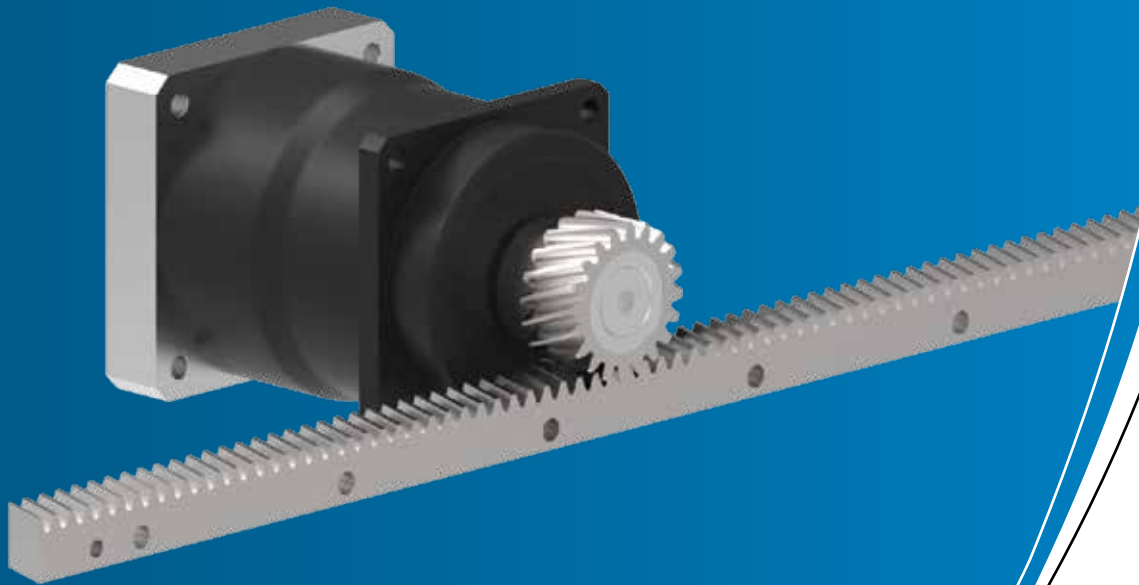


# *GAM Rack & Pinion*



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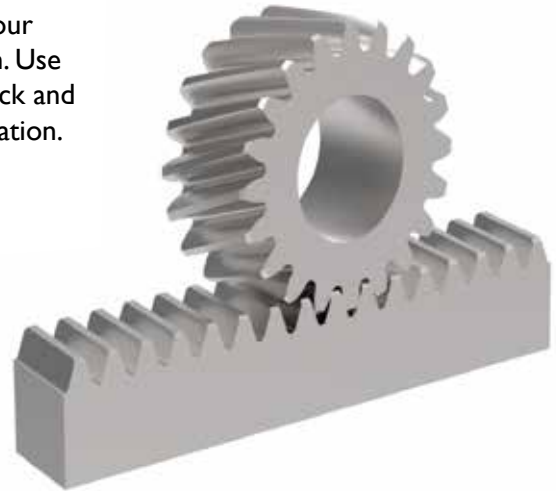
# ▶ GAM RACK & PINION

## GAM Rack & Pinion

The **GAM Helical Rack and Pinion** series, along with our broad gearbox offering, provide a complete linear solution. Use our motion control engineering expertise to select the rack and pinion and match it with the right gearbox for your application.

- High precision helical rack for smooth, quiet operation
- Precision pinions easily mount to GAM gearboxes
- Pinion can be pre-mounted to the gearbox
- Racks and pinions are matched to GAM gearboxes for easy selection
- GAM engineering expertise to select the best solution for your application

Whether you need components or a complete package, GAM has the rack and pinion solution for your application.



### What is Rack & Pinion?

A linear actuator that converts the rotary motion of the (circular) pinion to linear motion at the (linear) rack.

### Why use a Rack & Pinion System?

A rack and pinion system is the most cost-effective way for linear movements greater than 2 meters.

### Why use a GAM Rack & Pinion System?

GAM matches the high quality rack and pinion with the best precision gearboxes for your application.

## Applications

| ISO Quality | Module    | Tooth Thickness Tolerance ( $\mu\text{m}$ ) | Application Examples   |
|-------------|-----------|---|--|
| 6           | 2.0 - 4.0 | -20 ~ 0                                     | <ul style="list-style-type: none"> <li>• Wood, Plastic, Composite, Aluminium Working Machines</li> <li>• Machine Tools, Integratable Racks, Water Cutting Machines, Tube Bending Systems, Plasma Cutting Machines, Laser Cutting Machines</li> </ul> |
| 10          | 2.0 - 4.0 | -90 ~ 0                                     | <ul style="list-style-type: none"> <li>• Lifting Axis, Handling, Welding Robots</li> </ul>   |

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# ▶ RACK & PINION SYSTEMS

## GAM Rack & Pinion Systems

Pair GAM gearboxes with our rack and pinion for a complete linear motion control system.

- Pinions are hardened and work with either ISO 6 or 10 hardened rack
- Optional mounting tool and felt gear (for lubrication) available



### Inline Systems



SPH-SP / PHGH-S



SPH-FP / PHGH-W



EPL-AP / PHGH-K



EPL-FP / PHGH-B

### Right Angle Systems



DS-FP / PHGH-W



DS-HP / PHGH-D



EPR-WP / PHGH-W



EPR-FP / PHGH-B

| Inline Gearbox | Pinion*             | Module | Number of Teeth | Maximum Speed ** (m/min) | Feed Force† (kN) |
|----------------|---------------------|--------|-----------------|--------------------------|------------------|
| SPH-SP-060     | PHGH-20-15-S16-06   | 2      | 15              | 200                      | 3.2              |
| SPH-SP-075     | PHGH-20-18-S22-06   | 2      | 18              | 240                      | 4.2              |
| SPH-SP-100     | PHGH-20-23-S32-06   | 2      | 23              | 307                      | 6.4              |
| SPH-SP-140     | PHGH-30-20-S40-06   | 3      | 20              | 400                      | 10.7             |
| SPH-SP-180     | PHGH-40-20-S55-06   | 4      | 20              | 533                      | 24.5             |
| SPH-FP-075     | PHGH-20-16-W50-06   | 2      | 16              | 213                      | 4.2              |
| SPH-FP-100     | PHGH-20-19-W63-06   | 2      | 19              | 253                      | 6.4              |
| SPH-FP-140     | PHGH-30-16-W80-06   | 3      | 16              | 320                      | 14.7             |
| EPL-AP-070     | PHGH-20-18-K16-06   | 2      | 18              | 240                      | 1.9              |
| EPL-AP-090     | PHGH-20-20-K22-06   | 2      | 20              | 267                      | 2.8              |
| EPL-AP-120     | PHGH-20-30-K32-06   | 2      | 30              | 333                      | 4.6              |
| EPL-AP-155     | PHGH-30-22-K40-06   | 3      | 22              | 330                      | 12.4             |
| EPL-FP-064     | PHGH-20-26-B31.5-06 | 2      | 26              | 347                      | 1.2              |
| EPL-FP-090     | PHGH-20-33-B50-06   | 2      | 33              | 440                      | 2.7              |
| EPL-FP-110     | PHGH-20-40-B63-06   | 2      | 40              | 444                      | 4.5              |
| EPL-FP-140     | PHGH-30-16-W80-06   | 3      | 16              | 240                      | 10.5             |

