



# Data Sheet

## Hybrid stepper motors

Size	Rear shaft	No. of wires	RS stock no.
17	No	6	440-420
	Yes		440-436
	No		191-8299
	No		191-8306
23	No	8	440-442
	Yes	8	440-458
	No	6	191-8328
	No	6	191-8334
	No	6	191-8340
	No	6	191-8356
	No	6	191-8362
	No	8	191-8378
34	Yes	8	440-464
	No	8	440-470

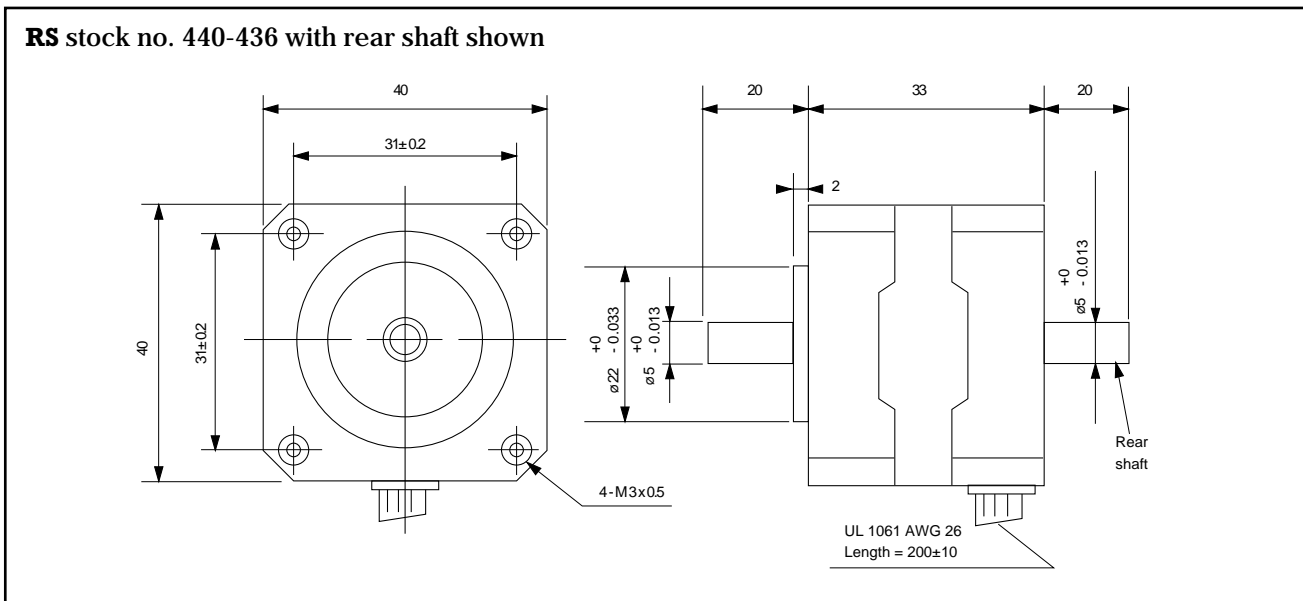
These 4 phase hybrid stepper motors are capable of delivering much higher working torques and stepping rates than permanent magnet (7.5° and 15°) types. Whilst at the same time maintaining a high detent torque even when not energised. This feature is particularly important for positional integrity. Many of the motors are directly compatible with the RS stepper motor drive boards (RS stock nos. 332-098, 342-051 and 440-240).

Size 34 motors and a number of size 23 motors are supplied in 8-lead configuration which allows the maximum flexibility when connecting to the drive boards.

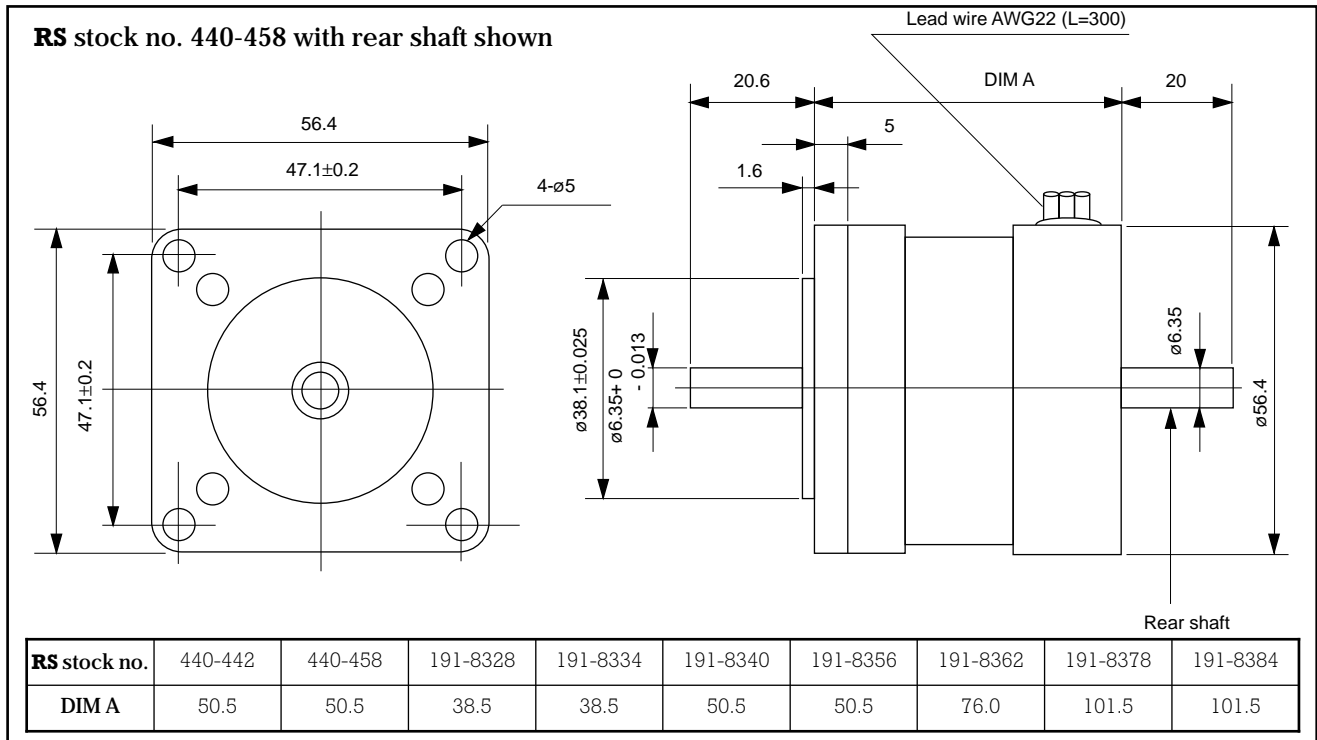
Rear extension shafts are provided on three of the motors to enable connection of other drive requirements and feedback devices.



