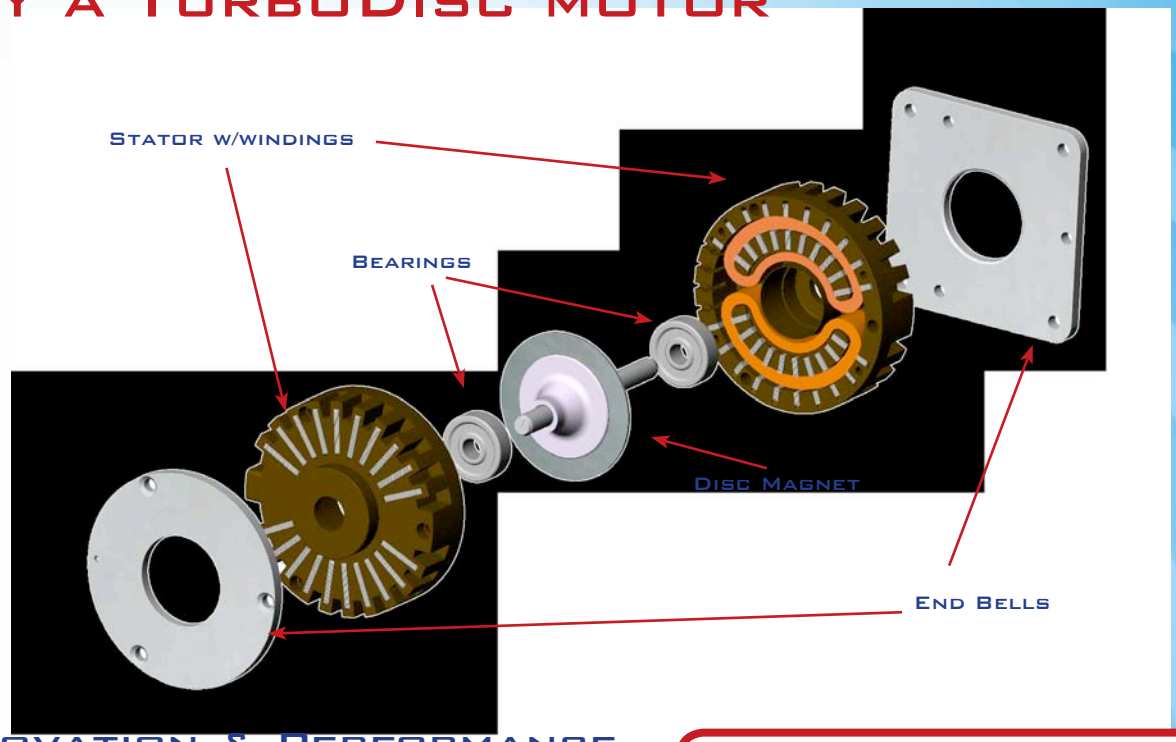
TURBODISC™ STEPPER MOTORS

Portescap
A Danaher Motion Company

The TurboDisc provides exceptional dynamic performance unparalleled by any other stepper on the market. The unique thin disc magnet enables finer step resolutions in the same diameter, significantly higher acceleration and greater top end speed than conventional steppers. TurboDisc excels in applications that require the precision of a stepper and the speed/acceleration of a DC motor.

Why a TurboDisc motor



Innovation & Performance

A technology providing unique results. At its heart there is the rotor, a thin disc or rare earth magnet material. Portescap's unique design allows for axial magnetizing with a high number of poles, and for optimizing the magnetic circuit with a corresponding reduction of losses. The quantum leap of this state-of-the-art technology developed by Portescap is extremely high dynamic performance comparable to DC servo motors but obtained from a simple stepper motor.

The TurboDisc is well suited to be tailored to your application requirements. Our design engineers can integrate our motor into your assembly. Our TurboDisc design assistance can range from providing additional components to a fully customized motion solution that optimizes the space and performance of your machine. TurboDisc advantages include:

- Precise - Well suited for microstepping
- Fast - Disc Magnet enables fastest acceleration and highest top speed of any step motor while maintaining accurate positioning
- Unique - Low detent torque and highly customizable
- Adaptable - Higher steps per revolution than CanStack products; can be increased through tooling
- Miniature - Down to 10 mm diameter with 24 steps per revolution

Your custom motion solution

- Sintered or ball bearings
- Various windings
- Shaft modifications – increase/decrease length, knurling
- Longer leads, connectors
- Gearheads for increased torque
- Encoders for position verification

Standard Features

Frame sizes ranging from:

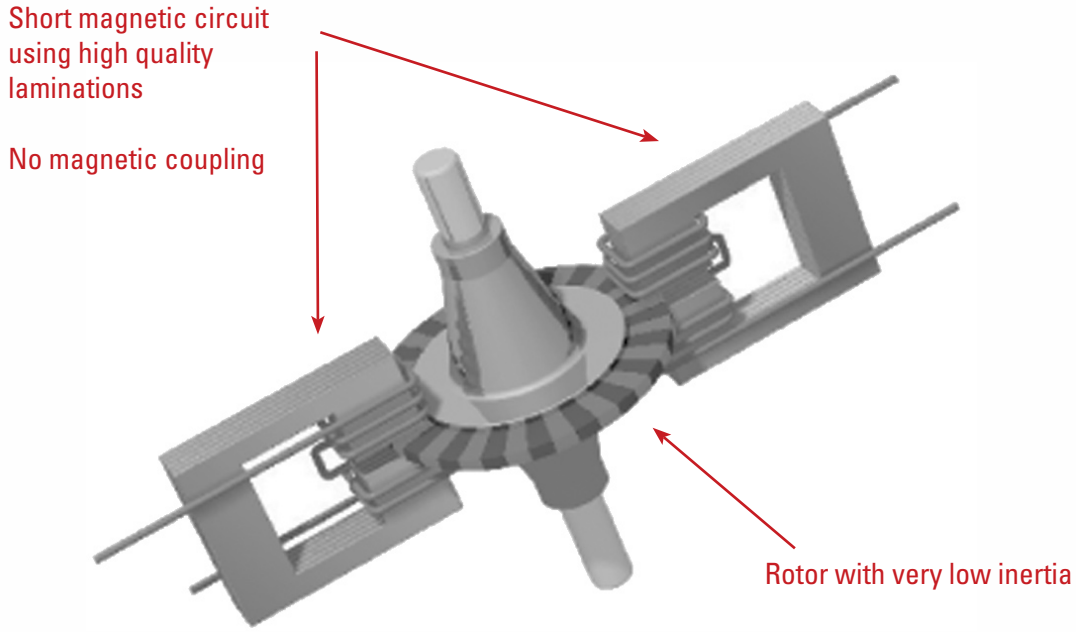
- **Outer diameter - 10 mm to 52 mm**
- **Output speed - up to 10,000 rpm**
- **Step angle – 3.6°, 6°, 9° & 15°**
- **Output torque - up to 350 mNm**

TurboDisc Motor Basics

The High Performance Disc Magnet Technology

The exceptional possibilities offered by the Turbo Disc line of disc magnet stepper motors are unequalled by any other kind of stepper motor. The advanced technology, developed and patented by Portescap, allows for truly exceptional dynamic performance. The rotor of these motors consists of a rare earth magnet having the shape of a thin disc which is axially magnetized. A particular magnetization method allows for a high number of magnetic poles, giving much smaller step angles than conventional two-phase permanent magnet stepper motors.

