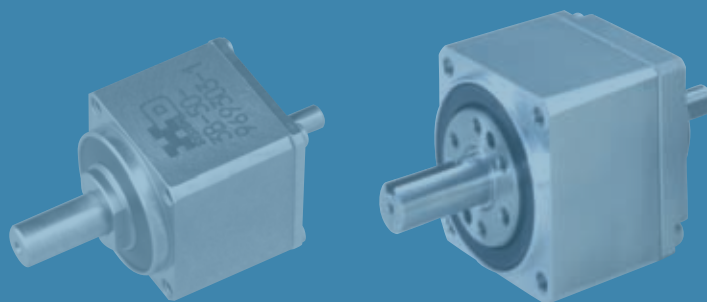


Harmonic Drive

REDUCER

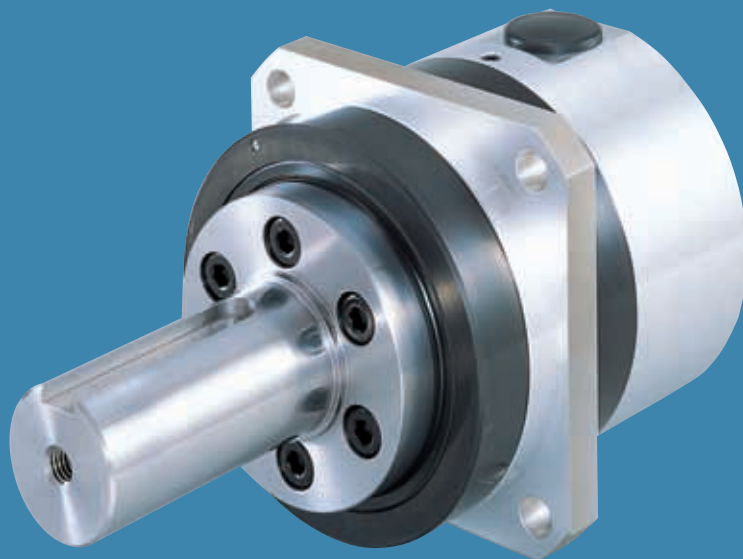


FINE MECHANICS & TOTAL *motion* CONTROL

精密控制用减速机
Reducer for precision control

Harmonic Drive 齿轮箱型产品综合目录 General catalog for Harmonic Drive Gear head type

- 技术资料
Engineering data
- 组合型
Unit type
- 齿轮箱型
Gear head type



一个发明改变了运动控制的世界

One invention has changed the motion control world.

Harmonic Drive的崭新理念、独特原理都是由美国的天才发明家C.W.Musser创造发明的。

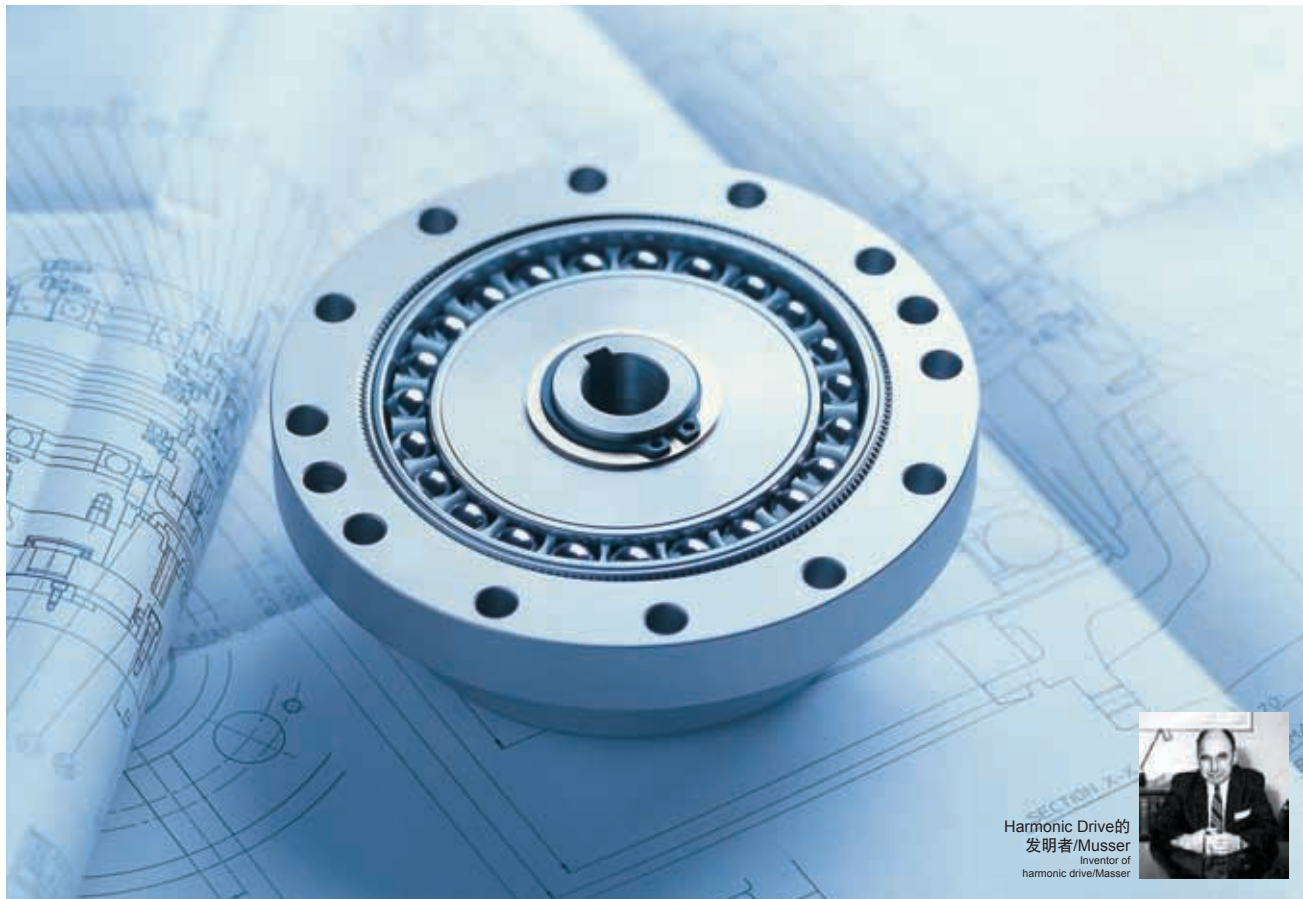
Musser的这一项颠覆了传统常识并应用于金属挠曲的发明，作为一种划时代的动力传递方式在当时引起了世界的注目。

之后，美国法人USM公司和本公司的前身株式会社长谷川齿车开始研究将其产品化的可能性，并为其命名。

Harmonic Drive with its novel idea and unique principle was invented by C.W. Musser, a genius inventor in the U.S.

