

### Harmonic Drive now offers a NEW lightweight version of our CSG-2UH Gear Units!

#### 30% lighter than our standard CSG-2UH! 30% More Torque than the CSF Series!

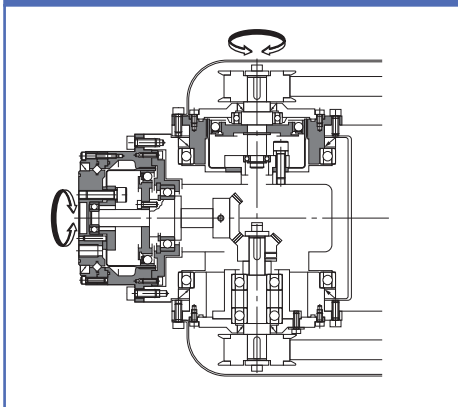
Using new lightweight materials and an optimized design, a 30% reduction in weight has been achieved without reducing the torque rating of the gear unit or significant changes to the interface dimensions. This weight reduction, combined with the CSG's high torque ratings, results in an exceptional "Torque Density" making it ideally suited for many applications including...

**Industrial Robots** – allowing operation with higher acceleration rates and payload capacity

**Mobile Robots** – allowing lower weight designs which improves battery life without sacrificing performance

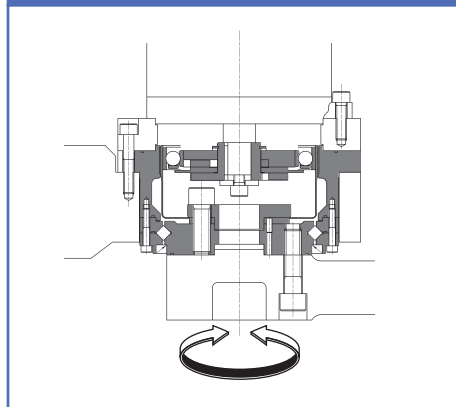
#### Application Examples

##### Robot Wrist



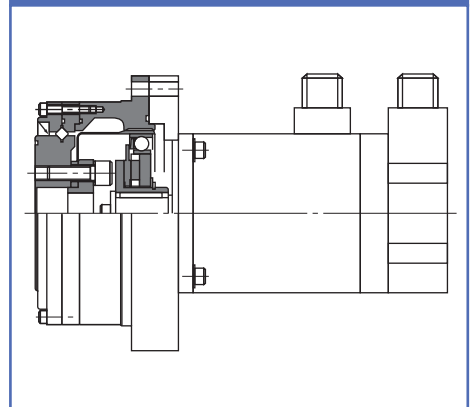
5th and 6th axis drive for the wrist of an Industrial Robot

##### SCARA Robot Arm



Drive for SCARA Robot

##### Direct Connection to a Servo Motor



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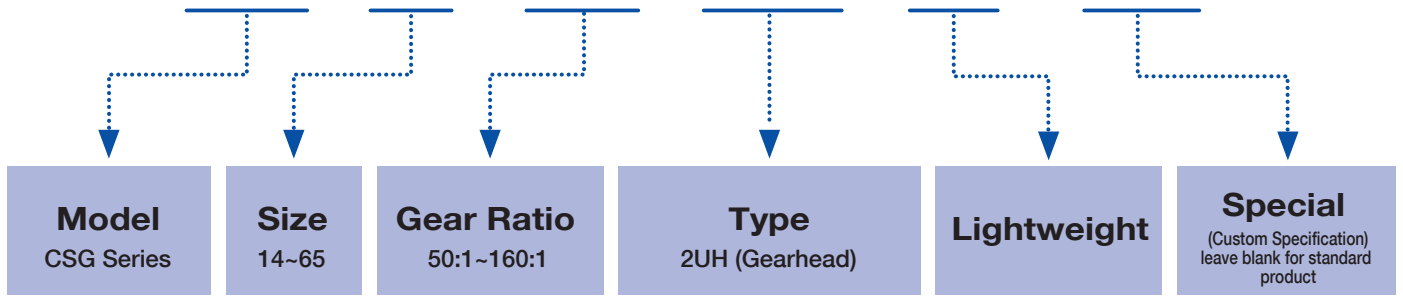
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[sales@electromate.com](mailto:sales@electromate.com)