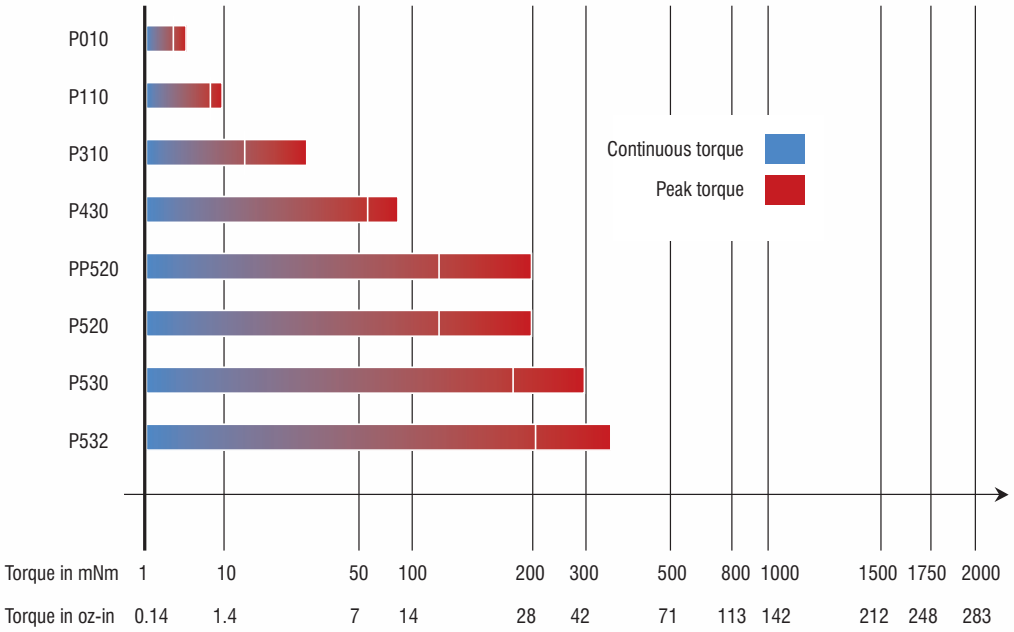
Such a rotor design has a very low moment of inertia, resulting in outstanding acceleration and dynamic behavior. These features, together with high peak speeds, mean that any incremental movement is carried out in the shortest possible time. Low inertia also means high start/stop frequencies allowing to save time during the first step and to solve certain motion problems without applying a ramp. Those motors, specially designed for microstepping, feature a sinusoidal torque function with very low harmonic distortion and low detent torque. Excellent static and dynamic accuracy is obtained for any position and under any load or speed conditions.



Concept Detail	Motor Characteristics	Advantages for the application
Thin multipolar rare earth disc magnet	Very low motor inertia	Very high acceleration, high start/stop frequencies
Very short iron circuit made of SiFe / NdFeB laminations, Coils placed near to the airgap	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

How to select your TurboDisc stepper

TurboDisc Motor Torque Range



TurboDisc Motor Designation

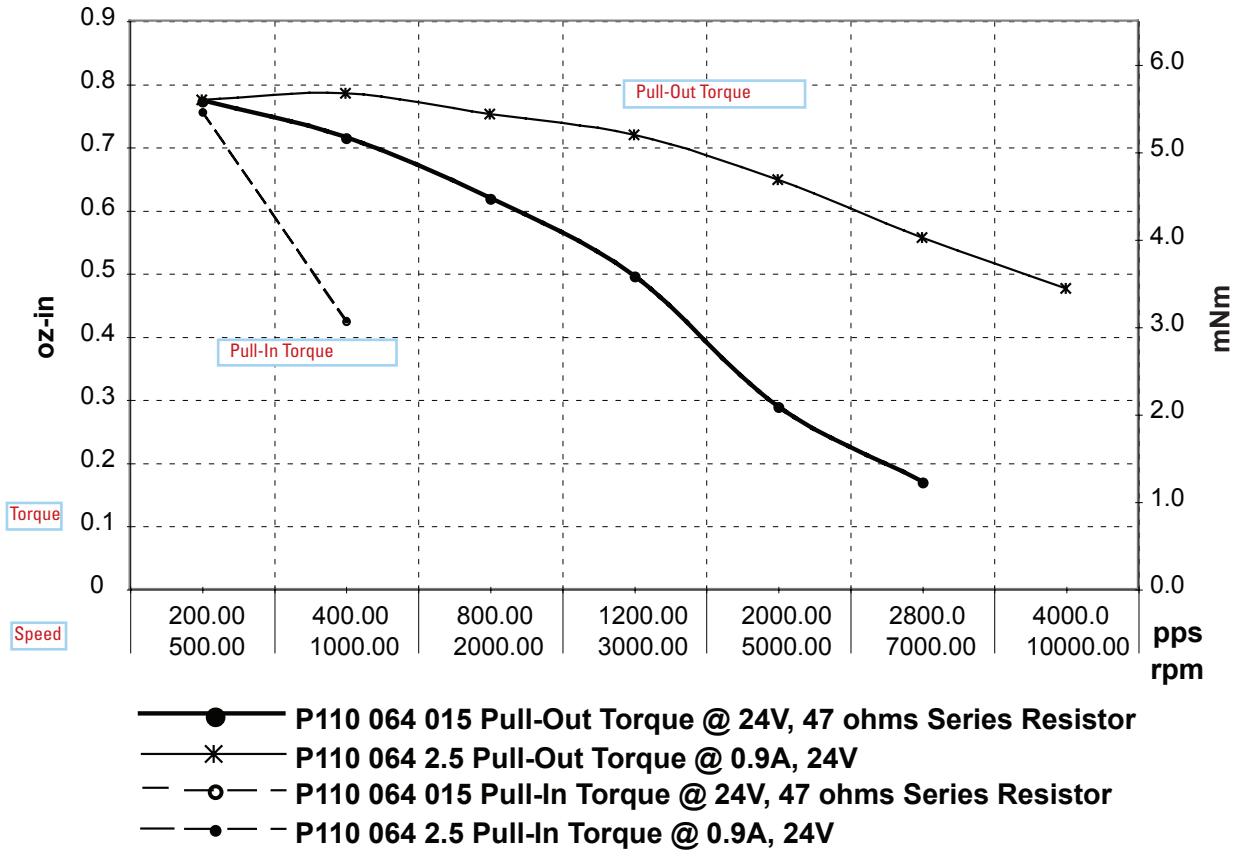
P	X	5	3	2	-25	8	012	14	V
TurboDisc	Internal Code	Code of diameter	Code of length	Motor version of full/half-step = 2 Motor version of microstep = 0	Number of rotor pole pairs	Number of connections or terminal wires	Resistance per winding	Motor execution code	Particular option