| Right Angle Gearbox | Pinion*             | Module | Number of Teeth | Maximum Speed ** (m/min) | Feed Force† (kN) |
|---------------------|---------------------|--------|-----------------|--------------------------|------------------|
| DS-FP-055           | PHGH-20-16-W50-06   | 2      | 16              | 284                      | 2.9              |
| DS-FP-075           | PHGH-20-16-W50-06   | 2      | 16              | 284                      | 5.8              |
| DS-FP-090           | PHGH-20-19-W63-06   | 2      | 19              | 296                      | 9.6              |
| DS-FP-115           | PHGH-30-16-W80-06   | 3      | 16              | 320                      | 13.3             |
| DS-FP-140           | PHGH-30-19-W80-06   | 3      | 19              | 317                      | 18               |
| DS-FP-190           | PHGH-40-20-W125-06  | 4      | 20              | 400                      | 30.1             |
| DS-HP-055           | PHGH-20-15-D20-06   | 2      | 15              | 267                      | 3.1              |
| DS-HP-075           | PHGH-20-18-D25-06   | 2      | 18              | 320                      | 5.2              |
| DS-HP-090           | PHGH-20-23-D30-06   | 2      | 23              | 358                      | 8.1              |
| DS-HP-115           | PHGH-30-20-D40-06   | 3      | 20              | 400                      | 11.6             |
| DS-HP-140           | PHGH-40-20-D55-06   | 4      | 20              | 444                      | 20               |
| DS-HP-190           | PHGH-40-20-D70-06   | 4      | 20              | 400                      | 30.1             |
| EPR-AP-070          | PHGH-20-18-K16-06   | 2      | 18              | 240                      | 1.8              |
| EPR-AP-090          | PHGH-20-20-K22-06   | 2      | 20              | 267                      | 2.7              |
| EPR-AP-120          | PHGH-20-30-K32-06   | 2      | 30              | 333                      | 4.6              |
| EPR-AP-155††        | PHGH-30-22-K40-06   | 3      | 22              | 330                      | 12.4             |
| EPR-FP-064          | PHGH-20-26-B31.5-06 | 2      | 26              | 347                      | 1.2              |
| EPR-FP-090          | PHGH-20-33-B50-06   | 2      | 33              | 440                      | 2.4              |
| EPR-FP-110          | PHGH-20-40-B63-06   | 2      | 40              | 444                      | 4                |
| EPR-FP-140††        | PHGH-30-16-W80-06   | 3      | 16              | 240                      | 10.5             |

\* See pages 8-12 for pinion information

\*\* 3:1 ratio with maximum input speed

† At 1 m/s, may vary based on speed and ratio

†† Contact GAM for availability



# ▶ GHGH SERIES HELICAL RACK (QUALITY Q6)

## Type Code

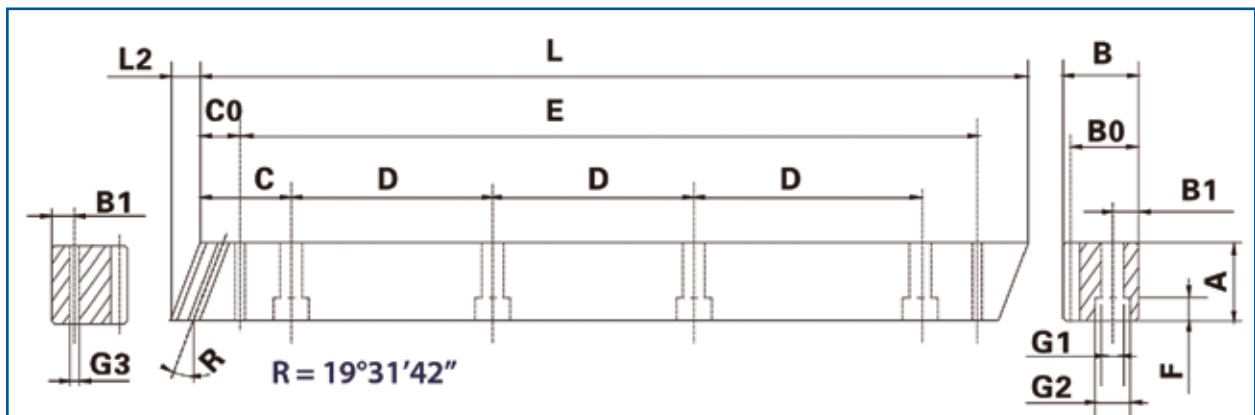
| Rack Series        | Module      | Length              | Precision Grade |
|--------------------|-------------|---------------------|-----------------|
| <b>GHGH</b>        | - <b>20</b> | - <b>10</b>         | - <b>06</b>     |
| Helical Teeth      | 20 = Mod 2  | 10 = 1 m (standard) | ISO 6           |
| Right Hand Helix   | 30 = Mod 3  |                     |                 |
| Ground             | 40 = Mod 4  |                     |                 |
| Induction Hardened |             |                     |                 |

## Specifications

|                |                        |                 |                    |
|----------------|------------------------|-----------------|--------------------|
| Quality        | ISO Q6                 | Hardness        | 50 - 55 HRC        |
| Helix Angle    | Right Hand 19° 31' 42" | Teeth Finish    | Ground             |
| Pressure Angle | 20°                    | Side/End Finish | Ground             |
| Material       | 1045                   | Heat Treatment  | Induction Hardened |

## Tolerance

|                                | Module | 2.0 | 3.0 | 4.0 |
|--------------------------------|--------|-----|-----|-----|
| Tooth Thickness Tolerance (µm) |        | -20 | -10 | -20 |
| Single Pitch Error (µm)        |        | ≤8  | ≤9  | ≤10 |
| Total Pitch Error (µm)         |        | ≤36 | ≤36 | ≤36 |



## Dimensions

| Type Code     | Module | No. of Teeth | L    | L2   | A  | B  | B0 | C    | D   | No of Holes | B1 | G1 | G2 | F | C0   | E      | G3  |
|---------------|--------|--------------|------|------|----|----|----|------|-----|-------------|----|----|----|---|------|--------|-----|
| GHGH-20-10-06 | 2      | 150          | 1000 | 8.5  | 24 | 24 | 22 | 62.5 | 125 | 8           | 8  | 7  | 11 | 7 | 31.7 | 936.60 | 5.7 |
| GHGH-30-10-06 | 3      | 100          | 1000 | 10.3 | 29 | 29 | 26 | 62.5 | 125 | 8           | 9  | 10 | 15 | 9 | 35   | 930.00 | 7.7 |
| GHGH-40-10-06 | 4      | 75           | 1000 | 13.8 | 39 | 39 | 35 | 62.5 | 125 | 8           | 12 | 10 | 15 | 9 | 33.3 | 933.4  | 7.7 |

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# ▶ GHFH SERIES HELICAL RACK (QUALITY Q10)



## Type Code

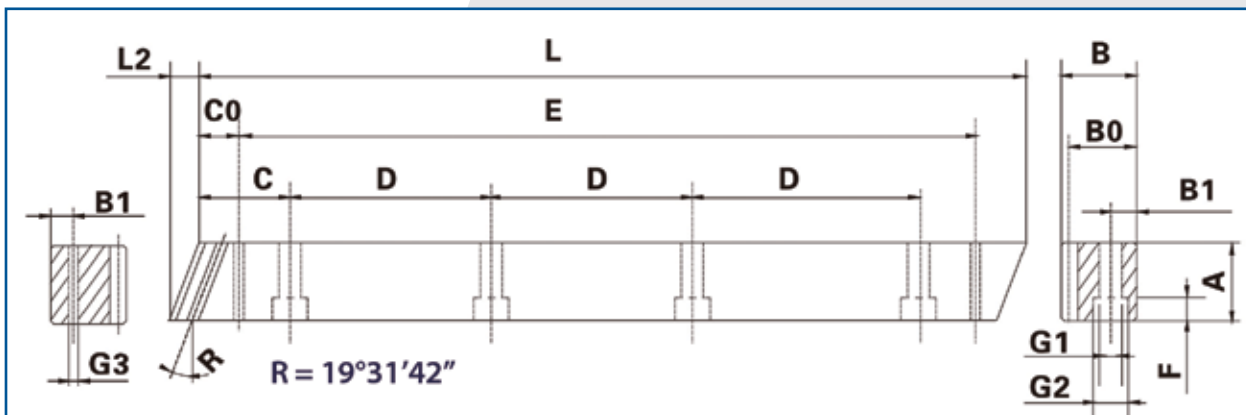
| Rack Series        | Module      | Length              | Precision Grade |
|--------------------|-------------|---------------------|-----------------|
| <b>GHFH</b>        | - <b>20</b> | - <b>10</b>         | - <b>10</b>     |
| Helical Teeth      | 20 = Mod 2  | 10 = 1 m (standard) | ISO 10          |
| Right Hand Helix   | 30 = Mod 3  |                     |                 |
| Finish Milled      | 40 = Mod 4  |                     |                 |
| Induction Hardened |             |                     |                 |