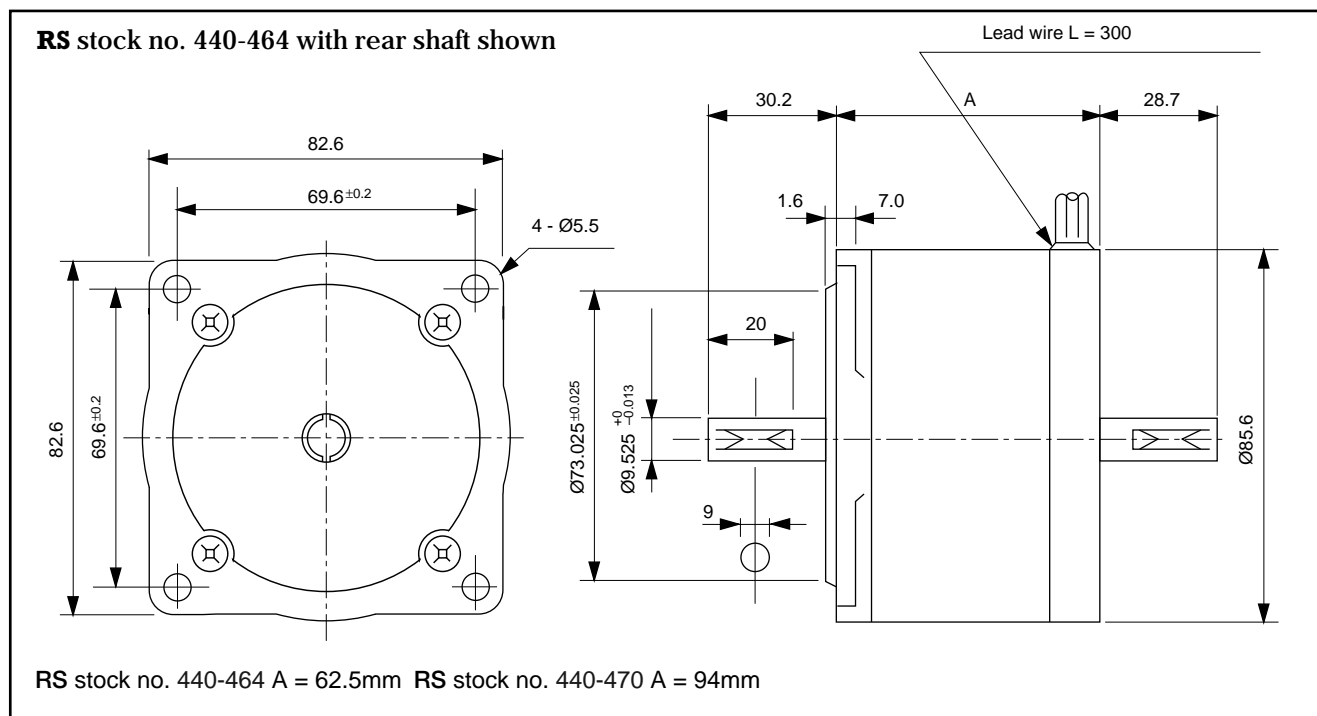
### Size 17



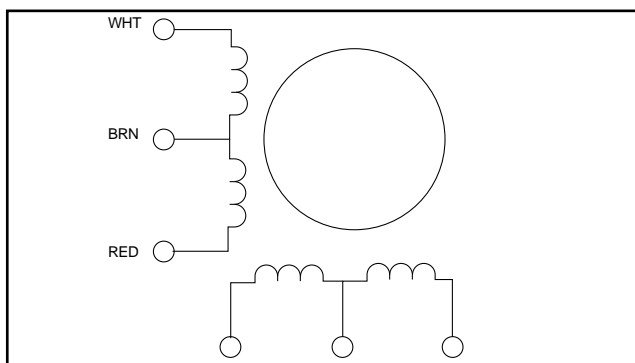
Size 23



Size 34

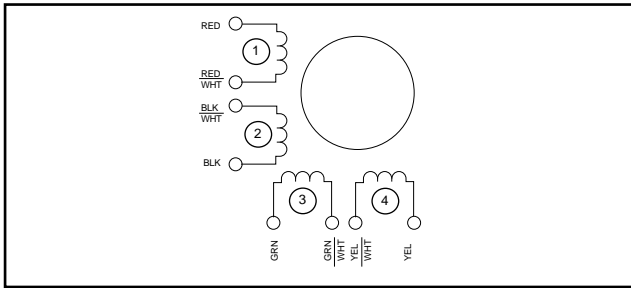


6 Wire configuration



Exciting sequence and direction of rotation when facing mounting flange end.						
Step	White	Blue	Red	Yellow	Brown	CW
1	On	On			+dcV	↓
2		On	On			
3			On	On		
4	On			On		

### 8 Wire configuration



Exciting sequence and direction of rotation when facing mounting flange end.						
Step	Red	Green	Black	Yellow	Com	CW
1	On	On			+dcV	↓
2		On	On			
3			On	On		
4	On			On		

### Technical specification

RS stock no.	440-420	440-436	440-442	440-458	440-464	440-470
Rated voltage (V)	5	12	5	12	3	2.5
Rated current (I)	0.5	0.16	1	0.6	2	4.5
Resistance ( $\Omega$ )	10	75	5	20	1.5	0.56
Inductance (mH)	6	36	9	32	4.5	2.8
Detent torque (mHm)	5	4	30	30	40	100
Holding torque (mNm)	70	70	500	500	1200	2200
Step angle accuracy (%)	5	5	5	5	5	5
Step angle	1.8	1.8	1.8	1.8	1.8	1.8
Insulation class	B	B	B	B	B	B

RS stock no.	191-8299	191-8306	191-8328	191-8334	191-8340	191-8356	191-8362	191-8378	191-8384
Rated voltage (V)	12	15	5	12	12	12	5.4	3.4	6
Rated current (I)	0.4	0.4	1	0.4	0.48	0.6	1.4	2.85	1.8
Resistance ( $\Omega$ )	30	45	5	40	25	20	3.8	1.2	3.5
Inductance (mH)	14	22	5.7	40	33	32	6.8	1.5	7.3
Detent torque (mHm)	3.5	3.5	14.8	14.8	29.6	29.6	56.5	77.6	77.6
Holding torque (mNm)	100	100	260	260	494	494	882	1200	1200
Step angle accuracy (%)	5	5	5	5	5	5	5	5	5
Step angle	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Insulation class	B	B	B	B	B	B	B	B	B

### Resonance

Certain operating frequencies cause resonance and the motor loses track of the drive input. Audible vibration may accompany resonance conditions. These frequencies should be avoided if possible. Driving the motor on the half step mode (see motor drive methods) greatly reduces the effect of resonance. Alternatively extra load inertia and external damping may be added to shift resonance regions away from the operating frequency.