**Ordering Code**

**CSG - 25 - 100 - 2UH - LW - SP**



**Rating Table**

Table 2-1

| Size | Ratio | Rated Torque at 2000rpm |        | Limit for Repeated Peak Torque |        | Limit for Average Torque |        | Limit for Momentary Torque |        | Maximum Input Speed |        | Max. Average Input Speed |        | Moment of Inertia             |                                |
|------|-------|-------------------------|--------|--------------------------------|--------|--------------------------|--------|----------------------------|--------|---------------------|--------|--------------------------|--------|-------------------------------|--------------------------------|
|      |       | Nm                      | lb-in  | Nm                             | lb-in  | Nm                       | lb-in  | Nm                         | lb-in  | Oil                 | Grease | Oil                      | Grease | $\times 10^{-4} \text{kgm}^2$ | $\times 10^{-3} \text{kgms}^2$ |
| 14   | 50    | 7.0                     | 62     | 23                             | 204    | 9                        | 80     | 46                         | 407    | 14,000              | 8,500  | 6,500                    | 3,500  | 0.033                         | 0.034                          |
|      | 80    | 10                      | 89     | 30                             | 266    | 14                       | 124    | 61                         | 540    |                     |        |                          |        |                               |                                |
|      | 100   | 10                      | 89     | 36                             | 319    | 14                       | 124    | 70                         | 620    |                     |        |                          |        |                               |                                |
| 17   | 50    | 21                      | 186    | 44                             | 389    | 34                       | 301    | 91                         | 805    | 10,000              | 7,300  | 6,500                    | 3,500  | 0.079                         | 0.081                          |
|      | 80    | 29                      | 257    | 56                             | 496    | 35                       | 310    | 113                        | 1,000  |                     |        |                          |        |                               |                                |
|      | 100   | 31                      | 274    | 70                             | 620    | 51                       | 451    | 143                        | 1,266  |                     |        |                          |        |                               |                                |
|      | 120   | 31                      | 274    | 70                             | 620    | 51                       | 451    | 112                        | 991    |                     |        |                          |        |                               |                                |
| 20   | 50    | 33                      | 292    | 73                             | 646    | 44                       | 389    | 127                        | 1,124  | 10,000              | 6,500  | 6,500                    | 3,500  | 0.193                         | 0.197                          |
|      | 80    | 44                      | 389    | 96                             | 850    | 61                       | 540    | 165                        | 1,460  |                     |        |                          |        |                               |                                |
|      | 100   | 52                      | 460    | 107                            | 947    | 64                       | 566    | 191                        | 1,690  |                     |        |                          |        |                               |                                |
|      | 120   | 52                      | 460    | 113                            | 1,000  | 64                       | 566    | 191                        | 1,690  |                     |        |                          |        |                               |                                |
|      | 160   | 52                      | 460    | 120                            | 1,062  | 64                       | 566    | 191                        | 1,690  |                     |        |                          |        |                               |                                |
| 25   | 50    | 51                      | 451    | 127                            | 1,124  | 72                       | 637    | 242                        | 2,142  | 7,500               | 5,600  | 5,600                    | 3,500  | 0.413                         | 0.421                          |
|      | 80    | 82                      | 726    | 178                            | 1,575  | 113                      | 1,000  | 332                        | 2,938  |                     |        |                          |        |                               |                                |
|      | 100   | 87                      | 770    | 204                            | 1,806  | 140                      | 1,239  | 369                        | 3,266  |                     |        |                          |        |                               |                                |
|      | 120   | 87                      | 770    | 217                            | 1,921  | 140                      | 1,239  | 382                        | 3,496  |                     |        |                          |        |                               |                                |
|      | 160   | 87                      | 770    | 229                            | 2,027  | 140                      | 1,239  | 382                        | 3,611  |                     |        |                          |        |                               |                                |
| 32   | 50    | 99                      | 876    | 281                            | 2,487  | 140                      | 1,239  | 497                        | 4,399  | 7,000               | 4,800  | 4,600                    | 3,500  | 1.69                          | 1.72                           |
|      | 80    | 153                     | 1,354  | 395                            | 3,496  | 217                      | 1,921  | 738                        | 6,532  |                     |        |                          |        |                               |                                |
|      | 100   | 178                     | 1,575  | 433                            | 3,832  | 281                      | 2,487  | 841                        | 7,443  |                     |        |                          |        |                               |                                |
|      | 120   | 178                     | 1,575  | 459                            | 4,062  | 281                      | 2,487  | 842                        | 7,895  |                     |        |                          |        |                               |                                |
|      | 160   | 178                     | 1,575  | 484                            | 4,284  | 281                      | 2,487  | 842                        | 7,895  |                     |        |                          |        |                               |                                |
| 40   | 50    | 178                     | 1,575  | 523                            | 4,629  | 255                      | 2,257  | 892                        | 7,895  | 5,600               | 4,000  | 3,600                    | 3,000  | 4.50                          | 4.59                           |
|      | 80    | 268                     | 2,372  | 675                            | 5,974  | 369                      | 3,266  | 1,270                      | 11,240 |                     |        |                          |        |                               |                                |
|      | 100   | 345                     | 3,054  | 738                            | 6,532  | 484                      | 4,284  | 1,400                      | 12,391 |                     |        |                          |        |                               |                                |
|      | 120   | 382                     | 3,381  | 802                            | 7,098  | 586                      | 5,187  | 1,488                      | 13,542 |                     |        |                          |        |                               |                                |
|      | 160   | 382                     | 3,381  | 841                            | 7,443  | 586                      | 5,187  | 1,488                      | 13,542 |                     |        |                          |        |                               |                                |
| 45   | 50    | 229                     | 2,027  | 650                            | 5,753  | 345                      | 3,054  | 1,235                      | 10,931 | 5,000               | 3,800  | 3,300                    | 3,000  | 8.68                          | 8.86                           |
|      | 80    | 407                     | 3,602  | 918                            | 8,125  | 507                      | 4,487  | 1,651                      | 14,613 |                     |        |                          |        |                               |                                |
|      | 100   | 459                     | 4,062  | 982                            | 8,691  | 650                      | 5,753  | 2,041                      | 18,064 |                     |        |                          |        |                               |                                |
|      | 120   | 523                     | 4,629  | 1,070                          | 9,470  | 806                      | 7,134  | 2,288                      | 20,250 |                     |        |                          |        |                               |                                |
|      | 160   | 523                     | 4,629  | 1,147                          | 10,152 | 819                      | 7,249  | 2,483                      | 21,976 |                     |        |                          |        |                               |                                |
| 50   | 80    | 484                     | 4,284  | 1,223                          | 10,824 | 675                      | 5,974  | 2,418                      | 21,401 | 4,500               | 3,500  | 3,000                    | 2,500  | 12.5                          | 12.8                           |
|      | 100   | 611                     | 5,408  | 1,274                          | 11,276 | 866                      | 7,665  | 2,678                      | 23,702 |                     |        |                          |        |                               |                                |
|      | 120   | 688                     | 6,089  | 1,404                          | 12,426 | 1,057                    | 9,355  | 2,678                      | 23,702 |                     |        |                          |        |                               |                                |
|      | 160   | 688                     | 6,089  | 1,534                          | 13,577 | 1,096                    | 9,700  | 3,185                      | 28,190 |                     |        |                          |        |                               |                                |
| 58   | 80    | 714                     | 6,319  | 1,924                          | 17,029 | 1,001                    | 8,860  | 3,185                      | 28,190 | 4,000               | 3,000  | 2,700                    | 2,200  | 27.3                          | 27.9                           |
|      | 100   | 905                     | 8,010  | 2,067                          | 18,294 | 1,378                    | 12,196 | 4,134                      | 36,589 |                     |        |                          |        |                               |                                |
|      | 120   | 969                     | 8,576  | 2,236                          | 19,790 | 1,547                    | 13,692 | 4,329                      | 38,315 |                     |        |                          |        |                               |                                |
|      | 160   | 969                     | 8,576  | 2,392                          | 21,171 | 1,573                    | 13,922 | 4,459                      | 39,465 |                     |        |                          |        |                               |                                |
| 65   | 80    | 969                     | 8,576  | 2,743                          | 24,278 | 1,352                    | 11,966 | 4,836                      | 42,802 | 3,500               | 2,800  | 2,400                    | 1,900  | 46.8                          | 47.8                           |
|      | 100   | 1,236                   | 10,940 | 2,990                          | 26,464 | 1,976                    | 17,489 | 6,175                      | 54,653 |                     |        |                          |        |                               |                                |
|      | 120   | 1,236                   | 10,940 | 3,263                          | 28,880 | 2,041                    | 18,064 | 6,175                      | 54,653 |                     |        |                          |        |                               |                                |
|      | 160   | 1,236                   | 10,940 | 3,419                          | 30,261 | 2,041                    | 18,064 | 6,175                      | 54,653 |                     |        |                          |        |                               |                                |