## Specifications

|                |                        |                 |                    |
|----------------|------------------------|-----------------|--------------------|
| Quality        | ISO Q10                | Hardness        | 50 - 55 HRC        |
| Helix Angle    | Right Hand 19° 31' 42" | Teeth Finish    | Finish Milled      |
| Pressure Angle | 20°                    | Side/End Finish | Finish Milled      |
| Material       | 1045                   | Heat Treatment  | Induction Hardened |

## Tolerance

|                                | Module | 2.0  | 3.0  | 4.0  |
|--------------------------------|--------|------|------|------|
| Tooth Thickness Tolerance (µm) |        | -124 | -124 | -124 |
| Single Pitch Error (µm)        |        | ≤37  | ≤39  | ≤43  |
| Total Pitch Error (µm)         |        | ≤148 | ≤162 | ≤175 |



## Dimensions

| Type Code     | Module | No. of Teeth | L    | L2   | A  | B  | B0 | C    | D   | No of Holes | B1 | G1 | G2 | F | C0   | E      | G3  |
|---------------|--------|--------------|------|------|----|----|----|------|-----|-------------|----|----|----|---|------|--------|-----|
| GHFH-20-10-10 | 2      | 150          | 1000 | 8.5  | 24 | 24 | 22 | 62.5 | 125 | 8           | 8  | 7  | 11 | 7 | 31.7 | 936.60 | 5.7 |
| GHFH-30-10-10 | 3      | 100          | 1000 | 10.3 | 29 | 29 | 26 | 62.5 | 125 | 8           | 9  | 10 | 15 | 9 | 35   | 930.00 | 7.7 |
| GHFH-40-10-10 | 4      | 75           | 1000 | 13.8 | 39 | 39 | 35 | 62.5 | 125 | 8           | 12 | 10 | 15 | 9 | 33.3 | 933.4  | 7.7 |



# ▶ RACK INSTALLATION

## Rack Installation

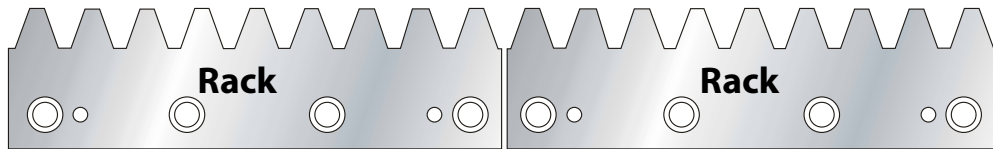
These are the three main steps to installing GAM rack. See the *GAM Rack Installation Instructions* for more detailed installation information. Installation of multiple rack pieces end-to-end requires an opposite tooth installation gauge:

### GAM Helical Tooth Installation Gauge

| Module                | 2.0              | 3.0              | 4.0              |
|-----------------------|------------------|------------------|------------------|
| Type Code             | GHGH-20-02-Gauge | GHGH-30-02-Gauge | GHGH-40-02-Gauge |
| Part Number           | 74030001         | 74030002         | 74030003         |
| Dimensions HxWxL (mm) | 24 x 24 x 200    | 29 x 29 x 200    | 39 x 39 x 200    |

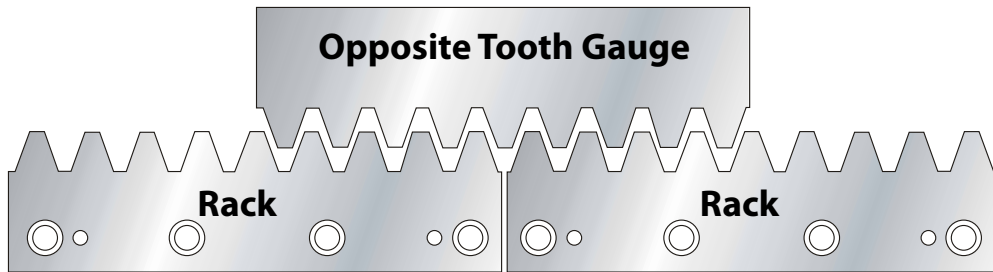
### Step 1

Put the racks on the base, end to end, without the screw



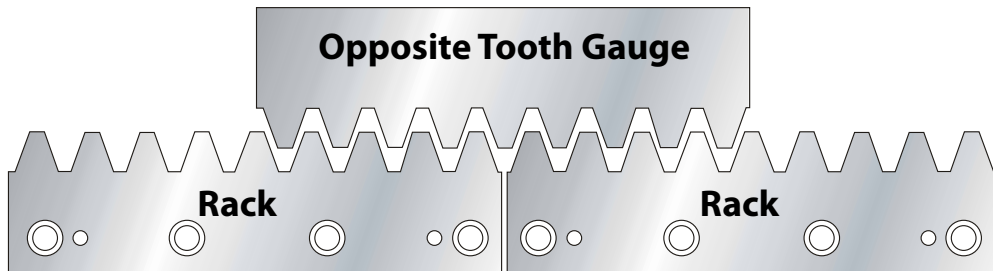
### Step 2

Put the Rack Gauge across the ends of the joined racks and adjust the pitch. The ends of the racks each form half a tooth.



### Step 3

Bolt the racks to the base in sequence. Install dowel pins.



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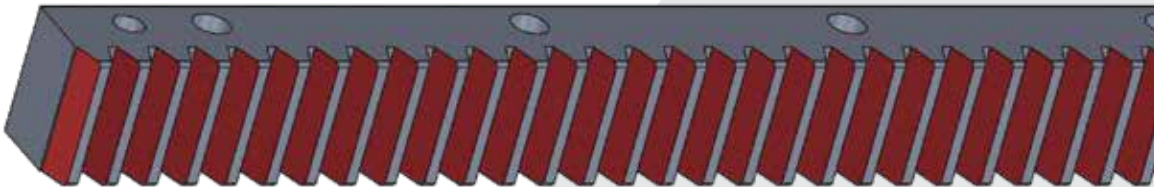
# ▶ RACK & PINION ALIGNMENT

## Rack & Pinion Alignment

For best performance, the rack and pinion must be installed with proper tooth engagement. To check this, we recommend using a red compound and check the gear mesh contact pattern under load conditions.