Explanation of Specifications

MOTOR PART NUMBER			P110 064 068 08/12	EXPLANATION
RATED VOLTAGE		vdc	12.00	Voltage rating of motor - motor can be run continuously at this voltage
RESISTANCE PER PHASE, ± 10%		ohms	62.00	Winding resistance dictated by magnet wire diameter and # of turns
INDUCTANCE PER PHASE, TYP		mH	46.00	Winding inductance dictated by magnet wire diameter and # of turns
RATED CURRENT PER PHASE *		amps	0.12	Current rating of motor - motor can be run continuously at this current
BACK-EMP AMPLITUDE		V/kst/s	10.80	The torque constant of the motor - the back EMF generated by the motor when externally spun at 1000 steps per second
HOLDING TORQUE, TYPICAL *		oz-in / mNm	1.0 / 7	When energized, the amount of torque to move from one mechanical step to the next
DETENT TORQUE, TYPICAL		oz-in / mNm	0.1 / 1	When un-energized, the amount of torque to move from one mechanical step to the next
STEP ANGLE, ± 10% *		degrees	15.00	360 deg / number of mechanical steps of the motor
STEPS PER REVOLUTION *		-	24.00	Number of mechanical steps of the motor
NATURAL RESONANCE FREQUENCY (NOMINAL CURRENT)		Hz	160.00	The frequency at which the motor vibrates at maximum amplitude
ELECTRICAL TIME CONSTANT		ms	0.80	Represents the time it takes for the input current to the motor coil to reach approximately 63% of its final value
ANGULAR ACCELERATION (NOMINAL CURRENT)		rad/s2	167000.00	The rotational acceleration of the motor when supplied with nominal current
THERMAL RESISTANCE		°C/watt	45.00	
ROTOR MOMENT OF INERTIA		oz-in-s2/ g-cm2	0.057 x 10E-4 / 0.4	Inertia of the rotor
AMBIENT TEMPERATURE RANGE	OPERATING	°C	-20 ~ +50	Temperature range which the motor will operate
	STORAGE	°C	-40 ~ +85	Storage temperature where the motor will operate
BEARING TYPE		-	SINTERED BRONZE SLEEVE (Optional Ball Bearing on request)	Bearings on front and rear of the motor
INSULATION RESISITANCE AT 500VDC		Mohms	100 MEGOHMS	
DIELECTRIC WITHSTANDING VOLTAGE		vac	300 FOR 5 SECONDS	
WEIGHT		lbs / g	0.05 / 23	Weight of the motor
SHAFT LOAD RATINGS, MAX AT 1500 RPM	RADIAL	lbs / N	0.12 / 0.5 (AT SHAFT CENTER)	Maximum load that can be applied against the shaft
	AXIAL	lbs / N	0.12 / 0.5 (BOTH DIRECTIONS)	Maximum load that can be applied directly down the shaft
LEADWIRES		-	Insulated Cable, AWG 26	Rating of the lead wires
TEMPERATURE CLASS, MAX		_	B (130°C)	Maximum temperature of the winding insulation
RoHS		_	COMPLIANT	

P010 064 015 /P110 064 003

Pull-Out Torque vs Speed • Full step, bipolar voltage

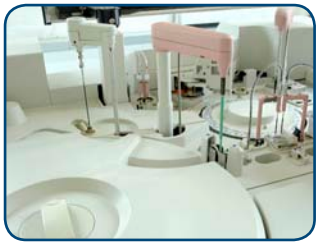


Definitions

Pull-Out Torque	The amount of torque that the motor can produce at speed without stalling
Pull-In Torque	The amount of torque that the motor can produce from zero speed without stalling
Speed	# of pulses per second provided to the motor, also stated in revolutions per minute
Voltage	Voltage applied to the drive
Current	Current applied to the drive
Drive	Chopper type drive - current controlled to the motor winding

Where to apply your TurboDisc stepper

The TurboDisc stepper provides the highest torque to inertia ratio and is ideal for applications requiring, fast and precise positioning.

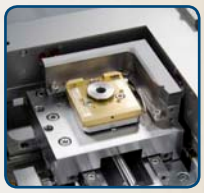


Focus On: Medical Analyzer

Portescap's challenge for the application was maximum torque in a small diameter package. speed capability of the TurboDisc allowed a hi gear ratio to be utilized, yielding an increase i output torque at the desired speed. The disc magnet design creates quick response time for the motor, increasing the throughput of the machine.

Textile

- Yarn monitoring system
- Electronic wire winding



Factory Automation

- Pick & place machines
- Head positioning
- Die bonding
- Wafer handling
- Feeders

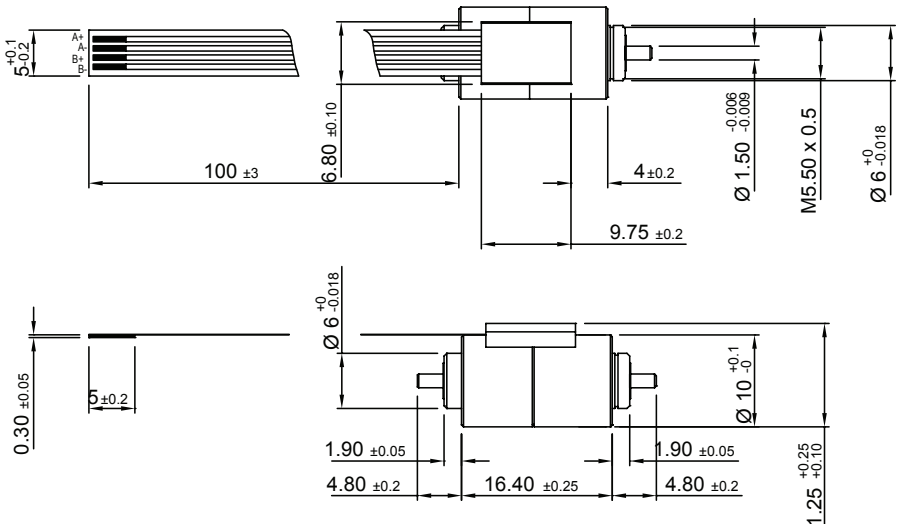
Medical & Lab Automation

- Analyzers
- Syringe pumps
- Pipettes
- Milling machines
- Prosthetics

Other Industries & Applications

- Engraving
- Laser cutting
- Bar code scanning
- Aircraft instrumentation
- Fiber optic splicers
- Mail sorting

24 steps/revolution
15º step angle

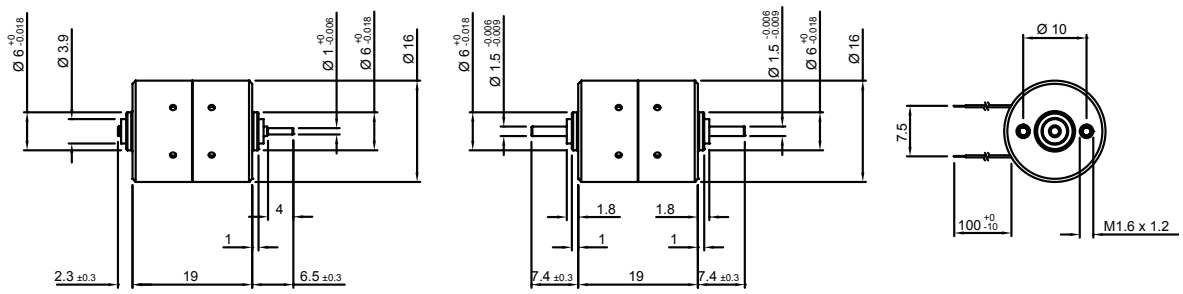


P010 • 064 ▪▪ • 02

Motor Part Number		P010 064 020 02	P010 064 003 02
Rated voltage	vdc	3.00	1.50
Resistance per phase, ± 10%	ohms	20.00	3.00
Inductance per phase, typ	mH	13.70	1.80
Rated current per phase *	amps	0.15	0.43
Back-emf amplitude	V/kst/s	2.30	0.81
Holding torque, typical *	oz-in / mNm	0.26 / 1.85	
Detent torque, typical	oz-in / mNm	0.06 / 0.4	
Step angle, ± 10% *	degrees	15.0	
Steps per revolution *		24	
Natural resonance frequency (nominal current)	Hz	200.00	
Electrical time constant	ms	0.6	
Angular acceleration (nominal current)	rad/s²	265,000	
Thermal resistance	ºC/watt	100.00	
Rotor moment of inertia	oz-in-s²/ g-cm²	0.010 x 10E^{-4} / 0.07	
Ambient temperature range			
Operating	ºC	-20 ~ +50	
Storage	ºC	-40 ~ +85	
Bearing type		ball bearing	
Insulation resisitance at 500vdc	Mohms	100 megohms	
Dielectric withstanding voltage	vac	200 for 5 seconds	
Weight	lbs / g	0.02 / 9	
Shaft load ratings, max at 1500 rpm			
Radial	lbs / N	0.56 / 2.5 (at shaft center)	
Axial	lbs / N	0.56 / 2.5 (both directions)	
Leadwires	Flex Circuit reinforcement for connector ZIP ZMP pitch 1mm		
Temperature class, max		B (130°C)	
RoHS		COMPLIANT	

