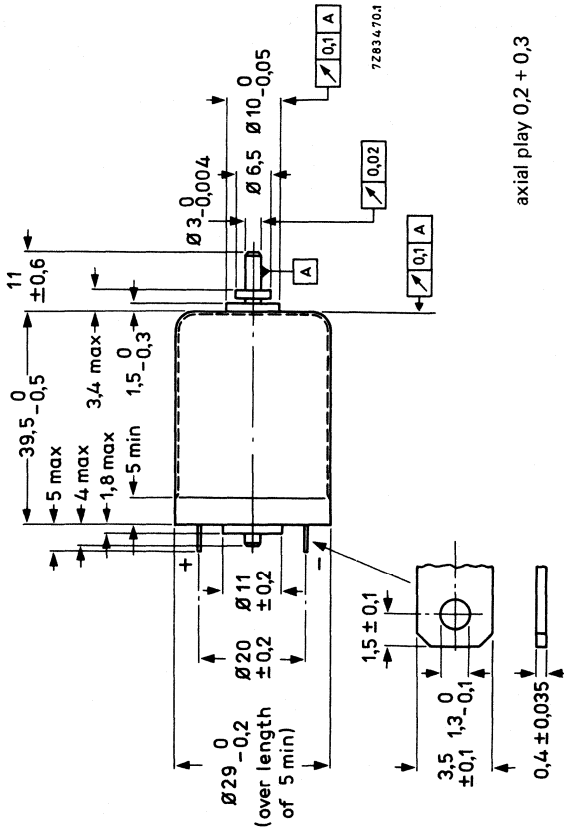


Fig. 1.

The direction of rotation is given in connection with the polarity (clockwise in Fig. 1).  
 The position of the soldering tags with respect to that of the mounting holes is arbitrary.  
 The motor is available with other spindle lengths.

Mass approximately 120 g.

**Mounting**

The motor is front mounted by means of three M2 screws. Permissible depth of screw insertion maximum 3 mm.

The values given below apply to an ambient temperature of  $+22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

Nominal voltage (d.c.)	9 V
Nominal torque	5 mNm
Speed	see Fig. 2
Bearings	slide
Direction of rotation	reversible
Climatic category (IEC 68)	10/060/21
E.M.F. at 3000 rev/min	5,4 - 7,0 V
Rotor resistance	$5,8 \Omega \pm 10\%$
Current at nominal voltage	
at nominal torque	257 - 377 mA
at no load	max. 96 mA
at a radial force of 3,5 N at 8 mm from mounting plane	max. 187 mA
Insulation between terminals and housing	min. 2 M $\Omega$
Test voltage (50 Hz) between terminals and housing, for 1 minute	250 V
Torque constant	e.m.f./100 $\pi$ Nm/A
Starting torque at nominal voltage	29,5 mNm
Rotor inductance	0,5 mH
Rotor moment of inertia	9 gcm <sup>2</sup>
Mechanical time constant	13 ms
Audio interference	see Fig. 3
Radio interference	see section General
Ambient temperature range	
operating	-10 to +60 °C
storage	-40 to +70 °C
Temperature coefficient of rotor resistance	0,4 %/K
e.m.f.	-0,02 %/K

**Limiting conditions**

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

Voltage	10 V
Torque	8 mNm
Current	475 mA
Repetitive peak current	1600 mA, 10 ms, 1 Hz
Speed	6000 rev/min
Output power	3 W
Continuous blocking permitted at	4,5 V
Radial force 8 mm from mounting plane	5 N
Axial force	0,5 N

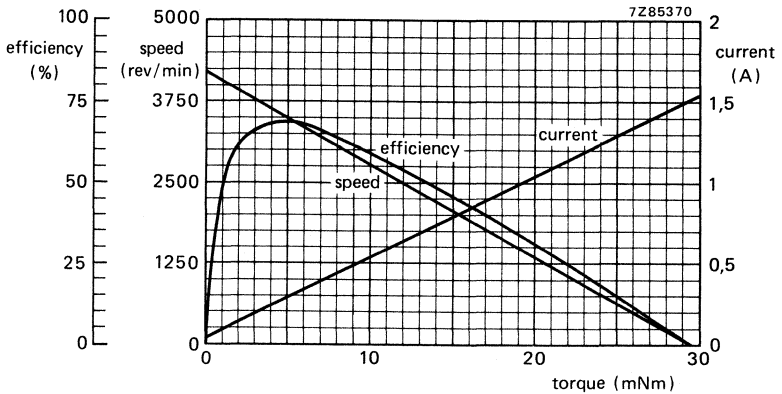


Fig. 2 Typical curves at 9 V,  $T_{amb} = 22\text{ }^{\circ}\text{C}$ .

