Nidec
All for dreams

# Smart-FLEXWAVE

Built-in Multi Sensor

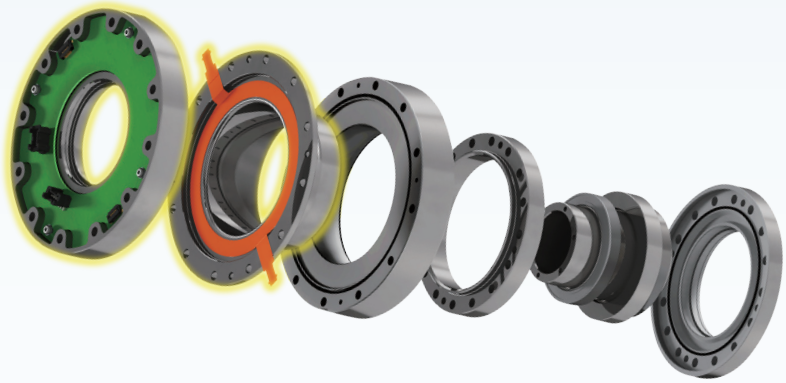
**WP series**

NIDEC DRIVE TECHNOLOGY CORPORATION

**Built-in Multi Sensor Gearbox**

# Smart-FLEXWAVE

Built-in Multi Sensor Gearbox assists in maximizing your manufacturing and automation capabilities.
It delivers a streamlined addition to your most demanding applications, saving space with its compact and lightweight design.



## 01 TORQUE SENSOR

The system's performance is optimized by accurately measuring the output torque from the gearbox.

## 02 TEMPERATURE SENSOR

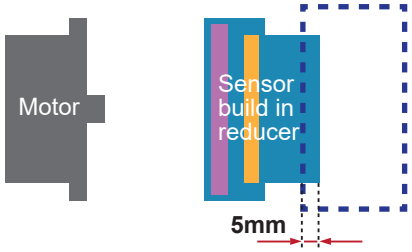
The system's stability is improved by continuously monitoring the gearbox temperature.

## 03 ANGLE SENSOR

The torque sensor achieves high-accuracy torque measurement by angle compensation.