Masser's invention that demolishes conventional common sense and applies metal deflection was spotlighted by the world at the time as an epoch-making power transmission method.

The company that provided the possibility to commercialize the product and submitted its name was USM (United Shoe Machinery) in the U.S. and our predecessor, Hasegawa Gear Co., Ltd.



Harmonic Drive的
发明者/Musser
Inventor of
harmonic drive/Musser



Musser发明的谐波齿轮传动在发表时被称为“Strain wave gearing”。

同时以该名称取得了专利，之后，株式会社Harmonic Drive Systems成功将该技术实用化。“Harmonic Drive”的学术、一般名称为“谐波齿轮传动”。

The harmonic drive gearing invented by Musser was announced under the name of “Strain wave gearing” at that time.

At the same time, it was patented under the name and later, the Harmonic Drive System was successful in practical application. Its general academic name is “harmonic drive gearing”.

1964年 Harmonic Drive实用化

Practical application of Harmonic Drive in 1964

1964年，本公司的前身、株式会社长谷川齿车HD事业部与USM Co.,Ltd展开技术合作，并在日本首次成功实现了Harmonic Drive的实用化，1970年，2个公司共同出资创建了本公司。

接下来在1979年，演变成为了现在的株式会社Harmonic Drive Systems。

Our predecessor, Hasegawa Gear HD division, formed a technical partnership with USM Co., Ltd in 1964 and was successful in putting Harmonic Drive into practical use for the first time in Japan. Our company was established through joint capital investment in 1970.

In 1979, it was renamed as the current Harmonic Drive Systems Co., Ltd.

致力于打造小型、轻量化的同时，实现高转矩和精准定位。 It assures high torque and accurate repeatability while being compact and light.

Harmonic Drive的最大特征是仅由3个基本部件组合而成，非常易于实现小型轻量化。

而且，由于齿轮啮合数多，也可生成较大的转矩并实现十分精准的定位。

在灵活运用该产品与生俱来的特点的同时，本公司以进一步小型轻量化为开发主题，推进Harmonic Drive的小型紧凑化。为满足顾客多方面的使用要求，我们也对产品类型进行了丰富，现在，我们的产品共包括22种形状、转矩容量从40Ncm至15500Nm不等（#5~#100）。随着我们根据独创的齿形理论开发的IH齿形的诞生，使齿底的弯曲应力和受齿面负载产生的齿根应力减少，并且与此同时全方位地注入高精度的加工技术，使得我们产品的强度和性能获得了大幅度的提升。

Harmonic Drive还将进一步升级进化。

The greatest characteristic of Harmonic Drive is the ease of downsizing and weight saving as it consists of only three basic parts.

As it has many teeth, it generates greater torque and allows very accurate repeatability.

We have pushed ahead with the downsizing of Harmonic Drive based on the development theme of reduction in size and weight, preserving the primary characteristic of the product. Currently, we are preparing a wide range of products including 22 kinds from 40-Ncm to 15500-Nm (#5-#100) torque capacity for various customer uses. We have reduced the bending stress of the bottom and the dedendum stress by the tooth plane load by developing an IH tooth profile invented from our own tooth profile theory, and we have improved the intensity and performance of the product by inputting all of our accumulated high-precision processing technology.

Harmonic Drive will continue to be developed in the future.



波发生器 Wave Generator

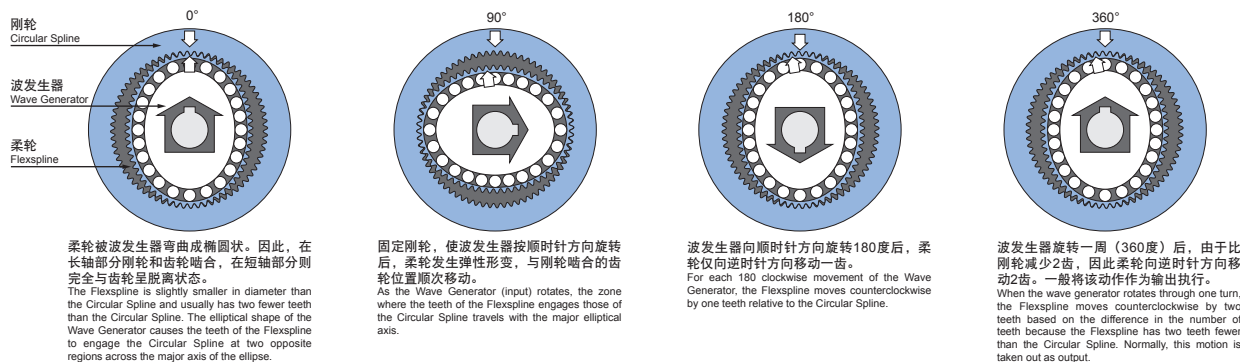
在椭圆状凸轮的四周组装薄壁滚珠轴承的部件。轴承的内轮固定在凸轮上，外轮可通过滚珠实施弹性变形。通常被安装在输入轴上。
The Wave Generator is a thin raced ball bearing fitted onto an elliptical hub serving as a high efficiency torque converter and generally mounted onto the input shaft.

柔轮 Flexspline

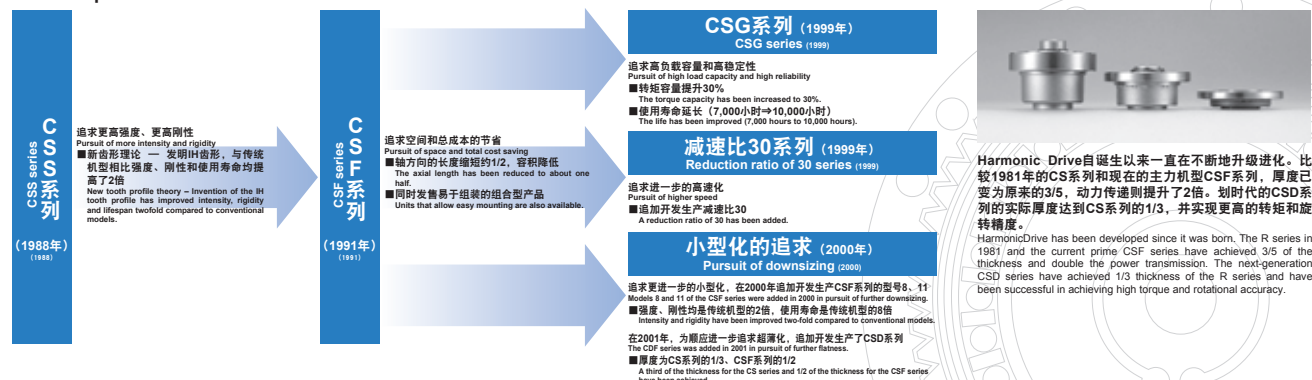
薄壁杯型金属弹性体部件。开口部外周刻有齿。柔轮底部（杯型底部）被称为膜片部，通常被安装在输出轴上。
The Flexspline is a non-rigid, thin cylindrical cup with external teeth on a slightly smaller pitch diameter than the Circular Spline. It fits over and is held in an elliptical shape by the Wave Generator.