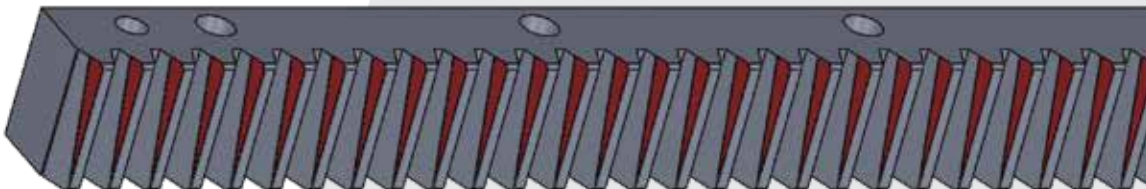
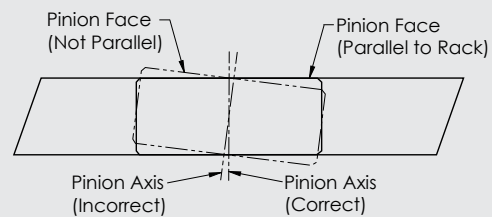
### Correct

Contact is even across the face of the tooth



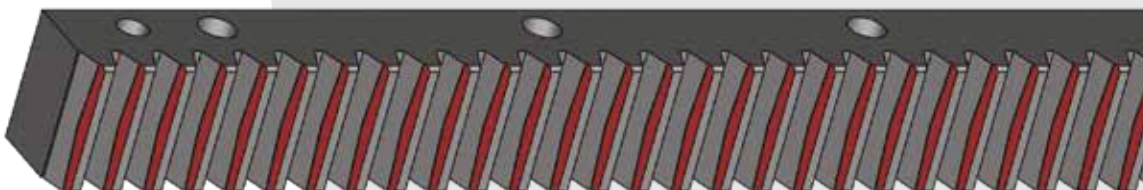
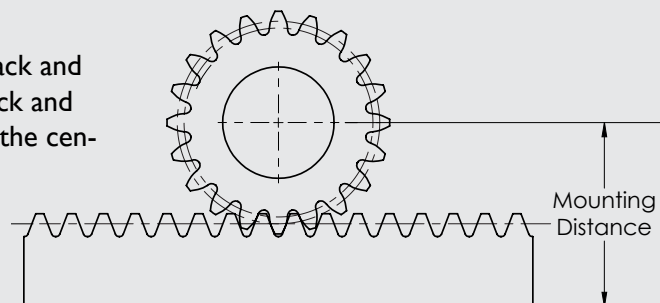
### Not Parallel

The pinion and rack are not parallel. Adjust the pinion so the face of the pinion and the side of the rack are parallel. The axis of the pinion should be perpendicular to the rack



### Incorrect Mounting Distance

There is insufficient tooth contact between the rack and pinion. Adjust the center distance between the rack and the pinion. The pinion specification tables include the center distance for each size pinion.



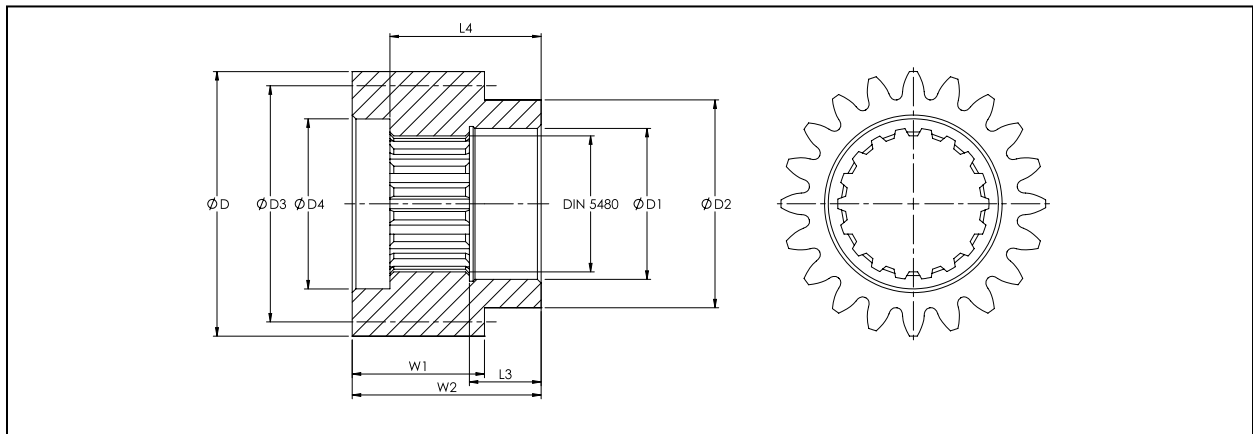


GAM Spline Pinions connect to the output shaft of the gearbox with a spline connection.

| Pinion Series  | Module (M)                             | Number of Teeth (z) | Pinion Type | Spline Diameter | Quality     |
|--|--|---------------------|-------------|-----------------|-------------|
| <b>PHGH</b>  | - <b>20</b>                            | - <b>18</b>         | - <b>S</b>  | <b>22</b>       | - <b>06</b> |
| 4140 Steel<br>Helical Teeth<br>Left Hand Helix<br>Ground<br>Induction Hardened | 20 = Mod 2<br>30 = Mod 3<br>40 = Mod 4 |                     | Spline      | See Table       | ISO 6       |

## Specifications

| Type Code         | Module (M) | No. of Teeth (z) | Spline Diameter (DIN 5480) | Travel per Rotation (mm) | Max Feed Force (kN) | Mounting Distance (mm) | Use with GAM Gearbox |
|-------------------|------------|------------------|----------------------------|--------------------------|---------------------|------------------------|----------------------|
| PHGH-20-15-S16-06 | 2          | 15               | N16x0.8x18x7H              | 100.00                   | 11.1                | 39.10                  | SPH-S-060            |
| PHGH-20-18-S22-06 | 2          | 18               | N22x1.25x16x7H             | 120.00                   | 11.9                | 42.10                  | SPH-S-075            |
| PHGH-20-23-S32-06 | 2          | 23               | N32x1.25x24x7H             | 153.33                   | 12.9                | 47.40                  | SPH-S-100            |
| PHGH-30-20-S40-06 | 3          | 20               | N40x2x18x7H                | 200.00                   | 22.2                | 59.20                  | SPH-S-140            |
| PHGH-40-20-S55-06 | 4          | 20               | N55x2x26x7H                | 266.67                   | 39.1                | 79.04                  | SPH-S-180            |



## Dimensions

| Type Code         | Spline Dia DIN 5480 | D (mm) | D1 (mm) F7 | D2 (mm) | D3 Pitch (mm) | Dw Working Pitch (mm) | D4 (mm) | W1 (mm) | W2 (mm) | L3 (mm) | L4 (mm) | x Shift Coefficient |
|-------------------|---------------------|--------|------------|---------|---------------|-----------------------|---------|---------|---------|---------|---------|---------------------|
| PHGH-20-15-S16-06 | N16x0.8x18x7H       | 38.2   | 16         | 25      | 31.831        | 34.200                | 20      | 26      | 32      | 11      | 26.5    | 0.59                |
| PHGH-20-18-S22-06 | N22x1.25x16x7H      | 44.2   | 22         | 30      | 38.197        | 40.200                | 25      | 26      | 33      | 12      | 27.5    | 0.50                |
| PHGH-20-23-S32-06 | N32x1.25x24x7H      | 54.8   | 32         | 40      | 48.808        | 50.800                | 35      | 26      | 34      | 13      | 27      | 0.50                |
| PHGH-30-20-S40-06 | N40x2x18x7H         | 72.4   | 40         | 55      | 63.662        | 66.400                | 45      | 31      | 51      | 20      | 41      | 0.46                |
| PHGH-40-20-S55-06 | N55x2x26x7H         | 96.08  | 55         | 75      | 84.883        | 88.080                | 60      | 41      | 54      | 20      | 44      | 0.40                |

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# ▶ PHGH-K PINION (KEYED SHAFT)

