RS DATA SUPPORT

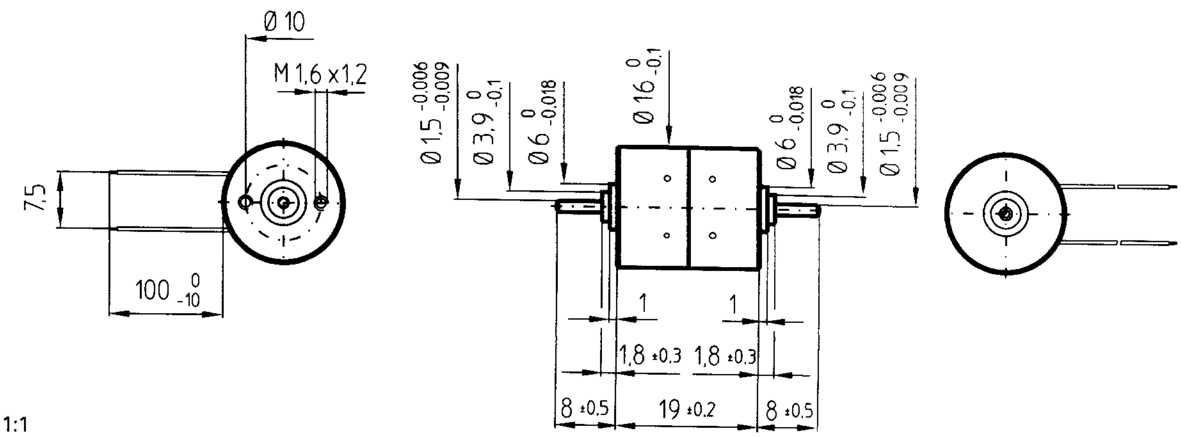
CROSS REFERENCE LIST

RS Stock Number	Supplier's Part Number
235-7768	P110-064-068.00
221-4734	P110-064-2.5.00

escap P 110

Stepper motor

Step angle: 15°



scale 1:1
dimensions in mm
mass: 23g
lead wires: 100_{-10}^{0} mm

P110-064 - • • • • 00

Windings available from stock • • •

			...- 068 •			...- 015 •			...- 2.5 •		
COIL DEPENDENT PARAMETERS			min	typ	max	min	typ	max	min	typ	max
1	Phase resistance	ohm	60	65	70	14	15	17	2.3	2.5	2.7
2	Phase inductance (1 kHz)	mH		46			12			2.2	
3	Nominal phase current (2 ph. on)	A		0.12			0.25			0.65	
4	Nominal phase current (1 ph. on)	A		0.17			0.35			0.9	
5	Back-EMF amplitude	V/kst/s	9.9	10.8	11.6	4.8	5.2	5.6	1.8	2	2.2

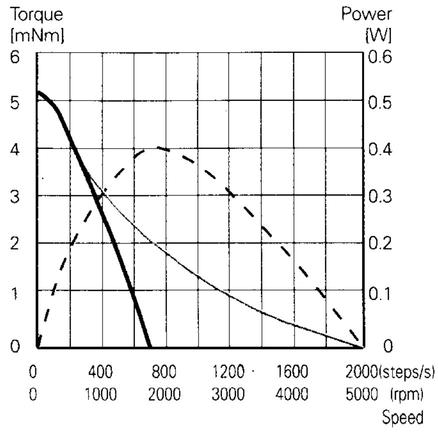
COIL INDEPENDENT PARAMETERS					
Torque parameters			min	typ	max
6	Holding torque (nominal current)	mNm (oz-in)	6.4 (0.91)	7 (1.0)	7.6 (1.08)
7	Holding torque (1.5 x nominal current) [1]	mNm (oz-in)	9.2 (1.31)	10 (1.4)	10.8 (1.54)
8	Detent torque amplitude and friction	mNm (oz-in)	0.6 (0.09)	1 (0.1)	1.5 (0.21)
Thermal parameters					
9	Thermal resistance coil-ambient [2]	°C/W		45	
10	Coil temperature	°C			130
11	Operating ambient temperature	°C	-30		50
Angular accuracy					
12	Absolute accuracy (2 ph. on full-step mode)	% full-step		±3	±5
Mechanical parameters					
13	Rotor inertia	$kgm^2.10^{-7}$		0.40	
14	Radial load	N			0.5
15	Axial load [3]	N			30
16	Radial shaft play (5 N)	µm			30
17	Axial shaft play (5 N)	µm			40
Other parameters					
18	Test voltage (1 min)	V_{RMS}		300	
19	Natural resonance frequency (nominal current)	Hz		160	
20	Electrical time constant	ms		0.8	
21	Angular acceleration (nominal current)	rad/s^2		167	
22	Power rate (nominal current)	kW/s		1.2	