刚轮 Circular Spline

刚性环状部件。内周刻有齿，比柔轮齿数多出2齿。通常被固定在机壳上。
The Circular Spline is a rigid ring with internal teeth, engaging the teeth of the Flexspline across the major axis of the Wave Generator. The Circular Spline has two more teeth than the Flexspline and is generally mounted onto housing.



Harmonic Drive的进化 Development of Harmonic Drive



■ 组合型 Unit Type

为组合型安装机壳并在输出轴侧内置精密高刚性轴承，降低组合难度和整体成本。

Casing the component type, a precision crossed roller bearing is contained on the output side for ease of assembly and for a reduction in total cost.

范例 ◎：极好 ○：优良 △：良好
Example ◎：Superlative ○：Excellent △：Good

系列名称 Series			产品特点 Product features										
			可变选项 Variation		转矩・重量比 Torqueweight Ratio	扭转刚性・力矩刚性 Torsional Stiffness	旋转精度 Positioning Accuracy	轻量 Lightweight	扁平形状 Flat Shape	中空构造 Hollow Structure	定制 Customizing	使用寿命 Life	登载页 Page in Catalog
			峰值转矩 (Nm) Peak Torque (Nm)	减速比 Reduction Ratio									
组合型 Unit Type	CSF supermini	超小型型号 Super Compact Type	0.13~0.30	30~100	○	△	◎	◎	○	—	○	○	033
	CSF-mini	小型型号 Compact Type	0.5~28	30~100	○	△	◎	◎	○	—	○	○	047

※ 产品优劣仅限本公司产品内部比较。
The relative merits and demerits of products are compared among our products.

■ 齿轮箱型

Gear head type

伺服电动机专用的齿轮箱。即使是不习惯使用Harmonic Drive的人员也能够简单操作。

This is a gear head for the servo motor. Even if you are not familiar with handling Harmonic Drive, you can handle it easily.

范例 ◎：极好 ○：优良 △：良好
Example ◎：Superlative ○：Excellent △：Good

系列名称 Series			产品特点 Product features										
			可变选项 Variation		转矩・重量比 Torqueweight Ratio	扭转刚性・力矩刚性 Torsional Stiffness	旋转精度 Positioning Accuracy	轻量 Lightweight	扁平形状 Flat Shape	中空构造 Hollow Structure	定制 Customizing	使用寿命 Life	登载页 Page in Catalog
			峰值转矩 (Nm) Peak Torque (Nm)	减速比 Reduction Ratio									
齿轮箱型 Gear Head Type	CSF-GH	齿轮箱型 Gear Head Type	18~2600	50~160	○	◎	◎	○	○	—	○	○	073

※ 产品优劣仅限本公司产品内部比较。
The relative merits and demerits of products are compared among our products.



CSFsupermini / CSF-mini



CSF-GH

■ 技术资料 Engineering Data ————— 006

Unit Type

■ 组合型 Unit Type ————— 033

•CSF supermini系列 CSF-supermini series 033

•CSF-mini系列 CSF-mini series 047

Gear Head Type

■ 齿轮箱型 Gear Head Type ————— 073

•CSF-GH系列 CSF-GH series..... 073

■ 关于保修、关于商标 104
Warranty period and terms, Trademark**■ Harmonic Drive安全使用注意事项 105**
For Safe Use of Harmonic drive

技术资料

Engineering Data

Engineering Data

关于齿形 On the tooth profile	•IH齿形机构 Mechanism of IH tooth profile	007
旋转方向和减速比 Rotational direction and reduction ratio	•杯型 Cup type	008
	•礼帽型 Silk hat type	009
	•薄饼型 Pancake type	009
额定表用语 Terms on the rated table		010
关于使用寿命 On lifespan		010
关于强度 On intensity		011
型号选定 Model number selection		012
关于润滑剂 On lubricant	•润滑脂润滑剂 Grease lubricant	014
	•Harmonic润滑脂4B No.2的使用注意事项 Precaution for using Harmonic grease 4B No.2	016
	•油润滑剂 Oil lubricant	016
	•特殊气体环境用润滑剂 Lubricant for special environments	017
关于刚性 On rigidity		018
角度传达精度 Angle transmission accuracy		019
关于振动 On vibration		019
关于起动转矩 On starting torque		020
关于增速起动转矩 On overdrive starting torque		020
无负载运行转矩 On no-load running torque		021
效率特性 Efficiency characteristics		021
设计注意事项 Precaution on design	•设计指南 Design guideline	022
	•输入输出轴的轴承支撑 Bearing support of the input and output shafts	023
	•关于波发生器 On the wave generator	024
组装注意事项 Precaution on assembly	•密封机构 Sealing mechanism	026
	•组装注意事项 Precaution on assembly	026
	•齿轮啮合偏移状态 "dedoi-dai" state	027
主轴承的确认 Checking main roller bearing	•确认步骤 Checking procedure	028
	•最大负载静力矩的计算方法 How to obtain the maximum load moment load	028
	•平均负载的计算方法 How to obtain the average load	029
	•径向负载系数(X)、轴向负载系数(Y)的计算方法 How to obtain the radial load coefficient (X) and thrust load coefficient (Y)	029
	•使用寿命的计算方法 How to obtain the life	030
	•摆动运动时使用寿命的计算方法 How to obtain the life under oscillating movement	031
	•静态安全系数的计算方法 How to obtain the static safety coefficient	032

关于齿形 On the tooth profile

■IH齿形机构

Mechanism of IH tooth profile

IH齿形是一种为满足Harmonic Drive的要求独创的齿形机构。该齿形具备IH齿形所独具的特殊曲线，可与同类齿形连续接触。此外，通过扩大与齿厚相对的齿沟的幅面、扩大齿底的R，缓和了应力集中的情况。

图中所示的是相对固定的刚轮齿轮，反复进行着弹性形变的柔轮齿轮发生移动时的情况。

齿轮接触将从啮合初期开始将持续进行。通过齿轮的连续接触，同时啮合的齿数将达到总齿数的约30%。使用IH齿形的Harmonic Drive是一种能够在保持应用渐开线齿形的传统机型顺畅性的同时，能够在精度、强度、刚性、使用寿命方面实现全面性飞跃的技术革新。

The IH tooth profile has been devised for Harmonic Drive with a unique mechanism by pursuing the optimum tooth profile.