**AUDIO INTERFERENCE**

**Measuring procedure**

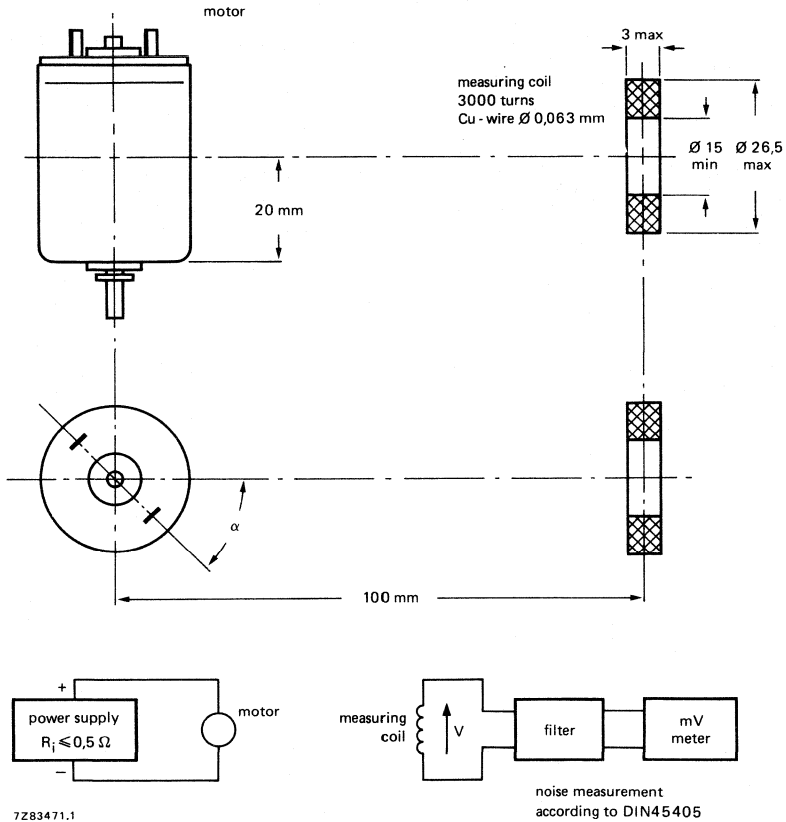


Fig. 3.

Motor speed 3500 rev/min.  
 Preferred direction of rotation (positive voltage to + terminal).  
 Torque 5 mNm  
 $\alpha$  is varied until maximum voltage is obtained.  
 $V_{p-p} = \text{max. } 4,4 \times 2\sqrt{2} \text{ mV.}$

**CATALOGUE NUMBERS**

4322 01. 76200

- \_\_\_\_\_ 0 stamped on motor, **not to be used** for ordering
- \_\_\_\_\_ 3 for bulk packing, to be used for ordering\*

\* Minimum packing quantity 170 items per cardboard box.



## DIRECT CURRENT MOTOR

ironless rotor type

### QUICK REFERENCE DATA

---

Nominal voltage (d.c.)	9 V
Nominal speed	5430 rev/min
Nominal torque	0,3 mNm

---

### APPLICATION

This motor has been designed for applications which require low noise level, smooth running, small size, high acceleration and accurate electronic speed control.

Examples:

- portable dictating machines;
- film cameras;
- process control systems (as a servo motor or tachogenerator).

### DESCRIPTION

The motor has an ironless rotor with oblique winding. The low moment of inertia ( $0,76 \text{ gcm}^2$ ), and the high starting torque yield a time constant of no more than 50 ms.

A gold-plated commutator with 5 segments and three-piece silver palladium plated brushes ensure optimum commutation, thus making the motor suitable for accurate electronic control and optimum functioning as a servo motor or tachogenerator. The powerful cylindrical steel permanent magnet, around which the rotor rotates, makes for high efficiency. The commutator/brush construction, together with the sintered bearings, ensures long life, smooth running and low noise level.

Motor 4322 010 77000 has counter-clockwise rotation.

## TECHNICAL DATA

## Outlines

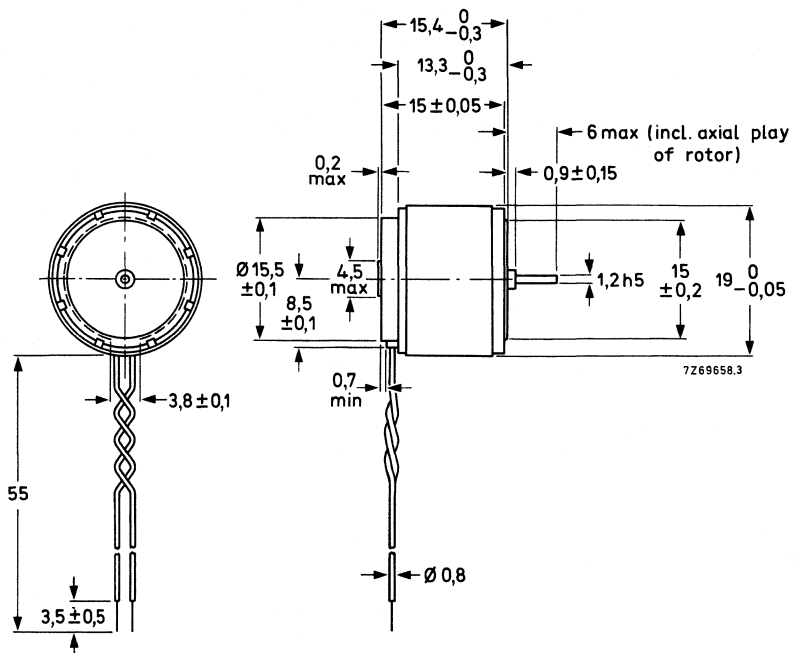


Fig. 1.

