



Reliance[®]

Precision Mechatronics



**Standard and Customised
Components and Assemblies**

A complete source for precise motion control

Round and Rectangular Racks and Pinions

6



Precision racks and pinions

A selection of tubular and solid round racks.

Rectangular section stainless steel and brass racks.

Precision rack pinions to suit.



Precision Rectangular Racks

Rectangular rack 1mm to 2.5mm circular pitch and 0.3 to 1.0 module
Lengths up to 500mm



Precision Round Racks

Tubular and solid round rack
Lengths up to 500mm



Hobbed Brass Racks

0.3 to 0.8 module
Lengths up to 500mm



Rack Pinions

Plain and anti-backlash pinions
Plain hardened pinions
6mm and 10mm bore

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For Technical Information
please see [Page T6-1](#)

Round and Rectangular Racks and Pinions

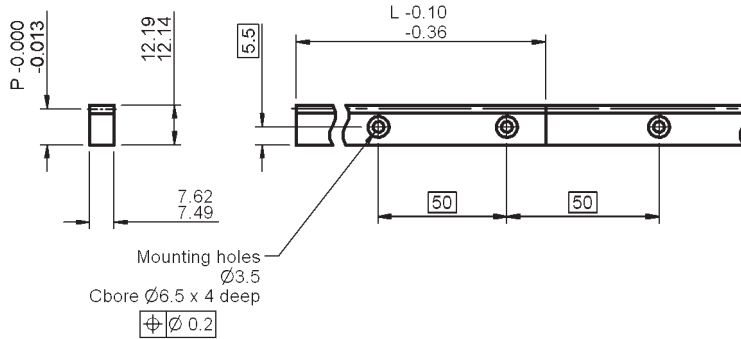


R9 Series 1, 2 & 2.5mm Circular Pitch

Precision Ground Rack Hardened Rectangular

All dimensions in mm
Material: Stainless steel grade 416
Treatment: Hardened to 35-45 HRc
Pressure angle 20°

Associated Products
Rack pinions: [page 6-8](#)



Part number selection table

Part Number	Circular Pitch (mm)	Length L	Pitch Height P	Number of Holes
R9-1M-300	1	300	11.869	6
R9-2M-300	2	300	11.550	6
R9-25M-300	2.5	300	11.391	6

- Cumulative pitch error less than 0.008mm per 300mm
- Ground teeth, standard accuracy grade 4
- Unlimited axis lengths possible by setting individual racks together
- PTFE based grease is recommended for lubrication

Non-standard options, please contact our sales team

- Shorter lengths
- Alternative pitches, including module
- See technical data, [page T6-1](#) for alternative grades



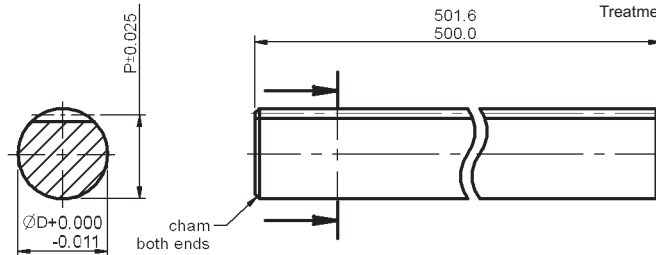
Precision Ground Rack Hardened Round

Ø12mm
2mm Circular Pitch



Associated Products
Rack pinions: [page 6-8](#)

All dimensions in mm
General tolerances ± 0.13 mm
Material: Linear bearing shaft
stainless steel grade 440C
or X90CrMoV18
Treatment: Case hardened to 55HRC min
Pressure angle 20°



Part number selection table

Part Number	Circular Pitch (mm)	Outer Dia $\varnothing D$	Pitch Height P	Rack Thrust (N)
RR12-2M-500	2	12	11.682	60*

* Rack thrust based on meshing with a 60 tooth hardened rack pinion.