## Built-in Multi Sensor Vs External Sensor

### Smart-FLEXWAVE

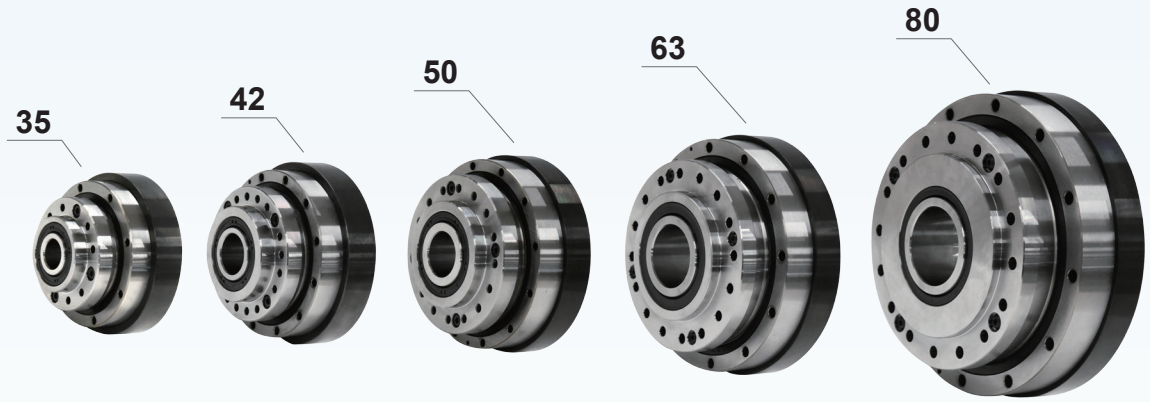



1. Light weight
2. Space saving
3. Cost-effective
4. High rigidity

### Conventional Gearbox


1. Heavy weight
2. Large size
3. Expensive
4. Low rigidity

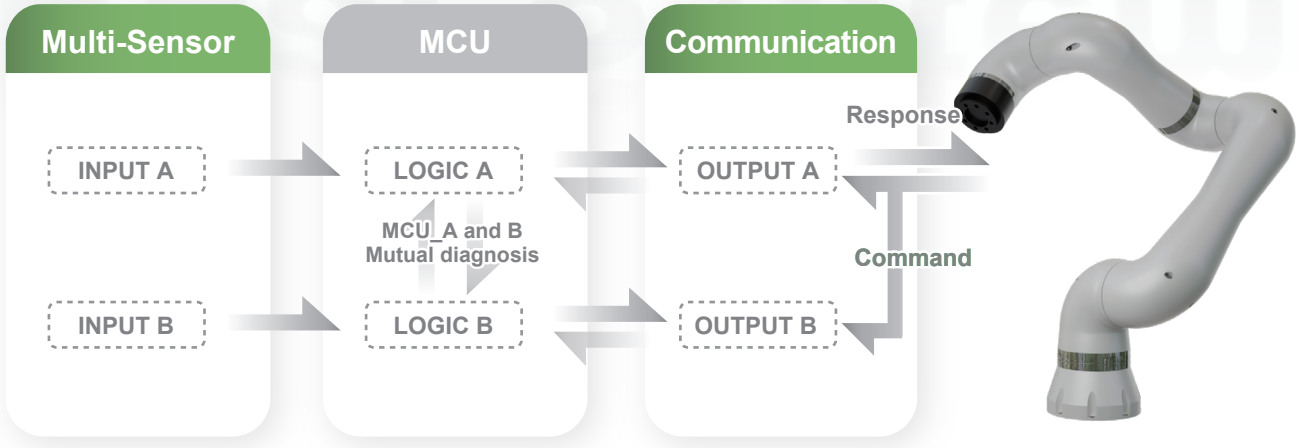
## Sizes




# Dual system + Collaborative robots

**WP** Series

The dual-channel multi-sensor system for collaborative robots ensures high level safety for operator. The multi-drop connection allows for the connection of up to 8 axes with simplified wiring.




## Designed for Safety Built for Trust

Smart-FLEXWAVE BD model complies with the functional safety standards for industrial equipment as a safety torque sensor and has obtained safety certification from the certification body, TÜV SÜD.

Applicable Standards：
EN ISO 13849-1:2023
IEC 61508: 2010
EN IEC 62061: 2021

Note: The integration of this product into the overall machine system does not guarantee that the essential requirements of the functional safety standards will be met.

# Model Nomenclature

| WP | U | — 35 | — 50 | - SRH | - BD |
|---|---|---|---|---|---|
| Series name | Type | Size | Ratio | Shaft code | Sensor code |
| WP Series | Unit type<br>• Hollow shaft unit<br>• Input shaft unit | 35<br>42<br>50<br>63<br>80 | 50<br>80<br>100<br>120<br>160 | SRH<br>SRJ | BD |

● Availability

| Frame size \ Ratio | 50 | 80 | 100 | 120 | 160 |
|---|---|---|---|---|---|
| 35 | ■ | ■ | ■ | | |
| 42 | ■ | ■ | ■ | ■ | |
| 50 | ■ | ■ | ■ | ■ | ■ |
| 63 | ■ | ■ | ■ | ■ | ■ |
| 80 | ■ | ■ | ■ | ■ | ■ |

# Gearbox Specification

| | | ＊1 | ＊2 | ＊3 | ＊4 | ＊5 | ＊6 |
|---|---|---|---|---|---|---|---|
| Size | Ratio | Nominal output torque | Maximum output torque | Emergency stop torque | Nominal input speed | Maximum input speed | Life |
| | | [Nm] | [Nm] | [Nm] | [r/min] | [r/min] | [hours] |
| 35 | 50 | 7 | 23 | 46 | 3000 | 8500 | 7692 |
| | 80 | 10 | 30 | 61 | | | |
| | 100 | 10 | 36 | 70 | | | |
| 42 | 50 | 21 | 44 | 91 | 3000 | 7300 | |
| | 80 | 29 | 56 | 113 | | | |
| | 100 | 31 | 70 | 143 | | | |
| | 120 | 31 | 70 | 112 | | | |
| 50 | 50 | 33 | 73 | 127 | 3000 | 6500 | |
| | 80 | 44 | 96 | 165 | | | |
| | 100 | 52 | 107 | 191 | | | |
| | 120 | 52 | 113 | 191 | | | |
| | 160 | 52 | 120 | 191 | | | |
| 63 | 50 | 51 | 127 | 242 | 3000 | 5600 | |
| | 80 | 82 | 178 | 332 | | | |
| | 100 | 87 | 204 | 369 | | | |
| | 120 | 87 | 217 | 365 | | | |
| | 160 | 87 | 229 | 408 | | | |
| 80 | 50 | 99 | 281 | 497 | 3000 | 4800 | |
| | 80 | 153 | 395 | 738 | | | |
| | 100 | 178 | 433 | 841 | | | |
| | 120 | 178 | 459 | 892 | | | |
| | 160 | 178 | 484 | 892 | | | |

＊1 The maximum allowable value at the input rotation speed of 2000r/min.
＊2 The maximum torque when starting and stopping.
＊3 The maximum torque when it receives shock.
＊4 The maximum average input speed.
＊5 The maximum input speed.
＊6 The life time at the input rotation speed of 2000 r/min and nominal output torque.