## Connections

brown = +, black = -

Mass: approx. 17 g



The values given below apply to an ambient temperature of  $+ 22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

Nominal voltage (d.c.)	9 V
Nominal torque	0,3 mNm
Speed	see Fig. 2
Bearings	slide
Direction of rotation	counter-clockwise
Climatic category (IEC 68)	10/050/21
E.M.F. at 3000 rev/min	3,0 to 4,1 V
Rotor resistance	85,5 $\Omega \pm 10\%$
Current at nominal voltage	
at nominal torque	25 to 41 mA
at no load	max. 9 mA
at a radial force of 0,5 N at 1,6 mm from mounting plane after 10 s	max. 20 mA
Insulation between terminals and housing	min. 2 M $\Omega$
Test voltage (50 Hz) between terminals and housing, for 1 minute	250 V
Torque constant	e.m.f. / $100\pi$ Nm/A
Starting torque at nominal voltage	1,16 mNm
Rotor inductance	2 mH
Rotor moment of inertia	0,76 gcm <sup>2</sup>
Mechanical time constant	50 ms
Ambient temperature range	
operating	-10 to + 50 °C
storage	-40 to + 85 °C
Temperature coefficient of rotor resistance	+ 0,4 %/K
e.m.f.	-0,02 %/K

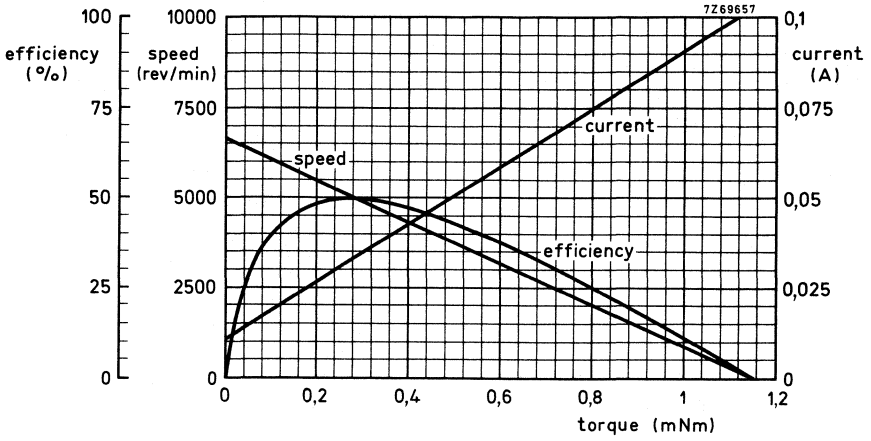


Fig. 2 Typical curves at 9 V,  $T_{amb} = 20\text{ }^{\circ}\text{C}$ .

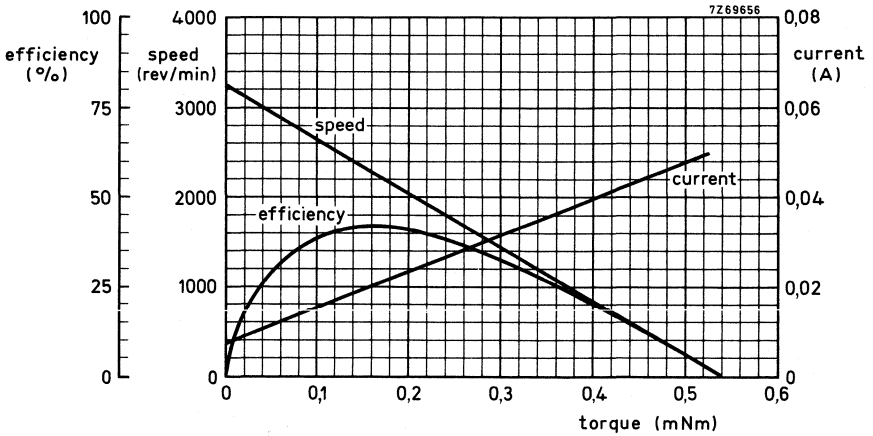


Fig. 3 Typical curves at 4,5 V,  $T_{amb} = 20\text{ }^{\circ}\text{C}$ .

**Limiting conditions**

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

Voltage	12 V
Torque	0,5 mNm
Current	60 mA
Repetitive peak current	120 mA, 10 ms, 1 Hz
Speed	9000 rev/min
Output power	0,25 W
Blocking time of rotor at 12 V	4 min
Radial force 1,6 mm from mounting plane	0,7 N
Axial force	
pressing	0,1 N
pulling	0,1 N

**CATALOGUE NUMBERS**

4322 01. 77000

_____	0 stamped on motor, <b>not to be used</b> for ordering
_____	3 for bulk packing, to be used for ordering*

\* Minimum packing quantity 170 items per cardboard box.





## DIRECT CURRENT MOTORS

ironless rotor type

### QUICK REFERENCE DATA

---

Nominal voltage (d.c.)	7,5 V
Nominal speed	4500 rev/min
Nominal torque	0,3 mNm

---

### APPLICATION

This motor has been designed for applications which require low noise level, smooth running, small size, high acceleration and accurate electronic speed control.

Examples:

- portable dictating machines;
- film cameras;
- process control systems (as a servo motor or tachogenerator).

### DESCRIPTION

The motor has an ironless rotor with oblique winding. The low moment of inertia ( $0,69 \text{ gcm}^2$ ), and the high starting torque yield a time constant of no more than 45 ms.

A gold-plated commutator with 5 segments and three-piece silver palladium plated brushes ensure optimum commutation, thus making the motor suitable for accurate electronic control and optimum functioning as a servo motor or tachogenerator. The powerful cylindrical steel permanent magnet, around which the rotor rotates, makes for high efficiency. The commutator/brush construction, together with the sintered bearings, ensures long life, smooth running and low noise level.