1. Moment of Inertia:  $I=1/4GD^2$

2. Please refer to the CSF/CSG Series catalog for an explanation of terms and technical information not included in this brochure.

## No Load Running Torque

No-load running torque is the input torque (high speed shaft) which is required to rotate the Harmonic Drive™ gear with no load applied to the output.

Measurement condition

3-1

| Ratio: 100  |        |                 |                       |
|---|--------|-----------------|-----------------------|
| Lubricant   | Grease | Name            | Harmonic grease SK-1A |
|   |        |                 | Harmonic grease SK-2  |
|   |        | Grease quantity | Recommended quantity  |
| Torque value is measured after 2 hour run-in at 2000 rpm input.<br>Please contact HDLLC if you are using oil lubricant. |        |                 |                       |

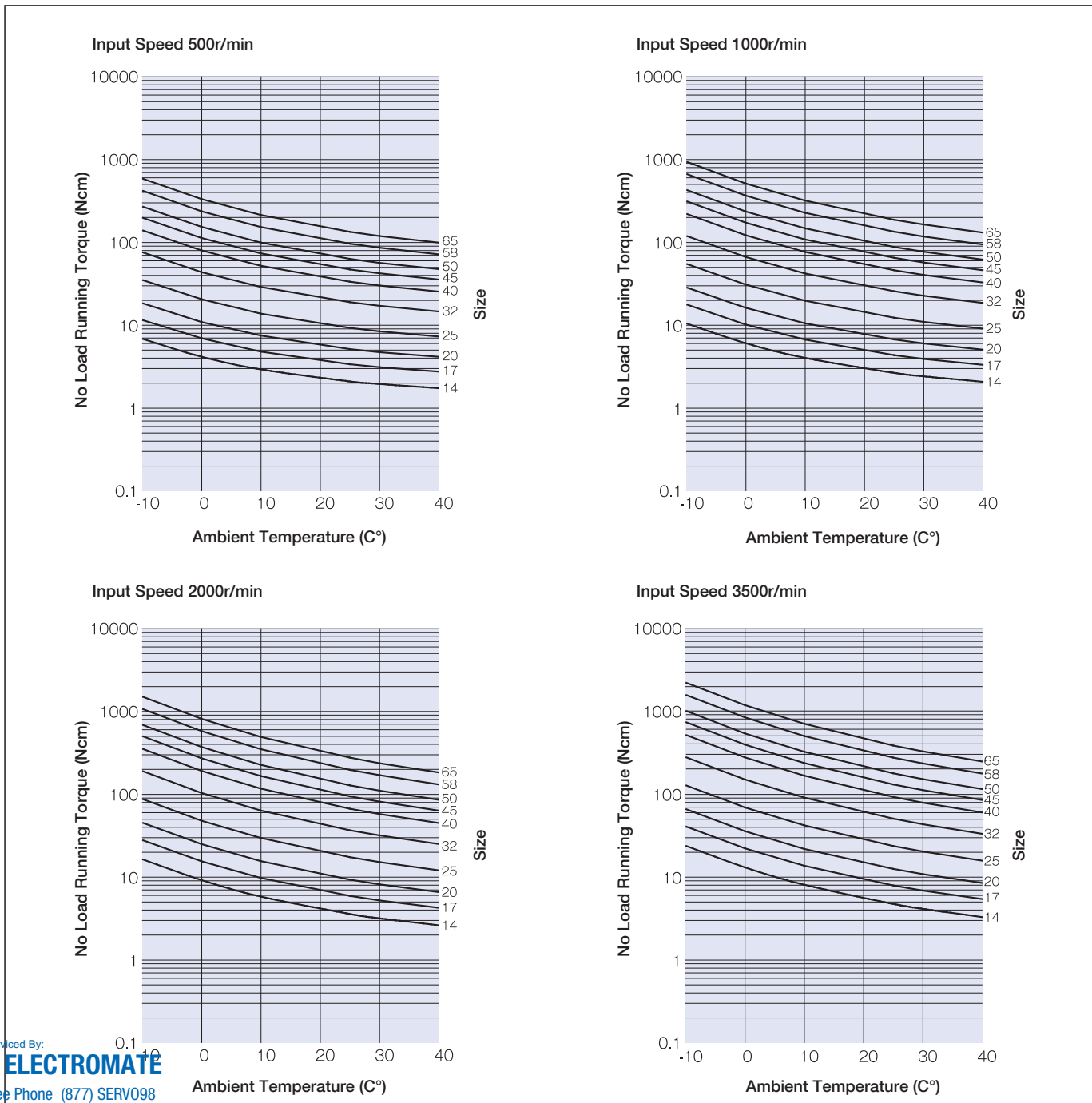
## Compensation Value for Each Ratio

The no load running torque of Harmonic Drive gears varies with the gear ratio. The graphs indicate a value for ratio 100. For other gear ratios, add the compensation value from table 3-2.