[1] Measurement with 1 phase on. The max. coil temperature must be respected
[2] Motor unmounted
[3] Shaft must be supported for press-fitting a pulley or a pinion

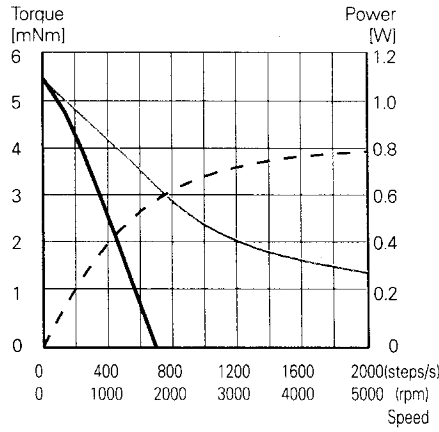
Executions: • 08 for gearbox B16
• 03 / • 04 for gearbox R16

The standard version available from stock is with sleeve bearings. This motor is also available with the B16 and R16 gearboxes.

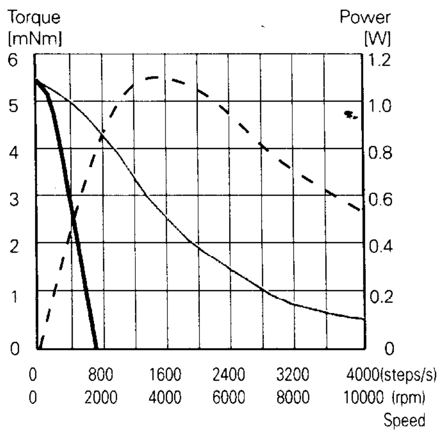
P110-064-015, U = 6V, Rs = 0Ω
P110-064-068, U = 12V, Rs = 0Ω
Voltage drive type L/R



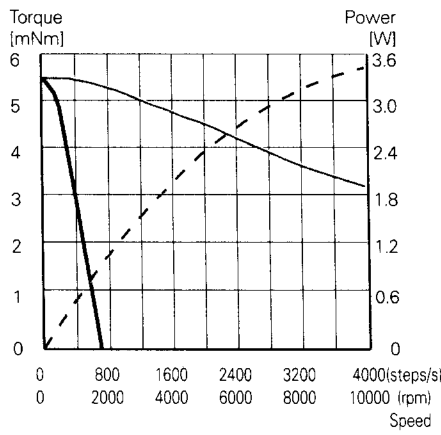
P110-064-015, U = 12V, Rs = 15Ω
P110-064-068, U = 24V, Rs = 68Ω
Voltage drive type L/R



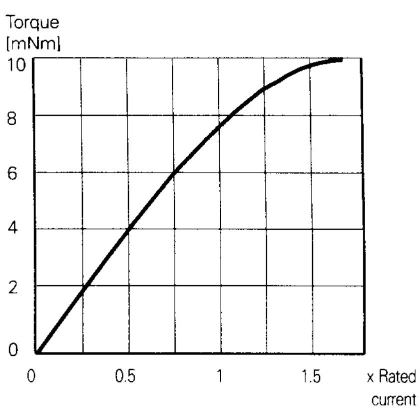
P110-064-015
Voltage drive type L/R
U = 24V, Rs = 47Ω

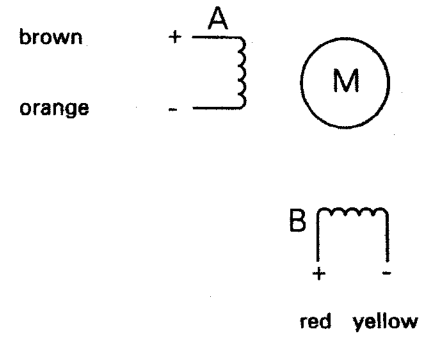


P110-064-2.5
Current source
I = 0.9A, U = 24V



Iron saturation effect
Torque / Current
One phase on





Motor connections

Pull-in range
Pull-out range
Power output

Notes

The high power/size ratio and high peak speed dedicate this motor to the most demanding fields of applications.
Its extended pull-in range and excellent efficiency are benefits for straight forward battery driven operation.
The speed scale is indicated in full-steps/s for all drive modes.
The motor is driven in half-steps unless otherwise specified.
The motor is energised with nominal current unless otherwise specified.
Pull-in is measured with a load inertia equal to the rotor inertia.
The following escap® drive circuits are recommended with the P110 motor, depending on the mode and the dynamic performance required: ELD-200, EDM-453, ESD-1200.
Please refer to pages 108/109 for more information on terminology and definitions.