TECHNICAL DATA

Outlines

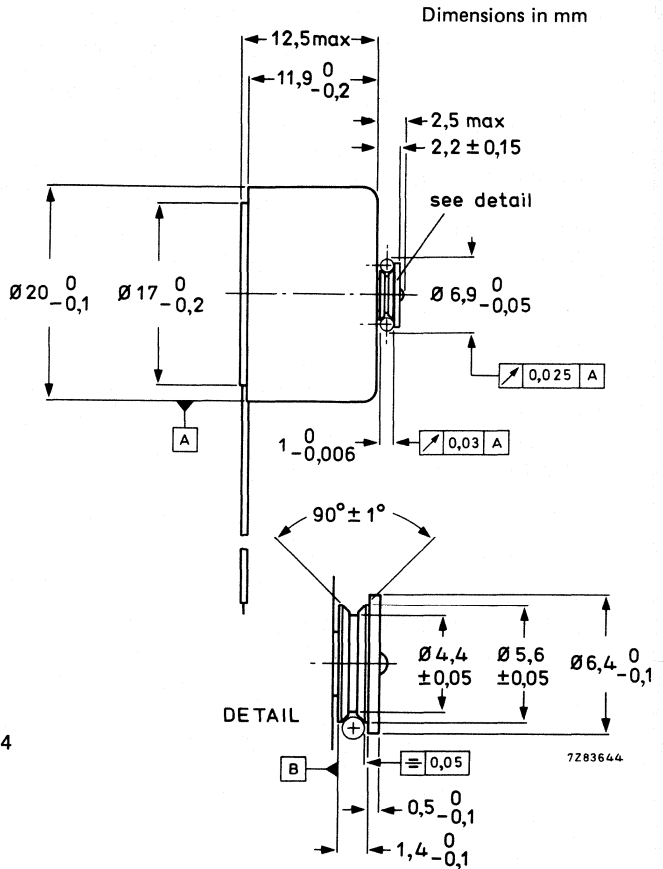
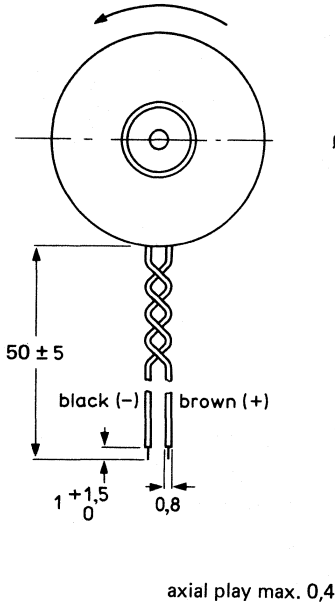


Fig. 1.

The direction of rotation is given in connection with the polarity (counter-clockwise in Fig. 1).

The motor is available with other spindle lengths.

**Mass** approximately 18 g.

**Mounting**

The motor is mounted by clamping the cylindrical housing.

Maximum permissible pulling force on connecting leads 3 N per lead.

The values given below apply to an ambient temperature of  $+22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

Nominal voltage (d.c.)	7,5 V
Nominal torque	0,3 mNm
Speed	see Fig. 2
Bearings	slide
Direction of rotation	reversible
Climatic category (IEC 68)	10/050/21
E.M.F. at 3000 rev/min	2,8 - 3,9 V
Rotor resistance	73 $\Omega \pm 10\%$
Current	
– at no load	
2000 rev/min, 2,0 - 3,0 V	max. 7,5 mA
4500 rev/min, 4,45 - 6,35 V	max. 10 mA
– loaded with 0,2 mNm	
2000 rev/min, 3,4 - 4,35 V	17 - 30 mA
– loaded with 0,3 mNm	
4500 rev/min, 6,6 - 8,3 V	25 - 44 mA
– at a radial force of 0,5 N	max. 22 mA
Insulation between terminals and housing	min. 2 M $\Omega$
Test voltage (50 Hz) between terminals and housing, for 1 minute	250 V
Torque constant	e.m.f./100 $\pi$ Nm/A
Starting torque at nominal voltage	min. 0,8 mNm
Rotor inductance	1,7 mH
Rotor moment of inertia	0,69 gcm <sup>2</sup>
Mechanical time constant	45 ms
Audio interference	see Fig. 3
Ambient temperature range	
operating	-10 to +50 °C
storage	-40 to +70 °C
Temperature coefficient of rotor resistance	0,4 %/K
e.m.f.	-0,02 %/K

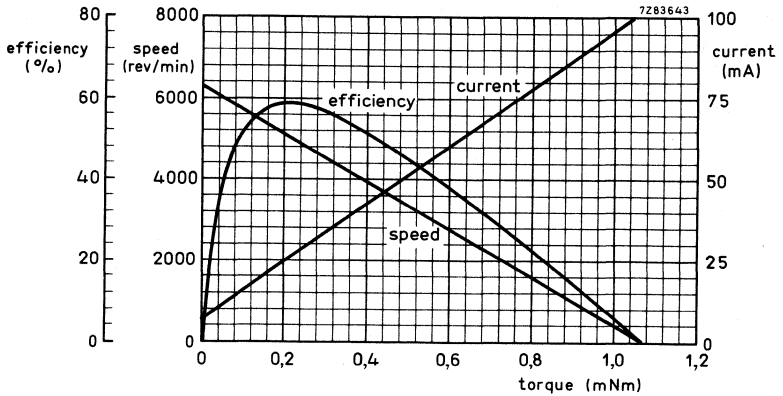


Fig. 2 Typical curves at 7,5 V,  $T_{amb} = 22\text{ }^{\circ}\text{C}$ .