It has a special curved surface unique to the IH tooth profile that allows continuous contact with the tooth profile. It also alleviates the concentration of stress by widening the width of the tooth groove against the tooth thickness and enlarging the circle on the bottom.

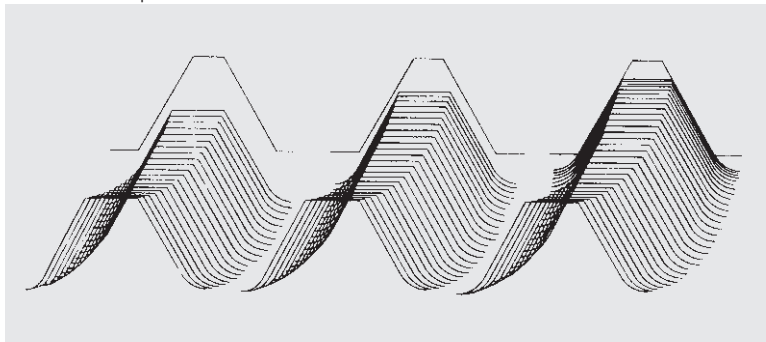
The figure shows how the teeth of flexspline that repeat elastic deformation move against the teeth of the fixed circular spline. The teeth maintain contact for some time from the beginning of engagement.

The number of simultaneously engaged teeth reaches 30% of the whole number of teeth by continuous contact with these teeth. Harmonic Drive that has implemented the IH tooth profile maintains the smoothness of the conventional mechanism using the involute tooth profile, and has achieved dramatic technological innovation in precision, intensity, rigidity and lifespan.

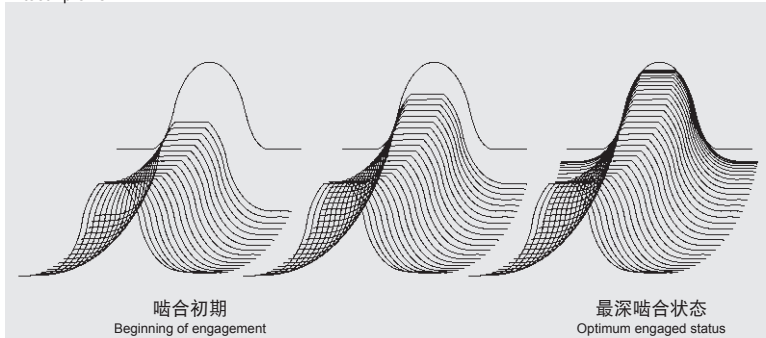
※已经取得专利权
Patent has been obtained

齿轮的啮合路径 Engaged route of teeth

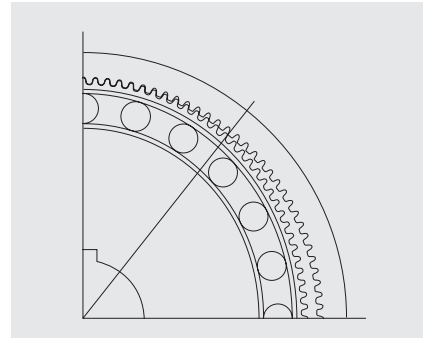
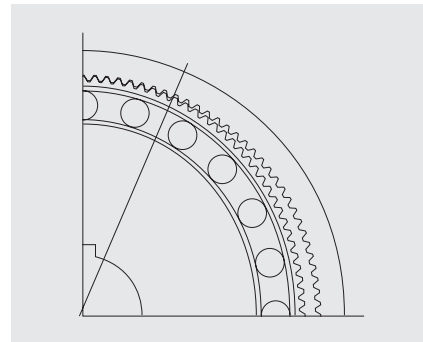
传统齿形 Conventional tooth profile



IH齿形 IH tooth profile



齿轮的啮合区间 Engaged area of teeth



旋转方向和减速比 Rotational direction and reduction ratio

杯型 Cup-type

杯型Harmonic Drive的旋转方向和减速比如下所示。

此外，杯型Harmonic Drive包括以下各系列。

CSG、CSF、CSD、CSF-mini、CSF-GH

The rotational direction and reduction ratio of the cup-type Harmonic Drive are shown below.

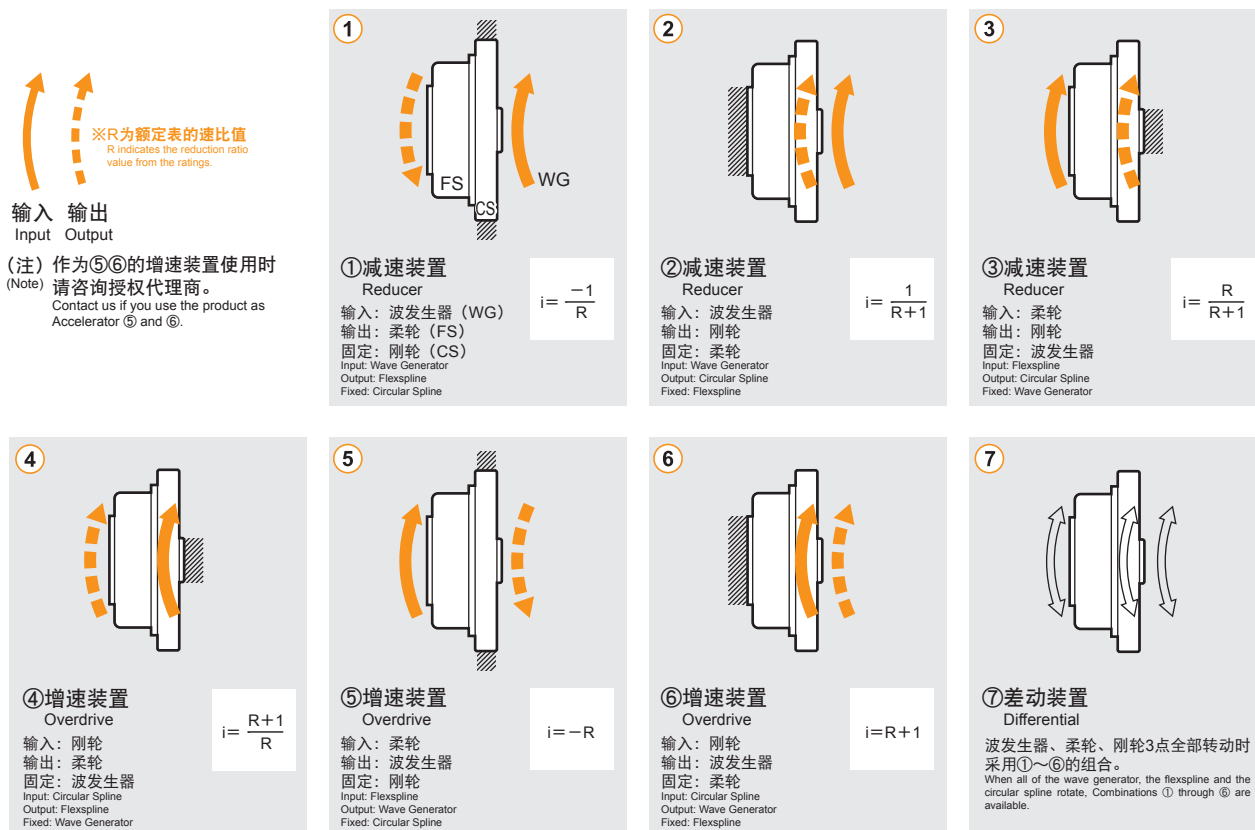
The cup-type Harmonic Drive is composed of the following series.