# Sensor Specification

| Sensor type | Item | Specification | Remarks |
|---|---|---|---|
| Torque sensor | Rated torque | The same as that of the maximum torque of the gearbox | |
| | Limited torque | The same as the emergency stop torque of the gearbox | |
| | Durability | The same as that of the gearbox | |
| | Non-linearity | ± 3%FS or less | Range to rated torque |
| | Hysteresis | 3%FS or less | Range to rated torque |
| | Cross-axis sensitivity | ± 1%FS or less | Range to moment of gearbox |
| | Measurement range(Full scale) | Determined by the size of the gearbox | See attached table |
| | Resolution | -2000d to +2000d | LSB：See attached table |
| | Compliance standards (Functional safety) | PLd, Category 3 /EN ISO13849-1: 2023<br>SIL2 /IEC 61508: 2010<br>maximum SIL2 /EN IEC 62061:2021 | |
| Temperature sensor | Accuracy | ± 5°C | |
| | Measurement range | 0°C to 80°C | |
| | Resolution | 0 to 800d | LSB: 0.1°C |
| General | Power supply voltage | 24V DC+10%/15% | |
| | Consumption current | 0.06A or less | |
| | Communication method | 2-wire RS-485 | |
| | Baud rate | 3.0Mbps | |
| | Operating temperature limit | 0°C to 80°C | |

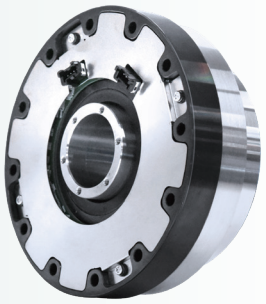
# Sensor Measurement Range

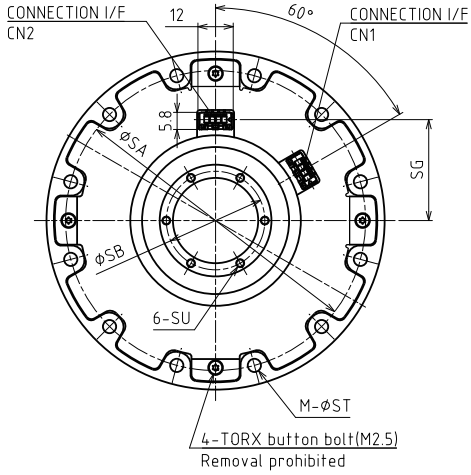
| Size | Ratio | Rated torque | Full Scale | LSB |
|---|---|---|---|---|
| | | [Nm] | [Nm] | [Nm] |
| 35 | 50 | 23 | ± 50 | 0.025 |
| | 80 | 30 | | |
| | 100 | 36 | | |
| 42 | 50 | 44 | ± 100 | 0.05 |
| | 80 | 56 | | |
| | 100 | 70 | | |
| | 120 | 70 | | |
| 50 | 50 | 73 | ± 150 | 0.075 |
| | 80 | 96 | | |
| | 100 | 107 | | |
| | 120 | 113 | | |
| | 160 | 120 | | |
| 63 | 50 | 127 | ± 300 | 0.15 |
| | 80 | 178 | | |
| | 100 | 204 | | |
| | 120 | 217 | | |
| | 160 | 229 | | |
| 80 | 50 | 281 | ± 600 | 0.3 |
| | 80 | 395 | | |
| | 100 | 433 | | |
| | 120 | 459 | | |
| | 160 | 484 | | |

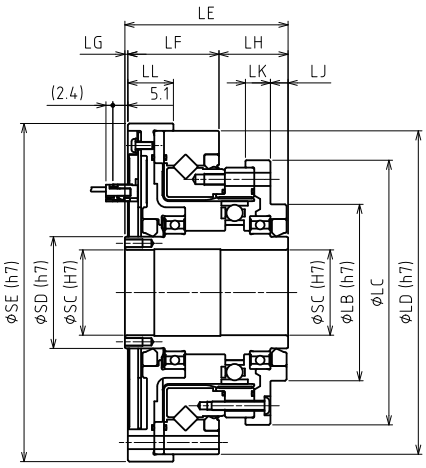
＊1 “+” sign indicates clockwise (CW) torque.
＊2 LSB is an abbreviation for Least Significant Bit.

