PLANETARY ROLLER SCREW

SPIRACON™

www.powerjacks.com
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1. Spiracon™ Roller Screw Overview

Go beyond the performance of ball screw with our high performance Spiracon™ Planetary Roller Screw. It’s a unique design to meet unique needs for linear motion applications.

**Principle of Operation**

The Spiracon™ system consists of a multi-start screw with an involute thread form and a number of planetary rollers with annular grooves, which engage with the screw. These rollers also engage with a grooved load bearing element, which transmits the load through roller thrust bearings, to the nut housing. The rolling action results in a high efficiency mechanism, while the line contact and hardened and ground construction achieves a high dynamic load carrying capacity, together with almost no axial backlash or wear.
Main Features of Spiracon™ Roller Screws

- High dynamic load capacity
- High efficiency
- High positional accuracy
- Long life and low maintenance
- Same nut fits both right and left handed screws
- Hardened and ground rolling elements
- Clean operation
- Low noise

Advantage over Ball Screws

- Higher dynamic load capacity
- Larger diameters and higher leads
- Higher positional accuracy
- Longer life
- Higher stiffness
- Higher speed and acceleration
- Low temperature operation
- Lower noise
- Nut easily removed with rollers retained
- Higher safety.

Applications for Spiracon™ Roller Screws

Spiracon™ roller screws are well proven throughout the world in a wide variety of industries including:

- Nuclear
- Aerospace
- Metal processing
- Medical
- Automotive
- Food Processing
- Paper
- Offshore and marine
- Communications
- Defence

Typical applications include:

- Robotics
- Laser tracking
- Indexing/adjusting
- Simulators
- Seismic testing
- Shield door adjustment
- Machine Tools
- Antenna dish adjustment
- Clamping mechanisms
- Medical scanners
- Continuous casting
2. Applications for Spiracon™ Roller Screws

**Application**
Anti-sway mechanism on ship-to-shore container cranes in Hong Kong.

**Linear Actuation Requirements**
All 4 screws and nuts required to be synchronised. High loads and an aggressive marine environment were also factors.

**Solution**
Four model 65 mm Spiracon™ roller screws (2 left hand and 2 right hand) with associated bevel gearboxes, couplings and shafting, per crane.

**Application**
Clamping machine for reclamation of steel rolls.

**Linear Actuation Requirements**
High dynamic load requirement, reliability of operation and a demanding operating environment.

**Solution**
Model 75 mm Spiracon™ roller screw operating a vertical clamp, to hold steel rolls in position.

**Application**
Flying shear for cutting to length pre-formed steel sheets.

**Linear Actuation Requirements**
The shear required to be operated continuously and accurate repeatability of positioning was important. Long life and low maintenance were necessary.

**Solution**
Model 55 mm Spiracon™ roller screw operating on a continuous reversal basis.

**Application**
Road bridge inspection and maintenance platforms.

**Linear Actuation Requirements**
Safety was the overriding requirement, as human cargo was involved. The units would be subjected to high load requirements and hostile weather conditions.

**Solution**
Two 15 tonne platforms, raised and lowered by model 75 mm Spiracon™ roller screws, fitted with disk brakes and mechanical stops as safety features.
3. **Spiracon™ Roller Screw Product Code**

The product code is of the following form:

```
  1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9
```

(1) **Product**

- **SPT** - Spiracon™ Screw and Nut.
- **SPS** - Spiracon™ Screw only.
- **SPM** - Spiracon™ Nut only.

(2) **Model**

A 3 figure code taken from the Technical Chart (Page 14).

(3) **Lead**

A 2 figure code taken from the Technical Chart (Page 14).

(4) **Pitch**

A 1 figure code taken from the Technical Chart (Page 14).

(5) **Direction of Thread**

- **RH** - Right Hand
- **LH** - Left Hand.

(6) **Overall Screw Length**

A 4 figure code to represent the overall screw length in mm.

(7) **Screw Threaded Length**

A 4 figure code to represent the threaded length of the screw in mm (travel) + B (nut length) + overtravel at each end.

(8) **Number of Spiracon™ Nuts**

A 1 figure code to represent the number of nuts required.

(9) **Nut Mounting Holes**

- **0** - Standard Mounting Holes
- **S** - To Customer Drawing

**Example Part Number**

```
  1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9
```

(1) Spiracon™ Screw and Nut

(2) Model 65

(3) 36 mm Lead

(4) 6 mm Pitch

(5) Right Hand Thread

(6) 1540 mm Overall Screw Length

(7) 1450 mm Screw Threaded Length

(8) 1 Spiracon™ Nut

(9) Standard Nut Mounting Holes

**Notes:**

1. In all cases, the customer should supply a detailed drawing, indicating the screw end matching details.
2. The above part number defines a standard catalogue unit. Where a standard unit does not meet the customer’s requirement, PowerJacks will be pleased to design a special unit.
3. All goods are sold subject to our Standard Conditions of Sale, a copy of which is available upon request.
4. Spiracon™ Roller Screw Range

There are 10 standard Spiracon™ roller screw models, with diameters from 15 mm to 120 mm, each with a choice of up to 3 leads. Dynamic load capacities of over 1000 kN (100 tonnes) and linear speeds of over 30 m/min are possible.