CSG, CSF, CSD, CSF-mini, CSF-GH

■ 旋转方向

Rotational direction

图010-1
Fig. 010-1



■ 减速比

Reduction ratio

Harmonic Drive的减速比由柔轮和刚轮的齿数决定。

The reduction ratio of Harmonic Drive is determined by the number of teeth of the Flexspline and the Circular Spline.

柔轮的齿数: Z_f

刚轮的齿数: Z_c

Number of teeth of the Flexspline: Z_f

Number of teeth of the Circular Spline: Z_c

▶ 输入: 波发生器
输出: 柔轮
固定: 刚轮
Input: Wave Generator
Output: Flexspline
Fixed: Circular Spline

减速比 Reduction ratio $i_1 = \frac{1}{R_1} = \frac{Z_f - Z_c}{Z_f}$

▶ 输入: 波发生器
输出: 刚轮
固定: 柔轮
Input: Wave Generator
Output: Circular Spline
Fixed: Flexspline

减速比 Reduction ratio $i_2 = \frac{1}{R_2} = \frac{Z_c - Z_f}{Z_c}$

■ 额定表的减速比值由R表示。

R indicates the reduction ratio value from the ratings.

“例” 柔轮的齿数: 200

刚轮的齿数: 202

“Example” Number of teeth of the Flexspline: 200

Number of teeth of the Circular Spline: 202

▶ 输入: 波发生器
输出: 柔轮
固定: 刚轮
Input: Wave Generator
Output: Flexspline
Fixed: Circular Spline

减速比 Reduction ratio $i_1 = \frac{1}{R_1} = \frac{200 - 202}{200} = \frac{-1}{100}$

▶ 输入: 波发生器
输出: 刚轮
固定: 柔轮
Input: Wave Generator
Output: Circular Spline
Fixed: Flexspline

减速比 Reduction ratio $i_2 = \frac{1}{R_2} = \frac{202 - 200}{202} = \frac{1}{101}$

礼帽型 Silk hat type

礼帽型Harmonic Drive的旋转方向和减速比如下所示。

此外，礼帽型Harmonic Drive包括以下各系列。

SHG、SHF、SHD

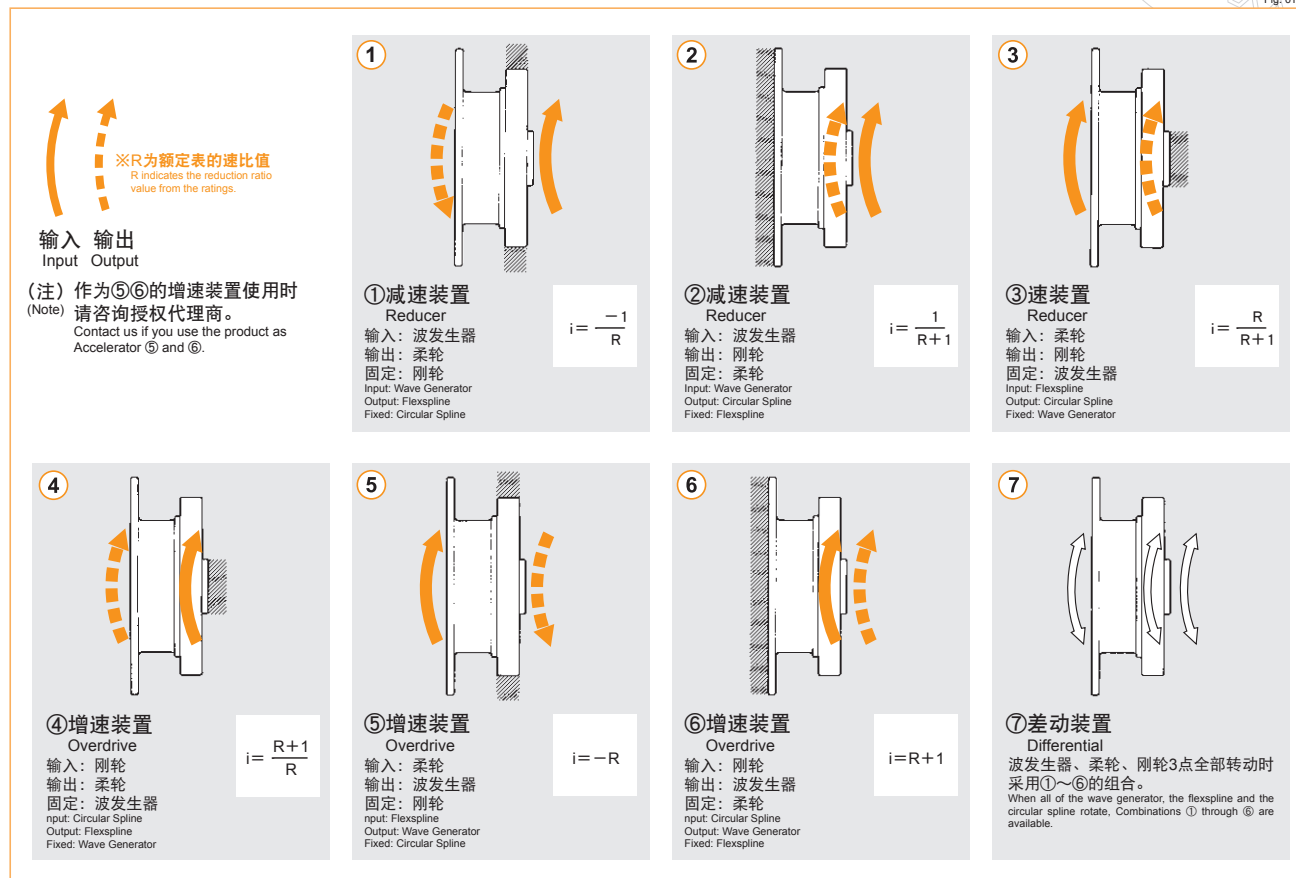
The rotational direction and reduction ratio of the silk hat type Harmonic Drive are shown below.