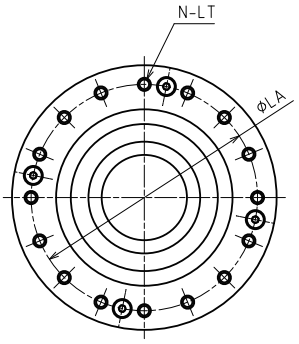
# SRH Hollow Shaft Unit

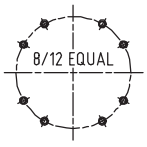
## WPU- □ - □ -SRH-BD



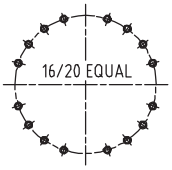


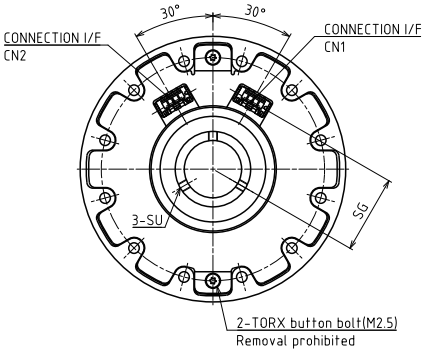



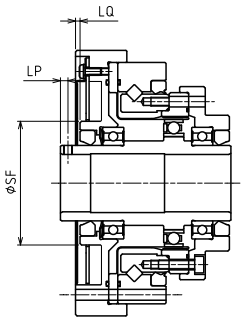




"N-LT"
ARRANGEMENT FOR 35




"N-LT"
ARRANGEMENT FOR 42




Size 35 & 42

| Size | Weight | Moment of inertia |
|---|---|---|
| | kg | $\times 10^{-4}$kgm$^2$ |
| 35 | 0.78 | 0.0924 |
| 42 | 1.05 | 0.207 |
| 50 | 1.4 | 0.408 |
| 63 | 2.1 | 1.06 |
| 80 | 4.2 | 2.72 |

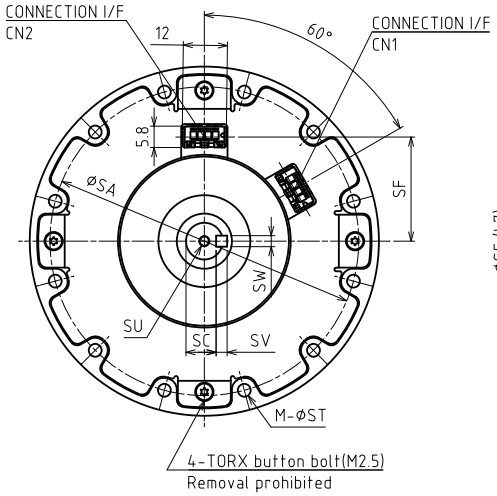
[mm]

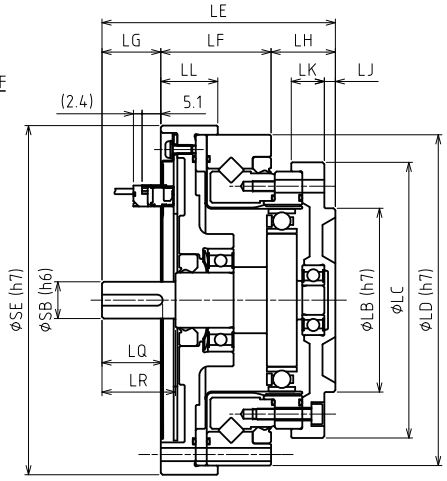
| Size | LA | LB | LC | LD | LE | LF | LG | LH | LJ | LK | LL | LP | LQ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 44 | 36 | 54 | 70 | 52.5 | 27.5 | 5 | 20 | 7.5 | 8 | 16 | 2.5 | 1.5 |
| 42 | 54 | 45 | 64 | 80 | 56.5 | 30 | 5 | 21.5 | 8.5 | 8.5 | 17 | 2.5 | 1.5 |
| 50 | 62 | 50 | 75 | 90 | 51.5 | 30 | 0 | 21.5 | 7 | 9 | 15.5 | - | - |
| 63 | 77 | 60 | 90 | 110 | 55.5 | 31 | 1 | 23.5 | 6 | 8.5 | 15.5 | - | - |
| 80 | 100 | 85 | 115 | 142 | 65.5 | 37 | 2 | 26.5 | 5 | 9.5 | 17 | - | - |

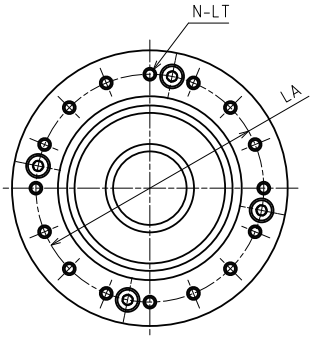
| Size | SA | SB | SC | SD | SE | SF | SG | M | ST | SU | N | LT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 64 | - | 14 | 20 | 78 | 36 | 21.6 | 8 | 3.5 | M3 | 8 | M3 × 5, ϕ 3.5 × 11.5 |
| 42 | 74 | - | 19 | 25 | 88 | 41 | 25.8 | 12 | 3.5 | M3 | 16 | M3 × 6, ϕ 3.5 × 12 |
| 50 | 84 | 25.5 | 21 | 30 | 95 | - | 28.3 | 12 | 3.5 | M3 × 6 | 16 | M3 × 6, ϕ 3.5 × 13.5 |
| 63 | 102 | 33.5 | 29 | 38 | 115 | - | 34.3 | 12 | 4.5 | M3 × 6 | 16 | M4 × 7, ϕ 4.5 × 15.5 |
| 80 | 132 | 40.5 | 36 | 45 | 147 | - | 42.9 | 12 | 5.5 | M3 × 6 | 16 | M5 × 8, ϕ 5.5 × 20.5 |