Where the standard range does not meet the application specification, special roller screws can be designed to meet customers’ specific requirements (Page 9).

Efficiency

The Spiracon™ roller screw has an efficiency of typically 85%. Power consumption is therefore minimised, and a compact screw system is possible. Such a high efficiency means that the screw is not self-sustaining, and a braking system is needed to prevent back driving.

Tolerancing

The highly accurate machining and assembly of each roller screw means total axial play of less than 0.01 mm can be achieved. The cumulative pitch error in the screw is typically less than 0.005 mm per 300 mm. Combined with a high stiffness, this means that accurate and repeatable positioning is possible. The screw straightness is within 0.1 : 1000.

Operating Life

Operating life is dependent upon the dynamic load. The maximum dynamic loads shown in the Technical Chart (Page 14) are equivalent to 1000000 revolutions of the screw. To determine actual operating life, please refer to “How to select a Spiracon™ Roller Screw” (Page 10). Where severe operating conditions exist, please consult our Technical Sales Department.

Guiding the Load

Loads should be guided, to remove any possible side load from the Spiracon™ nut. The guide system will also resist the torque developed by the roller screw mechanism.

Mounting

The Spiracon™ nut can be mounted using the standard mounting holes and location diameter. Screw end machining to suit thrust bearings is provided, or this can be specified to suit customer requirements. Mounting for operation in any orientation is possible.
Screw Length
The screw length is determined by the load and speed conditions [please refer to Step 2 of How to Select a Spiracon™ Roller Screw, Page 11]. For total screw lengths greater than shown in the table, please consult our Technical Sales Department.

<table>
<thead>
<tr>
<th>Screw Diameter</th>
<th>Maximum Length</th>
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<tr>
<td>Up to 20mm</td>
<td>2 meters</td>
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<tr>
<td>30mm to 90mm</td>
<td>6 meters</td>
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<tr>
<td>120mm</td>
<td>3 meters</td>
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</table>

Operating Environment
All units are constructed and finished to suit industrial operating conditions. Normal operating temperatures are from -10°C to +50°C. However, Power Jacks products have been proven in very low operating temperatures [-30°C - Arctic] and in higher temperatures [+70°C - steelworks]. Wiper seals prevent the entry of large particles into the nut mechanism, and bellows can be provided to protect the screw. Please contact our Technical Sales Department to discuss hostile or hazardous operating environments.

Lubrication and Maintenance
Spiracon™ roller screws require only a minimum of maintenance during the normal operating life. Depending upon the duty, periodic lubrication should be carried out using Rocol Sapphire Hi-Pressure 2 (or equivalent) grease, through the nipple provided.

Specials
Spiracon™ can be offered to suit “special” applications, requiring for example:
- Special screw diameters or leads.
- Left hand screw threads.
- Very high dynamic load [over 1000 kN].
- Special materials e.g. stainless steel.
- Temperature extremes or hazardous environments.
- Special screw end machining or nut mounting e.g. trunnions.
6. How to Select a Spiracon Roller Screw

Step 1 - Load, Speed and Life
From the Technical Chart on page 14, make an initial selection of a Spiracon™ model to suit the required maximum dynamic and static loads.

Choose a screw lead and calculate the rotational speed to suit the required linear speed:

\[
\text{Rotational speed} = \frac{\text{Linear speed (mm/minute)}}{\text{Screw lead (mm)}}
\]

Check that the rotational speed is below the maximum speed shown in the Technical Chart for the model selected.

Calculate the total number of revolutions of the screw for the operating life required:

\[
\text{Required no. of screw revs.} = \text{Life (hours)} \times \text{Rotational speed (rpm)} \times 60
\]

Check the operating life for the selected Spiracon™ model:

\[
C = \text{Dynamic capacity (kN) from Technical Chart}
\]
\[
F = \text{Application dynamic load (kN) (or Fm, mean load as below)}
\]

Actual no. of screw revs. = \[
\left( \frac{C}{F} \right)^{3.33} \times 10^6
\]

Therefore Actual life in hours = \[
\frac{\text{No. of screw revs.}}{\text{Rotational speed} \times 60}
\]

If required, reiterate the calculation to achieve the required life.

