HepcoMotion®

PSD80

screw driven linear actuator
The **HepcoMotion® PSD80** is a new screw driven linear unit, which is a companion to the popular and cost-effective PDU2 range of belt driven units, and to the larger PSD120 unit.

It shares the PDU2’s use of Hepco Herculane® wheels running inside a profile and is actuated by a stainless steel leadscrew with a bearing quality polymer nut. Ballscrew versions are available on request. The closed unit is fully covered with a stainless steel sealing band.

Screw leads of 4, 15, 25 & 70mm are available, meaning that carriage speeds from zero up to ~1m/s are possible without the need for additional gearing 10.

PSD80 carriages have a substantial 500N load capacity, and are also capable of thrust loads of 300N 9 - 10.

The PSD80 beam profile is compatible with the Hepco MCS aluminium frame construction system, and can be assembled into multi-axis systems with Hepco PDU2 and PDU2M units 3 - 4.

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**PSD80 Closed Unit**

- **Internal Buffers**
  - End of stroke protection at both ends

- **Carriage**
  - High load capacity - up to 500N and 7.5Nm
  - High speed - up to 1m/s
  - Long life with no re-lubrication
  - Multiple carriages on a single unit available
  - Top plate easily removed & machined.

- **Stainless Steel Cover**
  - Effectively seals the unit from debris

- **Aluminium Beam**
  - Rigid & lightweight
  - T-slots in bottom & side faces
  - Lengths to 3m +

- **Polymer Drive Nut**
  - Smooth & durable. Most pitches will back-drive.
  - Thrust loads to 300N 9-10.

- **Hepco Herculane® Wheels**
  - Ultra-high performance wheels mounted in adjustable carriage body for zero play.

- **Stainless Steel Leadscrew**
  - Smooth, strong & precise. Available in leads of 4, 15, 25 & 70mm with right and left handed threads.
  - A ballscrew version also available.

- **Limit Switch & Bracket**
  - Mechanical & inductive versions available. IP67 rating.
PSD80 linear modules include many useful variants to provide a comprehensive and flexible range.

- The closed unit is rugged, tolerant of debris, and has many mounting options.
- The open version is compact, light, has low friction, and is lower in cost than the closed unit.
- A “slave axis” without the driving screw is available for both closed and open units.
- Units may be specified with any number of carriages.
- A “double acting” version of the unit is available in which two or more carriages move symmetrically about the middle of the beam.
- A corrosion resistant version is available with all ferrous parts made from stainless steel.
- Axes with ballscrews (instead of leadscrews) are available on request.
- Dedicated carriage designs are available to facilitate multi-axis connections.

**PSD80 Double Acting Unit**

- **Centre Bearing Assembly**
  - Guides and connects the two screws

- **Left Hand Screw**
  - With 15, 25 or 70mm lead

- **Removable Carriage Top Plate**

- **Buffers**
  - At the inner and outer ends of stroke

- **Right Hand Screw**
  - With 15, 25 or 70mm lead

- **PSD80 Open Unit**
  - Compact and cost-effective
  - Double acting version available

- **Motor Connections**
  - Motor connection kits are available which include the flanges, housings, fasteners and couplings to suit standard motors.
  - Motors and drive systems are also available on request.
X-Y-Z Multi-Axis System

The Hepco PDU2 family of products can connect together to make multi-axis systems in a large range of configurations.

The example shown has a PDU2 X-axis, a PDU2M Y-axis and PSD80 Z-axis. It is typical of lightweight pick and place units. Each axis has differing requirements for load capacity, stiffness and gearing, and each of the units is perfectly suited for this duty.

Hepco will supply complete mechanical systems as shown including all axes, connectors and brackets, cable chains and trays, motor connections, drive shafts and frame elements.

On application, motors, drives, cables, electrical connectors and a turnkey service can be supplied.

Centre Opening Hatch

A double acting PSD80 unit with two additional slave carriages (two carriages move left and two right) is partnered with a parallel PSD80 slave unit with 4 carriages.

Two heavy hatch doors are each supported with a carriage at each corner.

A single motor without gearbox is sufficient to drive this centre-opening hatch arrangement, which is part of an automated processing line.
System Configurations and Applications

**X-Y Driven Table**

Hepco PSD80 units can connect together in a number of useful X-Y configurations.

The example shown has a PSD80 open X-axis with extra slave carriage, and parallel to this is a PSD80 slave unit again with two carriages. These open units are mounted upside-down such that any debris from the environment will not accumulate in the channel and thus degrade performance. On top of these axes is a simple drilled connecting plate and on top of that is a similar arrangement of PSD80 open units for the Y-axes.