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- Cumulative pitch error less than 0.025mm
- Ground teeth, standard accuracy grade 3
- Can be used with both open and closed linear bearings with either 4, 5 or 6 ball tracks
(The bearing must be positioned so the balls do not run on the edges of the teeth. See technical section, [page T6-3](#)).
- Bearing surface and drive in one component
- PTFE based grease is recommended for lubrication



Non-standard options, please contact our sales team

- Modifications:
ie. flats, journals, end modifications
- Shorter lengths
- Alternative pitches
- Higher accuracy grades



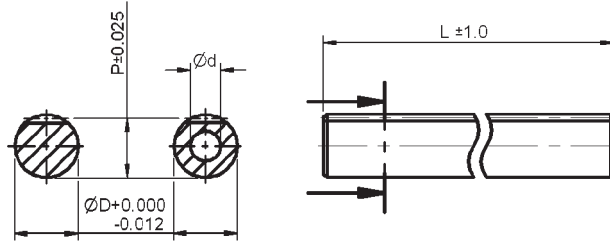


1mm Circular Pitch 0.3 & 0.5 Module

Precision Ground Rack Soft Round

All dimensions in mm
General tolerances $\pm 0.13\text{mm}$
Material: See notes below
Pressure angle 20°

Associated Products
Rack pinions - CP: [page 6-8](#)
Rack pinions - Module: [page 4-1](#)



RRS **RRT**
Solid Rack Tubular Rack

Part number selection table

Part Number	Pitch (mm)	Length L	Outer Dia ØD	Bore Dia Ød	Pitch Height P	Rack Thrust (N)
RRT06-1M-500	1mm CP	500	6	3.6	5.682	20*
RRT06-030-500	0.3 module				5.700	
RRS06-1M-500	1mm CP	500	10	-	5.682	20*
RRS10-050-500	0.5 module				9.500	

* Rack thrust based on meshing with a 50 tooth stainless steel pinion, 3N if used with a 50 tooth PEEK™ polymer pinion.

- Cumulative pitch error less than 0.050mm
- Ground teeth, standard accuracy grade 2
- Tubular rack manufactured from stainless steel grade 316
- Solid rack manufactured from stainless steel grade 300
- Hollow shaft allows for the passage of fluids, fibre-optics and gasses etc
- High resistance to pitting corrosion
- Ideal for medical and scientific applications
- Bearing surface and drive in one component
- PTFE based grease is recommended for lubrication



Non-standard options, please contact our sales team

- Modifications:
ie. flats, journals, end modifications
- Shorter lengths
- Alternative pitches



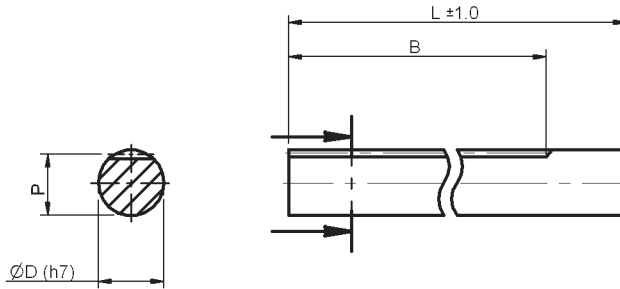
Precision Hobbed Rack Soft Round

0.5, 0.75, 0.8
& 1.0 Module



Associated Products
Rack pinions: page 4-1

All dimensions in mm
Material: Stainless steel grade 304
Pressure angle 20°



Part number selection table

Part Number	Module	Number of Teeth	Length L	Pitch Height P	Extent of Teeth B	Diameter D	Weight (g)
ORK50SU2-0815	0.5	95	202	7.5	149	8	78
ORK75SU2-0815	0.75	63	202	7.25	148	8	76
ORK80SU2-0815	0.8	59	202	7.2	148	8	76
ORK1SU3-1024	1.0	76	305	9.0	238	10	177

- PTFE based grease is recommended for lubrication
- Longer tooth lengths available, please enquire

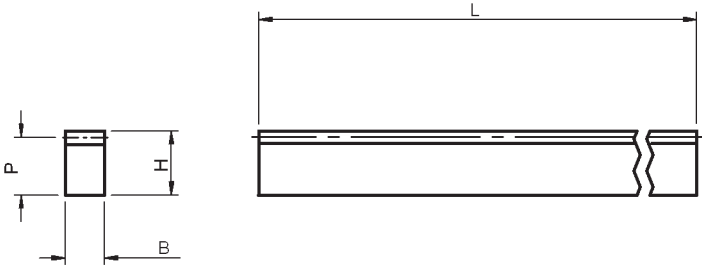


0.5, 0.75, 0.8
& 1.0 Module

Precision Hobbed Rack Soft Rectangular

All dimensions in mm
Material: Stainless steel grade 304
Pressure angle 20°

Associated Products
Rack pinions: [page 4-1](#)