Disc magnet stepper motors
The high performance technology

The Rotor
The rotor as the heart of this technology consists of a rare earth magnet in the shape of a thin disc. Portescap's know-how and experience has allowed us to optimise the magnetic circuit, and to axially magnetise the disc with a large number of pole pairs. Compared to traditional two phase PM stepper motors this gives a higher number of steps/rev. Unlike other motor technologies the rotor does not require an additional iron structure to obtain flux variations; therefore ***rotor inertia is very low.*** *It is capable of exceptional accelerations which, together with a high peak speed, make this motor technology suitable for fast incremental motion.*

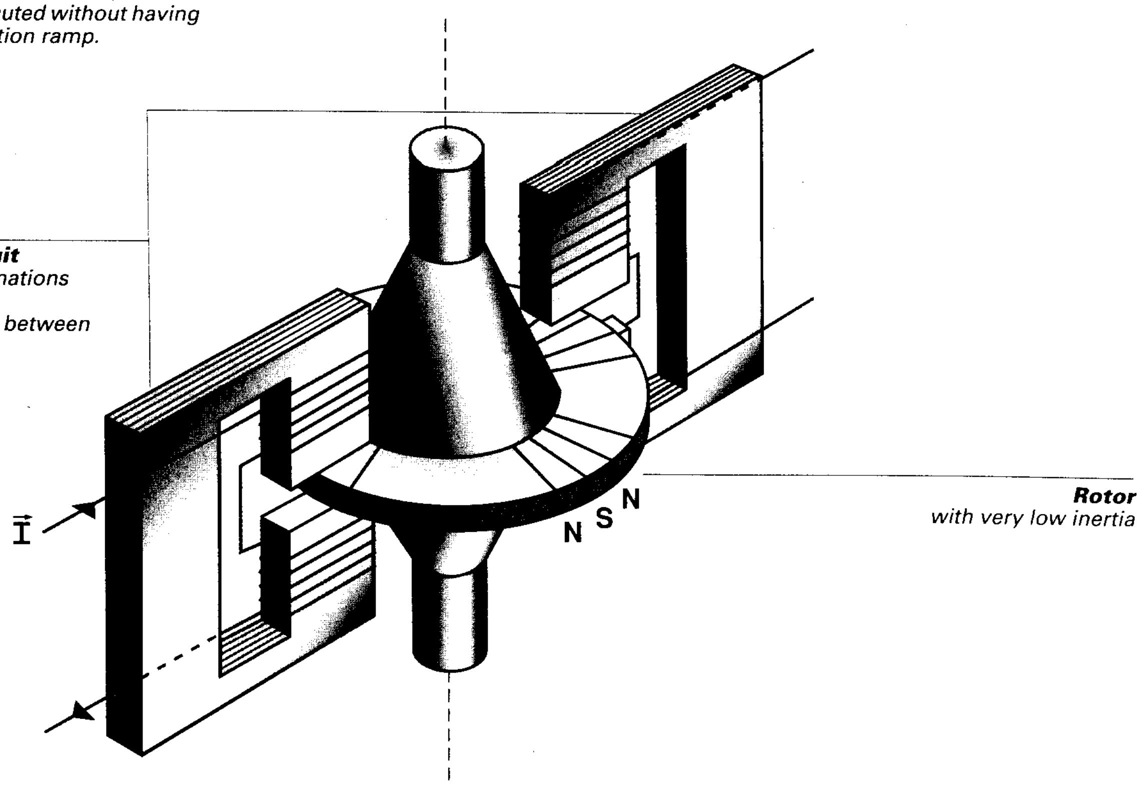
Furthermore, the low rotor inertia favours high starting frequencies which save time during the first step. In addition, certain movements can be executed without having to generate an acceleration ramp.