ALL MOTOR DATA VALUES AT 25ºC UNLESS OTHERWISE SPECIFIED
* ENERGISE AT RATED CURRENT, 2 PHASE ON

24 steps/revolution
15º step angle

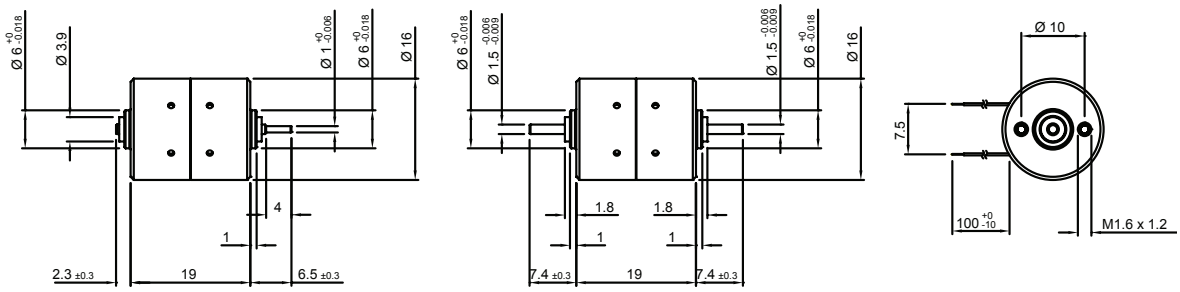


P110 • 064 ▪▪ • 08 **P110 • 064 ▪▪ • 12**

Motor Part Number		P110 064 068 08/12	P110 064 015 08/12	P110 064 2.5 08/12
Rated voltage	vdc	12.00	6.00	3.00
Resistance per phase, ± 10%	ohms	62.00	15.00	2.50
Inductance per phase, typ	mH	46.00	12.00	2.20
Rated current per phase *	amps	0.12	0.25	0.65
Back-emf amplitude	V/kst/s	10.80	5.20	2.00
Holding torque, typical *	oz-in / mNm		1.0 / 7	
Detent torque, typical	oz-in / mNm		0.1 / 1	
Step angle, ± 10% *	degrees		15.0	
Steps per revolution *			24.0	
Natural resonance frequency (nominal current)	Hz		160.00	
Electrical time constant	ms		0.8	
Angular acceleration (nominal current)	rad/s^2		167,000	
Thermal resistance	ºC/watt		45.0	
Rotor moment of inertia	oz-in-s^2/ g-cm^2		0.057 x 10E^{-4} / 0.4	
Ambient temperature range				
Operating	ºC		-20 ~ +50	
Storage	ºC		-40 ~ +85	
Bearing type		Sintered bronze sleeve (optional ball bearing on request)		
Insulation resisitance at 500vdc	Mohms		100 megohms	
Dielectric withstanding voltage	vac		300 for 5 seconds	
Weight	lbs / g		0.05 / 23	
Shaft load ratings, max at 1500 rpm				
Radial	lbs / N		0.11 / 0.5 (at shaft center)	
Axial	lbs / N		0.11 / 0.5 (both directions)	
Leadwires			Insulated Cable, AWG 26	
Temperature class, max			B (130°C)	
RoHS			COMPLIANT	

ALL MOTOR DATA VALUES AT 25ºC UNLESS OTHERWISE SPECIFIED
* ENERGISE AT RATED CURRENT, 2 PHASE ON

40 steps/revolution
9º step angle

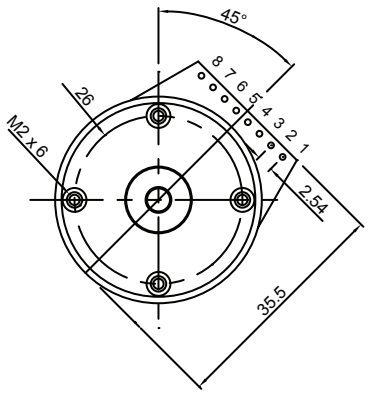


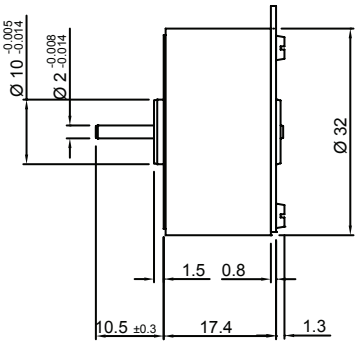
P110 • 104 ▪▪ • 08 **P110 • 104 ▪▪ • 12**

Motor Part Number		P110 104 068 08/12	P110 104 015 08/12	P110 104 2.5 08/12
Rated voltage	vdc	12.00	6.00	3.00
Resistance per phase, ± 10%	ohms	62.00	15.00	2.50
Inductance per phase, typ	mH	46.00	12.00	2.20
Rated current per phase *	amps	0.12	0.25	0.65
Back-emf amplitude	V/kst/s	5.70	2.75	1.10
Holding torque, typical *	oz-in / mNm		0.864 / 6.1	
Detent torque, typical	oz-in / mNm		0.085 / 0.6	
Step angle, ± 10% *	degrees		9.0	
Steps per revolution *			40.0	
Natural resonance frequency (nominal current)	Hz		200.00	
Electrical time constant	ms		0.8	
Angular acceleration (nominal current)	rad/s²		150,000	
Thermal resistance	ºC/watt		45.0	
Rotor moment of inertia	oz-in-s²/ g-cm²		0.057 x 10E-4 / 0.4	
Ambient temperature range				
Operating	ºC		-20 ~ +50	
Storage	ºC		-40 ~ +85	
Bearing type		Sintered bronze sleeve (optional ball bearing on request)		
Insulation resisitance at 500vdc	Mohms		100 megohms	
Dielectric withstanding voltage	vac		300 for 5 seconds	
Weight	lbs / g		0.05 / 23	
Shaft load ratings, max at 1500 rpm				
Radial	lbs / N		0.11 / 0.5 (at shaft center)	
Axial	lbs / N		0.11 / 0.5 (both directions)	
Leadwires			Insulated Cable, AWG 26	
Temperature class, max			B (130°C)	
RoHS			COMPLIANT	

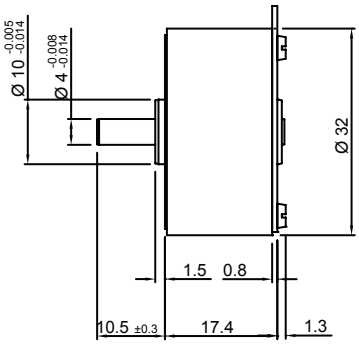
ALL MOTOR DATA VALUES AT 25ºC UNLESS OTHERWISE SPECIFIED
* ENERGISE AT RATED CURRENT, 2 PHASE ON