#### Limiting conditions

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

Voltage	9 V
Torque	0,5 mNm
Current	50 mA
Repetitive peak current	125 mA, 10 ms, 1 Hz
Speed	7000 rev/min
Output power	0,25 W
Continuous blocking permitted at	9 V
Radial force	0,7 N
Axial force	0,1 N



**AUDIO INTERFERENCE**

**Measuring procedure**

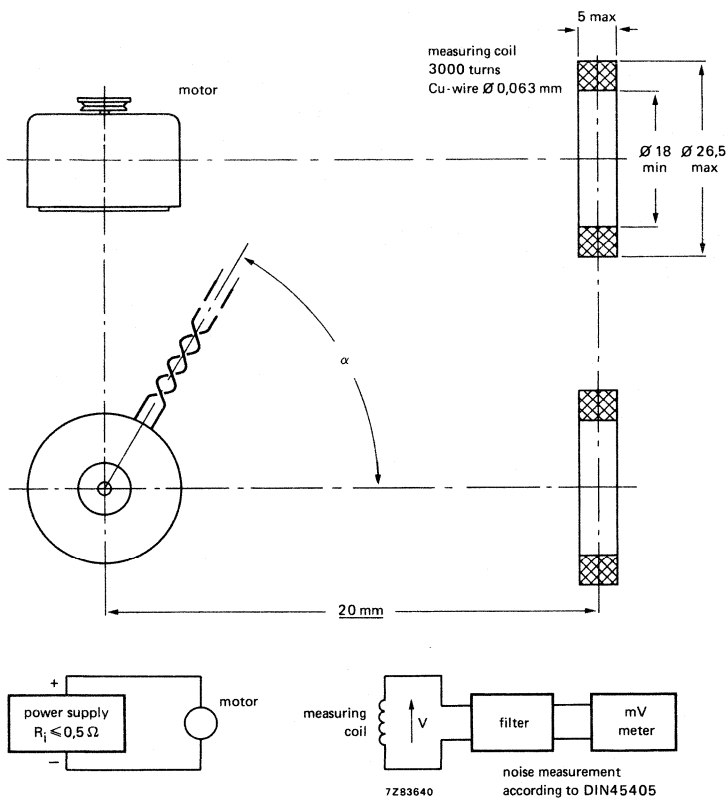


Fig. 3.

Motor speed 2000 rev/min.

Preferred direction of rotation (positive voltage to + terminal).

Current 28 mA.

$V_{p-p} = \text{max. } 6 \times 2 \sqrt{2} \text{ mV for } \alpha \text{ between } 24 \text{ and } 44^\circ.$

**CATALOGUE NUMBERS**

4322 01. 77010

- \_\_\_\_\_ 0 stamped on motor, **not to be used** for ordering
- \_\_\_\_\_ 3 for bulk packing, to be used for ordering\*

\* Minimum packing quantity 560 items per cardboard box.



## DIRECT CURRENT MOTOR

ironless rotor type

### QUICK REFERENCE DATA

---

Nominal voltage (d.c.)	30 V
Nominal speed	2150 rev/min
Nominal torque	100 mNm
Mechanical time constant	17 ms

---

### APPLICATION

As servomotor with high acceleration, high efficiency, long life and outstanding reliability this motor is ideal for the following applications:

- printer-carriage drives
- telex machines
- magnetic disc drive systems
- medical pumps
- instrumentation recorders
- digital/analogue recorders.

### DESCRIPTION

The motor has an ironless rotor with nine oblique windings and a permanent magnet stator, implying extremely high efficiency, low mechanical time constant, high starting torque and smooth running.

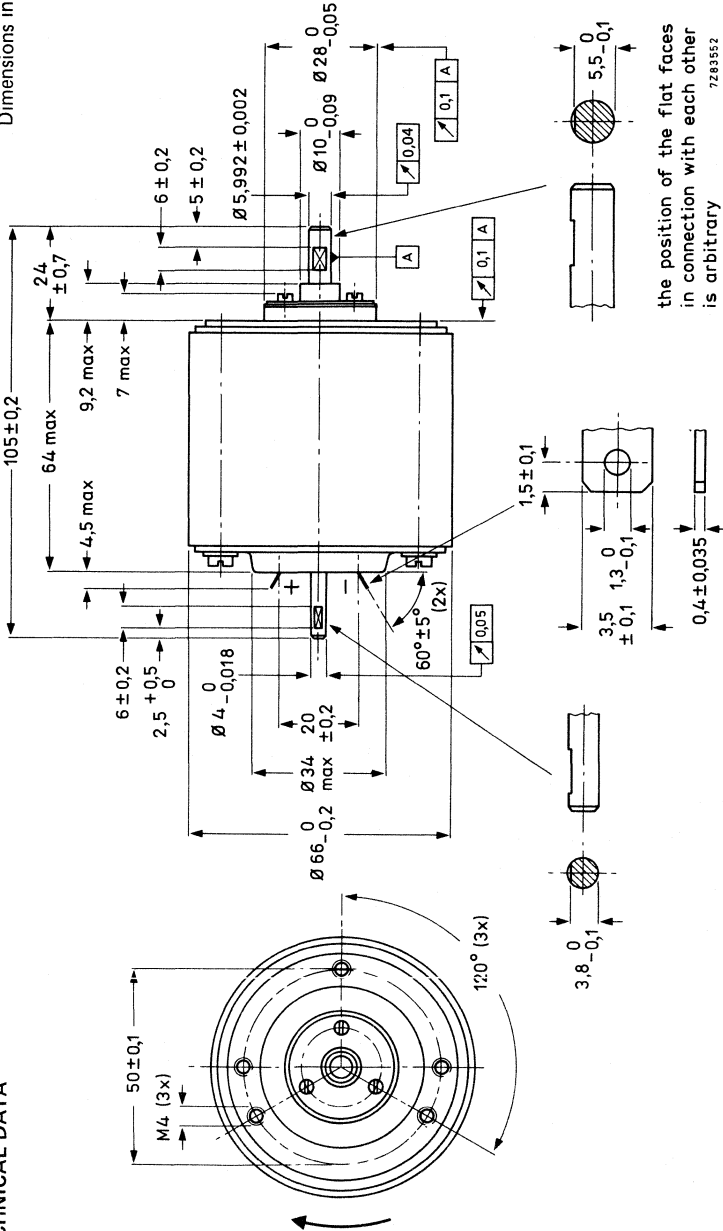
The precious metal brush-commutator construction combined with nine built-in bi-polar electrolytic capacitors connected between the commutator segments for spark suppression, make the motor suitable for heavy duty applications.