### Motor drive methods

The normal way of driving a 4-phase stepper motor is shown in Figure 1.

This is commonly known as the 'Unipolar L/nr drive'. Here the current in each winding, when energised, flows in one direction only 'n', value is  $\geq 1$  (but not necessarily an integer) and nR is the sum of the external resistance plus the winding resistance (R). By selecting a higher value for n (ie. larger external resistance) and using a higher dc supply to maintain the rated voltage and current for each winding, improved torque speed characteristics can be obtained. Thus a 6V, 6 $\Omega$  motor (1A per phase) can be driven from a 6Vdc supply without any series resistor, in the L/R mode. Alternatively it can be driven from a 24Vdc supply using 18 $\Omega$  series resistance in the L/4R mode with much improved performance.

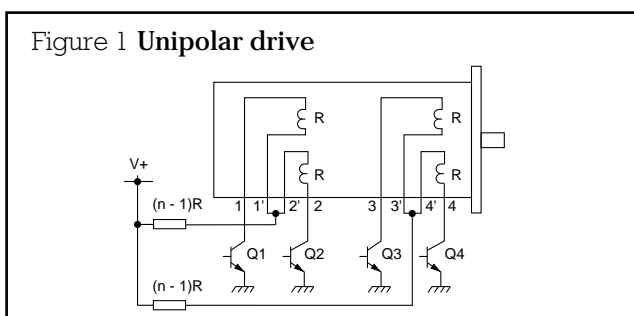
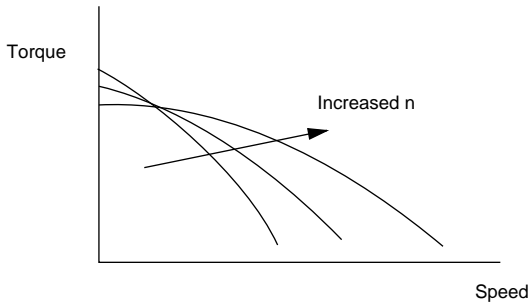


Figure 1 Unipolar drive

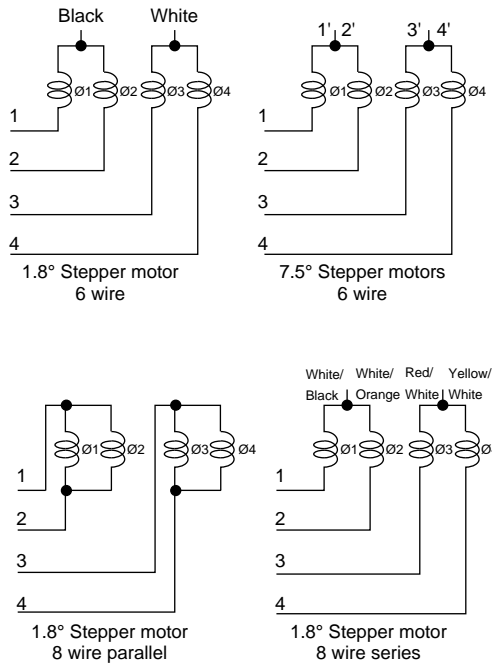
Figure 2 Effect on motor performance of higher supply voltages and larger series limiting resistance



Connection to RS bipolar stepper motor board

When the windings of the RS stepper motors are assigned (Ø1-Ø4) as shown in Figure 3, they can be connected to the board according to Figure 1.

Figure 3 Typical motor winding connections



When using 8 lead motors with coils in parallel the motor current should be set no greater than:

$$I \text{ per phase} \times \sqrt{2}$$

When using 6 lead or 8 lead motors with coils in series the motor current should be set no greater than:

$$I \text{ per phase} \times \sqrt{\frac{1}{2}}$$

Motors with 4 leads have a bipolar rating and can be used according to manufacturer's specification.

To step a motor in a particular direction a specific switching sequence for the drive transistors Q1-Q4 needs to be followed. If this sequence is in Table 1 (known as the unipolar full step mode) it results in the rotor advancing through one complete step at a time.

Table 1 Full step mode

Step No.	Q1	Q2	Q3	Q4
	ON	OFF	OFF	ON
1	ON	OFF	ON	OFF
2	OFF	ON	ON	OFF
3	OFF	ON	OFF	ON
4	ON	OFF	OFF	ON
5	ON	OFF	ON	OFF

Start position (arbitrary) →

↑ Anti-clockwise

↓ Clockwise

← Above sequence repeating

Table 2 Half step mode

Step No.	Q1	Q2	Q3	Q4
	ON	OFF	ON	OFF
1	ON	OFF	OFF	OFF
2	ON	OFF	OFF	ON
3	OFF	OFF	OFF	ON
4	OFF	ON	OFF	ON
5	OFF	ON	OFF	OFF
6	OFF	ON	ON	OFF
7	OFF	OFF	ON	OFF
8	ON	OFF	ON	OFF
9				

Start position →

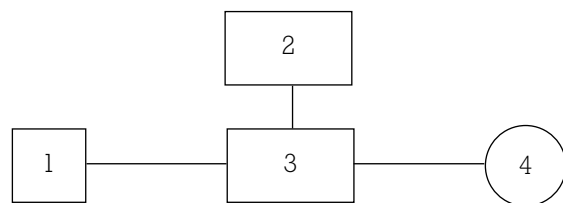
↑ Anti-clockwise

↓ Clockwise

← Above sequence repeating

Typical stepper motor control system

The operation of a stepper motor requires the presence of the following elements:



1. **A control unit.** Usually a microprocessor based unit which gives step and direction signals to the drive card. RS stepper motor control board (RS stock no. 440-098) is ideally suited for this function.
2. **Power supply.** Giving the required voltage and current for the drive card using a linear power supply.
3. **Drive card.** This converts the signals from the control unit in to the required stepper motor sequence. RS stock nos. 332-098, 342-051 and 440-240 are designed for the function.
4. **Stepper motor.**

## Stepper motor drive boards

For control of stepper motors **RS** has three types of stepper drive board which are suitable to drive stepper motors of various current ranges.