The use of open PSD80 units keeps costs down and reduces system height.

The above construction is suitable for a broad range of sizes, and a similar approach can also be used with closed PSD80 units. Hepco will specify and supply complete mechanical systems including all the plates above, plus motors and drives, on request.

**X-Y Manual Table**

The example shows two axes connected with a PSD80XYCK1 connection kit to make a simple X-Y movement.

This construction is only suitable for very short strokes on the Y-axis as the PSD80 has limited stiffness under Ms loading. For longer strokes and improved stiffness, use the slave axis construction (as shown above), or use two driven PSD80 units in parallel, and gear the screws together.

Contact Hepco for a full specification and design service and for application advice.
Data & Dimensions - Closed Units

The main dimensions of the PSD80 closed unit are shown in the drawing below. Further details can be obtained from the 2D and 3D CAD files, available from www.hepcomotion.com

PSD80 closed units are covered by a stainless steel band with contacting seals on the ends and sides of the carriage. This arrangement provides good protection for the unit's moving parts against ingress of debris.

The above drawing shows a unit with a single carriage, but it is also possible to specify units (closed, open and double-acting) with one or more additional carriages. The usual arrangement for such systems is for just one carriage to have a drive nut, but it is also possible (on request) to offer units in which multiple carriages are driven by the same screw. For closed units with more than one carriage, the carriage centres should be separated by at least 270mm to allow the cover to function correctly. Contact Hepco's Technical Department for full details.

The length of screw driven PSD80 units is limited by the available screw length. Units with beams up to 2850mm long can be made, but in many cases the performance of the screw (due to whipping & buckling) will limit the practicable length to between 1 and 1.5m. These aspects of performance are calculated 10. If units have additional carriages, then it is possible to increase the unit length before encountering dynamic problems. Contact Hepco for details.

Slave units may be ordered with beam lengths up to 6m in one piece. Slave units are normally supplied with a fitted nut so that the stroke length and buffer positions match driven units of the same length. This nut can be deleted if not required 8.

Both driven and slave units have internal buffers. It is usual practice with driven systems to stop motion some distance before the buffers are contacted.
The main dimensions of the PSD80 open unit are shown in the drawing below. Further details can be obtained from the 2D and 3D CAD files, available from www.hepcomotion.com.

PSD80 open units are very compact, being two thirds the height of the covered type. They benefit from lower friction due to the elimination of the seal contact, and are substantially lower in cost and weight due to the reduction in the number of parts.

Herculane wheels can be sensitive to particles of debris which could fall into and accumulate in the beam channel, and so it is recommended that PSD80 open units are used in clean environments, or are configured to avoid any debris getting in (for example by arranging the units upside down 4).

PSD80 units may be specified with a broad range of thread leads: 4, 15, 25 & 70mm with the 15, 25 & 70 also being available with a left hand thread. The screws are made from stainless steel, and run with ultra-smooth, durable polymer nuts. This broad range of threads allows for a very wide range of speeds up to 1m/s. See 10 for full details of screw performance.

All types of PSD80 unit may be ordered with the corrosion resistant option. For these versions, in addition to all external aluminium components being anodised, all the steel parts are made from stainless steel. This includes bearings and fasteners as well as the main screw.
PSD80 double acting units have two (or more) carriages whose movements are symmetrical about the middle of the beam, this motion being achieved by using linked left and right hand threaded screws. The units may be ordered with 15, 25 and 70mm screw leads.

They share the same major parts, and have the same benefits as other PSD80 units, and are available in both closed and open formats, as well as in a corrosion resistant version.

The units shown above just have two carriages, but it is common to have additional slave carriages, particularly if the items to be moved are large (see application example 3).

PSD80 double acting units are suitable in numerous applications including mechanical handling, automation and as an actuator for sliding doors (see application example 3). All the screws and nuts have low friction and those with a large helix angle (particularly pitches 25 and 70mm) are easily back driven. This means that in the event of an electrical failure, the carriages can be moved by hand (subject to the type of drive).

Units can be made with beams up to 5770mm long, but in many cases the performance of the screw (due to whipping & buckling) will limit the practicable length to between 2 and 3m. These aspects of performance are calculated 10. For units which have additional carriages, it is possible to extend the length of the beams while still avoiding dynamic problems with the screws. Please contact Hepco for full details.

PSD80 units have a beam profile with 6mm wide T-slots which are compatible with profiles, T-nuts, covers and brackets from the HepcoMotion MCS aluminium frame construction system. The same T-slot size and spacing is also used on companion products PDU2 and PDU2M.
How To Order

This ordering information is given to assist communication, but we recommend that you discuss the application with Hepco first so that we can help to specify the best unit for your needs.