The silk hat type Harmonic Drive is composed of the following series.
SHG, SHF, SHD

■ 旋转方向

Rotational direction

图011-1
Fig. 011-1



■ 减速比

Reduction ratio

Harmonic Drive的减速比由柔轮和刚轮的齿数决定。

The reduction ratio of Harmonic Drive is determined by the number of teeth of the Flexspline and the Circular Spline.

柔轮的齿数：Zf

刚轮的齿数：Zc

Number of teeth of the Flexspline: Zf

Number of teeth of the Circular Spline: Zc

▶ 输入：波发生器
输出：柔轮
固定：刚轮
Input: Wave Generator
Output: Flexspline
Fixed: Circular Spline

减速比
Reduction ratio

$$i_1 = \frac{1}{R_1} = \frac{Z_f - Z_c}{Z_f}$$

▶ 输入：波发生器
输出：刚轮
固定：柔轮
Input: Wave Generator
Output: Circular Spline
Fixed: Flexspline

减速比
Reduction ratio

$$i_2 = \frac{1}{R_2} = \frac{Z_c - Z_f}{Z_c}$$

■ 额定表的减速比值由R表示。

R indicates the reduction ratio value from the ratings.

“例” 柔轮的齿数：200

刚轮的齿数：202

“Example” Number of teeth of the Flexspline: 200

Number of teeth of the Circular Spline: 202

▶ 输入：波发生器
输出：柔轮
固定：刚轮
Input: Wave Generator
Output: Flexspline
Fixed: Circular Spline

减速比
Reduction ratio

$$i_1 = \frac{1}{R_1} = \frac{200 - 202}{200} = -\frac{1}{100}$$

▶ 输入：波发生器
输出：刚轮
固定：柔轮
Input: Wave Generator
Output: Circular Spline
Fixed: Flexspline

减速比
Reduction ratio

$$i_2 = \frac{1}{R_2} = \frac{202 - 200}{202} = \frac{1}{101}$$

薄饼型 Pancake type

薄饼型Harmonic Drive的转动方向和减速比请参照各系列的相关章节。此外，薄饼型Harmonic Drive包括以下各系列。

FB、FR

See the corresponding pages of each series for the rotational direction and reduction ratio of the pancake type Harmonic Drive.

The pancake type Harmonic Drive is composed of the following series.

FB, FR

额定表用语 Terms on the rated table

Harmonic Drive的额定表由6个数值加上转动惯量组成。

额定表的数值请参照各系列的相关章节。

The ratings of Harmonic Drive consist of 6 values and inertia moment.

See the corresponding pages of each series for values from the ratings.

■额定转矩

Rated torque

表示输入转速为2000r/min时的容许连续负载转矩。

This indicates the permissible continuous load torque when the input rotational speed is 2000 r/min.

■起动停止时的容许峰值转矩（参照图012-1）

Permissible peak torque for start and stop (see Graph 012-1)

起动停止时，根据负载转动惯量，会有大于正常转矩的负载作用到Harmonic Drive。

额定表的数值是此时峰值转矩的容许值。

Load larger than the steady torque is applied to Harmonic Drive by the load inertia moment for start and stop. Values from the ratings show the acceptable value at peak torque.

■平均负载转矩的容许最大值

Permissible maximum value at average load torque

负载转矩、输入转速变化时，需计算出负载转矩的平均值。

额定表的数值表示的是此时平均负载转矩的容许值。

平均负载转矩（计算公式：详见第012页）超过额定表数值时，会因发热而造成润滑剂早期劣化及齿轮磨损异常。请充分注意。

When the load torque and input rotational speed change, the average value of the load torque needs to be obtained.

Values from the ratings show the acceptable value at average load torque.

When the average load torque (calculation formula: Page 012) exceeds the value from the ratings, generation of heat degrades the lubricant earlier and accelerates the abrasion of the teeth. Due care should be taken.

■瞬间容许最大转矩（参照图012-1）

Permissible maximum momentary torque (see Graph 012-1)

除通常负载转矩、起动停止时的负载转矩以外，还存在来自外部、无法预期的冲击转矩。额定表的数值表示的是此时的容许值。

此外，对这种转矩的作用频度设定限制。请参照“关于使用寿命”“关于强度”项目的内容。

Unexpected impact torque may be applied from the exterior except regular-load torque and load torque for start and stop. Values from the ratings show the acceptable value at the time.

The frequency of applying this torque is limited. See "On intensity" and "On lifespan" section.

■容许最高输入转速、容许平均输入转速

Permissible maximum input rotational speed, permissible average input rotational speed

在使用时请注意，不要使输入转速超过额定表所示的容许值。

（平均输入转速的计算公式：详见第012页）

Use the input rotational speed within the limit of acceptable values shown from the ratings (calculation formula of the average input rotational speed: Page 012).

■转动惯量

Inertia moment

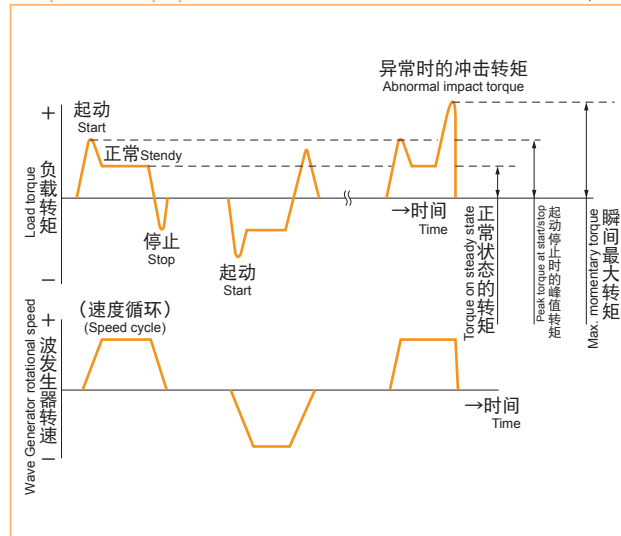
表示各型号波发生器轴上的转动惯量。

The inertia moment on the axes of the wave generators of each model is indicated.

负载转矩模式示例

Example of load torque pattern

图012-1
Graph 012-1



关于使用寿命 On lifespan

■波发生器的使用寿命

Lifespan of the wave generator

Harmonic Drive的使用寿命取决于波发生器轴承的使用寿命。与普通滚珠轴承相同，可通过转速和负载转矩计算出来。

The lifespan of Harmonic Drive is determined by the lifespan of the wave generator, and you can calculate this by the rotational speed and the load torque just as with a general ball bearing.