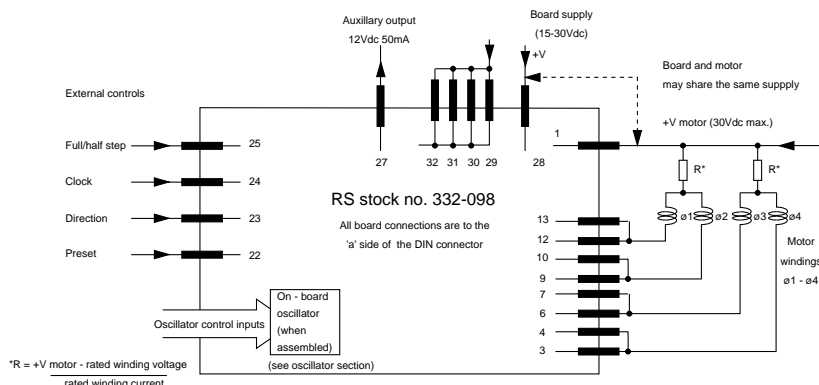
Drive board	RS stock nos.	Suitable stepper motors	Suggested wiring configuration
Unipolar 2A (RS stock no. 332-098) This drive is only suitable for applications where low speeds and low torques are required	440-420 440-436 191-8299 191-8306 440-442 440-458 191-8328 191-8334 191-8340 191-8356 191-8362 191-8384	Size 17 Size 17 Size 17 Size 17 Size 23 Size 23 Size 23 Size 23 Size 23 Size 23 Size 23 Size 23	N/A
Bipolar 3.5A (RS stock no. 342-051) Suitable for medium current, medium torque applications	440-442 440-455 191-8328 191-8362 191-8378 191-8384 440-464 440-470	Size 23 Size 23 Size 23 Size 23 Size 23 Size 23 Size 34 Size 34	Series or parallel Parallel connection Series Series Series or parallel Series or parallel Series or parallel connection Series or parallel connection
Bipolar 6A (RS stock no. 440-240). Suitable for high current, high torque applications	191-8378 191-8384 440-464 440-470	Size 23 Size 23 Size 34 Size 34	Series or parallel Parallel Parallel connection Series or parallel connection

**Note:** Connecting a stepper motor in series will give a good low speed high torque performance.

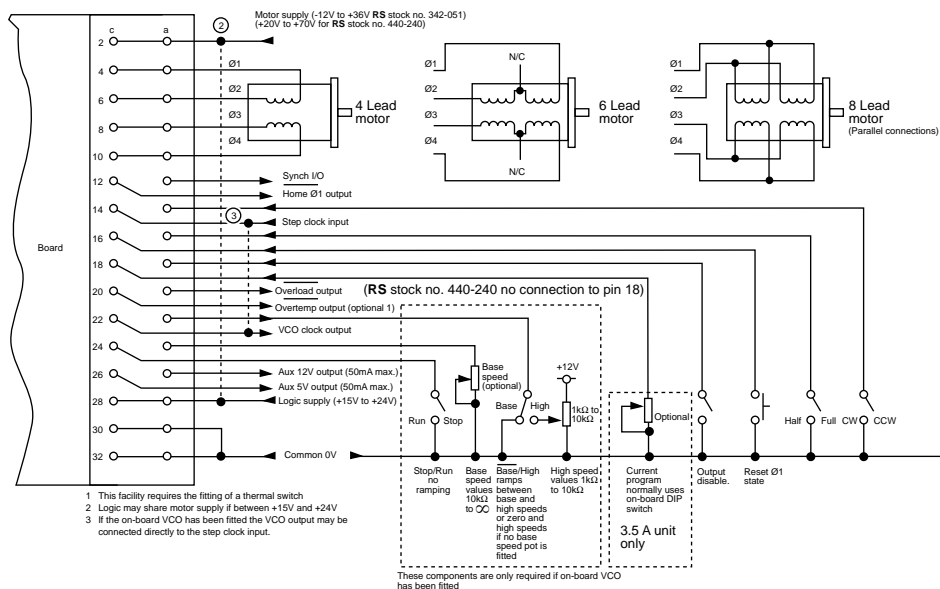
Connecting a stepper motor in parallel will give a good high speed lower torque performance.