Ball bearings allow for high radial and axial force on the 6 mm shaft. A second shaft at the rear side permits mounting of a d.c. or frequency tacho generator, or an optical encoder.

The motor can be supplied with a.c. or d.c. tacho on request.

TECHNICAL DATA

Dimensions in mm



the position of the flat faces  
in connection with each other  
is arbitrary  
728352

Fig. 1.

The direction of rotation is given in connection with the polarity.

Mass approximately 900 g.

Mounting The motor is front mounted by means of three M4 screws. Permissible depth of screw insertion maximum 8 mm.

The values given below apply to an ambient temperature of  $+22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

All values without further indication are approximate values.

Nominal voltage (d.c.)	30 V
Nominal torque	100 mNm
Speed	see Fig. 2
Bearings	ball
Direction of rotation	reversible
Climatic category (IEC 68)	5/060/21
E.M.F. at 3000 rev/min	28,4 – 33,2 V
Rotor resistance	7,8 $\Omega \pm 7\%$
Current at nominal voltage	
at nominal torque	960 – 1180 mA
at no load	max. 65 mA
at a radial force of 20 N at 20 mm from mounting plane	typ. 75 mA
Insulation between terminals and housing	min. 2 M $\Omega$
Test voltage (d.c.) between terminals and housing, for 1 minute	500 V
Starting torque at nominal voltage	310 mNm
Rotor inductance	5,7 mH
Rotor moment of inertia	21,4 $\times 10^{-6}$ kg m <sup>2</sup>
Mechanical time constant	17 ms
Audio interference	see Fig. 3
Radio interference	see section General
Ambient temperature range	
operating	–5 to +60 °C
storage	–40 to +70 °C
Thermal resistance between winding and housing	typ. 2,6 K/W
Temperature coefficient of	
rotor resistance	+0,4 %/K
e.m.f.	–0,2 %/K

**Limiting conditions**

The following maximum values indicate those circumstances under which the motor can run continuously without being damaged, but under these circumstances the motor life is reduced.

Voltage	40 V
Torque	130 mNm
Current	1550 mA
Repetitive peak current	3500 mA, 10 ms, 1 Hz
Speed	3200 rev/min
Output power	25 W
Continuous blocking when mounted on heatsink (Fig. 3) permitted at	16,1 V
Radial force 20 mm from mounting plane	25 N
Axial force	
pressing	15 N
pulling	15 N

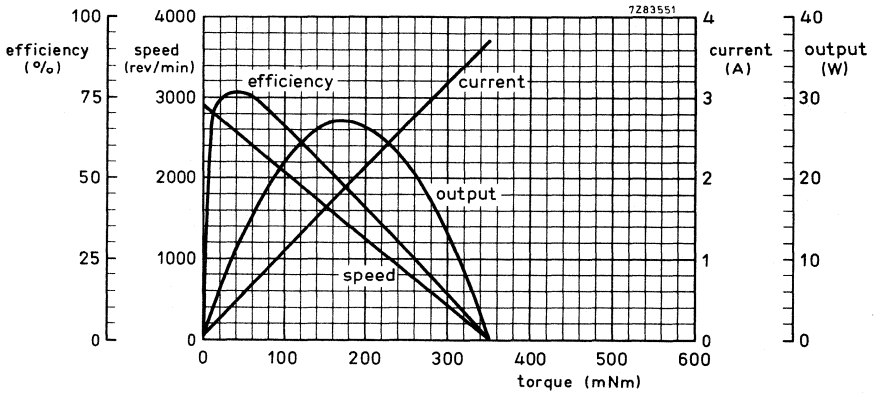
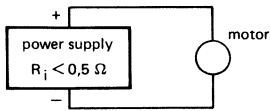
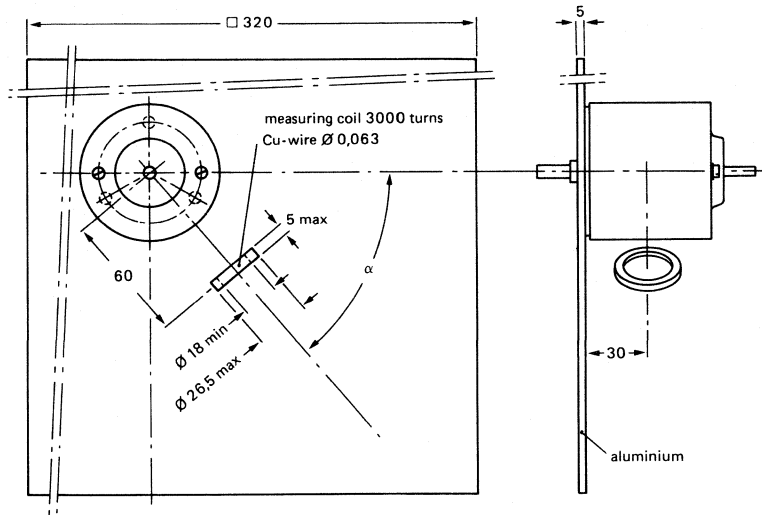


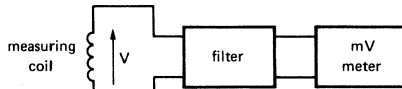
Fig. 2 Typical curves at 30 V,  $T_{amb} = 22\text{ }^{\circ}\text{C}$ .