The magnetic circuit
The C-shaped magnetic circuit is very short. Unlike the hybrid motor the iron volume is not used as a structural support but optimised strictly in view of the magnetic induction. Each elementary circuit is made of SiFe laminations; their low volume assures minimum iron losses from hysteresis and eddy currents. Thus ***very high peak speeds*** *can be achieved; even at 10'000 steps/s iron losses will not cause an excessive temperature rise.*

For the user this means a ***very high power output*** *from a small motor size, e.g. up to 50 W for the P532 motor (52mm Ø x 33 mm).*

Although the iron circuit is very short, it is still dimensioned in order ***not to saturate under boost conditions.*** *For the customer this may allow the use of a smaller size motor and boosting it during acceleration or braking. This results in a higher torque to inertia ratio.*

Contrary to other stepper motor technologies, with disc magnet motors there is no magnetic coupling between the phases. Each phase is entirely independent. Thus its geometry can be adapted to obtain a truly ***sinusoidal function of torque vs rotor position,*** *and a value of* ***detent torque*** *which is* ***very small*** *compared to holding torque. These are prime conditions with microstep operation, if* ***high positioning accuracy*** *is needed on any microstep.*



Basic principles
The fundamental advantage of a stepper motor is its ability to execute a given speed profile and to position a load, without needing an encoder and a position loop. The difference between the stepper and the DC motor, or the BLDC motor, is in the motor concept and in their commutation.

The commutation
of stepper motors takes place outside and is independent of the angular rotor position. In DC motors it depends on the rotor position and is done either mechanically through the brush gear, or electronically in the case of a brushless DC motor.

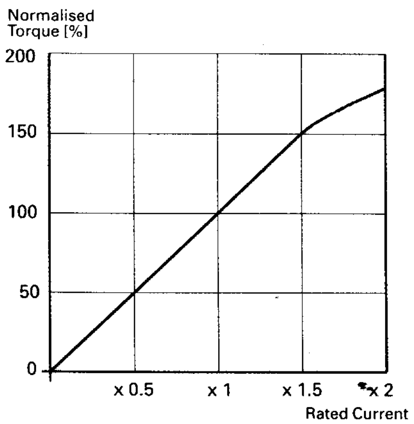
The concept
of the stepper motor differs from that of the DC and BLDC motor in so far as it generates a large number of stable positions within one revolution. This originates in the principle of construction: a two phase motor using a rotor with a magnet of one pole pair has four stable positions per rev., whereas a two phase motor with 50 pole pairs has 200 of them and therefore makes 200 full steps/rev.

The number of commutations per rev. depends on the number of steps/rev. of the motor. Every electrical commutation provokes a variation of the magnetic flux, and each flux variation generates iron losses. In a stepper motor with many commutations per rev. these iron losses can no longer be neglected. It is for this reason that stepper motors of conventional design are not intended for rapid movements. The disc magnet stepper motor is the only one to offer exceptional dynamic behaviour.
This technology, developed by Portescap and for which a patent was granted, fully exploits newly available materials like rare earth magnets, which in conjunction with an innovative concept have produced exceptional results.

Concept detail	Motor characteristics	Advantages for the application
Thin multipolar rare earth disc magnet	Very low rotor inertia	**Very high acceleration** **High start/stop frequencies**
Very short iron circuit made of SiFe laminations Coils placed right next to the airgap	Low iron losses More torque at high step rates	**High speeds** **High power/volume ratio**
Independent magnetic circuit Simple magnetic circuit	No coupling between phases Sinusoidal torque function, low detent torque	**Superior angular resolution in microstep mode**
Optimally dimensioned iron circuit	Torque constant is linear up to 2 to 3 times nominal current	**High peak torques**
High energy magnet	High power to weight ratio	**For motors in mobile applications** **For size limitations**

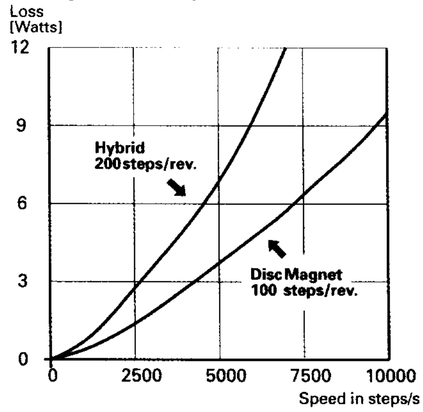
Iron saturation effects

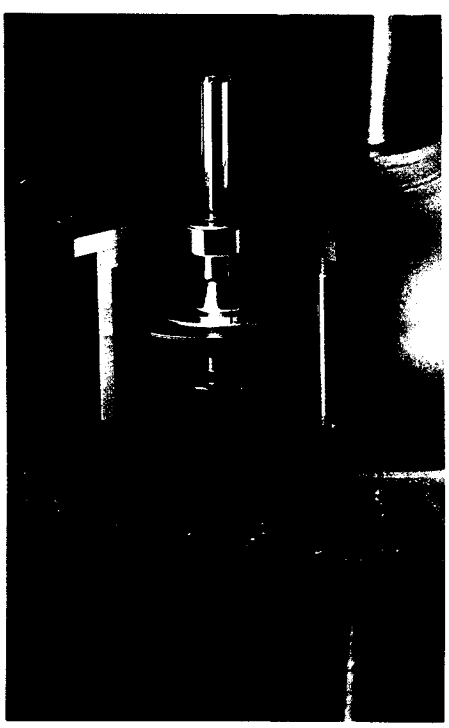
Torque / Current
example: escap® motor type P532



Iron losses

Comparison DM/Hybrid
same torque, losses due
to magnet flux only.