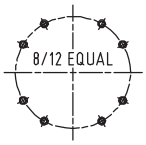
# SRJ Input Shaft Unit

## WPU- □ - □ -SRJ-BD

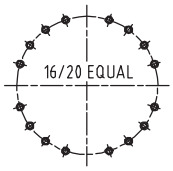


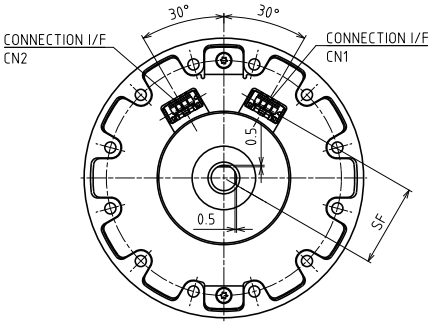



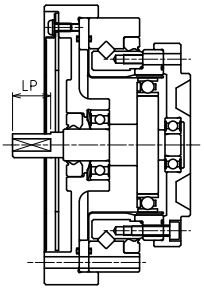




"N-LT"
ARRANGEMENT FOR 35




"N-LT"
ARRANGEMENT FOR 42




Size 35 & 42

| Size | Weight | Moment of inertia |
|---|---|---|
| | kg | $\times 10^{-4}$kgm$^2$ |
| 35 | 0.71 | 0.0266 |
| 42 | 0.96 | 0.0666 |
| 50 | 1.4 | 0.155 |
| 63 | 2.1 | 0.382 |
| 80 | 4.1 | 1.28 |

[mm]

| Size | LA | LB | LC | LD | LE | LF | LG | LH | LJ | LK | LL | LP | LQ | LR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 44 | 36 | 54 | 70 | 50.5 | 27.5 | 8 | 15 | 2.5 | 8 | 16 | 11 | - | - |
| 42 | 54 | 45 | 64 | 80 | 56 | 30 | 10 | 16 | 3 | 8.5 | 17 | 12 | - | - |
| 50 | 62 | 50 | 75 | 90 | 63.5 | 30 | 16 | 17.5 | 3 | 9 | 15.5 | - | 16.5 | 20 |
| 63 | 77 | 60 | 90 | 110 | 72.5 | 31 | 21 | 20.5 | 3 | 8.5 | 15.5 | - | 22.5 | 25 |
| 80 | 100 | 85 | 115 | 142 | 84.5 | 37 | 21 | 26.5 | 5 | 9.5 | 17 | - | 22.5 | 25 |

| Size | SA | SB | SC | SE | SF | SV | SW | M | ST | SU | N | LT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 64 | 6 | - | 78 | 21.6 | - | - | 8 | 3.5 | - | 8 | M3 × 5, ϕ 3.5 × 11.5 |
| 42 | 74 | 8 | - | 88 | 25.8 | - | - | 12 | 3.5 | - | 16 | M3 × 6, ϕ 3.5 × 12 |
| 50 | 84 | 10 | 8.2 | 95 | 28.3 | 3 | 3 | 12 | 3.5 | M3× 6 | 16 | M3 × 6, ϕ 3.5 × 13.5 |
| 63 | 102 | 14 | 11 | 115 | 34.3 | 5 | 5 | 12 | 4.5 | M5× 10 | 16 | M4 × 7, ϕ 4.5 × 15.5 |
| 80 | 132 | 14 | 11 | 147 | 42.9 | 5 | 5 | 12 | 5.5 | M5× 10 | 16 | M5 × 8, ϕ 5.5 × 20.5 |