Main Unit

Product range = **PSD80**

**L1246** = beam length in mm (max 2850 for standard, 5770 for double acting and 6000 for slave units).

**T** = beam with T-slots (this is the only option at present).

Unit configuration: **C** = Closed; **P** = Open.

Drive type: **D** = Driven; **DA** = Double acting; **S** = Slave; **SW** = Slave without nut.

**25** = Screw lead in mm. Choose from 4, 15, 25 & 70 and also L15, L25 & L70 (left hand threads).

If a ballscrew is required, please contact Hepco

**CP1** = Special carriage for Y-Z connection to PDU2M - see 3. Leave blank for the standard version.

**C** = Corrosion resistant version. Leave blank for the standard version.

Additional Carriages

**AC** = Additional closed carriage; **AP** = Additional open carriage

**C** = Corrosion resistant version. Leave blank for the standard version.

**N** = Additional carriage requires a nut. Leave blank for no nut required.

To specify additional slave carriage(s) on a PSD80 unit, simply put the quantity and the relevant part number on the order after the part number for the main PSD80 unit, and state where the carriages should be fitted (i.e. at the driven or non-driven end. If the **N** option is specified, then the carriage spacing centre distances must also be stated).

Ancillary Components

Limit switch assembly (includes switch, bracket & fixings) = PDU2-V3SWA-M (mechanical), PDU2-V3SWA-I (inductive).

T-nuts: M3 = 1-242-1022; M4 = 1-242-1023.

T-slot cover (supplied fitted in each of the T-slots) = 1-242-1037.

Motor Connection Kits

These include the flange tube, motor flange, coupling components and all fasteners required to connect the customer’s motor to a PSD80 unit.

The following standard kits are available from stock:

**PSD80MCK-NEMA23** Suits 23 frame stepper motors

**PSD80MCK-NEMA34** Suits 34 frame stepper motors

**PSD80MCK-IEC56** Suits 56 frame induction motors

**PSD80MCK-IEC63** Suits 63 frame induction motors

**PSD80MCK-IEC71** Suits 71 frame induction motors

When ordering these motor kits, please state the motor shaft diameter, length and key details, as these may vary between manufacturers.

Hepco will make flanges to fit any motor type, on request.

Hepco will supply units with fitted motors and drives, on request.
Calculations & Performance

Carriage Service Interval Calculation

After very long service, slight play in the carriage may develop due to wheel wear. This can be corrected by re-adjusting the carriage, which will return the unit to its original condition. Adjustment is quick and simple and may be repeated several times.

The table shows the maximum carriage loading, and the calculation below determines the service interval.

Note that the life of the nut should also be considered as this may be the determining factor (see 10).

Hepco will provide more data and calculations for your application, on request.

<table>
<thead>
<tr>
<th>Carriage Load Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
</tr>
<tr>
<td>500N</td>
</tr>
</tbody>
</table>

To determine service interval, first calculate the load factor LF using the equation below.

\[
LF = \left(\frac{L_1}{M_{s_{\text{max}}}}\right) + \left(\frac{L_2}{M_{v_{\text{max}}}}\right) + \left(\frac{M_{s}}{M_{s_{\text{max}}}}\right) + \left(\frac{M_{v}}{M_{v_{\text{max}}}}\right) + \left(\frac{M}{M_{\text{max}}}\right) \leq 1
\]

Service Interval (km) = \frac{5000}{0.25 + 0.75 \times LF}  
Note: life will be several times this service interval

PSD Unit Weights (kg)

<table>
<thead>
<tr>
<th>Standard Units (1 carriage)</th>
<th>Slave Units (1 carriage)</th>
<th>Double Acting Units (2 carriages)</th>
<th>Carriage Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed</td>
<td>Open</td>
<td>Closed</td>
<td>Open</td>
</tr>
<tr>
<td>3.5 \times L + 1.5</td>
<td>3.4 \times L + 0.82</td>
<td>2.9 \times L + 1.3</td>
<td>2.8 \times L + 0.63</td>
</tr>
</tbody>
</table>

The weight of a unit is calculated using the formulae in the table above, where L is the beam length in m. For units with extra carriages, add the weight per carriage shown in the table above. This data will also allow the calculation of the mass of the moving parts.

Drive Data & Calculations

The linear force which can be generated by a PSD80 unit is determined by the torque applied (T in Nm), the force coefficient (Cf) and composite drag (Dc) of the PSD80 unit.