**AUDIO INTERFERENCE**

**Measuring**



7283550



noise measurement according to DIN45405

Fig. 3.

Motor unloaded at 30 V.

Preferred direction of rotation (positive voltage to + terminal).

$\alpha$  is varied until maximum voltage is obtained.

$$V_{p-p} = \max. 4,2 \times 2\sqrt{2} \text{ mV.}$$

**CATALOGUE NUMBERS**

4322 01. 78010

- 0 stamped on motor, **not to be used** for ordering
- 3 for bulk packing, to be used for ordering \*

\* Minimum packing quantity 170 items per cardboard box.





## DIRECT CURRENT MOTOR

iron rotor type

### QUICK REFERENCE DATA

---

Nominal voltage (d.c.)	12 V
Nominal speed	5900 rev/min
Nominal torque	5 mNm

---

### APPLICATION

This small d.c. motor has been designed for applications which require high quality, long life and high torque.

Examples:

- motor car industry: fans, car vacuum cleaners, windscreen washers and actuator systems,
- general industrial.

### DESCRIPTION

The motor has been provided with a permanent-magnet system. It has a grey, injection-moulded housing of polyacetal resin, which offers an excellent resistance to chemicals and corrosion.

The application of great special brushes, a flat commutator, a new permanent magnet material and a special rotor construction guarantee a long life, high efficiency and high torque, and make the motor very suitable for applications which require low current consumption (e.g. supply from dry cells or rechargeable cells).

A voltage dependent resistor (VDR) is built in and acts as a spark suppressor. This and the fact that the commutator is flat make for a good interference suppression so that the motor can also be remotely controlled.

TECHNICAL DATA

Dimensions in mm

Outlines

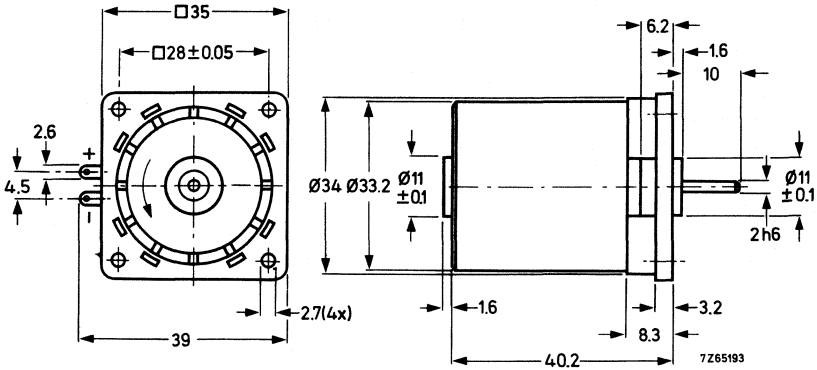


Fig. 1 The direction of rotation is given in connection with the polarity.

Mass approx. 120 g

Mounting

The motor can be fixed by means of four screws (M2,6), washers and nuts.

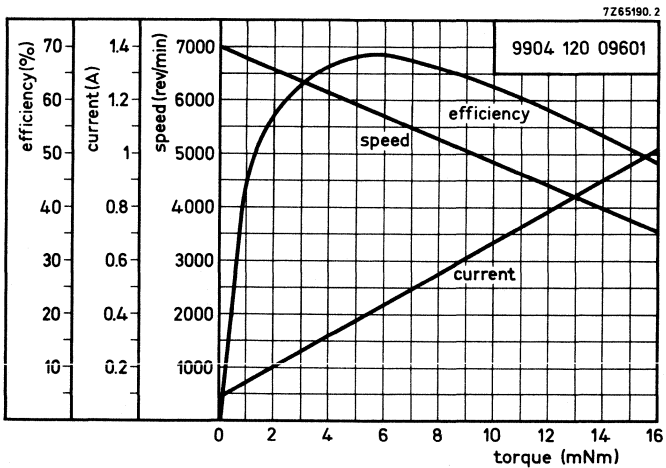


Fig. 2 Typical curves at 12 V, T<sub>amb</sub> = 22 °C.

The values given below apply to an ambient temperature of  $22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 - 75%.

**Nominal values**

Voltage (d.c.)	12 V	
Torque	5 mNm	
Speed at nominal load	5900 rev/min	
at no load	7000 rev/min	
Current at nominal load	0,55 A	←
at no load	0,150 A	←
Starting torque	$\geq 30$ mNm	
Input power	4,8 W	
Direction of rotation	reversible, see Fig. 1	
Ambient temperature range	-20 to + 60 °C	
Bearings	slide bearings; self-lubricating	
Maximum radial force on the bearings	2,5 N	
Maximum axial force	2 N	
Housing		
material	polyacetal resin	
colour	grey	

**Limiting conditions**

The following maximum values should never be exceeded.

Maximum voltage (d.c.)	15 V
Maximum permissible load	15 mNm
Maximum permissible input current	1,5 A



## DIRECT CURRENT MOTORS with reduction

### QUICK REFERENCE DATA

catalogue numbers			reduction ratio	speed rev/min	torque mNm
nominal voltage 6 V d.c.	nominal voltage 12 V d.c.	nominal voltage 24 V d.c.			
9904 120 52402	9904 120 52602	9904 120 52702	9 : 1	330	25
9904 120 52405	9904 120 52605	9904 120 52705	50 : 1	60	125
9904 120 52407	9904 120 52607	9904 120 52707	150,4 : 1	23	125
9904 120 52409	9904 120 52609	9904 120 52709	451,25 : 1	8,2	125

### APPLICATION

These small d.c. motors with integrated gearboxes have been designed for applications which require a driving system of good quality and a long life.