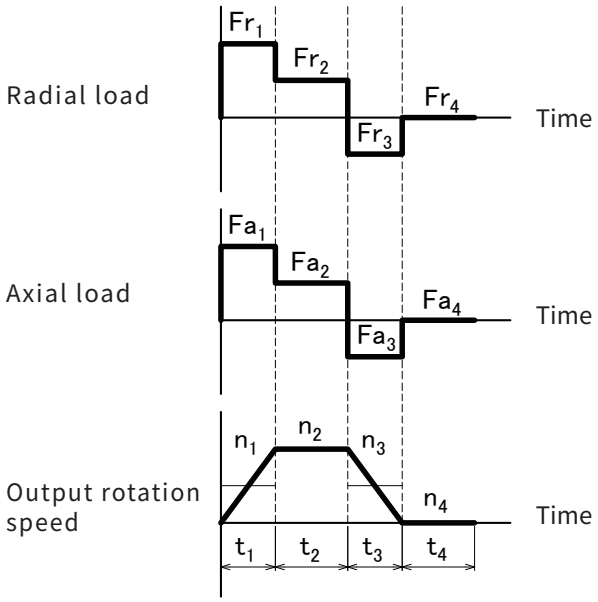
# Lifespan Estimation

## Main bearing specification(Cross roller bearing)

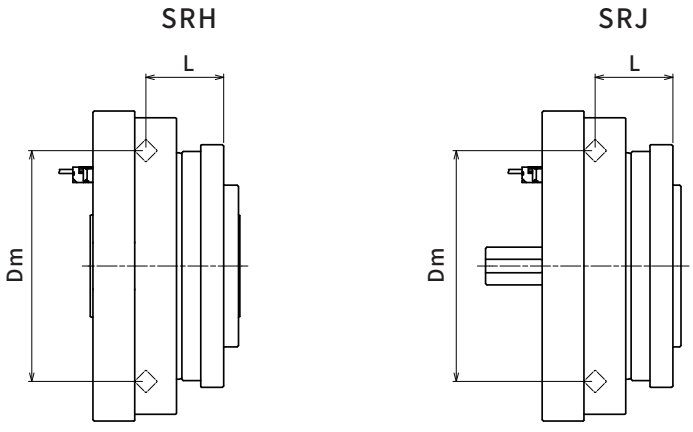
| Series | Size | Pitch circle diameter of the bearing rollers | Offset | Basic dynamic load rating | Basic static load rating | Allowable moment | Moment rigidity |
|---|---|---|---|---|---|---|---|
| | | Dm | L | C | Co | Mal | Km |
| | | m | m | N | N | Nm | $\times 10^4$Nm/rad |
| WPU-□-□-SRH<br>WPU-□-□-SRJ | 35 | 0.0500 | 0.0217 | 5800 | 8600 | 74 | 8.5 |
| | 42 | 0.0600 | 0.0239 | 10400 | 16300 | 124 | 15.4 |
| | 50 | 0.0700 | 0.0255 | 14600 | 22000 | 187 | 25.2 |
| | 63 | 0.0850 | 0.0296 | 21800 | 35800 | 258 | 39.2 |
| | 80 | 0.111 | 0.0364 | 38200 | 65400 | 580 | 100 |

## Lifespan for the main bearing

### Operation cycle example




### External load



# Lifespan Estimation (Main bearing)

## ①Calculation formula for the largest working moment

| | | | |
|---|---|---|---|
| Peak working moment | Mm | Nm | $Mm = Frm \cdot (Lr + L) + Fam \cdot La$ |
| Peak radial load | Frm | N | $Frm$ = Largest among $Fr_1$, $Fr_2$ $\cdots$ $Fr_n$ |
| Peak axial load | Fam | N | $Fam$ = Largest among $Fa_1$, $Fa_2$, $\cdots$ $Fa_n$ |

Please make sure the peak working moment is below the maximum allowable moment.

## ②Calculation formula for the average radial load, average axial load, average output rotation speed, average working moment

| | | | |
|---|---|---|---|
| Average radial load | Fra | N | $Fra = \sqrt[10/3]{\dfrac{n_1 \cdot t_1 \cdot \lvert Fr_1 \rvert^{10/3} + n_2 \cdot t_2 \cdot \lvert Fr_2 \rvert^{10/3} + \cdots + n_n \cdot t_n \cdot \lvert Fr_n \rvert^{10/3}}{n_1 \cdot t_1 + n_2 \cdot t_2 + \cdots + n_n \cdot t_n}}$ |
| Average axial load | Faa | N | $Faa = \sqrt[10/3]{\dfrac{n_1 \cdot t_1 \cdot \lvert Fa_1 \rvert^{10/3} + n_2 \cdot t_2 \cdot \lvert Fa_2 \rvert^{10/3} + \cdots + n_n \cdot t_n \cdot \lvert Fa_n \rvert^{10/3}}{n_1 \cdot t_1 + n_2 \cdot t_2 + \cdots + n_n \cdot t_n}}$ |
| Average output rotation speed | nao | r/min | $nao = \dfrac{n_1 \cdot t_1 + n_2 \cdot t_2 \cdots n_n \cdot t_n}{t_1 + t_2 + \cdots + t_n}$ |
| Average working moment | Ma | Nm | $Ma = Fra \cdot (Lr + L) + Faa \cdot La$ |

## ③Calculation formula for the loading factor, equivalent radial load

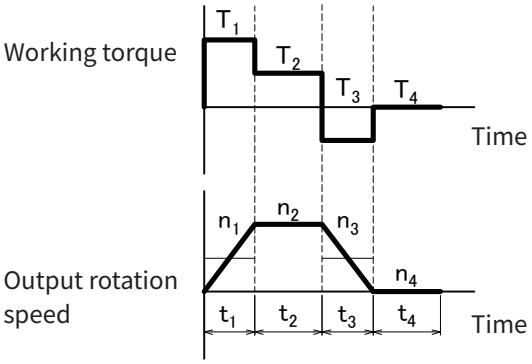
| | | | |
|---|---|---|---|
| Loading factor | Xc, Yc | - | In case of $\dfrac{Faa}{Fra + 2Ma / Dm} \leqq 1.5$ $Xc = 1.0$ , $Yc = 0.45$ |
| | | | In case of $\dfrac{Faa}{Fra + 2Ma / Dm} > 1.5$ $Xc = 0.67$ , $Yc = 0.67$ |
| Equivalent radial load | Pc | N | $Pc = Xc \cdot (Fra + 2Ma/Dm) + Yc \cdot Faa$ |