## Drive board connections

### RS unipolar stepper motor drive board connections

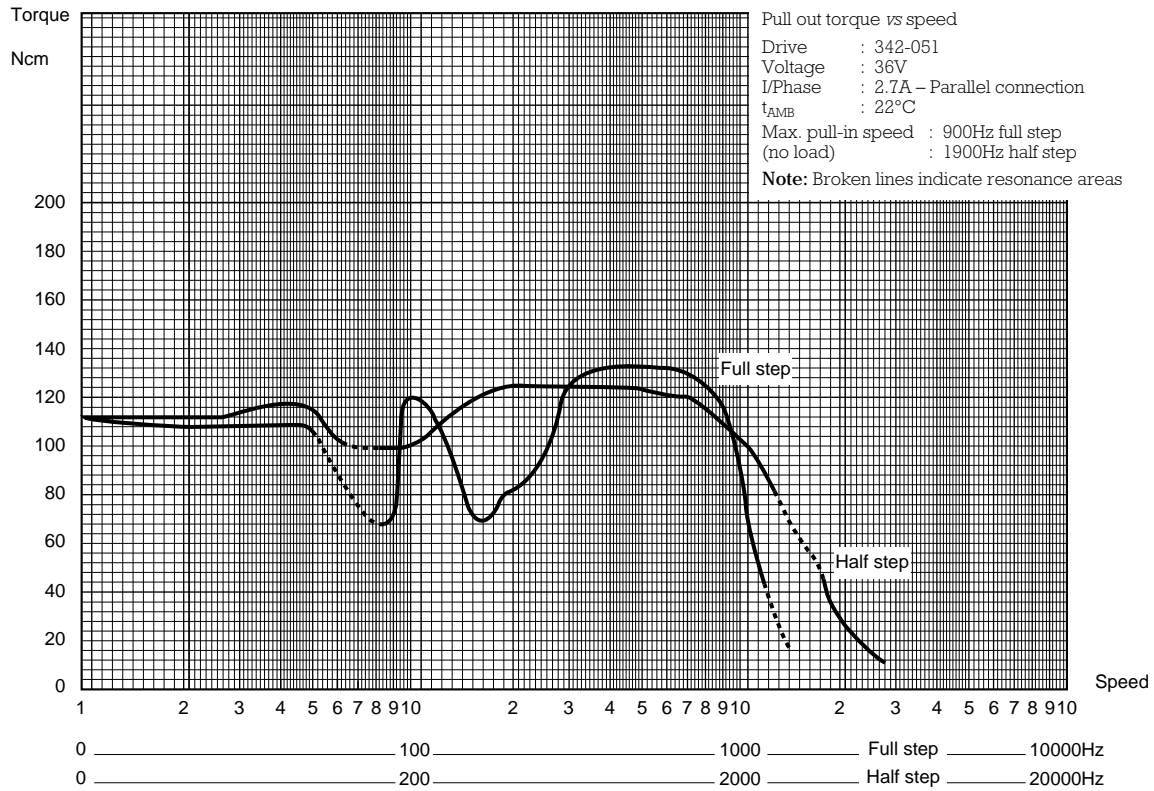


### Bipolar stepper motor drive board connections (RS stock nos. 342-051 and 440-240)

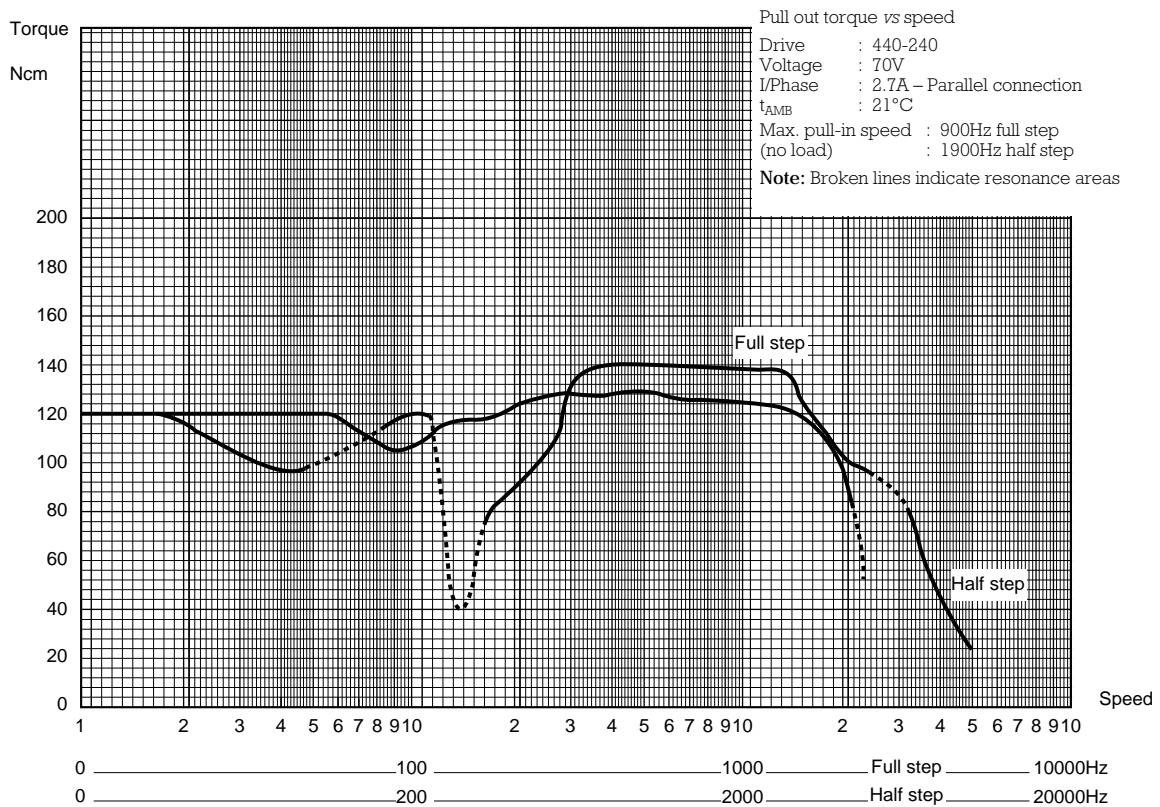


Typical drive motor speed torque curves

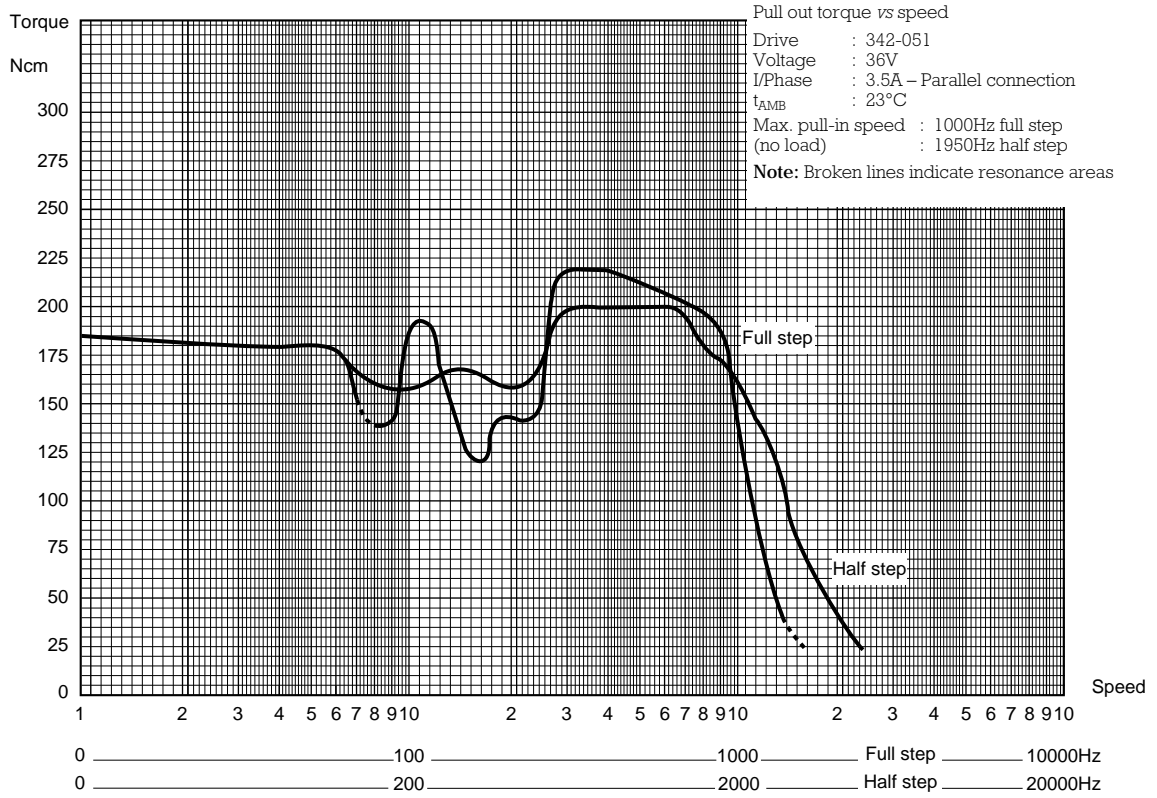
Size 34 single stack (RS stock no. 440-464)  
 using 3.5A bipolar chopper drive (RS stock no. 342-051)