3-2  
Unit: Ncm

| Size \ Ratio | 30  | 50  | 80  | 120  | 160  |
|--------------|-----|-----|-----|------|------|
| 14           | 2.5 | 1.1 | 0.2 | —    | —    |
| 17           | 3.8 | 1.6 | 0.3 | -0.2 | —    |
| 20           | 5.4 | 2.3 | 0.5 | -0.3 | -0.8 |
| 25           | 8.8 | 3.8 | 0.7 | -0.5 | -1.2 |
| 32           | 16  | 7.1 | 1.3 | -0.9 | -2.2 |
| 40           | —   | 12  | 2.1 | -1.5 | -3.5 |
| 45           | —   | 16  | 2.9 | -2.1 | -4.9 |
| 50           | —   | 21  | 3.7 | -2.6 | -6.2 |
| 58           | —   | 30  | 5.3 | -3.8 | -8.9 |
| 65           | —   | 41  | 7.2 | -5.1 | -12  |

## No Load Running Torque for Ratio 100



# Efficiency

The gear efficiency is affected by many factors. Efficiency depends on the gear ratio, input speed, load torque, temperature, quantity of lubricant and type of lubricant. Efficiency values shown in the tables shown below are for rated torque. If the actual load torque is below rated torque, a compensation factor must be used.

Load Torque  $\geq$  Rated Torque : Efficiency = Efficiency from Graph  
 Load Torque  $<$  Rated Torque : Efficiency = Efficiency from Graph x Compensation Coefficient from Graph 4-1.

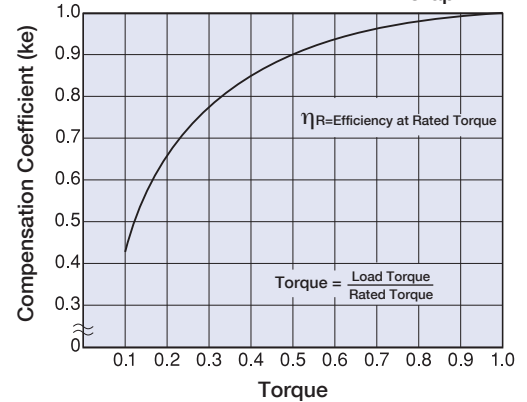
Measurement condition

Table 4-1

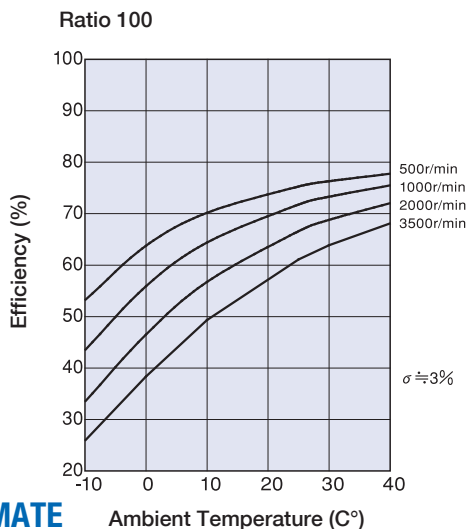
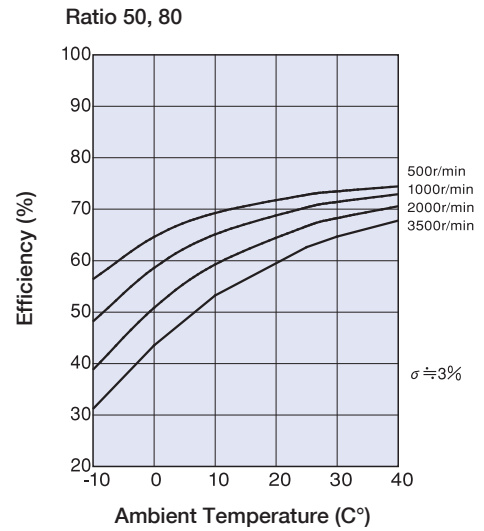
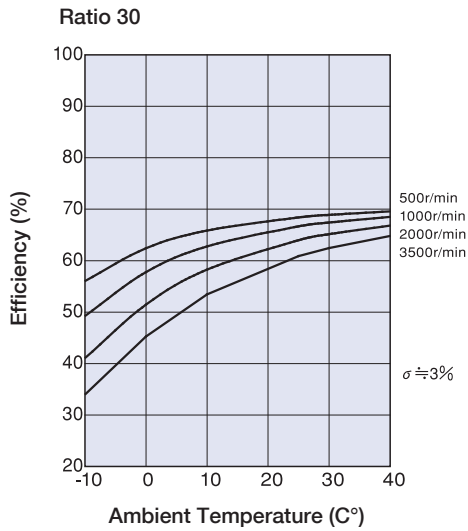
|              |                                |                 |                       |
|--------------|--------------------------------|-----------------|-----------------------|
| Installation | Based on recommended tolerance |                 |                       |
| Load torque  | Rated torque                   |                 |                       |
| Lubricant    | Grease                         | Name            | Harmonic grease SK-1A |
|              |                                | Grease quantity | Recommended quantity  |