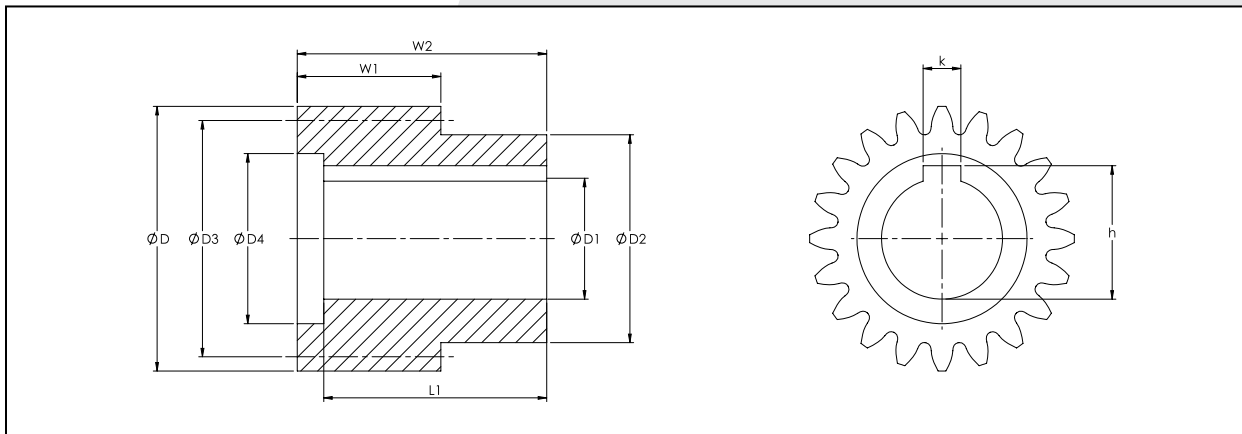


GAM Keyed Pinions connect to the output shaft of the gearbox with a key

| Pinion Series  | Module                                 | Number of Teeth | Pinion Type | Shaft Diameter | Quality     |
|--|--|-----------------|-------------|----------------|-------------|
| <b>PHGH</b>  | - <b>20</b>                            | - <b>18</b>     | - <b>K</b>  | <b>16</b>      | - <b>06</b> |
| 4140 Steel<br>Helical Teeth<br>Left Hand Helix<br>Ground<br>Induction Hardened | 20 = Mod 2<br>30 = Mod 3<br>40 = Mod 4 |                 | Keyed Shaft | Diameter (mm)  | ISO 6       |

## Specifications

| Type Code         | Module (M) | No. of Teeth (z) | D1 Shaft Diameter (mm) | Travel per Rotation (mm) | Max Feed Force (kN) | Mounting Distance (mm) | Use with GAM Gearbox  |
|-------------------|------------|------------------|------------------------|--------------------------|---------------------|------------------------|-----------------------|
| PHGH-20-18-K16-06 | 2          | 18               | 16                     | 120.00                   | 12.88               | 41.10                  | EPL-A-070 / EPR-A-070 |
| PHGH-20-20-K22-06 | 2          | 20               | 22                     | 133.33                   | 13.37               | 43.22                  | EPL-A-090 / EPR-A-090 |
| PHGH-20-30-K32-06 | 2          | 30               | 32                     | 200.00                   | 15.02               | 53.83                  | EPL-A-120 / EPR-A-120 |
| PHGH-30-22-K40-06 | 3          | 22               | 40                     | 220.00                   | 20.05               | 61.01                  | EPL-A-155 / EPR-A-155 |



## Dimensions

| Type Code         | D (mm) | D1 (mm) F7 | D2 (mm) | D3 Pitch (mm) | D4 (mm) | W1 (mm) | W2 (mm) | L1 (mm) | k (mm) | h (mm) |
|-------------------|--------|------------|---------|---------------|---------|---------|---------|---------|--------|--------|
| PHGH-20-18-K16-06 | 42.4   | 16         | 25      | 38.20         | 25      | 28      | 34.5    | 29      | 5      | 18.3   |
| PHGH-20-20-K22-06 | 46.4   | 22         | 36      | 42.44         | 30      | 28      | 42.5    | 37      | 6      | 24.8   |
| PHGH-20-30-K32-06 | 67.7   | 32         | 55      | 63.66         | 45      | 28      | 66      | 59      | 10     | 35.3   |
| PHGH-30-22-K40-06 | 76     | 40         | 62      | 70.03         | 50      | 28      | 93      | 83      | 12     | 43.3   |



# ▶ PHGH-W PINION (WELDED FLANGE)

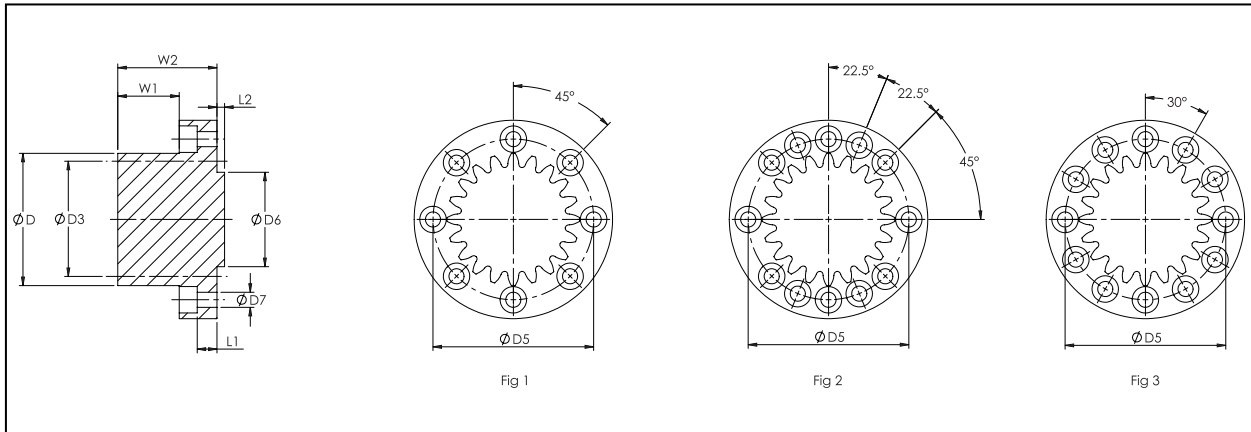


GAM Welded Flange Pinions mount to flange-output gearboxes.

| Pinion Series  | Module (M)                             | Number of Teeth (z) | Pinion Type      | Flange Bolt Circle | Quality     |
|--|--|---------------------|------------------|--------------------|-------------|
| <b>PHGH</b>  | <b>- 20</b>                            | <b>- 16</b>         | <b>- W</b>       | <b>50</b>          | <b>- 06</b> |
| 4140 Steel<br>Helical Teeth<br>Left Hand Helix<br>Ground<br>Induction Hardened | 20 = Mod 2<br>30 = Mod 3<br>40 = Mod 4 | Per Table           | Welded<br>Flange | Diameter<br>(mm)   | ISO 6       |

## Specifications

| Type Code          | Module (M) | No. of Teeth (z) | D5 Bolt Circle ISO 9409 Flange (mm) | Travel per Rotation (mm) | Max Feed Force (kN) | Mounting Distance (mm) | Fig | Use with GAM Gearbox             |
|--------------------|------------|------------------|-------------------------------------|--------------------------|---------------------|------------------------|-----|----------------------------------|
| PHGH-20-16-W50-06  | 2          | 16               | 50                                  | 106.67                   | 14.8                | 38.98                  | 1   | SPH-F-075 / DS-F-055 / DS-F-075  |
| PHGH-20-19-W63-06  | 2          | 19               | 63                                  | 126.67                   | 15.7                | 42.16                  | 2   | SPH-F-100 / DS-F-090             |
| PHGH-30-16-W80-06  | 3          | 16               | 80                                  | 160.00                   | 27.7                | 51.46                  | 3   | SPH-F-140 / EPL-F-140 / DS-F-115 |
| PHGH-30-19-W80-06  | 3          | 19               | 80                                  | 190.00                   | 29.5                | 56.24                  | 3   | DS-F-140                         |
| PHGH-40-20-W125-06 | 4          | 20               | 125                                 | 266.67                   | 55.5                | 77.44                  | 3   | DS-F-190                         |