Part number selection table

Part Number	Module	Number of Teeth	Length L	Pitch Height P	Face width B (h12)	Height H (h12)	Weight (g)
RK50SU2-0310	0.5	126	202~205	9.5	3	10	45
RK50SU2-0808				7.5	8	8	95
RK75SU2-0310	0.75	83	202~205	9.25	3	10	44
RK75SU2-0808				7.25	8	8	91
RK80SU5-0510	0.8	198	505~508	9.2	5	10	183
RK1SU5-0810	1.0	158	505~508	9	8	10	280

- Racks are manufactured from cold drawn material
- Overall length has a tolerance of -0.06 to +0.5mm
- PTFE based grease is recommended for lubrication



Hobbed Brass Rack Rectangular

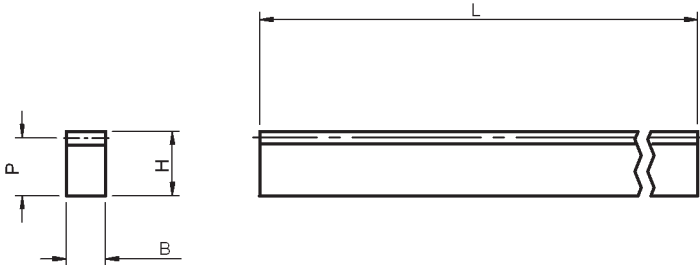
0.3, 0.5, 0.75
& 0.8 Module



Associated Products

Rack pinions: [page 4-1](#)

All dimensions in mm
Material: Brass grade CuZn39Pb3
Pressure angle 20°



Part number selection table

Part Number	Module	Number of Teeth	Length L	Pitch Height P	Face width B (h11)	Height H (h11)	Weight (g)
RK30B2-0308	0.3	210	200	7.7	3	8	38
RK50B2-0808	0.5	125	200	7.5	8	8	98
RK75B2-0808	0.75	82	200	7.25	8	8	95
RK80B5-0510	0.8	198	505	9.2	5	10	191

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- Brass racks, ideal for lightly loaded applications, an economic balance of accuracy and load capacity against cost
- Racks are manufactured from cold drawn material
- Overall length has a tolerance of -0.06 to +0.5mm



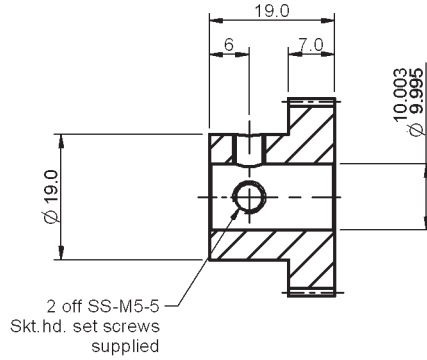
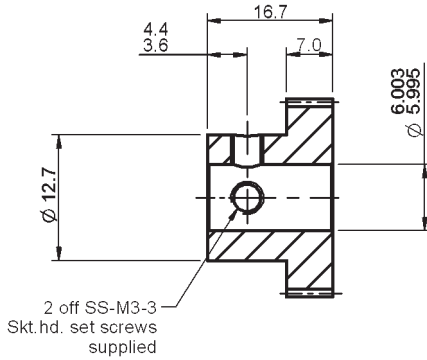


6mm & 10mm Bore

Plain and Hardened Rack Pinions

All dimensions in mm
 General tolerances $\pm 0.13\text{mm}$
 Material: See notes
 Pressure angle 20°

Associated Products
 Racks: [page 6-2](#)



Part number selection table

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Example Part No:- SH2MS2B6F7A- 32

Basic Part Number		Circular Pitch (mm)	Bore Size $\varnothing B$	Number of Teeth	
Plain	Hardened			Min	Max
SH1MS2B6F7A-	SH1MS8B6F7A-	1	6	43	111
SH2MS2B6F7A-	SH2MS8B6F7A-	2		23	54
SH25MS2B6F7A-	SH25MS8B6F7A-	2.5		19	43
SH1MS2B10F7A-	SH1MS8B10F7A-	1	10	63	104
SH2MS2B10F7A-	SH2MS8B10F7A-	2		33	51
SH25MS2B10F7A-	SH25MS8B10F7A-	2.5		27	40

- Standard accuracy AQ10 - see [page T4-1](#)
- Hardened pinions manufactured from stainless steel 17-4 PH, 35-42HRC
- Plain pinions are manufactured from stainless steel 316
- Hardened pinions provide longer pinion life, higher load capacity and higher thrust