Efficiency Compensation Coefficient

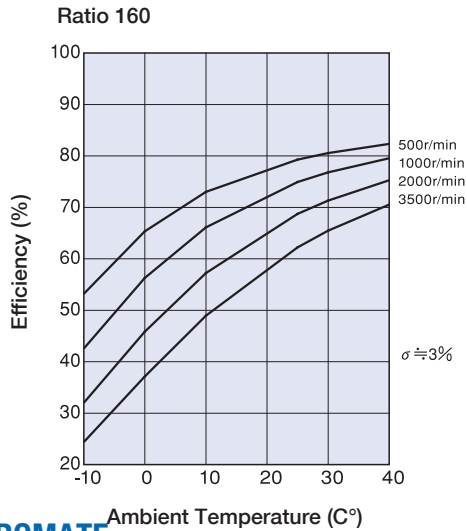
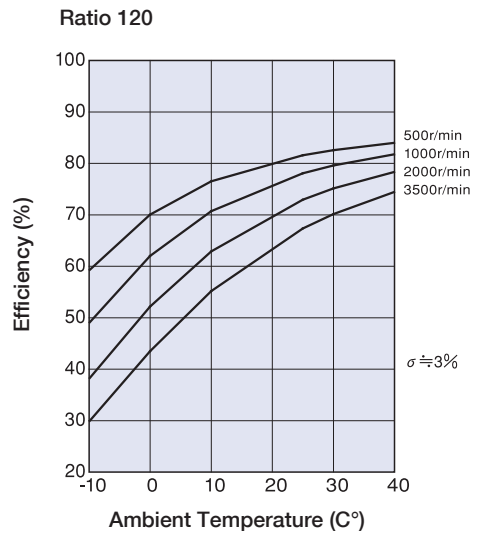
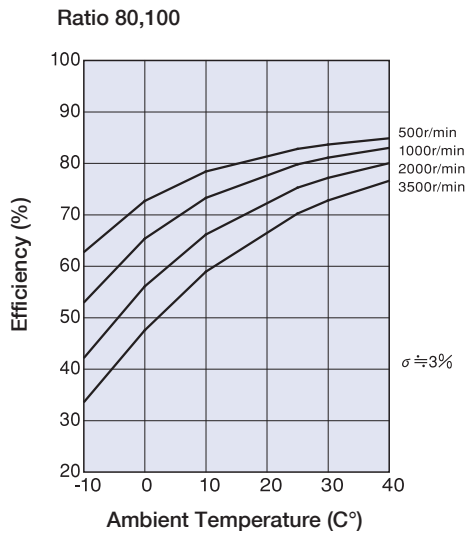
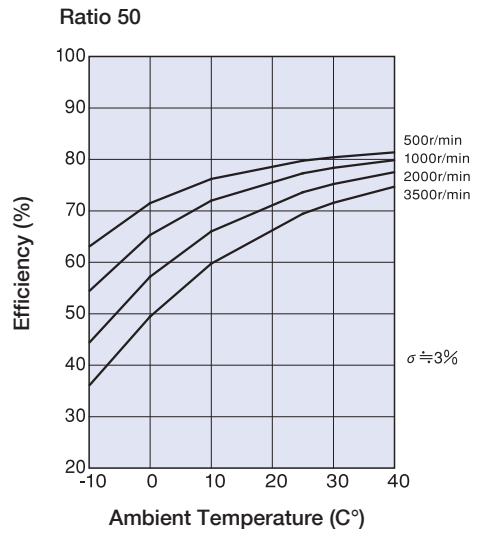
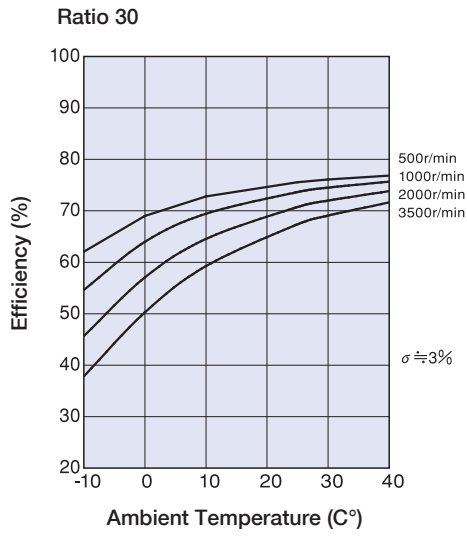
Graph 4-1



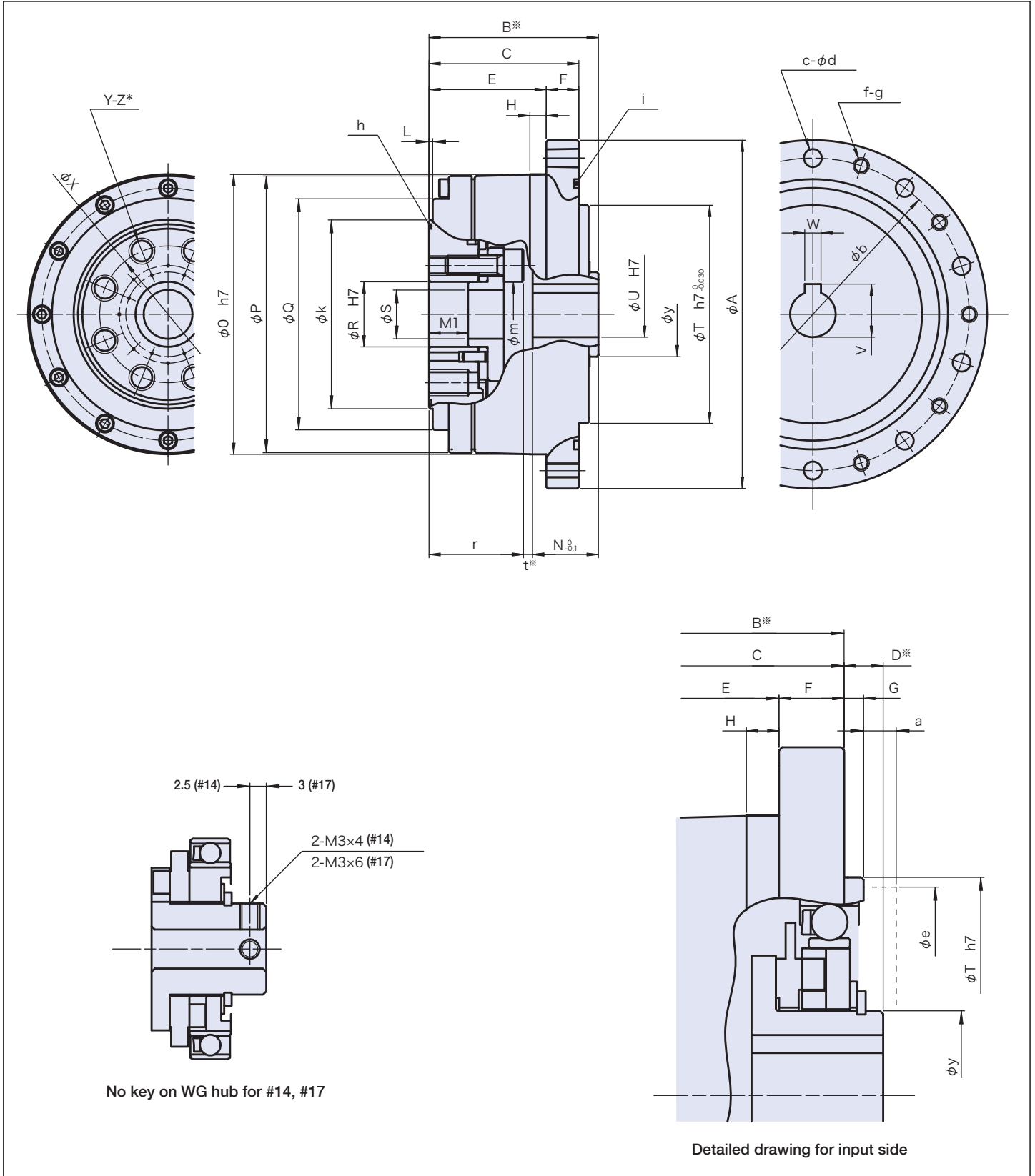
## Efficiency at Rated Torque (Size 14)