表012-1
Table 012-1

	使用寿命时间 Lifespan	
系列名称 Series name	CSF,CSD,SHF,SHD, CSF-mini,CSF-GH	CSG,SHG
L ₁₀ (10%破损率) L ₁₀ (10% damage probability)	7,000小时 7,000 hours	10,000小时 10,000 hours
L ₅₀ (平均使用寿命) L ₅₀ (average lifespan)	35,000小时 35,000 hours	50,000小时 50,000 hours

※额定表记载的额定转速、额定转矩时的使用寿命。
Lifespan is based on the rated rotational speed and rated torque from the ratings.

实际运转条件下使用寿命 (L_h) 的计算公式

Calculation formula for lifespan (L_h) by actual operation condition

公式012-1
Formula 012-1

$$L_h = L_n \cdot \left(\frac{T_r}{T_{av}} \right)^3 \cdot \left(\frac{N_r}{N_{av}} \right)$$

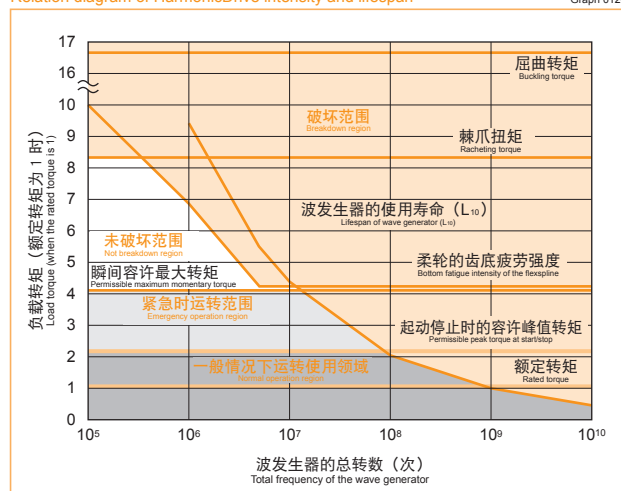
表012-2
Table 012-2

L _n	L ₁₀ 或L ₅₀ 时的使用寿命时间 Lifespan of L ₁₀ and L ₅₀
T _r	额定转矩 Rated torque
N _r	额定转速 Rated rotational speed
T _{av}	输出侧的平均负载转矩（计算公式：详见第012页） Average load torque on the output side (calculation formula: Page 012)
N _{av}	平均输入转速（计算公式：详见第012页） Average input rotational speed (calculation formula: Page 012)

Harmonic Drive的强度与使用寿命的关系图

Relation diagram of Harmonic Drive intensity and lifespan

图012-2
Graph 012-2



(注)

请在“一般情况下运转使用领域”内使用Harmonic Drive。超过“紧急时运转范围”使用会造成Harmonic Drive发生早期破损。

(Note)

Use Harmonic Drive within the range of "Normal operation area." Using it beyond "Emergency operation area" may result in damaging Harmonic Drive earlier than usual.

※上表中未考虑齿面磨损等润滑寿命。

Lubricant lifespan such as for abrasion on the tooth surface is not taken into consideration in the graph described above.

※上表中的数值请作为参考值使用。

Use the graph above as reference values.

关于强度 On intensity

■ 柔轮的强度

Intensity of flexspline

由于柔轮会反复发生弹性形变，因此Harmonic Drive的传递转矩是以柔轮齿底的疲劳强度为基准进行确定。

额定转矩、起动停止时的容许峰值转矩的数值均为柔轮齿底疲劳界限以内的数值。

瞬间容许最大转矩（冲击转矩）的数值是柔轮齿底疲劳界限内的极限值，频繁超过瞬间容许至于大转矩时将可能发生疲劳破坏。因此为避免发生疲劳破坏，要对冲击转矩的次数设定限制。

As flexspline repeats elastic deformation, the transmission torque of Harmonic Drive is calculated based on the fatigue strength of the bottom of the flexspline. Values of the rated torque and permissible peak torque for start and stop are those within the fatigue limit of the bottom of the flexspline.

Although the value of the permissible maximum momentary torque (impact torque) fully endures the fatigue limit of the bottom of the flexspline, it could generate fatigue fracture if it frequently exceeds the permissible maximum momentary torque. Therefore, the number of applications of impact torque is limited to prevent possible fatigue fracture.

根据冲击转矩作用时波发生器的旋转，确定柔轮挠曲次数限制：

Restriction on the bending frequency of the flexspline by the rotation of the wave generator while the impact torque is applied:

$$1.0 \times 10^4 \text{ (回) (frequency)}$$

根据挠曲次数限制可计算出冲击转矩作用的容许次数。

You can calculate the permissible frequency of impact torques from this restriction on the bending frequency.

计算公式

Calculation formula

公式013-1
Formula 013-1

$$N = \frac{1.0 \times 10^4}{2 \times \frac{n}{60} \times t}$$

表013-1
Table 013-1

容许次数 Permissible frequency	N次 N frequency
冲击转矩的作用时间 Time that impact torque is applied	t sec
此时波发生器的转速速度 Rotational speed of the wave generator	n r/min
波发生器旋转1圈，柔轮挠曲2次。 The flexspline bends two times by one cycle of the wave generator.	



注意
Caution

超出容许次数后，柔轮可能会发生疲劳破坏。

Exceeding the permissible frequency may cause fatigue damage to the flexspline.

■ 屈曲转矩

Buckling torque

波发生器处于固定状态下向柔轮（输出）作用过度转矩时，柔轮会发生塑性形变，不久柔轮中部会发生屈曲，形成破损。

此时的转矩称为屈曲转矩。

When excess torque is applied to the flexspline (output) with the wave generator fixed, the flexspline causes elastic deformation, buckles on the body before long and will be destroyed. The torque at the time is called buckling torque.

※屈曲转矩的数值请参照各系列的相关章节。

See the corresponding pages of each series for buckling torque values.



警告
Warning

请注意，当柔轮发生屈曲时Harmonic Drive不可使用。

When the flexspline buckles, Harmonic Drive will be put out of commission. Therefore, exercise adequate care.

■ 棘爪扭矩

Ratcheting torque

运转中受到过度的冲击转矩作用时，在柔轮等未发生破损的状态下刚轮和柔轮齿轮的啮合会瞬间发生偏移。这种现象被成为棘爪，此时的转矩被称为棘爪扭矩（棘爪扭矩的数值请参照各系列的相关章节）。如果发生棘爪现象仍继续使其运转，会由于棘爪发生时产生的磨损粉尘导致齿轮发生早期磨损、缩短波发生器轴承的使用寿命。

When excess impact torque is applied during operation, the engagement of the teeth between the circular spline and the flexspline may be put momentarily out of alignment instead of damaging the flexspline. This phenomenon is called ratcheting, and the torque is called ratcheting torque (see values on the corresponding page of each series). Operating the drive without fixing ratcheting will result in earlier abrasion of the teeth and shorter lifespan of the wave generator bearing due to the effect of the grinding powder generated by ratcheting.