Non-standard options, please contact our sales team

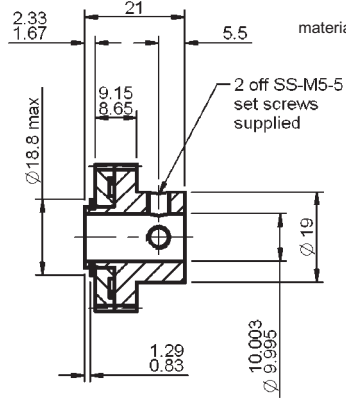
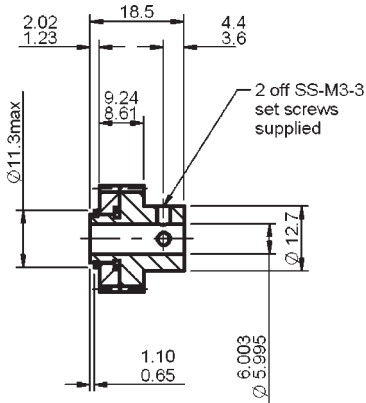
- Higher accuracies
- Alternative pitches, including module
- Alternative bore sizes, including imperial
- Alternative materials
- Special wear resistant coating





Associated Products
Racks: [page 6-2](#)

All dimensions in mm
General tolerances $\pm 0.13\text{mm}$
Pressure angle 20°
material: Stainless steel 316



Part number selection table

Example Part No:- [AH25MS2B6F89A- 20](#)

Basic Part Number	Circular Pitch (mm)	Bore Size \O B	Number of Teeth	
			Min	Max
AH1MS2B6F89A-	1	6	46	54
AH2MS2B6F89A-	2		24	26
AH25MS2B6F89A-	2.5		20	20
AH1MS2B10F89A-	1	10	87	104
AH2MS2B10F89A-	2		45	51
AH25MS2B10F89A-	2.5		37	40

- Standard accuracy AQ10 - see [page T4-1](#)
- Ideal for use with Reliance soft and hardened, round and rectangular rack
- Ideal for lightly loaded measurement applications

Non-standard options, please contact our sales team

- Higher accuracies
- Alternative pitches, including module
- Alternative bore sizes, including imperial
- Alternative materials
- Special wear resistant coating

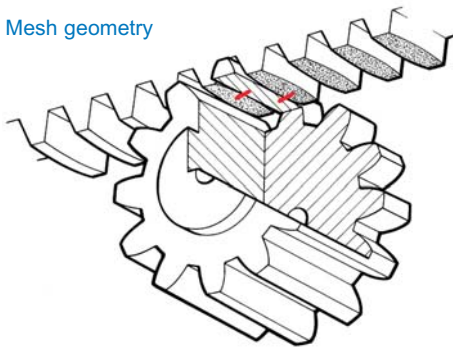


RACK MANUFACTURE

Reliance standard precision racks are produced by a thread grinding process, which generates teeth of helicoidal form. This provides two distinct advantages: very good pitch accuracy and sufficient tolerance of meshing conditions (within 0.25°) to make high precision alignment of the pinion unnecessary.

This feature will be appreciated from the diagram below. Slight misalignment of the straight-tooth pinion, in terms of deviation from a true right-angle between the axis and rack in either plane, results merely in a change of position of the contact points across the face.

Mesh geometry



--- Points of contact.
Standard pressure angle is 20° .
 25° pressure angle available on request.

RACK STANDARDS AND TOLERANCES

Reliance precision racks are offered in four basic grades of accuracy through most of the range, please see the individual product pages for details. Grade 4b has been introduced to offer a lower cost grade 4 where a single rack is to be used in a non-butting application.

The tooth form is generally in accordance with BS 4582 part 1, fig 1, for metric racks.

Rack Grade	5	4	4b	3	2	1
Max pitch error between any two points per 300mm of rack	0.005	0.008	0.008	0.015	0.025	0.050
Max end to end pitch error up to 300mm of track*	± 0.004	± 0.004	± 0.008	± 0.008	± 0.013	± 0.025
Adjacent tooth error	0.0025	0.0025	0.0025	0.005	0.010	0.013
Pitch height variation	+0 -0.013	+0 -0.013	+0 -0.013	+0 -0.013	+0 -0.018	+0 -0.025

* Applies pro rata to length >300 mm

All dimensions in mm



ENGINEERING DATA

1. Linear Speed

Linear speeds of up to 10 metres/second can be achieved with correctly installed rack and pinion systems. When specifying a system, care needs to be taken to ensure that the transducer count rates are not exceeded. With grease lubrication, care should be taken to ensure that the lubrication is not thrown off the pinion

2. Load Capacity

The following analysis is intended to give a guide to the load capacity of a rack system. To simplify the calculation a number of assumptions have to be made. In many applications this will give a conservative estimate of the gear capacity, therefore in critical applications an exact analysis must be completed. Please consult the relevant gear standards or Reliance Technical Sales.