# Efficiency at Rated Torque (Sizes 17-65)



# External Dimensions



Please contact Harmonic Drive LLC for installation drawings.

\* Please Note: The bolts must not extend beyond the length of the threaded hole. If the length of thread engagement exceeds dimension 'Z', damage to the flexspine may occur. Please refer to installation drawing.

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## Dimension Table

Table 7-1  
Unit: mm

| Symbol                           | Size | 14                                | 17                                | 20                                  | 25                                | 32                                | 40                                  | 45                                  | 50                                | 58                                   | 65                                 |
|----------------------------------|------|-----------------------------------|-----------------------------------|-------------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|-------------------------------------|-----------------------------------|--------------------------------------|------------------------------------|
| $\phi A$                         |      | 73                                | 79                                | 93                                  | 107                               | 138                               | 160                                 | 180                                 | 190                               | 226                                  | 260                                |
| B*                               |      | 41 <sup>0.0</sup> <sub>-0.9</sub> | 45 <sup>0.0</sup> <sub>-0.9</sub> | 45.5 <sup>0.0</sup> <sub>-1.0</sub> | 52 <sup>0.0</sup> <sub>-1.0</sub> | 62 <sup>0.0</sup> <sub>-1.1</sub> | 72.5 <sup>0.0</sup> <sub>-1.1</sub> | 79.5 <sup>0.0</sup> <sub>-1.2</sub> | 90 <sup>0.0</sup> <sub>-1.3</sub> | 104.5 <sup>0.0</sup> <sub>-1.3</sub> | 115 <sup>0.0</sup> <sub>-1.3</sub> |
| C                                |      | 34                                | 37                                | 38                                  | 46                                | 57                                | 66.5                                | 74                                  | 85                                | 97                                   | 108.5                              |
| D*                               |      | 7 <sup>0.4</sup> <sub>-0.4</sub>  | 8 <sup>0.4</sup> <sub>-0.4</sub>  | 7.5 <sup>0.4</sup> <sub>-0.4</sub>  | 6 <sup>0.5</sup> <sub>-0.5</sub>  | 5 <sup>0.6</sup> <sub>-0.6</sub>  | 6 <sup>0.6</sup> <sub>-0.6</sub>    | 5.5 <sup>0.6</sup> <sub>-0.6</sub>  | 5 <sup>0.6</sup> <sub>-0.6</sub>  | 7.5 <sup>0.6</sup> <sub>-0.6</sub>   | 6.5 <sup>0.6</sup> <sub>-0.6</sub> |
| E                                |      | 27                                | 29                                | 28                                  | 36                                | 45                                | 50.5                                | 58                                  | 69                                | 77                                   | 84.5                               |
| F                                |      | 7                                 | 8                                 | 10                                  | 10                                | 12                                | 16                                  | 16                                  | 16                                | 20                                   | 24                                 |
| G                                |      | 2                                 | 2                                 | 3                                   | 3                                 | 3                                 | 4                                   | 4                                   | 4                                 | 5                                    | 5                                  |
| H                                |      | 4                                 | 4                                 | 5                                   | 5                                 | 4.5                               | 4.5                                 | 6                                   | 6                                 | 6                                    | 6                                  |
| L                                |      | 1.1                               | 1.1                               | 1.1                                 | 1.1                               | 1.2                               | 1.6                                 | 1.6                                 | 1                                 | 1.5                                  | 1.5                                |
| M1                               |      | 9.4                               | 9.5                               | 9                                   | 12                                | 15                                | 5                                   | 6                                   | 8                                 | 10                                   | 10                                 |
| M2                               |      | -                                 | -                                 | -                                   | -                                 | -                                 | -                                   | -                                   | -                                 | -                                    | 4                                  |
| N <sup>0.1</sup> <sub>-0.1</sub> |      | 18.5                              | 20.7                              | 21.5                                | 21.6                              | 23.6                              | 29.7                                | 30.5                                | 34.8                              | 38.3                                 | 44.6                               |
| $\phi Oh7$                       |      | 56                                | 63                                | 72                                  | 86                                | 113                               | 127                                 | 148                                 | 158                               | 186                                  | 212                                |
| $\phi P$                         |      | 54.6                              | 59.5                              | 70                                  | 84.6                              | 110                               | 124.5                               | 143                                 | 155                               | 183                                  | 208                                |
| $\phi Q$                         |      | 40.5                              | 47.5                              | 55.5                                | 71                                | 91.1                              | 103                                 | 123                                 | 130                               | 155                                  | 180                                |
| $\phi R1H7$                      |      | 11                                | 10                                | 14                                  | 20                                | 26                                | 32                                  | 32                                  | 40                                | 46                                   | 52                                 |
| $\phi R2H7$                      |      | -                                 | -                                 | -                                   | -                                 | -                                 | -                                   | -                                   | -                                 | -                                    | 142                                |
| $\phi S$                         |      | 8                                 | 7                                 | 10                                  | 15                                | 20                                | 24                                  | 25                                  | 32                                | 38                                   | 44                                 |
| $\phi Th7$                       |      | 38                                | 48                                | 56                                  | 67(68)                            | 90                                | 110                                 | 124                                 | 135                               | 156                                  | 177                                |