## Dimensions

| Type Code          | Figure | D (mm) | D3 (mm) | D5 Bolt Circle (mm) | D6 (mm) k6 | D7 (mm) | W1 (mm) | W2 (mm) | L1 (mm) | L2 (mm) |
|--------------------|--------|--------|---------|---------------------|------------|---------|---------|---------|---------|---------|
| PHGH-20-16-W050-06 | 1      | 37.95  | 33.953  | 50                  | 31.5       | 6.6     | 26      | 41      | 8.5     | 5       |
| PHGH-20-19-W063-06 | 2      | 44.30  | 40.319  | 63                  | 40         | 6.6     | 26      | 41      | 8.5     | 5       |
| PHGH-30-16-W080-06 | 3      | 56.90  | 50.930  | 80                  | 50         | 9       | 32.5    | 52.5    | 12      | 5       |
| PHGH-30-19-W080-06 | 3      | 66.50  | 60.479  | 80                  | 50         | 9       | 32.5    | 52.5    | 12      | 5       |
| PHGH-40-10-W125-06 | 3      | 92.90  | 84.883  | 125                 | 80         | 11      | 45      | 70      | 15      | 6       |

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# ▶ PHGH-B PINION (BOLT-THROUGH)

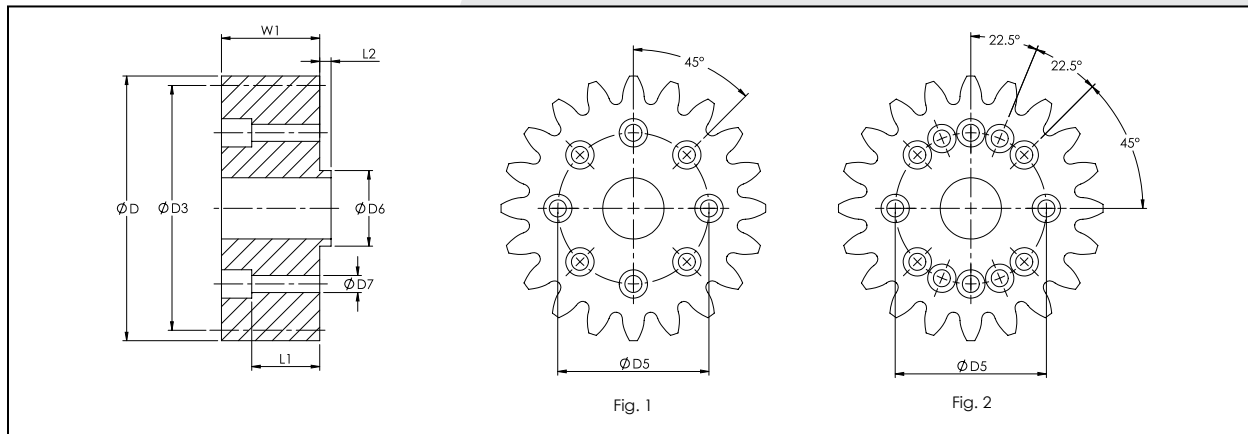


GAM Bolt-Through Pinions mount to flange-output gearboxes.

| Pinion Series  | Module      | Number of Teeth | Pinion Type  | Bolt Circle   | Quality     |
|--|-------------|-----------------|--------------|---------------|-------------|
| <b>PHGH</b>  | - <b>20</b> | - <b>26</b>     | - <b>B</b>   | <b>31.5</b>   | - <b>06</b> |
| 4140 Steel<br>Helical Teeth<br>Left Hand Helix<br>Ground<br>Induction Hardened | 20 = Mod 2  |                 | Bolt-Through | Diameter (mm) | ISO 6       |

## Specifications

| Type Code           | Module (M) | No. of Teeth (z) | D5 Bolt Circle (ISO 9409 Flange) (mm) | Travel per Rotation (mm) | Max Feed Force (kN) | Mounting Distance (mm) | Figure | Use with GAM Gearbox              |
|---------------------|------------|------------------|---------------------------------------|--------------------------|---------------------|------------------------|--------|-----------------------------------|
| PHGH-20-26-B31.5-06 | 2          | 26               | 31.5                                  | 173.334                  | 13.4                | 50.40                  | 1      | EPL-F-064 / EPR-F-064<br>DS-F-055 |
| PHGH-20-33-B50-06   | 2          | 33               | 50                                    | 220.000                  | 18.4                | 57.80                  | 1      | EPL-F-090 / EPR-F-090             |
| PHGH-20-40-B63-06   | 2          | 40               | 63                                    | 266.667                  | 14.8                | 65.20                  | 2      | EPL-F-110 / EPR-F-110             |



## Dimensions

| Type Code           | Figure | D (mm) | D3 Pitch Dia (mm) | Dw Working Pitch (mm) | D5 Bolt Circle (mm) | D6 (mm) | D7 (mm) | W1 (mm) | L1 (mm) | L2 (mm) | x Shift Coefficient |
|---------------------|--------|--------|-------------------|-----------------------|---------------------|---------|---------|---------|---------|---------|---------------------|
| PHGH-20-26-B31.5-06 | 1      | 60.80  | 55.174            | 56.800                | 31.5                | 20      | 5.5     | 26      | 14      | 3       | 0.4065              |
| PHGH-20-33-B050-06  | 1      | 75.60  | 70.028            | 71.599                | 50                  | 31.5    | 6.6     | 26      | 12      | 3       | 0.3928              |
| PHGH-20-40-B063-06  | 2      | 90.40  | 84.883            | 86.400                | 63                  | 40      | 6.6     | 26      | 12      | 3       | 0.3792              |



# ▶ PHGH-D PINION (SHAFT)

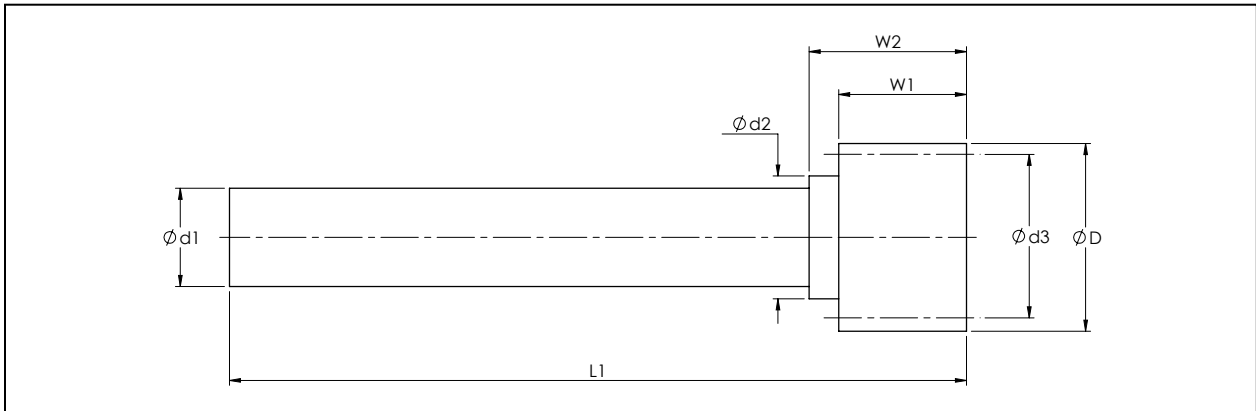


GAM Shaft Pinions mount to hollow output shaft gearboxes

| Pinion Series  | Module (M)                             | Number of Teeth (z) | Pinion Type | Shaft Diameter | Quality     |
|--|--|---------------------|-------------|----------------|-------------|
| <b>PHGH</b>  | - <b>20</b>                            | - <b>18</b>         | - <b>D</b>  | <b>25</b>      | - <b>06</b> |
| 4140 Steel<br>Helical Teeth<br>Left Hand Helix<br>Ground<br>Induction Hardened | 20 = Mod 2<br>30 = Mod 3<br>40 = Mod 4 |                     | Shaft       | Diameter (mm)  | ISO 6       |