The basic load capacity (F_b) of a rack and pinion is defined as the maximum linear force at which they can operate indefinitely.

F_b has two values: one calculated from tooth strength (F_{bs}) and one for tooth flank wear (F_{bw}). The useful or transmitted load capacity, F_t , is usually less than F_b due to transient or dynamic loads generated within the mechanism.

For tooth root strength $F_{ts} = F_{bs}/K_a$ K_a & C_a = application factors

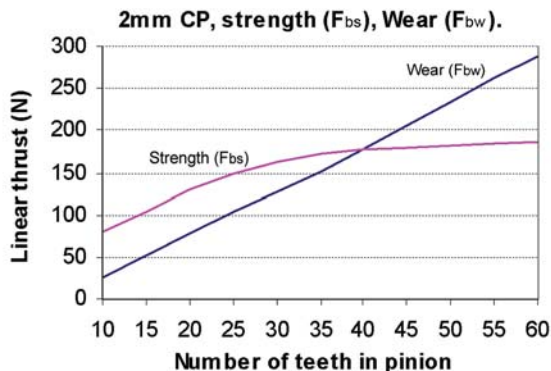
For tooth flank pitting (wear) $F_{tw} = F_{bw}/C_a$

Both calculations should be made and the lower value used.

The application factors K_a and C_a make allowance for any externally applied loads in excess of the nominal linear force F_b . These are most accurately determined by direct measurement. In determining application factors, consideration should be given to the fact that many prime movers develop momentary peak torques appreciably greater than those determined by the nominal ratings of either the prime mover or the driven equipment.

There are many possible sources of overload which should be considered, including system vibrations, acceleration torques, overspeeds, variations in system operation and changes in process load conditions. Impact loads due to reversing across backlash can be significant in servo systems.

As a general guide application factors for a motor gear system range from 1.0 for uniform loads up to 1.75 where heavy shock loads are anticipated.



The previous graph has been calculated in accordance with AGMA 2001-B88 for a life of at least 10⁸ load cycles, and a rack hardness exceeding 50HRc and pinion material 17-4PH. For alternative pitches and materials the graph values need to be modified as shown in the table below:

Pitch and Rack/Pinion Material Modification Factors				
Rack	Pinion	Pitch (mm)	Strength	Wear
Hardened Round Rack (hardness>50HRc)	17-4PH	1	0.50	0.50
	316	1	0.23	0.10
	PEEK™ polymer	1	0.04	0.01
Rectangular Rack # (hardness 35-45HRc)	17-4PH	1	0.38	0.28
		2	0.75	0.56
		2.5	0.94	0.70
	316	1	0.23	0.10
		2	0.47	0.20
		2.5	0.59	0.25
	PEEK™ polymer	1	0.04	0.01
Tubular and Round Rack	17-4PH	1	0.23	0.10
	316	1	0.23	0.10
	PEEK™ polymer	1	0.04	0.01

For R5 a further reduction of 50% is required due to the thin face width

Example:

A 40 tooth, 1mm CP pinion material 316 meshing with rack of hardness <50HRc.
The application factors should be applied after the reduction for material and pitch.

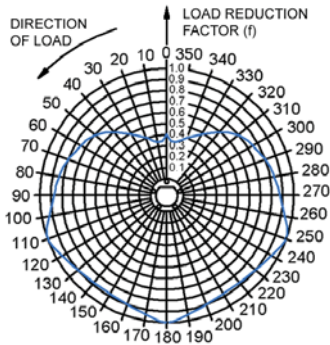
$$F_{bw} = 175 \times 0.10 = 17.5N$$

$$F_{bs} = 170 \times 0.23 = 39.1N$$

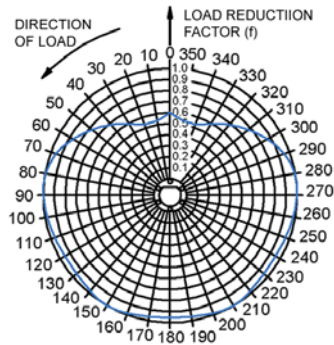
3. Bearing Capacity

When linear bearings are used with the hardened round bar racks the capacity of the support bearings needs to be considered. Where possible the bearings should be positioned with all the ball rows running on the rack shaft. However, it is important that the balls do not run on the edges of the teeth. If necessary the 5 and 6 row bearings can be used with 1 row above the teeth. In this scenario, the manufacturer's ratings apply with a modification for the direction of the load application. The factors given in the following charts should be substituted for the bearing manufacturer's load reduction.