60 steps/revolution
6º step angle





P310 • 158 ▪▪ • 09

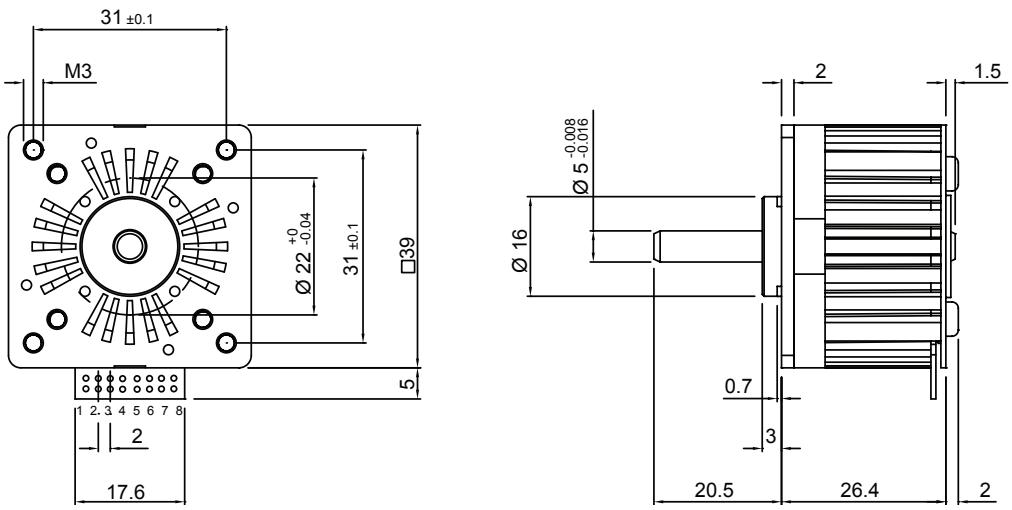


P310 • 158 ▪▪ • 10

Motor Part Number		P310 158 170 09		P310 158 005 09	
		Series	Parallel	Series	Parallel
Rated voltage	vdc	20.00	10.00	6.00	6.00
Resistance per phase, ± 10%	ohms	332.00	83.00	10.50	2.60
Inductance per phase, typ	mH	184.00	46.00	6.40	1.60
Rated current per phase *	amps	0.06	0.12	0.36	0.72
Back-emf amplitude	V/kst/s	18.00	9.00	3.20	1.60
Holding torque, typical *	oz-in / mNm	2.0 / 14			
Detent torque, typical	oz-in / mNm	0.3 / 2.5			
Step angle, ± 10% *	degrees	6.0			
Steps per revolution *		60			
Natural resonance frequency (nominal current)	Hz	230.00			
Electrical time constant	ms	0.60			
Angular acceleration (nominal current)	rad/s²	140,000			
Thermal resistance	ºC/watt	25.00			
Rotor moment of inertia	oz-in-s²/ g-cm²	0.122 X 10E-4 / 0.86			
Ambient temperature range					
Operating	ºC	-20 ~ +50			
Storage	ºC	-40 ~ +85			
Bearing type		Sintered bronze sleeve or ball bearings			
Insulation resisitance at 500vdc	Mohms	100 megohms			
Dielectric withstanding voltage	vac	500 for 2 seconds			
Weight	lbs / g	0.09 / 40			
Shaft load ratings, max at 1500 rpm					
Radial	lbs / N	0.22 / 1.0, 2.2^ / 10^ (at shaft center)			
Axial	lbs / N	0.11 / 0.5, 4.5^ / 20^ (both directions)			
Leadwires		NA (PCB connection)			
Temperature class, max		B (130°C)			
RoHS		COMPLIANT			

ALL MOTOR DATA VALUES AT 25ºC UNLESS OTHERWISE SPECIFIED
* ENERGISE AT RATED CURRENT, 2 PHASE ON
^ Ball bearings

100 steps/revolution
3.6º step angle



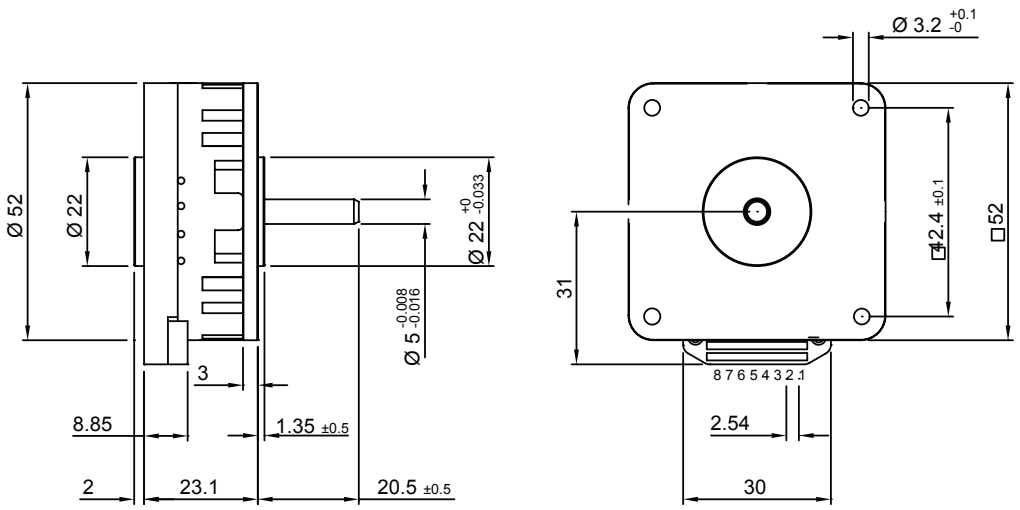
P430 • 258 ▪▪ • 01

Motor Part Number		P430 258 013 01		P430 258 005 01	
		Series	Parallel	Series	Parallel
Rated voltage	vdc	12.00	12.00	12.00	12.00
Resistance per phase, ± 10%	ohms	26.00	6.50	10.00	2.50
Inductance per phase, typ	mH	40.00	10.00	14.00	3.50
Rated current per phase *	amps	0.34	0.68	0.56	1.12
Back-emf amplitude	V/kst/s	7.50	3.80	4.70	2.30
Holding torque, typical *	oz-in / mNm	8.5 / 60			
Detent torque, typical	oz-in / mNm	0.5 / 3.5			
Step angle, ± 10% *	degrees	3.60			
Steps per revolution *		100			
Natural resonance frequency (nominal current)	Hz	360.00			
Electrical time constant	ms	1.50			
Angular acceleration (nominal current)	rad/s²	200,000			
Thermal resistance	ºC/watt	11.00			
Rotor moment of inertia	oz-in-s²/ g-cm²	0.425 x 10E-4 / 3.0			
Ambient temperature range					
Operating	ºC	-20 ~ +50			
Storage	ºC	-40 ~ +85			
Bearing type		Radial ball bearings			
Insulation resisitance at 500vdc	Mohms	100 megohms			
Dielectric withstanding voltage	vac	500 for 5 seconds			
Weight	lbs / g	0.22 / 100			
Shaft load ratings, max at 1500 rpm					
Radial	lbs / N	4.5 / 20 (at shaft center)			
Axial	lbs / N	6.7 / 30 (both directions)			
Leadwires		NA (PCB connection)			
Temperature class, max		B (130°C)			
RoHS		COMPLIANT			