The standard test for disc magnet stepper motors
The high quality level offered by Portescap is assured by testing and checking throughout the manufacturing process. These tests follow a standard quality plan and well established procedures.

The following motor parameters are checked against the values given in the catalogue or in their specification, at a temperature of 20/25°C.

100% test:

1. the resistance of each winding.
2. back-EMF of each phase to determine their holding torque and any difference between them.
3. phase changes of back-EMF periods over one revolution.
4. the quadrature between both phases to determine angular accuracy.
5. friction torque.
6. detent torque.

Specific tests:
Tests of other parameters and/or following other criteria may be done according to customer needs. They are then part of the customer specification and are noted on a quality control document.

escap® Disc magnet stepper motors
Terminology and definitions

Step sequence
In a two phase motor each phase may carry either positive or negative current. Therefore one sequence consists of four successive states of excitation corresponding to four steps (see charts below). The sequence can be made with either one or both phases energised at a time. In the first case, a 40% current increase will provide a torque close to the one obtained with both phases energised. By alternately energising one and two phases, an 8 state sequence is generated corresponding to 8 halfsteps.

Microstep mode
A full step can be divided into microsteps by successively decreasing the current in one phase while increasing it in the other phase. This mode decreases the ripple content of motor torque and speed; it increases system resolution and assures a smooth and silent operation without resonance problems.

Drive circuits
A stepper motor drive circuit requires a drive logic circuit, two power stages and, possibly, an optional damping circuit.
The clock generates the pulses, each of which represents one step or microstep. In positioning systems the controller (generally a microprocessor) generates the clock pulses corresponding to the number of steps to be made, at the rate wanted which may include an acceleration ramp.
The translator (or sequencer) coordinates the power transistor control signals which assure the correct energising of the phases as required for the move.
An electronic damping circuit can be used to damp end-of-step ringing, which may be disturbing in systems having low friction. This is achieved by using either speed sensors or the Back-EMF of one of the two coils of each phase, for modulating the phase currents such as to generate viscous torque.

Pull-in frequency
Step rate at which the motor can start and stop without loosing or gaining steps. It depends on the rotor inertia and the load.

Pull-out frequency
Highest step rate the motor can follow, after ramp-up, without error. It depends on motor iron losses, on the driver and its voltage, and on the load.

Useful torque
Highest possible load torque indicated by the torque-speed curves. At low speed it is usually about 60 to 80% of holding torque. At higher step rates it is largely influenced by the driver type and supply voltage. As the type of load and stiffness of its coupling may also affect it, these curves merely give an indication.

DEFINITION OF CHARACTERISTICS
Holding torque
Highest load torque applicable to an energised motor without causing continuous rotation.

Detent torque
Highest load torque applicable to a de-energised motor without causing continuous rotation. Detent torque includes magnetic cogging, bearing friction and hysteresis. The rest positions without current are the same as with one phase energised.

Temperature
All values are measured at 22°C. In continuous operation, the maximum rated temperature of the phase windings sets the limit at 130°C. The temperature rise is mainly due to Joule losses. At high step rates iron losses are added.

Angular accuracy
It depends on the overall quality of the motor and the driver. The step positions are measured for an unloaded motor, with a driver introducing a negligible error. The absolute error, due to manufacturing tolerances, is the error between the real rotor position and its theoretical position.

Power rate
This figure of merit represents the motor's ability of supplying power to a load. It equals the square of the motor torque divided by its rotor inertia. The higher its value, the shorter is the time needed for positioning the load.

Full-step mode
2 phases on

Step No	Phase A	Phase B	Direction of rotation
1	+	+	C.W. ↓ / C.C.W. ↑
2	–	+	
3	–	–	
4	+	–	

Full-step mode
1 phase on

Step No	Phase A	Phase B	Direction of rotation
1	+	0	C.W. ↓ / C.C.W. ↑
2	0	+	
3	–	0	
4	0	–	

Half-step mode

Half-step No	Phase A	Phase B	Direction of rotation
1	+	0	C.W. ↓ / C.C.W. ↑
2	+	+	
3	0	+	
4	–	+	
5	–	0	
6	–	–	
7	0	–	
8	+	–	