<table>
<thead>
<tr>
<th>PSD80 Force Coefficient Cf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw Lead /mm</td>
</tr>
<tr>
<td>Force Coefficient Cf</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PSD80 Composite Drag Dc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Units</td>
</tr>
<tr>
<td>Closed Units</td>
</tr>
</tbody>
</table>

Linear Force (N) = Cf \times T - Dc

The above equation gives the linear force developed by a typical system in typical conditions, but there will be some variation. It is recommended to select motors that have significantly more than the minimum torque, to ensure performance and reliability. Applications in which the applied load is in the opposite direction (i.e. when the load is trying to back-drive the unit) will demand less torque. Please contact Hepco for calculation assistance in these cases.

Beam Deflection Calculations & Data

The deflection of a PSD80 under load follows conventional beam calculations.

For example, the deflection of a PSD80 unit L (mm) long, simply supported at the ends and subject to a central load F [N] is:

\[
\text{Deflection (mm)} = \frac{F \times L^3}{48 \times E \times I}
\]

Where E is the young’s modulus of aluminium alloy (= 7 \times 10^4 N/mm²) and I is the second moment of area of the PSD80 beam section (= 2.0 \times 10^5 mm² for L_1 loading direction and 7.8 \times 10^5 mm² for L_2 loading direction).

Example: in the case of a simply supported PSD80 beam 1000mm between supports, and subject to a central L_1 loading of 150N, the deflection at the centre of the span will be 0.22mm.
Calculations & Performance

Thrust Load Performance

The amount of thrust which a PSD80 unit can produce depends upon the screw lead, the speed, and the life required.

As the screw turns faster, the nut’s ability to transmit load reduces: For very light loads and occasional rapid movements, shaft speeds of up to 1000rpm are possible, but for sustained loads and higher thrusts it is best to operate at below 600 rpm. Conversely, it is possible to generate substantial thrust loads on an occasional basis and when the speeds are low. The table below gives an indication of typical loadings, but please contact Hepco for advice on suitability for your duty. Contact Hepco for details of the performance of units with the optional ballscrew drive.

<table>
<thead>
<tr>
<th>Screw Lead mm</th>
<th>Static Thrust Load Capacity</th>
<th>Thrust Load Capacity for occasional, slow speed use</th>
<th>Thrust Load Capacity for typical applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>4mm</td>
<td>&gt;500N</td>
<td>300N</td>
<td>100N</td>
</tr>
<tr>
<td>15mm</td>
<td>&gt;500N</td>
<td>280N</td>
<td>90N</td>
</tr>
<tr>
<td>25mm</td>
<td>&gt;500N</td>
<td>300N</td>
<td>100N</td>
</tr>
<tr>
<td>70mm</td>
<td>&gt;500N</td>
<td>210N</td>
<td>70N</td>
</tr>
</tbody>
</table>

Rotary - Linear Speed Equivalence

<table>
<thead>
<tr>
<th>Rotary Speed rpm</th>
<th>100</th>
<th>200</th>
<th>400</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw Lead mm</td>
<td>4</td>
<td>15</td>
<td>25</td>
<td>70</td>
</tr>
<tr>
<td>Linear Speed m/s</td>
<td>0.007</td>
<td>0.025</td>
<td>0.042</td>
<td>0.117</td>
</tr>
<tr>
<td></td>
<td>0.013</td>
<td>0.050</td>
<td>0.083</td>
<td>0.233</td>
</tr>
<tr>
<td></td>
<td>0.027</td>
<td>0.1</td>
<td>0.167</td>
<td>0.467</td>
</tr>
<tr>
<td></td>
<td>0.04</td>
<td>0.15</td>
<td>0.25</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Screw Critical Speed

For any PSD80 unit, there is a critical speed of rotation beyond which the screw is susceptible to large amplitude vibration and deflection due to “whip”. The speed at which this becomes possible depends upon the maximum length of the screw between support bearing and nut, and the type of screw. It is important that operating speeds are below this critical speed.

The curves shown include 1.5:1 safety factor on speed.

The addition of extra slave carriages can stabilise the screws in long systems, and thus allow operation at higher speeds than the graph below predicts. Please contact Hepco’s Technical Department for details.

Screw Buckling Load

The maximum axial load on the screw can be limited by buckling of the screw, where systems are long or thrust loads are high. The curves shown include a 2:1 safety factor on load.

For long systems, where the loading on the screw (which is fixed at the drive end and floats axially and the other end) is high, then it may be possible to arrange the principal load to put the screw in tension. Buckling can be delayed in some systems by the addition of slave carriages. Contact Hepco for details.