ALL MOTOR DATA VALUES AT 25ºC UNLESS OTHERWISE SPECIFIED
* ENERGISE AT RATED CURRENT, 2 PHASE ON

Turbo Disc™ P520

100 steps/revolution
3.6° step angle

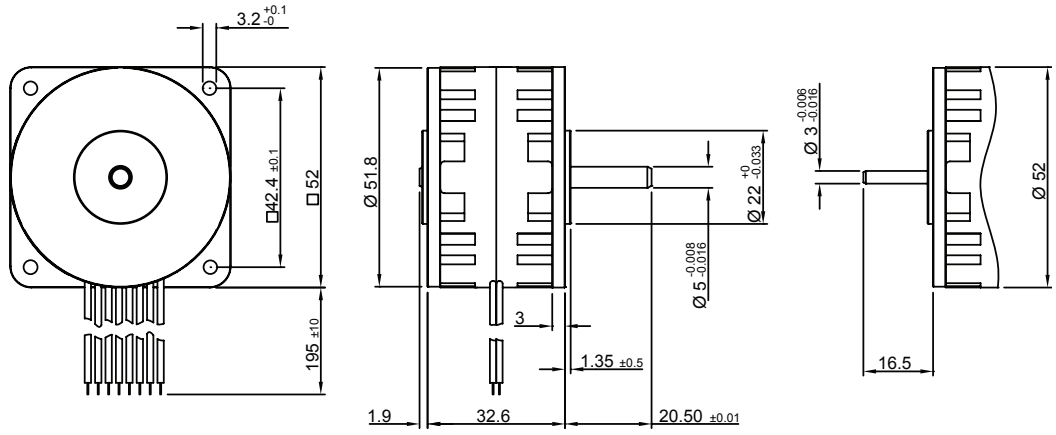


PP520 • 258 ▪▪• 01

Motor Part Number		P520 254 013 60 PP520 258 013 01	P520 254 004 60 PP520 258 004 01	P520 254 0.7 60 PP520 258 0.7 01
Rated voltage	vdc	12.00	12.00	12.00
Resistance per phase, ± 10%	ohms	13.50	4.40	0.70
Inductance per phase, typ	mH	27.00	8.00	1.30
Rated current per phase *	amps	0.50	0.90	2.30
Back-emf amplitude	V/kst/s	9.80	5.50	2.10
Holding torque, typical *	oz-in / mNm		17 / 120	
Detent torque, typical	oz-in / mNm		1.4 / 10	
Step angle, ± 10% *	degrees		3.60	
Steps per revolution *			100.00	
Natural resonance frequency (nominal current)	Hz		250.00	
Electrical time constant	ms		1.80	
Angular acceleration (nominal current)	rad/s²		100,000	
Thermal resistance	°C/watt		9.50	
Rotor moment of inertia	oz-in-s²/ g-cm²		1.7 x 10E-4 / 12	
Ambient temperature range				
Operating	°C		-20 ~ +50	
Storage	°C		-40 ~ +85	
Bearing type			Radial Ball Bearings	
Insulation resisitance at 500vdc	Mohms		100 megohms	
Dielectric withstanding voltage	vac		500 for 5 seconds	
Weight	lbs / g		0.40 / 180	
Shaft load ratings, max at 1500 rpm				
Radial	lbs / N		4.5 / 20 (at shaft center)	
Axial	lbs / N		6.7 / 30 (both directions)	
Leadwires			Insulated Cable, AWG 24	
Temperature class, max			B (130°C)	
RoHS			COMPLIANT	

ALL MOTOR DATA VALUES AT 25°C UNLESS OTHERWISE SPECIFIED
* ENERGISE AT RATED CURRENT, 2 PHASE ON

100 steps/revolution
3.6º step angle



P530 • 258 ▪▪• 10

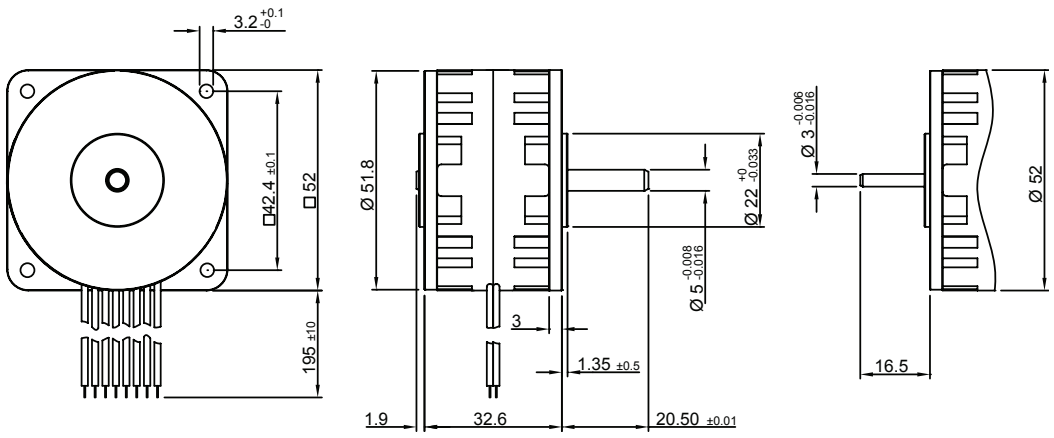
P530 • 258 ▪▪• 84

Motor Part Number		P530 258 012 10/84	P530 258 004 10/84		P530 258 0.7 10/84
		Series	Parallel	Series	Parallel
Rated voltage	vdc	15.00	12.00	6.00	3.00
Resistance per phase, ± 10%	ohms	27.00	8.80	2.20	0.35
Inductance per phase, typ	mH	64.00	20.00	5.00	0.70
Rated current per phase *	amps	0.40	0.70	1.40	3.70
Back-emf amplitude	V/kst/s	20.00	11.00	5.50	2.10
Holding torque, typical *	oz-in / mNm	25 / 175			
Detent torque, typical	oz-in / mNm	1.4 / 10			
Step angle, ± 10% *	degrees	3.60			
Steps per revolution *		100			
Natural resonance frequency (nominal current)	Hz	300.00			
Electrical time constant	ms	2.30			
Angular acceleration (nominal current)	rad/s²	141,000			
Thermal resistance	ºC/watt	7.30			
Rotor moment of inertia	oz-in-s²/ g-cm²	1.7 X 10E-4 / 12			
Ambient temperature range					
Operating	ºC	-20 ~ +50			
Storage	ºC	-40 ~ +85			
Bearing type		Ball bearings			
Insulation resisitance at 500vdc	Mohms	100 megohms			
Dielectric withstanding voltage	vac	500 for 5 seconds			
Weight	lbs / g	0.55 / 250			
Shaft load ratings, max at 1500 rpm					
Radial	lbs / N	4.5 / 20.0 (at shaft center)			
Axial	lbs / N	6.75 / 30.0 (both directions)			
Leadwires		INSULATED CABLE, 0.25 mm2 (AWG 24)			
Temperature class, max		B (130°C)			
RoHS		COMPLIANT			