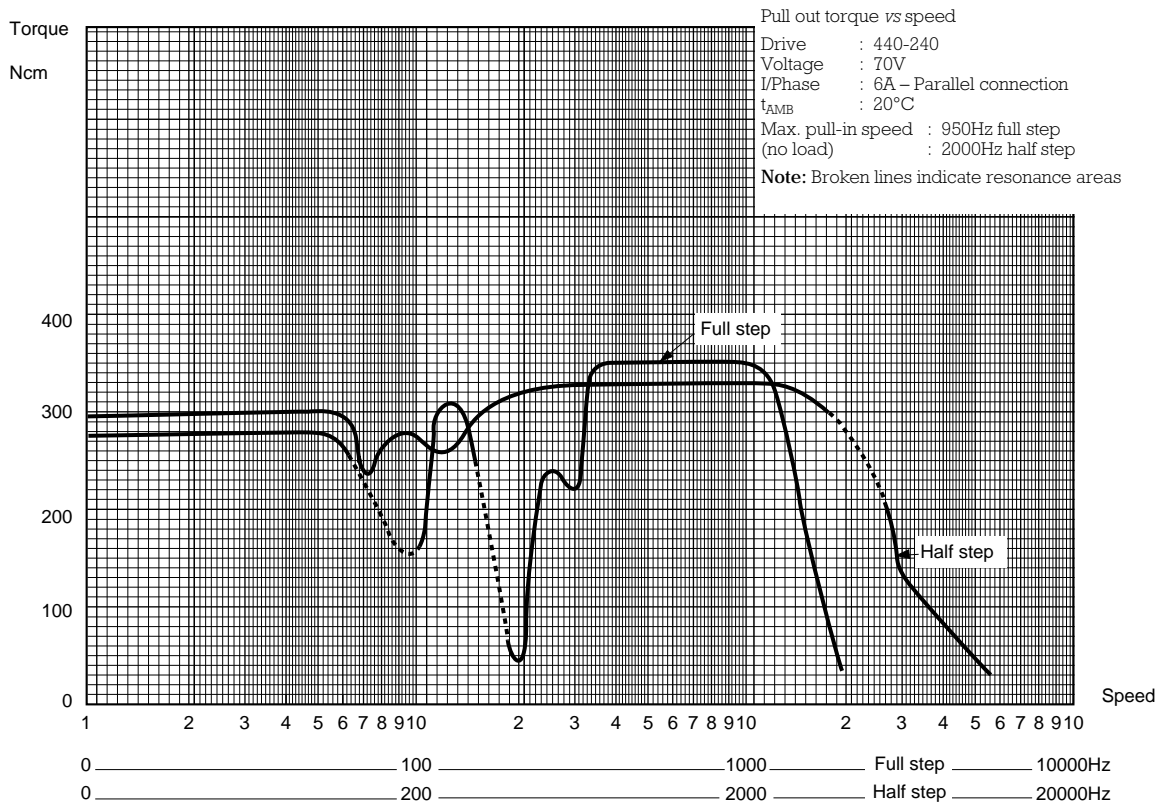
Size 34 single stack (RS stock no. 440-464)  
 using 6A bipolar chopper drive (RS stock no. 440-240)



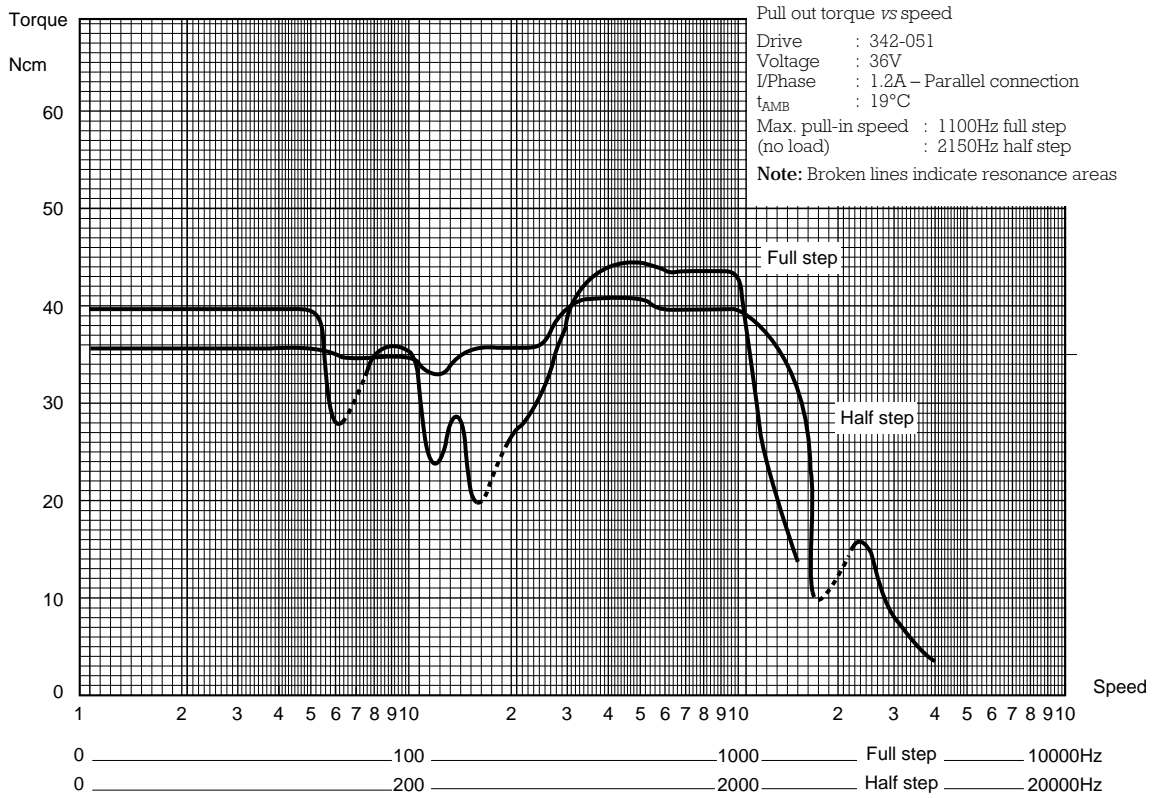
**Size 34 double stack (RS stock no.440-470)  
using 3.5A bipolar chopper drive (RS stock no. 342-051)**