## Specifications

| Type Code         | Module (M) | No. of Teeth (z) | D1 Shaft Diameter (mm) | Travel per Rotation (mm) | Max Feed Force (kN) | Mounting Distance (mm) | Use with GAM Gearbox |
|-------------------|------------|------------------|------------------------|--------------------------|---------------------|------------------------|----------------------|
| PHGH-20-15-D20-06 | 2          | 15               | 20                     | 100.00                   | 11.1                | 39.10                  | DS-H-055             |
| PHGH-20-18-D25-06 | 2          | 18               | 25                     | 120.00                   | 11.9                | 42.10                  | DS-H-075             |
| PHGH-20-23-D30-06 | 2          | 23               | 30                     | 153.33                   | 12.9                | 47.40                  | DS-H-090             |
| PHGH-30-20-D40-06 | 3          | 20               | 40                     | 200.00                   | 22.2                | 59.20                  | DS-H-115             |
| PHGH-40-20-D55-06 | 4          | 20               | 55                     | 266.67                   | 39.1                | 79.04                  | DS-H-140             |
| PHGH-40-20-D70-06 | 4          | 20               | 70                     | 266.67                   | 39.1                | 79.04                  | DS-H-190             |



## Dimensions

| Type Code         | D (mm) | D1 (mm) F7 | D2 (mm) | D3 Pitch (mm) | Dw Working Pitch (mm) | W1 (mm) | W2 (mm) | L1 (mm) | x Shift Coefficient |
|-------------------|--------|------------|---------|---------------|-----------------------|---------|---------|---------|---------------------|
| PHGH-20-15-D20-06 | 38.2   | 20         | 25      | 31.83         | 34.20                 | 26      | 32      | 150     | 0.59                |
| PHGH-20-18-D25-06 | 44.2   | 25         | 30      | 38.20         | 40.20                 | 26      | 33      | 164     | 0.50                |
| PHGH-20-23-D30-06 | 54.8   | 30         | 40      | 48.81         | 50.80                 | 26      | 34      | 189     | 0.50                |
| PHGH-30-20-D40-06 | 72.4   | 40         | 55      | 63.66         | 66.40                 | 31      | 51      | 230     | 0.46                |
| PHGH-40-20-D55-06 | 96.08  | 55         | 75      | 84.88         | 88.08                 | 41      | 54      | 268     | 0.40                |
| PHGH-40-20-D70-06 | 96.08  | 70         | 75      | 84.88         | 88.08                 | 41      | 54      | 325     | 0.40                |

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## Rack Installation Gauge

These opposite tooth gauges assist with installing rack pieces end-to-end. Select the gauge that matches the module of your rack.



## Helical Tooth Installation Gauge

| Module                | 2.0              | 3.0              | 4.0              |
|-----------------------|------------------|------------------|------------------|
| Type Code             | GHGH-20-02-Gauge | GHGH-30-02-Gauge | GHGH-40-02-Gauge |
| Part Number           | 74030001         | 74030002         | 74030003         |
| Helix                 | Left Hand        | Left Hand        | Left Hand        |
| Dimensions HxWxL (mm) | 24 x 24 x 200    | 29 x 29 x 200    | 39 x 39 x 200    |

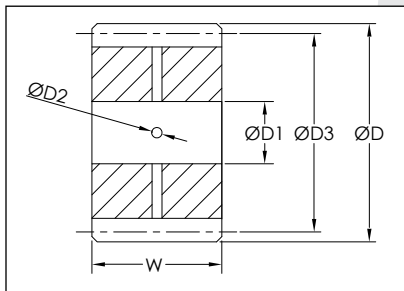
## Felt Pinions

Use a felt pinion with your lubrication system to lubricate the rack and pinion. Felt pinions can be mounted to lubricate either the rack or the pinion.



## Felt Pinions

| Module      | 2.0       |            | 3.0       |            | 4.0       |            |
|-------------|-----------|------------|-----------|------------|-----------|------------|
| Helix       | Left Hand | Right Hand | Left Hand | Right Hand | Left Hand | Right Hand |
| Mounts to   | Rack      | Pinion     | Rack      | Pinion     | Rack      | Pinion     |
| Type Code   | PHFP-20-L | PHFP-20-R  | PHFP-30-L | PHFP-30-R  | PHFP-40-L | PHFP-40-R  |
| Part Number | 74030004  | 74030005   | 74030006  | 74030007   | 74030008  | 74030009   |



| Module | Number of Teeth (z) | D (mm) | D1 (mm) | D2 (mm) | D3 Pitch (mm) | W (mm) |
|--------|---------------------|--------|---------|---------|---------------|--------|
| 2      | 18                  | 42     | 12      | 2       | 38.2          | 25     |
| 3      | 18                  | 63     | 12      | 3       | 57.3          | 30     |
| 4      | 18                  | 84     | 12      | 4       | 76.4          | 40     |



# ▶ RACK & PINION TERMINOLOGY

## Module

The module is the relative size of the rack and pinion as described by the pinion. It is the ratio of the diameter of a gear to the number of teeth on the gear. The module and number of teeth give the reference pitch diameter:

$$\text{Module (M)} = \frac{\text{Pitch Diameter}}{\text{Number of Teeth (z)}}$$

$$\text{Reference Pitch Diameter} = \text{Module (M)} \times \text{Number of Teeth (z)}$$

The rack and pinion must have the same module.

## ISO Quality Number

The ISO Quality Number describes the accuracy of the gear including the tooth alignment and profile, spacing variation and radial runout among other things. GAM stocks Q6 and Q10 racks along with Q6 pinions.

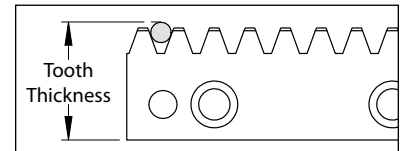
### Gear Quality Number

| ISO | DIN | AGMA | JIS |
|-----|-----|------|-----|
| 6   | 6   | 12   | 2   |
| 10  | 10  | 8    | 6   |

## Tooth Thickness Tolerance

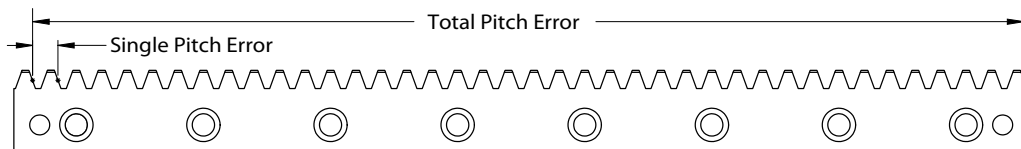
Tooth Thickness Tolerance is the relationship between tooth thickness and a measuring pin measurement.

- The tooth thickness of racks is usually measured via the pin measurement as tooth thickness can not be measured directly.
- A measuring pin is put into the teeth and measured to the back of the rack.