Closed bearing 5 rows of balls



Closed bearing 6 rows of balls



4. Lubrication

Lubrication is not required when using PEEK™ polymer pinions. For other combinations unlubricated systems are not recommended. Measurement applications should use a very thin coat of light oil, in many machine tool applications stray cutting oil is sufficient. Grease lubrication is recommended for higher loads, but care should be taken to ensure the lubrication is not thrown off the pinion at speed.

INSTALLATION

The installation techniques differ according to the type of rack. All racks should be mounted with teeth pointing downwards wherever possible so that dust etc cannot settle in them.

1. Soft Round and Tubular Rack

Plastic moulded bearings are recommended for use with soft round and tubular racks, these can be found in the Bearings and Spacers section of the Reliance catalogue. Round racks are not recommended for multi-section use.

2. Hardened Round Rack

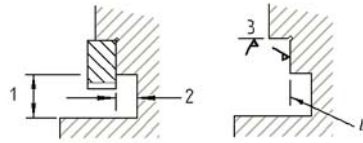
Bearings for the round bar rack should be fitted in accordance with the manufacturer's instructions. It is important that the balls do not run on the edge of the teeth. Suitable bearings can be found in the Linear Bearings section of the Reliance catalogue. Round racks are not recommended for multi-section use.

3. Rectangular Rack

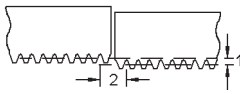
Reliance rectangular section rack is manufactured to enable butting to form infinite lengths. Socket head cap screws, plain washers and a thread locking adhesive are preferred for mounting. Dowels are not recommended. The pitch line of the rack must be constrained to be straight to obtain maximum accuracy. To avoid distortion, racks should be screwed to a machined flat surface.

Machining requirements for rack location

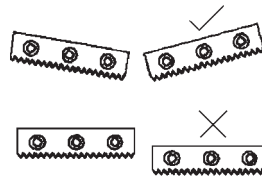
1. Pinion clearance
2. Clearance required if:
 - a) anti-backlash pinions are used
 - b) full face of rack is to be used
3. Abutment
4. Mounting face



To align racks, two adjustments need to be made, pitch line alignment and pitch adjustment. The pitch line straightness is not critical (see drawing below) but steps at the joints should be avoided as they can lead to excessive noise and wear.



1. Pitch line alignment
2. Pitch adjustment and error compensation

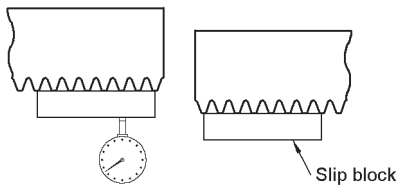


Pitch Line Alignment

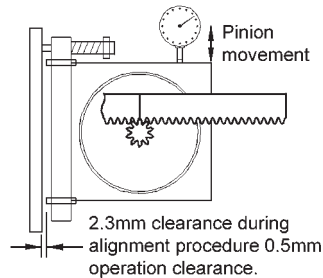
There are three methods of setting the pitch line at a joint. These are:

- i) Setting the base of the racks against an abutment perpendicular to the mounting face. The misalignment is then governed by the rack pitch line to base tolerance.
- ii) Using the tops of the rack teeth as a reference. These are parallel to the pitch line within 0.008mm. Use a short straight edge (eg. slip block) as shown below.
- iii) The best measurement of the pitch line is with the pinion installed on a Flexplate. A dial indicator fitted as shown gives a direct reading of the pitch line straightness.