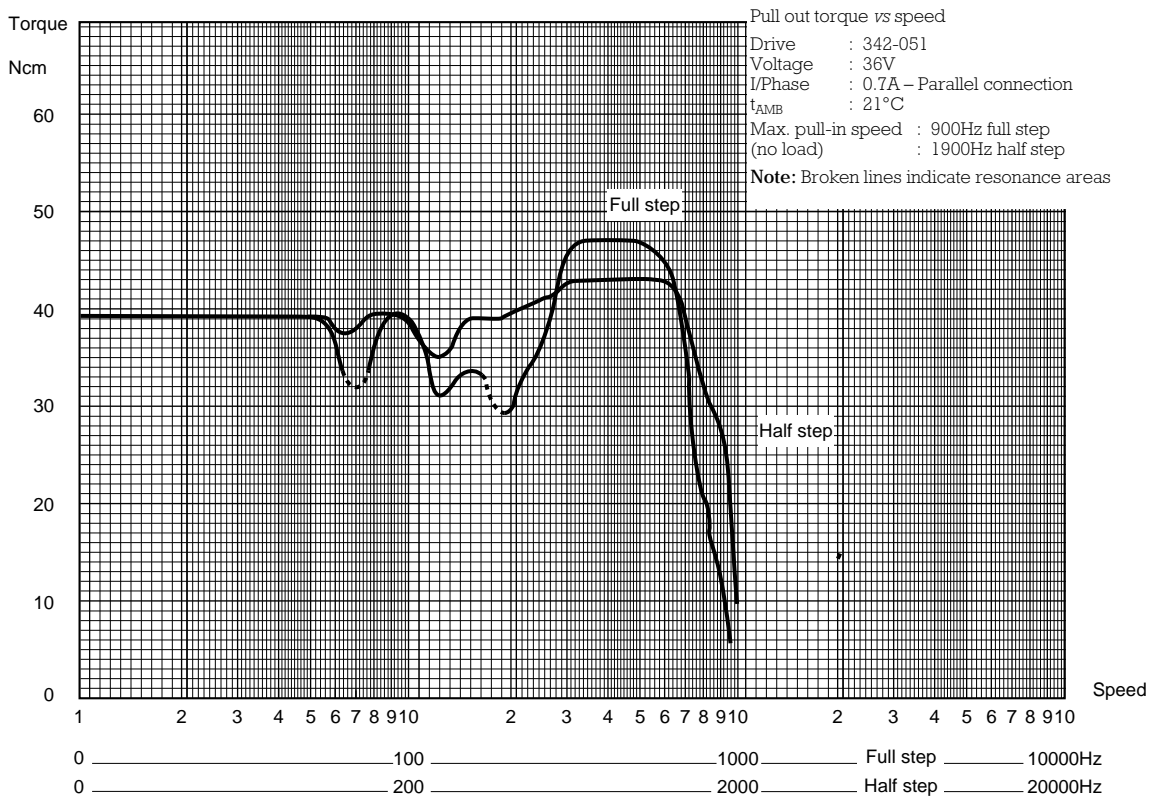
**Size 34 double stack (RS stock no.440-470)  
using 6A bipolar chopper drive (RS stock no. 440-240)**