Where the dynamic load varies, the mean load (Fm) can be approximated as follows:

\[
F_m = \sqrt[3]{\frac{[F_1^3 \times U_1] + [F_2^3 \times U_2] + \ldots}{U}}
\]

F1, F2 = constant loads during U1, U2 revolutions
U = total number of revolutions

Where the dynamic load varies between a minimum (Fmin) and maximum (Fmax) the mean load is:

\[
F_m = \frac{F_{\text{min}} + 2 \times F_{\text{max}}}{3}
\]
Step 2 - Critical Speed, Buckling and Deflection

Establish length \( L \) based on the required stroke and bearing support conditions. For length \( L \), check that the rotational speed is below the critical speed limit, given by the formula:

\[
\text{Critical speed limit (rpm)} = \frac{10^7 \times f_1 \times J}{L^2}
\]

Where \( f_1 \), \( f_2 \) and \( f_3 \) are defined by the bearing support conditions shown in the diagram below, and \( J \) is the root diameter of the Spiracon™ thread given in the Technical Chart on page 14.

Where the screw is under a compression load, check that the chosen screw diameter and length \( L \) are within the load limit for column strength, given by the formula:

\[
\text{Load limit (N)} = \frac{10^5 \times f_2 \times J^4}{L^2}
\]

For long horizontal screws, check the deflection of the screw under its own weight:

\[
\text{Deflection (mm)} = \frac{6 \times 10^{-9} \times L^4}{f_3 \times J^2}
\]

Bearing Support Conditions

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Step 3 - Torque and Power

Calculate the torque required to drive the screw:

\[
\text{Torque (Nm)} = \frac{\text{Dynamic load (N) x Lead (mm)}}{2000 \times \pi \times \text{Efficiency (0.85)}}
\]

\[
\text{Power (kW)} = \frac{\text{Torque (Nm) x Rotational speed (rpm)}}{9550}
\]

Note: Where there is a high acceleration or inertia, please consult our Technical Sales Department.
Example
Select a standard right hand Spiracon™ screw and nut for the following:

- Dynamic load = 220 kN (in compression)
- Linear speed = 900 mm/minute
- Required life = 2000 hours
- Required stroke = 1200 mm
- Overall screw length = 1850 mm
- Screw mounting = Vertical
- Bearing support condition = 2

Step 1
From the chart on page 14, make initial selection of:

**Model 65 x 36 lead**

Select a lead of 36 mm to give a rotational speed of:

\[
\frac{900}{36} = 25 \text{ rpm (OK<1700 rpm)}
\]

Calculate the number of revolutions of the screw to give the required life:

**Required no. of screw revs. = 2000 x 25 x 60 = 3 x 10^6**

Check the operating life for selected Spiracon™ model:

**Actual no. of screw revs. = \left( \frac{310}{220} \right)^{1.33} \times 10^4 = 3.14 \times 10^4 \text{ (OK>3 x 10^4)}**

**Therefore Actual life in hours = \frac{3.14 \times 10^4}{25 \times 60} = 2093 \text{ hours (OK>2000 hours)}**

Step 2
Stroke = 1200 mm
Length (L) = 1600 mm [refer bearing support condition]

Check the critical speed limit:

**Speed limit (rpm) = \frac{10^7 \times 15 \times 63.7}{1600^2} = 3732 \text{ rpm (OK>25 rpm)}**

Check column strength of the screw:

**Load limit (N) = \frac{10^7 \times 6.5 \times 63.7^4}{1600^2} = 418 \text{ kN (OK>220 kN)}**
Step 3  
The torque and power are:

\[
\text{Torque (Nm)} = \frac{220000 \times 36}{2000 \times \pi \times 0.85} = 1483 \text{ Nm}
\]

\[
\text{Power (kW)} = \frac{1483 \times 25}{9550} = 3.88 \text{ kW}
\]

Therefore the complete product code is **SPT-065-36-6-RH-1850-1450-1-0** (refer Page 7 for full product code description)

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**Example Part Number**

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(1) **Spiracon™ Screw and Nut**  
(2) Model 65  
(3) 36mm Lead  
(4) 6 mm Pitch  
(5) Right Hand Thread  
(6) 1850mm Overall Screw Length  
(7) 1450mm Screw Threaded Length  
(8) 1 Spiracon™ Nut  
(9) Standard Nut Mounting Holes

Notes:
1. In all cases, the customer should supply a detailed drawing, indicating the screw end matching details.
2. The above part number defines a standard catalogue unit. Where a standard unit does not meet the customer’s requirement, PowerJacks will be pleased to design a special unit.
3. All goods are sold subject to our Standard Conditions of Sale, a copy of which is available upon request.
7. Technical Data and Dimensions

Note
* = Customer to define at time of ordering
ø J = Root diameter of Roller screw

## Technical Dimensions Chart

<table>
<thead>
<tr>
<th>Model</th>
<th>Lead (mm)</th>
<th>Pitch (mm)</th>
<th>Dynamic C (kN) Load Capacity</th>
<th>Static Co (kN) Load Capacity</th>
<th>ø A</th>
<th>B</th>
<th>ø C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>ø H</th>
<th>ø J</th>
<th>Max Speed (rpm)</th>
<th>Nut (kg)</th>
<th>Screw per 100mm (kg)</th>
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