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

**RS stock no. 440-436 with rear shaft shown**
Size 23

RS stock no. 440-458 with rear shaft shown

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DIM A</td>
<td>50.5</td>
<td>50.5</td>
<td>38.5</td>
<td>38.5</td>
<td>50.5</td>
<td>50.5</td>
<td>76.0</td>
<td>101.5</td>
<td>101.5</td>
</tr>
</tbody>
</table>

Size 34

RS stock no. 440-464 with rear shaft shown

RS stock no. 440-464 A = 62.5mm  RS stock no. 440-470 A = 94mm

6 Wire configuration

<table>
<thead>
<tr>
<th>Step</th>
<th>White</th>
<th>Blue</th>
<th>Red</th>
<th>Yellow</th>
<th>Brown</th>
<th>CW</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>On</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>On</td>
<td>On</td>
<td></td>
<td></td>
<td></td>
<td>+dcV</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>On</td>
<td>On</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>On</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 ≥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, 6Ω 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 18Ω series resistance in the L/4R mode with much improved performance.
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:

\[ I_{\text{per phase}} \times \frac{1}{\sqrt{2}} \]

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

<table>
<thead>
<tr>
<th>Step No.</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>2</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>3</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>4</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>5</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>

### Table 2 Half step mode

<table>
<thead>
<tr>
<th>Step No.</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>2</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>3</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>4</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>5</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>6</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>7</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>8</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>

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. 440-088](#)) 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 into 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.

<table>
<thead>
<tr>
<th>Drive board</th>
<th>RS stock nos.</th>
<th>Suitable stepper motors</th>
<th>Suggested wiring configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bipolar 3.5A (RS stock no. 342-051)</td>
<td>440-442 440-455 191-8328 191-8362 191-8378 191-8384 440-446 440-470 191-8378 191-8384 440-464 440-470</td>
<td>Size 23 Size 23 Size 23 Size 23 Size 23 Size 23 Size 34 Size 34 Size 23 Size 23 Size 34 Size 34</td>
<td>Series or parallel Parallel Parallel Parallel Series or parallel Series or parallel Series or parallel Series or parallel Series or parallel Series or parallel Series or parallel</td>
</tr>
<tr>
<td>Bipolar 6A (RS stock no. 440-240)</td>
<td>191-8378 191-8384 440-464 440-470</td>
<td>Size 23 Size 23 Size 34 Size 34</td>
<td>Series or parallel Series or parallel Series or parallel Series or parallel Series or parallel Series or parallel Series or parallel</td>
</tr>
</tbody>
</table>

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

Pull out torque vs speed
Drive : 342-051
Voltage : 36V
I/Phase : 2.7A – Parallel connection
tAMB : 22°C
Max. pull in speed : 900Hz full step
(no load) : 1900Hz half step
Note: Broken lines indicate resonance areas

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

Pull out torque vs speed
Drive : 440-240
Voltage : 70V
I/Phase : 2.7A – Parallel connection
tAMB : 21°C
Max. pull in speed : 900Hz full step
(no load) : 1800Hz half step
Note: Broken lines indicate resonance areas
Size 34 double stack (RS stock no.440-470) using 3.5A bipolar chopper drive (RS stock no. 342-051)

Pull out torque vs speed
Drive : 342-051
Voltage : 36V
I/Phase : 3.5A – Parallel connection
tAMB : 23°C
Max. pull-in speed : 1000Hz full step (no load) : 1950Hz half step
Note: Broken lines indicate resonance areas

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

Pull out torque vs speed
Drive : 440-240
Voltage : 70V
I/Phase : 6A – Parallel connection
tAMB : 20°C
Max. pull-in speed : 950Hz full step (no load) : 2000Hz half step
Note: Broken lines indicate resonance areas
Size 23 (5V 1A) (RS stock no. 440-442) using 3.5A bipolar chopper drive

Pull out torque vs speed
Drive : 342-051
Voltage : 36V
I Phase : 1.2A – Parallel connection
tAMB : 19°C
Max. pull-in speed : 1100Hz full step
(no load) : 2150Hz half step
Note: Broken lines indicate resonance areas

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

Pull out torque vs speed
Drive : 342-051
Voltage : 36V
I Phase : 0.7A – Parallel connection
tAMB : 21°C
Max. pull-in speed : 900Hz full step
(no load) : 1900Hz half step
Note: Broken lines indicate resonance areas
Size 23 (5V 1A) (RS stock no. 440-442) using 2A unipolar drive

- Pull out torque vs speed
  - Drive: 332-098
  - Voltage: 24V
  - I/Phase: 1A – Unipolar L/nR
  - tAM: 18°C
  - Max. pull-in speed: 1000Hz full step, 2000Hz half step

Note: Broken lines indicate resonance areas

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

- Pull out torque vs speed
  - Drive: 332-098
  - Voltage: 25V
  - I/Phase: 600mA Unipolar L/nR
  - tAM: 22°C
  - Max. pull-in speed: 750Hz full step, 1550Hz half step
Size 17 (5V 0.5A) (RS stock no. 440-420) using 2A unipolar drive board (RS stock no. 332-098)

Pull out torque vs speed
Drive : 332-098
Voltage : 25V
I/Phase : 500mA – Unipolar L/nR
Max. pull-in speed : 2700Hz half step
(no load) : 6000Hz half step

Note: Broken lines indicate resonance areas

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

Pull out torque vs speed
Drive : 332-098
Voltage : 27V
I/Phase : 160mA – Unipolar L/nR
Max. pull-in speed : 1000Hz full step
(no load) : 2000Hz half step

Note: Broken lines indicate resonance areas

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