| $\phi UH7$                       |      | 6                                 | 8                                 | 12                                  | 14                                | 14                                | 14                                  | 19                                  | 19                                | 22                                   | 24                                 |
| V                                |      | -                                 | -                                 | 13.8                                | 16.3                              | 16.3                              | 16.3                                | 21.8                                | 21.8                              | 24.8                                 | 27.3                               |
| WJs9                             |      | -                                 | -                                 | 4                                   | 5                                 | 5                                 | 5                                   | 6                                   | 6                                 | 6                                    | 8                                  |
| $\phi X$                         |      | 23                                | 27                                | 32 <sup>+0.1</sup> <sub>0</sub>     | 42 <sup>+0.1</sup> <sub>0</sub>   | 55 <sup>+0.1</sup> <sub>0</sub>   | 68 <sup>+0.1</sup> <sub>0</sub>     | 82 <sup>+0.1</sup> <sub>0</sub>     | 84 <sup>+0.1</sup> <sub>0</sub>   | 100 <sup>+0.1</sup> <sub>0</sub>     | 110 <sup>+0.2</sup> <sub>0</sub>   |
| Y                                |      | 6                                 | 6                                 | 8                                   | 8                                 | 8                                 | 8                                   | 8                                   | 8                                 | 8                                    | 8                                  |
| Z                                |      | M4x8                              | M5x10                             | M6x9                                | M8x12                             | M10x15                            | M10x15                              | M12x18                              | M14x21                            | M16x24                               | M16x24                             |
| a                                |      | 1                                 | 1                                 | 1.5                                 | 1.5                               | 1.5                               | 2                                   | 2                                   | 2                                 | 2.5                                  | 2.5                                |
| $\phi b$                         |      | 65                                | 71                                | 82                                  | 96                                | 125                               | 144                                 | 164                                 | 174                               | 206                                  | 236                                |
| c                                |      | 6                                 | 8                                 | 8                                   | 10                                | 14                                | 10                                  | 16                                  | 18                                | 16                                   | 12                                 |
| $\phi d$                         |      | 4.5                               | 4.5                               | 5.5                                 | 5.5                               | 6.6                               | 9                                   | 9                                   | 9                                 | 11                                   | 14                                 |
| $\phi e$                         |      | 38                                | 45                                | 53                                  | 66                                | 86                                | 106                                 | 119                                 | 133                               | 154                                  | 172                                |
| f                                |      | 6                                 | 8                                 | 8                                   | 10                                | 14                                | 10                                  | 16                                  | 18                                | 16                                   | 12                                 |
| g                                |      | M4                                | M4                                | M5                                  | M5                                | M6                                | M8                                  | M8                                  | M8                                | M10                                  | M12                                |
| h                                |      | 29.0x0.50                         | 34.5x0.80                         | 40.64x1.14                          | 53.28x0.99                        | S71                               | A5568-042                           | S100                                | S105                              | S125                                 | S135                               |
| i                                |      | S50                               | S56                               | S67                                 | S80                               | S105                              | S125                                | S145                                | S155                              | S180                                 | S205                               |
| $\phi k$                         |      | 31                                | 38                                | 45                                  | 58                                | 78                                | 90                                  | 107                                 | 112                               | 135                                  | 155                                |
| $\phi m$                         |      | 10                                | 10.5                              | 15.5                                | 20                                | 27                                | 34                                  | 36                                  | 39                                | 46                                   | 56                                 |
| r                                |      | 21.4                              | 23.5                              | 23                                  | 29                                | 37                                | 39.5                                | 45.5                                | 53                                | 62.8                                 | 66.5                               |
| t*                               |      | 1.1                               | 0.8                               | 1                                   | 1.4                               | 1.4                               | 3.3                                 | 3.5                                 | 2.2                               | 3.4                                  | 3.9                                |
| u*                               |      | 5.1                               | 5.8                               | 6                                   | 7.4                               | 9.4                               | 13.3                                | 15.5                                | 16.2                              | 19.4                                 | 19.9                               |
| $\phi y$                         |      | 14                                | 18                                | 21                                  | 26                                | 26                                | 32                                  | 32                                  | 32                                | 40                                   | 48                                 |
| Weight (kg)                      |      | 0.32                              | 0.46                              | 0.64                                | 1.1                               | 2.2                               | 3.5                                 | 5.1                                 | 7.0                               | 11.3                                 | 16.2                               |

Note 1: Dimensions in parentheses indicates values for 30:1 gear ratio.

Note 2: \* Dimensions B, D, t and u indicate the location and tolerance of the wave generator flexspline and circular spline. Please strictly comply with these dimensions since it influences performance and strength of the gear.