ALL MOTOR DATA VALUES AT 25ºC UNLESS OTHERWISE SPECIFIED
* ENERGISE AT RATED CURRENT, 2 PHASE ON

Turbo Disc™ P532

100 steps/revolution
3.6º step angle



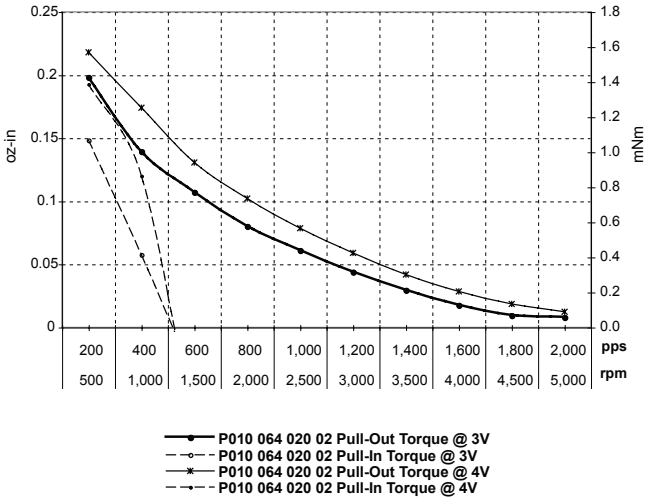
P532 • 258 ▪▪ • 10

P532 • 258 ▪▪ • 84

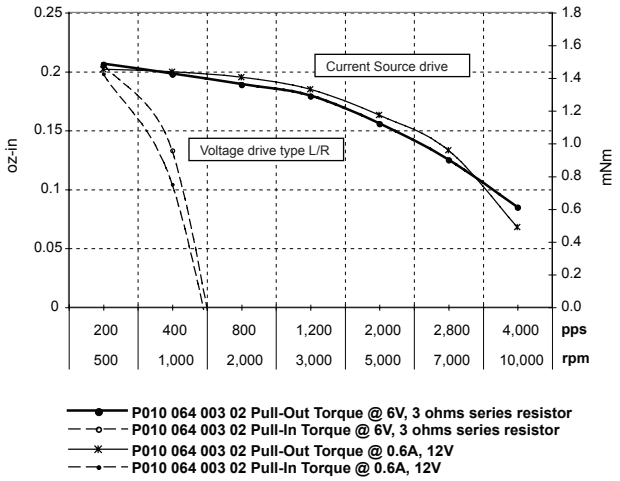
Motor Part Number		P532 258 012 10/84	P532 258 004 10/84		P532 258 0.7 10/84
		Series	Parallel	Series	Parallel
Rated voltage	vdc	15.00	12.00	6.00	3.00
Resistance per phase, ± 10%	ohms	27.00	8.80	2.20	0.35
Inductance per phase, typ	mH	64.00	20.00	5.00	0.70
Rated current per phase *	amps	0.40	0.70	1.40	3.70
Back-emf amplitude	V/kst/s	21.00	12.00	6.00	2.30
Holding torque, typical *	oz-in / mNm	29 / 205			
Detent torque, typical	oz-in / mNm	4.0 / 28			
Step angle, ± 10% *	degrees	3.60			
Steps per revolution *		100			
Natural resonance frequency (nominal current)	Hz	330.00			
Electrical time constant	ms	2.30			
Angular acceleration (nominal current)	rad/s²	171,000			
Thermal resistance	ºC/watt	7.30			
Rotor moment of inertia	oz-in-s²/ g-cm²	1.7 X 10E-4 / 12			
Ambient temperature range					
Operating	ºC	-20 ~ +50			
Storage	ºC	-40 ~ +85			
Bearing type		Ball bearings			
Insulation resisitance at 500vdc	Mohms	100 megohms			
Dielectric withstanding voltage	vac	500 for 5 seconds			
Weight	lbs / g	0.55 / 250			
Shaft load ratings, max at 1500 rpm					
Radial	lbs / N	4.5 / 20.0 (at shaft center)			
Axial	lbs / N	6.7 / 30.0 (both directions)			
Leadwires		INSULATED CABLE, 0.25 mm² (AWG 24)			
Temperature class, max		B (130°C)			
RoHS		COMPLIANT			

ALL MOTOR DATA VALUES AT 25ºC UNLESS OTHERWISE SPECIFIED
* ENERGISE AT RATED CURRENT, 2 PHASE ON

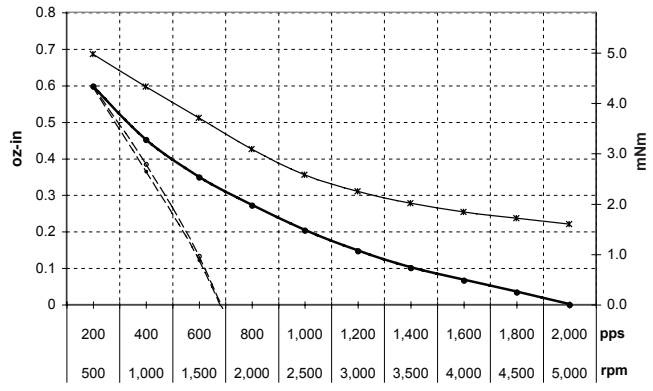
P010 064 020 02
Torque vs Speed
Full step, bipolar voltage drive



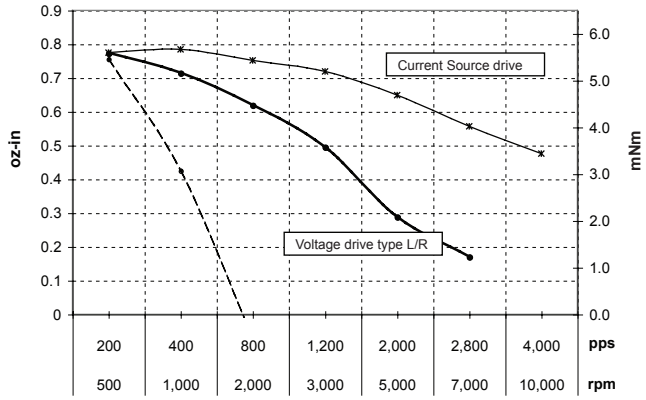
P010 064 003 02
Torque vs Speed
Full step, bipolar voltage/current drive



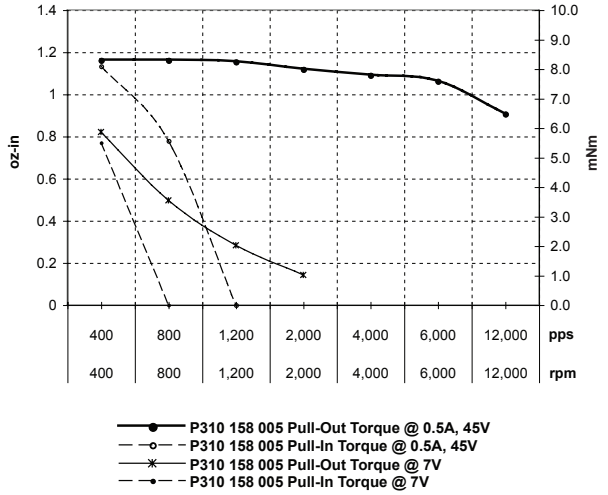
P110 064 068
Torque vs Speed
Full step, bipolar voltage drive



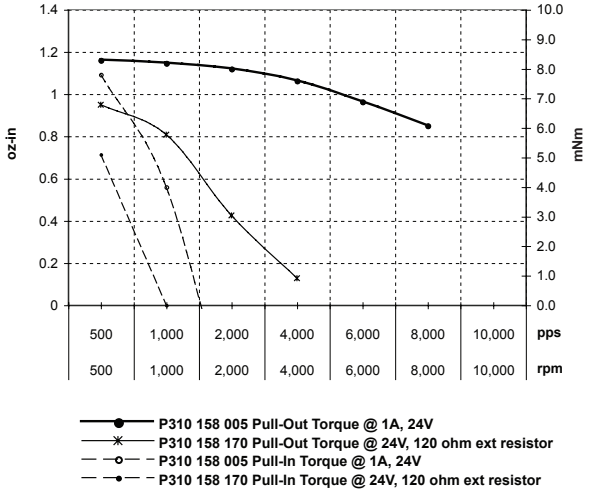
P110 064 015 / P110 064 003
Torque vs Speed
Full step, bipolar voltage