Pitch line alignment using slip block



Dial indicator carried with Flexplate



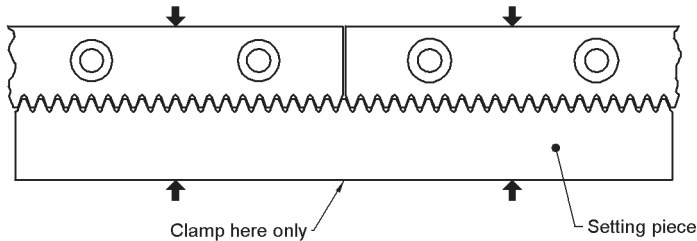
The Flexplate spring loads the pinion into mesh on both flanks of the teeth, ensuring complete backlash elimination. For more information on the Flexplate assembly, please enquire.

Pitch Adjustment and Error Correction

Pitch accuracy can be obtained by one of three methods depending upon accuracy required.

GRADE 1 (and for the initial setting of all grades)

For pitch accuracy across the joint of $\pm 0.020\text{mm}$ the Rack Setting Piece is the simplest method.



GRADE 2, 3 or 4

After initial setting and with the measuring system functioning, length bars may be used as references. Checks made against these allow adjustment to be made within the system resolution.

GRADE 3, 4 or 5

After initial setting and with the measuring system functioning, comparison should be made with a laser measuring system. This allows pitch adjustment and machine error compensation within the system resolution over the full travel of the axis.

RACK APPLICATIONS

Reliance precision racks are manufactured in both round and rectangular sections, and can be used for both measurement and actuation. In general the smaller pitches (1mm) are ideal for measurement, as the smaller pinion diameter gives higher linear resolutions. The larger pitches (2mm and 2.5mm) allow a higher load capacity.

For most applications the rack can be used for both the feedback and the actuation. In very precise applications we recommend that an unused section of the actuation rack is used for feedback. Alternatively a separate rack can be used.

All Reliance racks are calibrated to measure correct at 20°C using a temperature compensated laser. Calibration graphs can be supplied if required.

RACK ACTUATOR

The rack actuator is supplied pre-assembled and should not be dismantled. The rack should not be removed from the housing. Any tampering with the assembly may result in the technical specification becoming invalid.



In addition to these conditions of sale, our standard Conditions of Sale also apply. A copy of these is available on request and from our website www.rpmechatronics.co.uk/en/help

Minimum order charge - Orders are subject to a minimum order charge of £25.00 unless they have been placed on our website at www.rpmechatronics.co.uk

Carriage and packing - Additional charges are made for carriage and packing.

Payment - Payment terms are 30 days. New customers are requested to complete an application form for a credit account. Customers who do not have a credit account with Reliance are requested to supply cheque with order. In addition, orders may be paid for by Visa and Mastercard.

Telephone orders - An order number must be quoted by customers and a written confirmatory order, clearly marked "CONFIRMATION", sent within 7 days. We reserve the right to supply parts against a telephone order. All telephone orders are accepted subject to these conditions of sale and those detailed on the acknowledgement of order. An acknowledgement will normally be sent by Reliance on receipt of order and goods will be supplied in accordance with the order acknowledgement.

Certificates of Conformance - Reliance's quality management system is certified to AS9100 and ISO 9001. A Certificate of Conformance can be supplied at an additional charge of £10.00 per delivery. Alternatively, a Certificate with full material traceability can be supplied at a charge of £20.00 per delivery.

Confirmation - All orders, other than telephone orders with a value of less than £500 and orders placed through our website, are subject to acceptance in writing by Reliance Precision Mechatronics.

Order amendments - Order amendments are subject to our approval and a charge will be made for reasonable compensation for any costs incurred.

Returns - Unused items may, solely at our discretion, be accepted for credit within 90 days of delivery. Any parts so accepted will be subject to a 20% service charge for re-inspection and handling. No credit can be allowed after the above period, or for any used or modified part, or for parts manufactured to a customer's specification.

Additional charges - Reliance reserves the right to charge for all additional expenses and taxes incurred over and above published prices (including without limitation duty, VAT, exchange rate fluctuations etc.)

Alterations - As a result of continuous product development, Reliance reserves the right to alter prices and other details without prior notice and to change dimensions where this does not affect the function of the item.

Contact details:

Telephone: +44(0)1484 601060

Email: sales@rpmechatronics.co.uk

Fax: +44(0)1484 601061

International Sales Representatives



Benelux, Denmark, Austria, Germany, Switzerland

Reliance Holland Florijnstraat 20, 4879 AH Etten-Leur, The Netherlands.

Tel: +31 (0) 76504 0790 Fax: +31 (0) 76504 0791 e-mail: jb@reliance.co.uk website: www.rpmechatronics.co.uk

France

Reliance France 33 rue Jean Racine, 11000 Carcassonne, France.