## Pitch Error

**Pitch:** Distance between teeth as measured from a point on one rack tooth to the corresponding point on the next gear tooth.



**Single Pitch Error:** Error in the pitch between two teeth relative to the ideal.

**Total Pitch Error:** Cumulative pitch error over the length of the rack.

| Tolerance                      | Module 2.0 |        | Module 3.0 |        | Module 4.0 |        |
|--------------------------------|------------|--------|------------|--------|------------|--------|
|                                | ISO 6      | ISO 10 | ISO 6      | ISO 10 | ISO 6      | ISO 10 |
| Tooth Thickness Tolerance (µm) | -20        | -124   | -10        | -124   | -20        | -124   |
| Single Pitch Error (µm)        | ≤ 8        | ≤ 37   | ≤ 9        | ≤ 39   | ≤ 10       | ≤ 43   |
| Total Pitch Error (µm)         | ≤ 36       | ≤ 148  | ≤ 36       | ≤ 162  | ≤ 36       | ≤ 175  |

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# ▶ RACK & PINION TERMINOLOGY



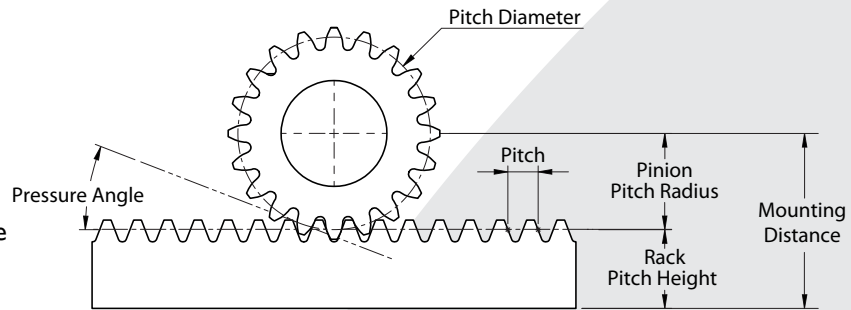
**Circular Pitch:** The distance from a point on one gear tooth to the corresponding point on the next gear tooth, measured along the pitch circle.

**Pitch Circle:** A circle transcribing the contact point on the teeth where the rack and pinion mesh correctly

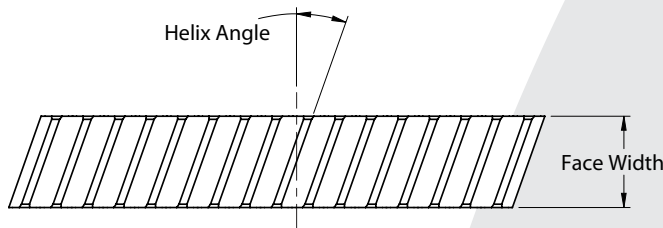
**Pitch Diameter:** The diameter of the gear's pitch circle.

**Pressure Angle:** The angle made by the sides of the tooth as it angles towards the top of the tooth. Mating gears and racks must have the same pressure angle.

**Mounting Distance:** Distance between the center of the pinion and the bottom of the rack that ensures proper mesh. The Mounting distance should stay consistent for the length of the rack.



$$\text{Mounting Distance} = \text{Pitch Height of Rack} + \text{Pitch Radius of Pinion}$$



**Helix Angle:** Angle of the rack or gear tooth. GAM racks and pinions use a common helix angle of 19°31'42"

## Gear Strength & Durability

Gear strength and durability depends on transmitted forces and power.

$$\text{Power (P}_{kW}) = \text{Force (F}_N) \times \text{Linear Velocity (V}_{mm/s})$$

$$\text{Force (F}_N) = \frac{1000 \times \text{Torque (T}_{Nm})}{\text{Pitch Radius (r}_{mm})}$$

$$\text{Linear Velocity (V}_{mm/s}) = \frac{\pi r_{mm} \times N_{RPM}}{60}$$

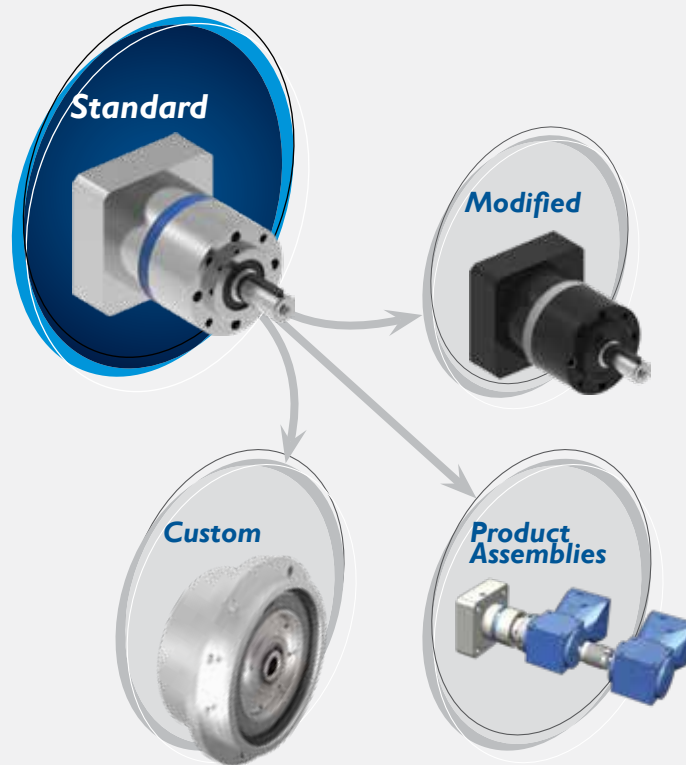
$$\text{Power (P}_{kW}) = \frac{T_{Nm} \times N_{RPM}}{9550}$$

The feed force required by the application should be less than the feed force capacity of the pinion or gearbox-pinion system as listed in this catalog. The feed force rating should be derated by the Overload Factor ( $K_a$ ) and the Life Factor ( $K_L$ )

$$\text{Application Feed Force (F)} < \frac{K_L}{K_a} \times \text{Rated Feed Force (F)}$$

| Overload Factor ( $K_a$ ) |                       |               |              | Life Factor ( $K_L$ ) |                          |
|---------------------------|-----------------------|---------------|--------------|-----------------------|--------------------------|
| Impact from Prime Mover   | Impact from Load Side |               |              | Number of Cycles      | Hardness (HRC) $\geq 45$ |
|                           | Uniform Load          | Medium Impact | Heavy Impact | Under 10,000          | 1.5                      |
| Uniform Load              | 1                     | 1.25          | 1.75         | $\sim 10^5$           | 1.5                      |
| Light Impact              | 1.25                  | 1.5           | 2            | $\sim 10^6$           | 1.1                      |
| Medium Impact             | 1.5                   | 1.75          | 2.25         | $\sim 10^7$           | 1.0                      |

## The GAM Advantage



### Find the your exact solution at GAM!

GAM's product range of gear reducers, couplings, and other specialized mechanical drive solutions is one of the largest in the industry. Even with such a wide offering, we realize that you may not find a standard product that meets your exact requirements.

One of our greatest strengths is our ability to modify standard designs, provide completely customized solutions, and integrated product assemblies to meet your specific application requirements. And, because of our flexible manufacturing, we can cost-effectively produce small batches of customized product in short lead-times.

So if you can't find what you are looking for, just ask!



GAM, a U.S. company, is your complete source for Gear Reducers, Servo Couplings, and other precision mechanical drive solutions used in automation technology.

With one of the largest product offerings in the motion control industry as well as the engineering expertise and manufacturing capabilities to develop customized solutions, GAM can help with your application.

U.S. manufacturing, being flexible to meet the needs of customer requests, and great service are what set us apart from the rest.

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