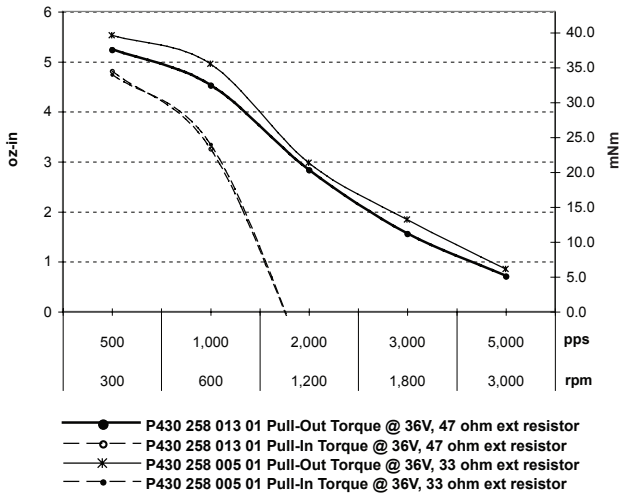
P310 158 005, P310 158 170 Series
Torque vs Speed
Full step, bipolar voltage drive



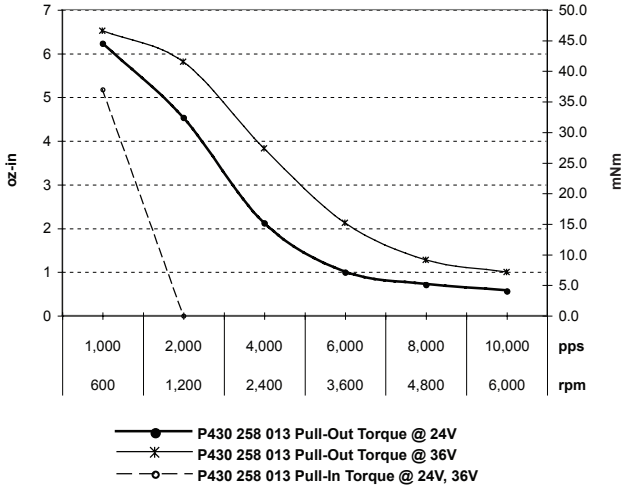
P310 158 005, P310 158 170 Parallel
Torque vs Speed
Full step, bipolar voltage drive



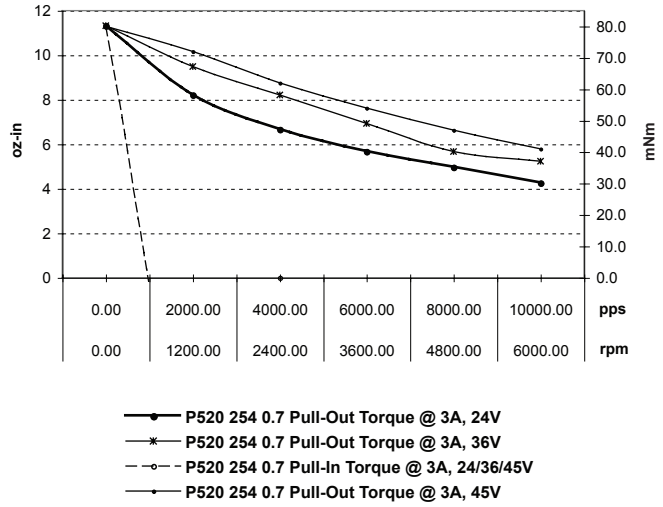
P430 258 013, P430 258 005 Series
Torque vs Speed
Full step, bipolar voltage drive



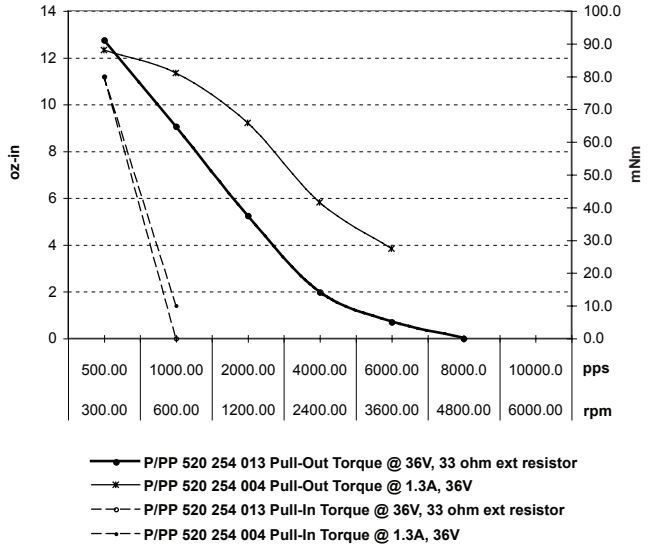
P430 258 013 Parallel
Torque vs Speed
Full step, bipolar voltage drive



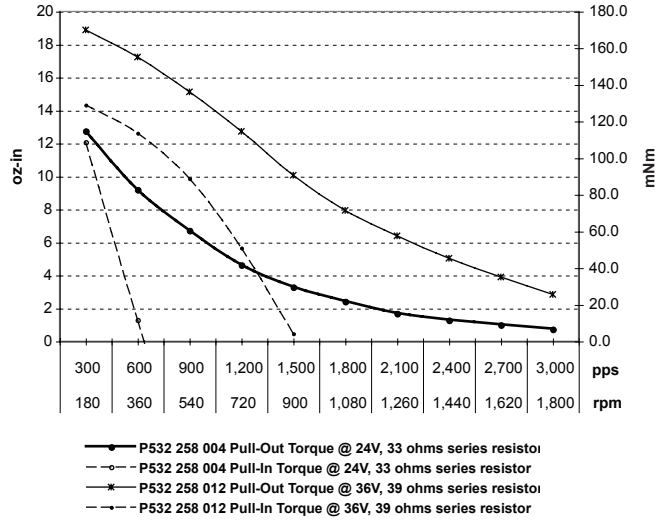
P520 254 0.7
Torque vs Speed
vdc, half step, bipolar voltage drive



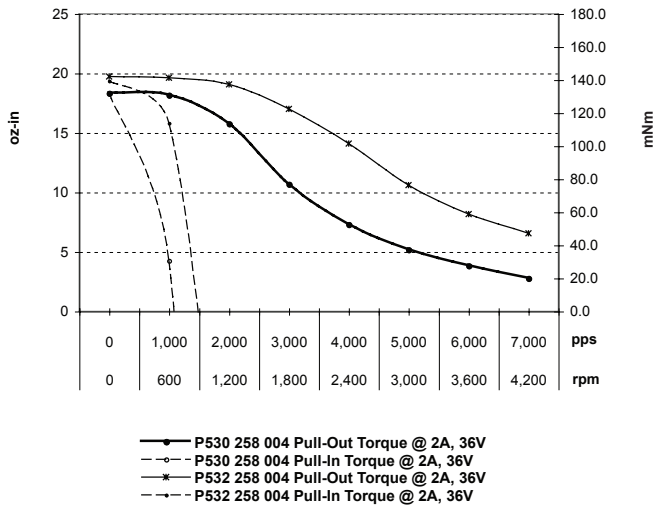
P/PP 520 254 013, P/PP 520 254 004 Series
Torque vs Speed
36 vdc, half step, bipolar voltage drive



P532 258 004, P532 258 012 Series
Torque vs Speed
Full step, bipolar voltage drive



P530 258 004, P532 258 004 Parallel
Torque vs Speed
Full step, bipolar voltage drive



Motor and sensor phase signals in electrical degrees for PP520
(CW operation as viewed from front of motor)