Tel: +33 (0) 468 470589 Fax: +33 (0) 468 471772 e-mail: ph@reliance.co.uk website: www.rpmechatronics.co.uk

Sweden

DJ Stork Drives AB Vretenvägen 4, ltr, PO Box 1037, SE-172 21 Sundbyberg Sweden.

Tel: +46 (0) 8635 6000 Fax: +46 (0) 8635 6001 e-mail: info@storkdrives.se website: www.storkdrives.se

Finland

Wexon OY Juhaniantie 4, 01740 Vantaa, Finland.

Tel: +358 (0) 9 290440 Fax: +358 (0) 9 29044100 e-mail: wexon@wexon.com website: www.wexon.com

Slovenia (covering all CEE countries)

Kolektor Synatec d.o.o. program Indutec, Vojkova ulica 8b o 5280 Idrija o Slovenia.

Tel: +386 30 612 867 kristof.debeljak@kolektorindutec.com website: www.kolektorindutec.com

Israel

Medital Hi-tech (1992) Ltd 7 Leshem Street, PO Box 7772, Petach Tikva 49170, Israel.

Tel: +972 (0) 3 9233323 Fax: +972 (0) 3 9228288 e-mail: hi-tech@medital.co.il website: www.medital.co.il

South Africa

Measuring Instruments Technology (MIT) Rm111, Building 33, CSIR Campus, Meiring Naude Drive, Brammeria 0184, Pretoria, South Africa.

Tel: +27 12 349 5191 Fax: +27 12 348 0564 e-mail: sales@marmit.co.za website: www.marmit.co.za

China

EM Components Co Ltd 665 ZhangJiang Road, Unit 902, ZhangJiang Hi-Tech Park, Shanghai Pudong, PR China 201210

Tel: +86 21 5895 0126 Fax: +86 21 5895 1160 e-mail: sales@emcomponents.com

Singapore

Elshin International PTE Ltd No.1 Kaki Bukit Avenue 3 (KB-1), #06-12 Singapore 416087.

Tel: +65 6286 7707 Fax: +65 6748 2618 e-mail: elshin@singnet.com.sg

Malaysia

CMS SUPPLIES Sdn Bhd 46, (1st Floor) Persiaran Mahsuri 1/2, Sunway Tunas Bayan Baru, 11900 Bayan Lepas Penang, Malaysia

Tel: +604 6446028 Fax: +604 6446082 e-mail: ycng@cmsupplies.com.my

Korea

Toptek Co. Ltd 412, Technozone, Yangchon Industrial Complex, Hagun-ri, Yangchonmyeon, Gimpo-si, Gyeonggi-do, Korea

Tel: +82 31 999 6980 Fax: +82 31 999 6983 e-mail: julius123@naver.com

Japan

Isel Co Ltd 1-2-16 Atobe-kitano-cho, Yao-city, Osaka 581-0068, Japan.

Tel: +81 (0) 7 2991 0450 Fax: +81 (0) 7 2994 7593 e-mail: t_watanabe@isel.co.jp

Canada

Myostat Motion Control Inc 17817 Leslie Street, Unit 43, Newmarket, Ontario L3Y 8C6, Canada.

Tel: +1 905 836 4441 Fax: +1 905 836 1214 e-mail: chris@coolmuscle.com website: www.myostat.ca

USA

The Precision Alliance 4215 Pleasant Road, Fort Mill, SC 29708 USA.

Tel: +1 (803) 396 5544 Fax: +1 (803) 396 7810 e-mail: info@tpa-us.com website: www.tpa-us.com

Australia

Reliance Australia 65 Macaulay Street, Coorparoo, Brisbane 4151, Queensland, Australia.

Tel: +61 (0) 439 780187 Fax: +61 (0) 738 478670 e-mail: grant@relianceprecision.com.au website: www.relianceprecision.com.au

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www.rpmechatronics.co.uk and www.reliance.co.uk

Standard Product Sales : +44 (0)1484 601060

www.rpmechatronics.co.uk

+44 (0)1484 601061

sales@rpmechatronics.co.uk



Reliance[®]

Precision Mechatronics

Rowley Mills, Penistone Road, Lepton
Huddersfield, HD8 0LE, England.

Tel: +44 (0) 1484 601002

Fax: +44 (0) 1484 601061

www.rpmechatronics.co.uk

e-mail: sales@rpmechatronics.co.uk

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