## Weight Comparison

Unit: kg

| Size                          | 14   | 17   | 20   | 25  | 32  | 40  | 45  | 50  | 58   | 65   |
|-------------------------------|------|------|------|-----|-----|-----|-----|-----|------|------|
| CSG Series standard unit type | 0.52 | 0.68 | 0.98 | 1.5 | 3.2 | 5.0 | 7.0 | 8.9 | 14.6 | 20.9 |
| CSG Series LW unit type       | 0.32 | 0.46 | 0.64 | 1.1 | 2.2 | 3.5 | 5.1 | 7.0 | 11.3 | 16.2 |
| Weight ratio                  | 62%  | 68%  | 65%  | 73% | 69% | 70% | 73% | 79% | 77%  | 78%  |

## Specification for Crossroller Bearing

| Size | Pitch Circle<br>dp | Offset<br>R | Basic Dynamic Rated Load<br>C |        | Basic Static Rated Load<br>Co |        | Allowable Moment Load<br>Mc |        | Moment Stiffness<br>Km  |                            |
|------|--------------------|-------------|-------------------------------|--------|-------------------------------|--------|-----------------------------|--------|-------------------------|----------------------------|
|      | m                  | m           | x10 <sup>2</sup> N            | lb     | x10 <sup>2</sup> N            | lb     | Nm                          | lb-in  | x10 <sup>4</sup> Nm/rad | x10 <sup>4</sup> lb-in/rad |
| 14   | 0.035              | 0.0093      | 47.0                          | 1,057  | 60.7                          | 1,365  | 33.6                        | 297    | 3.6                     | 32                         |
| 17   | 0.0425             | 0.0091      | 52.9                          | 1,189  | 75.5                          | 1,697  | 52.5                        | 465    | 6.4                     | 57                         |
| 20   | 0.05               | 0.0098      | 57.8                          | 1,299  | 90.0                          | 2,023  | 74.6                        | 660    | 10.5                    | 93                         |
| 25   | 0.064              | 0.0118      | 96.0                          | 2,158  | 151                           | 3,395  | 128                         | 1,133  | 19.8                    | 175                        |
| 32   | 0.083              | 0.0133      | 150                           | 3,372  | 250                           | 5,620  | 257                         | 2,275  | 44.2                    | 391                        |
| 40   | 0.096              | 0.0148      | 213                           | 4,788  | 365                           | 8,206  | 369                         | 3,266  | 74.6                    | 660                        |
| 45   | 0.111              | 0.0158      | 230                           | 5,171  | 426                           | 9,577  | 563                         | 4,983  | 116                     | 1,027                      |
| 50   | 0.119              | 0.0180      | 348                           | 7,823  | 602                           | 13,534 | 622                         | 5,505  | 140                     | 1,239                      |
| 58   | 0.141              | 0.0205      | 518                           | 11,645 | 904                           | 20,323 | 838                         | 7,417  | 201                     | 1,779                      |
| 65   | 0.16               | 0.0185      | 556                           | 12,499 | 1,030                         | 23,155 | 1,525                       | 13,497 | 331                     | 2,930                      |

## Installation and Transmission Torque

### Bolt connection to output flange and resulting transmission torque

| Size                         |       | 14  | 17   | 20    | 25    | 32     | 40     | 45     | 50     | 58     | 65     |
|------------------------------|-------|-----|------|-------|-------|--------|--------|--------|--------|--------|--------|
| Number of screws             |       | 6   | 6    | 8     | 8     | 8      | 8      | 8      | 8      | 8      | 8      |
| Size of screws               |       | M4  | M5   | M6    | M8    | M10    | M10    | M12    | M14    | M16    | M16    |
| Pitch circle diameter        | mm    | 23  | 27   | 32    | 42    | 55     | 68     | 82     | 84     | 100    | 110    |
| Screw Tightening Torque      | Nm    | 5.4 | 10.8 | 18.4  | 45    | 89     | 89     | 154    | 246    | 383    | 383    |
|                              | lb-in | 48  | 96   | 163   | 398   | 788    | 788    | 1,363  | 2,177  | 3,390  | 3,390  |
| Torque transmitting capacity | Nm    | 58  | 109  | 245   | 580   | 1,220  | 1,510  | 2,624  | 3,690  | 5,981  | 6,579  |
|                              | lb-in | 513 | 965  | 2,168 | 5,133 | 10,798 | 13,365 | 23,224 | 32,659 | 52,936 | 58,229 |

### Bolt connection to housing and resulting transmission torque

| Size                                 |       | 14  | 17    | 20    | 25    | 32    | 40     | 45     | 50     | 58     | 65     |
|--------------------------------------|-------|-----|-------|-------|-------|-------|--------|--------|--------|--------|--------|
| Number of screws                     |       | 6   | 8     | 8     | 10    | 12    | 10     | 16     | 18     | 16     | 12     |
| Size of screws                       |       | M4  | M4    | M5    | M5    | M6    | M8     | M8     | M8     | M10    | M12    |
| Pitch circle diameter                | mm    | 65  | 71    | 82    | 96    | 125   | 144    | 164    | 174    | 206    | 236    |
| Screw Tightening Torque <sup>5</sup> | Nm    | 3.2 | 3.2   | 6.4   | 6.4   | 10.8  | 26.5   | 26.5   | 26.5   | 51.9   | 90     |
|                                      | lb-in | 28  | 28    | 57    | 57    | 96    | 235    | 235    | 235    | 459    | 797    |
| Torque transmitting capacity         | Nm    | 98  | 143   | 261   | 382   | 842   | 1,488  | 2,712  | 3,237  | 5,350  | 6,649  |
|                                      | lb-in | 867 | 1,266 | 2,310 | 3,381 | 7,452 | 13,170 | 24,003 | 28,650 | 47,351 | 58,849 |

1. Recommended bolt : JIS B 1176 socket head cap screw strength range : JIS B 1051 over 12.9

2. Torque coefficient : K=0.2

3. Clamp coefficient A=1.4

4. Coefficient of friction: 0.15

5. Strict compliance to the recommended screw tightening torques is especially important for the lightweight aluminum housing flange. Exceeding the recommended values (over tightening) can cause deformation of the housing flange under the bolt heads. This will result in the housing slipping under full torque loads. (Please contact a Sales Engineer for more information.)