Application examples are:

- rotating warning lights e.g. on cars
- positioning of searchlights e.g. on cars
- headlamp wipers on cars
- automation systems

### DESCRIPTION

The motor has been provided with a permanent-magnet stator system. A reduction gearbox has been built in with gearwheels made of polyacetal resin; various reductions are available.

The use of special brushes, a flat commutator and built-in spark suppressor (voltage dependent resistor) guarantee a long life and a low interference level. The new stator magnet material and the special rotor construction give the motor a high efficiency. The grey injection-moulded housing of polyacetal resin is highly resistant to chemicals and corrosion.

### MOUNTING

Mounting the motor is easy since it is provided with a flange having four holes. Four screws M 2,5 and washers can be used.

TECHNICAL DATA

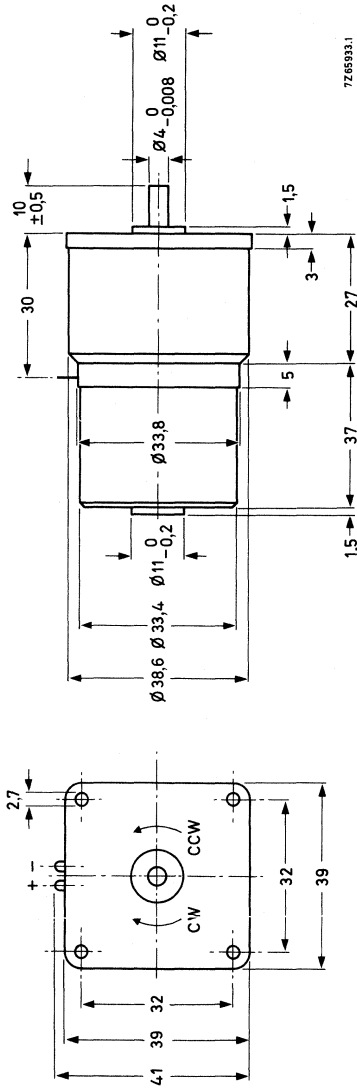


Fig. 1.

The direction of rotation is given in connection with the polarity (see table next page).

Ambient temperature range -20 to +60 °C

Bearings bronze, self lubricating

Maximum axial play 0,5 mm

Housing, material polyacetal resin  
colour grey

Gears, material polyacetal resin

Mass 125 g approx.

The values given below apply to an ambient temperature of  $22 \pm 5$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

catalogue number 9904 120 52. . .	402	602	702	405	605	705	407	607	707	409	609	709	
reduction ratio	9 : 1			50 : 1			150,4 : 1			451,25 : 1			

**Nominal values**

voltage (d.c.)	6	12	24	6	12	24	6	12	24	6	12	24	V
torque	25			125			125			125			mNm
speed at nom. load at no load	330 415			60 78			23 26			8,2 8,5			rev/ min
current at nom. load at no load	360 80	185 45	105 35	360 80	185 45	105 35	180 75	100 40	60 35	110 70	60 40	45 35	mA mA
input power	2,1	2,2	2,5	2,1	2,2	2,5	1,1	1,2	1,4	0,7	0,7	1,1	W
direction of rotation (see also Fig. 1)	CW			CW			CCW			CW			
max. radial force on the bearings	2			6			8			10			N
max. axial force	2			6			8			10			N

**Limiting conditions**

max. voltage (d.c.)	9	18	28	9	18	28	9	18	28	9	18	28	V
max. perm. load	37,5			150			150			150			mNm

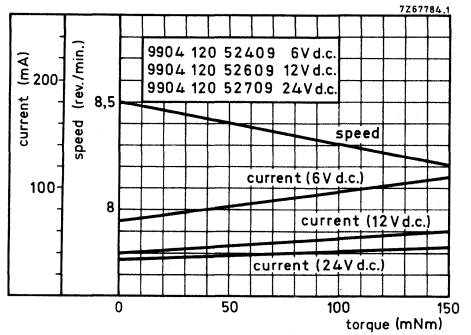
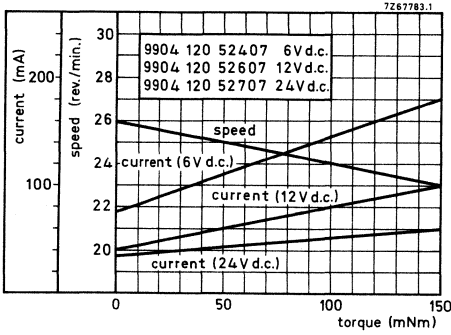
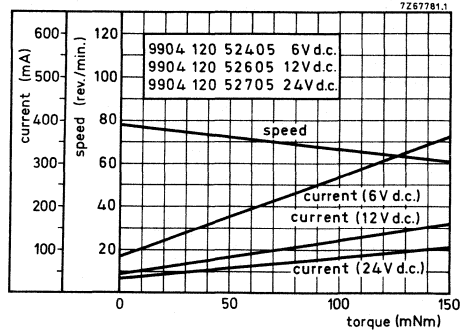
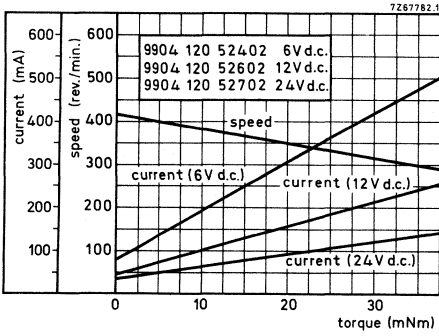


Fig. 2 Typical curves at 6, 12 and 24 V,  $T_{amb} = 22\text{ }^{\circ}\text{C}$ .





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