## ④Lifespan for the main bearing

| | | | |
|---|---|---|---|
| Life span for the main bearing | Lhc | h | $Lhc = \dfrac{10^6}{60 \cdot nao} \cdot \left( \dfrac{C}{fw \cdot Pc} \right)^{\frac{10}{3}}$ |
| Impact factor | fw | - | 1.0：no shock |
| | | | 1.2：with some shock |
| | | | 1.5：with shock and vibration |

# Lifespan Estimation (Elastic bearing)

## Operation cycle example




### ① Calculation formula for output torque

| | | | |
|---|---|---|---|
| Average output torque | Tao | Nm | $Tao = \sqrt[3]{\frac{n_1 \cdot t_1 \cdot \lvert T_1 \rvert^3 + n_2 \cdot t_2 \cdot \lvert T_2 \rvert^3 + \cdots + n_n \cdot t_n \cdot \lvert T_n \rvert^3}{n_1 \cdot t_1 + n_2 \cdot t_2 \cdots n_n \cdot t_n}}$ |
| Peak output torque value | Tmo | Nm | $Tmo$ = Largest among $T_1$, $T_2$, $\cdots T_n$ |

Please make sure the peak output torque is below the maximum output torque in the specification table.

### ② Calculation formula for input speed

| | | | |
|---|---|---|---|
| Average output rotation speed | nao | r/min | $nao = \frac{n_1 \cdot t_1 + n_2 \cdot t_2 \cdots n_n \cdot t_n}{t_1 + t_2 + \cdots + t_n}$ |
| Peak output rotation speed | nmo | r/min | $nmo$ = Largest among $n_1$, $n_2$, $\cdots n_n$ |
| Average input speed | nai | r/min | $nai = nao \times R$ （R = ratio ） |
| Peak input speed value | nmi | r/min | $nmi = nmo \times R$ （R = ratio ） |

Please make sure the peak input speed value is below the maximum input speed in the specification table.

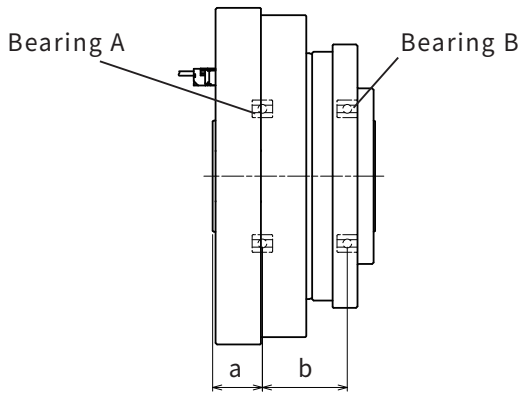
### ③ Calculation formula for life span

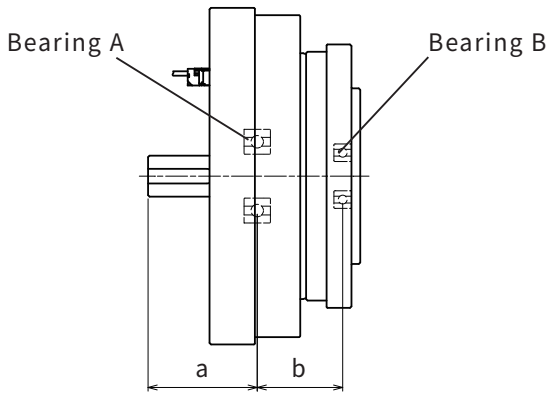
| | | | |
|---|---|---|---|
| Part life span for the elastic bearing | Lhe | h | $Lhe = 7692 \times \left(\frac{Tar}{Tao}\right)^3 \times \left(\frac{nar}{nai}\right)$ |
| Rating torque | Tar | Nm | Nominal output torque in the specification table |
| Rating input rotation speed | nar | r/min | 2000 r/min |

# Maximum Load at Input Shaft

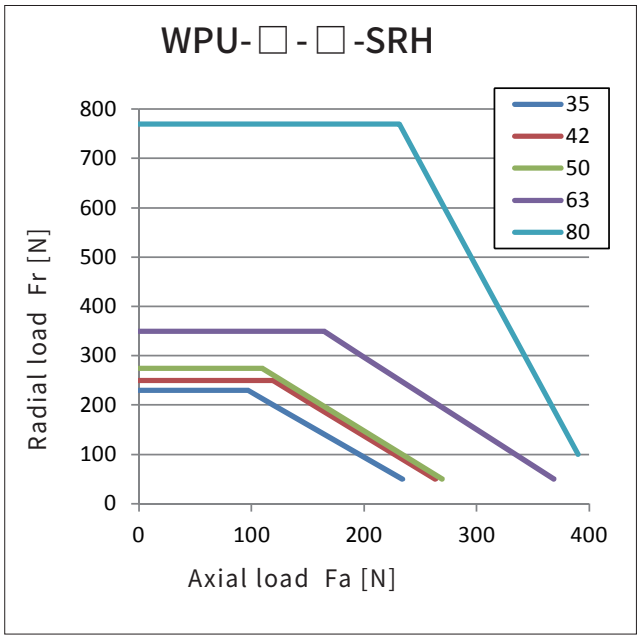
## Bearing specification (Open type, Unit)