Size 23 (5V 1A) (RS stock no. 440-442) using 3.5A bipolar chopper drive

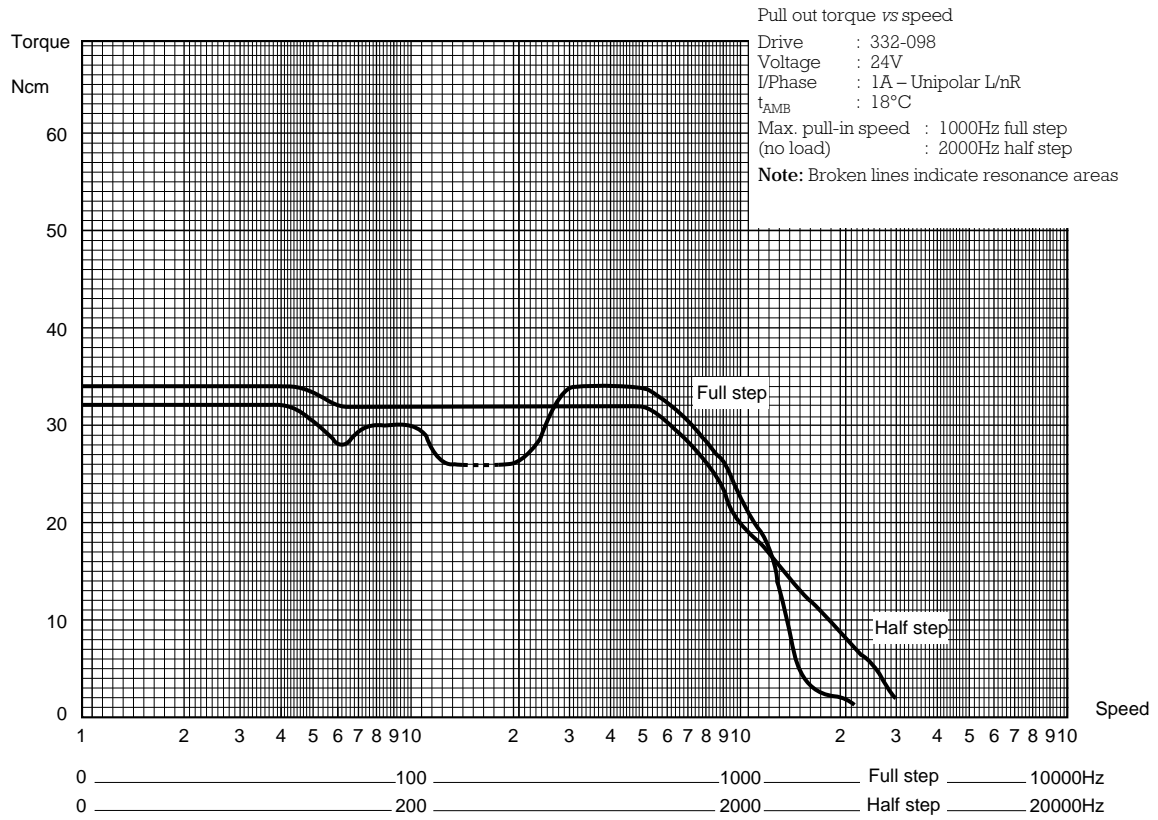


Size 23 (12V 0.6A) (RS stock no. 440-458) using 3.5A bipolar chopper drive

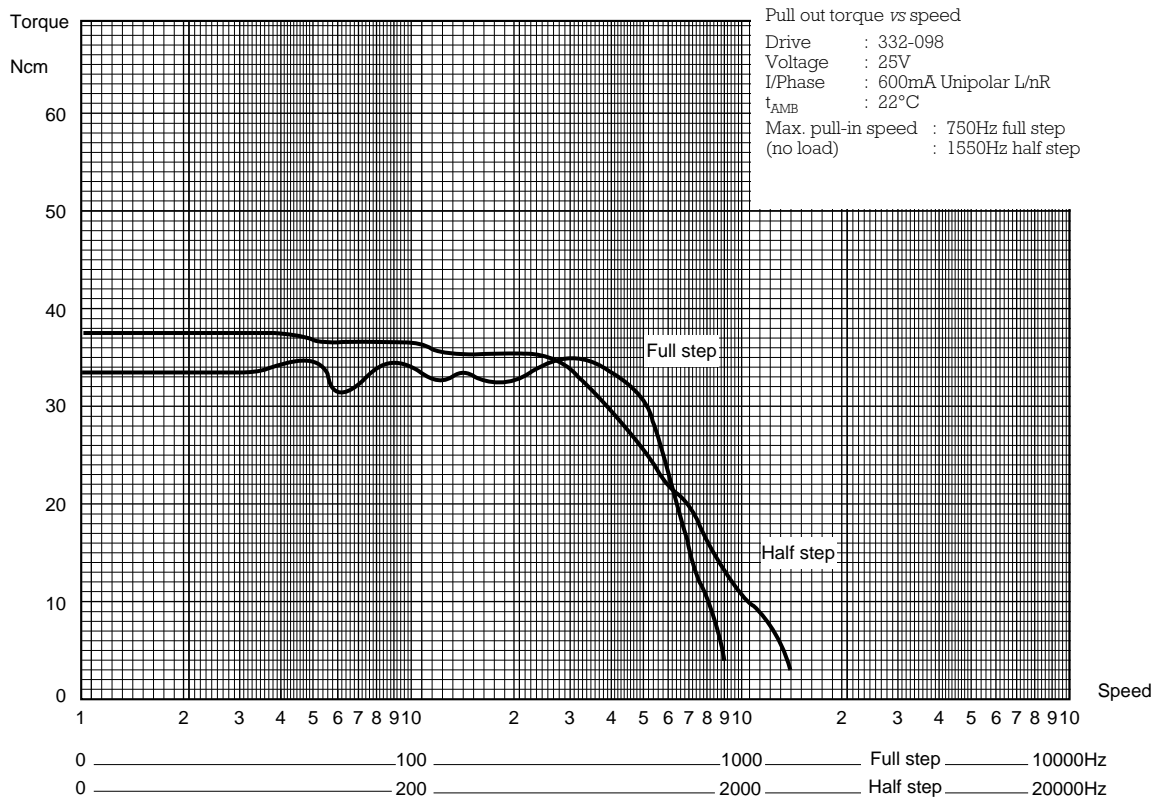




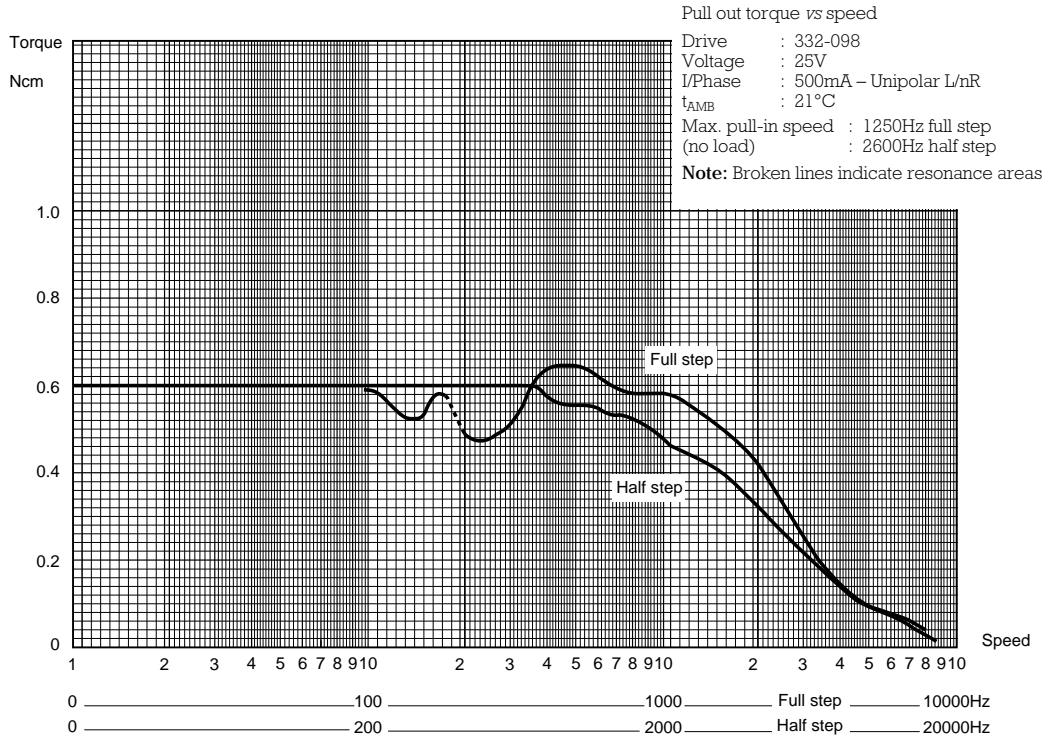
Size 23 (5V 1A) (RS stock no. 440-442) using 2A unipolar drive



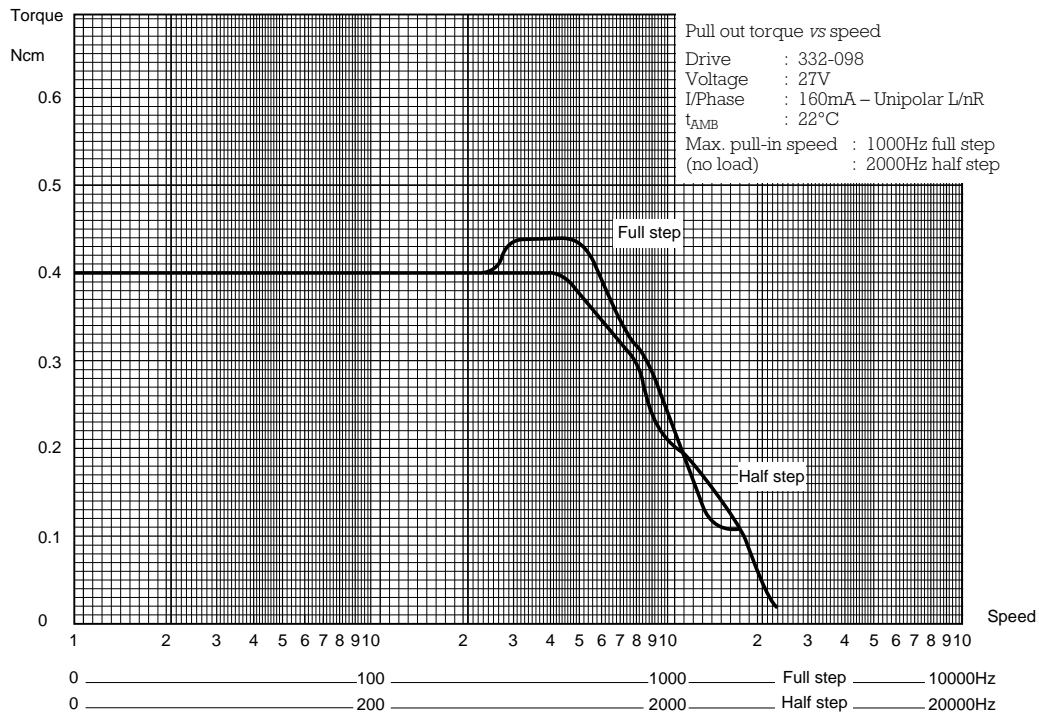
Size 23 (12V 0-6A) (RS stock no. 440-458) using 2A unipolar drive



Size 17 (5V 0.5A) (RS stock no. 440-420) using 2A unipolar drive board (RS stock no. 332-098)



Size 17 (12V 0.16A) (RS stock no. 440-436) using 2A unipolar drive board (RS stock no. 332-098)



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