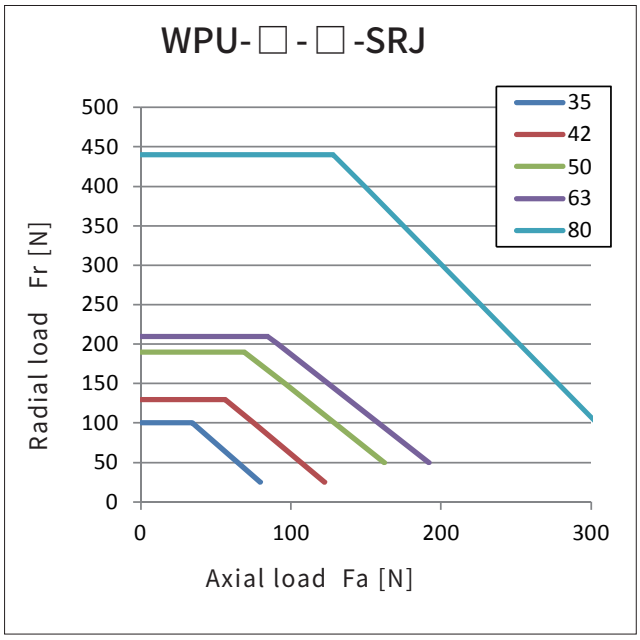
| Series | Size | Bearing A | | Bearing B | | a | b |
|---|---|---|---|---|---|---|---|
| | | Basic dynamic load rating | Basic static load rating | Basic dynamic load rating | Basic static load rating | | |
| | | C | Co | C | Co | | |
| | | N | N | N | N | mm | mm |
| WPU-□-□-SRH | 35 | 4000 | 2470 | 4000 | 2470 | 16.5 | 26.5 |
| | 42 | 4300 | 2950 | 4300 | 2950 | 17.5 | 29.5 |
| | 50 | 4500 | 3450 | 4500 | 3450 | 16 | 26 |
| | 63 | 4900 | 4350 | 4900 | 4350 | 17 | 29 |
| | 80 | 14100 | 10900 | 5350 | 5250 | 20 | 35.5 |
| WPU-□-□-SRJ | 35 | 2240 | 910 | 1080 | 430 | 24.5 | 21 |
| | 42 | 2700 | 1270 | 1610 | 710 | 27.5 | 23 |
| | 50 | 4350 | 2260 | 2240 | 910 | 32.3 | 25.2 |
| | 63 | 5600 | 2830 | 2700 | 1270 | 37.3 | 29.2 |
| | 80 | 9400 | 5000 | 4350 | 2260 | 39.4 | 38.1 |




## Maximum load (Average input rotation speed : 2000r/min, Lifespan : 10000h)



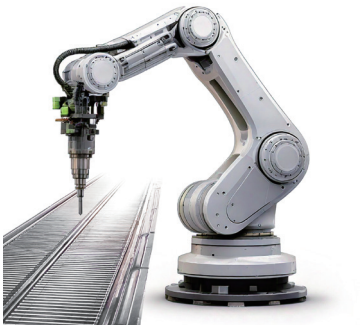



# Application

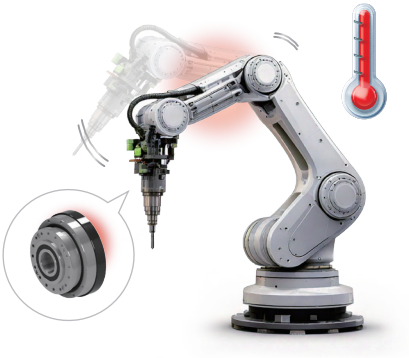
＊ This example of application is not included in scope of safety certification.

### Collision detection / Overload monitoring

### Monitoring torque for screw tightening

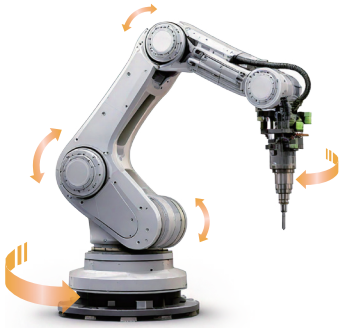


### Arm heat effect compensation / Overheat monitoring



### Robot stop position / Angle monitoring

＊ Please consult with us.



### Network monitoring system



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