※棘爪扭矩的数值请参照各系列的相关章节。

See the corresponding pages of each series for ratcheting torque values.

※棘爪扭矩会受到安装刚轮外壳刚性的影响。详情请咨询授权代理商。

Ratcheting torque can be influenced by the rigidity of mounting circular spline's housing. Contact our distributor for details.



注意
Caution

发生棘爪时可能会出现齿轮啮合不正常、如图013-1所示呈单侧偏移的状态。此时继续运转会发生振动、引起柔轮破损，需特别注意。

When ratcheting is caused, the teeth may not be correctly engaged and become out of alignment as shown in Figure 013-1. As operating the drive in this condition will generate vibration and damage the flexspline, adequate care should be exercised.



注意
Caution

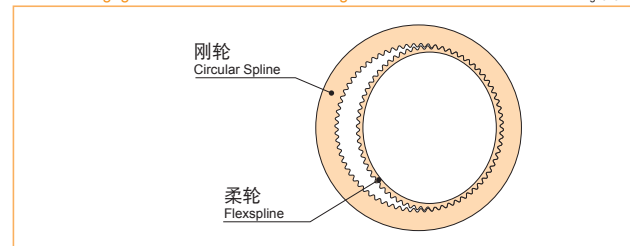
发生一次棘爪后齿顶会出现磨损，发生两次以上时棘爪的发生转矩值将会降低。请特别注意。

Once ratcheting is caused, the tips of the teeth are worn and the torque value generated by ratcheting will be lowered. Pay due attention to this point as well.

齿轮啮合呈单侧偏移的状态

When the engagement of the teeth is out of alignment

图013-1
Fig. 013-1



这一状态被称为齿轮啮合偏移。

This condition is called "dedoi-dal".

型号选定 Model number selection

一般来讲，伺服系统几乎没有带着一定的负载连续运转的状态。输入转速和负载转矩会发生变化，起动、停止时也会有较大的转矩作用。此外，还会出现无法预期的冲击转矩。

通过这些变动负载转矩换算为平均负载转矩，实施型号的选定。此外，组合型时，外部负载的直接支撑部位（输出法兰部）组装有精密交叉滚子轴承，因此，请确认最大负载静力矩、交叉滚子轴承的使用寿命以及静态安全系数。（参照第028页“主轴承的确认”）

In general, the servo system is rarely in a continuous constant load state. The input rotational speed, load torque change and comparatively large torque are applied at start and stop. Unexpected impact torque may be applied.

These fluctuating load torques should be converted to the average load torque in selecting a model number. As an accurate cross roller bearing is built in the direct external load support (output flange) of the unit type, the maximum moment load, lifespan of the cross roller bearing and the static safety coefficient should also be checked (see "Checking the main roller bearing" on Page 028).

■负载转矩模式的确认

Checking the load torque pattern

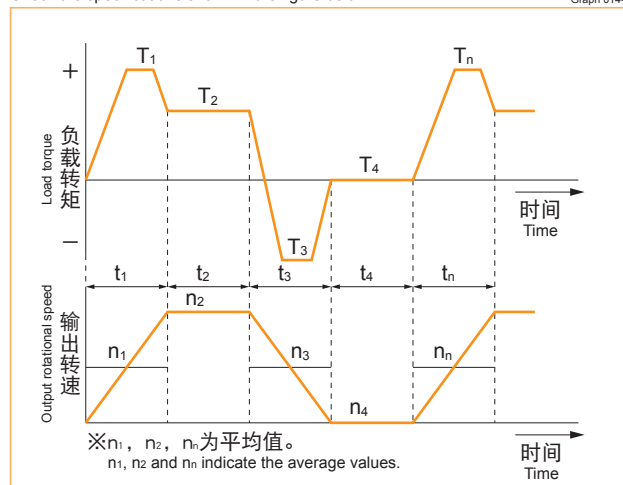
首先，必须掌握负载转矩的模式。请确认下图所示的各规格。

First, you need to look at the picture of the load torque pattern.

Check the specifications shown in the figure below.

图014-1

Graph 014-1



计算出各负载转矩模式的数值

Obtain the value of each load torque pattern.

负载转矩 Load torque T_n (Nm)

时间 Time t_n (sec)

输出转速 Output rotational speed n_n (r/min)

输出转速 Output rotational speed n_n (r/min)

<通常运转模式>

<Normal operation pattern>

起动时 Starting time T_1, t_1, n_1

正常运转时 Steady operation time T_2, t_2, n_2

停止(减速)时 Stopping (slowing) time T_3, t_3, n_3

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

停机时 Break time T_4, t_4, n_4

■型号选定的流程图

Flowchart of model number selection

请根据以下的流程图进行型号的选定。

任何一个数值超过额定表的数值时，都请重新考虑大一个的型号，或考虑降低负载转矩等条件。

Select a model number according to the following flowchart.

If you find a value exceeding that from the ratings, you should review it with the upper-level model number or consider reduction of conditions including the load torque.

根据负载转矩模式计算出向Harmonic Drive输出侧施加的平均负载转矩： T_{av} (Nm)

Calculate the average load torque applied on the output side of Harmonic Drive from the load torque pattern: T_{av} (Nm).

$$T_{av} = \sqrt[3]{\frac{n_1 \cdot t_1 \cdot |T_1|^3 + n_2 \cdot t_2 \cdot |T_2|^3 + \dots + n_n \cdot t_n \cdot |T_n|^3}{n_1 \cdot t_1 + n_2 \cdot t_2 + \dots + n_n \cdot t_n}}$$

根据以下条件暂时选定型号。 $T_{av} \leq$ 平均负载转矩的容许最大值

Select a model number temporarily with the following conditions. $T_{av} \leq$ Permissible maximum value of the average load torque

(参照各系列的额定表)
(See the ratings of each series)

计算出平均输出转速：

no_{av} (r/min)

Calculate the average output rotational speed: no_{av} (r/min)

$$no_{av} = \frac{n_1 \cdot t_1 + n_2 \cdot t_2 + \dots + n_n \cdot t_n}{t_1 + t_2 + \dots + t_n}$$

确定减速比 (R)。

ni_{max} 会根据电动机等进行限制。

Obtain the reduction ratio (R).

A limit is placed on " ni_{max} " by motors.

$$\frac{ni_{max}}{no_{max}} \geq R$$

根据平均输出转速 (no_{av}) 和减速比 (R) 计算出平均

输入转速： ni_{av} (r/min)

Calculate the average input rotational speed from the average output rotational speed (no_{av}) and the reduction ratio (R): ni_{av} (r/min)

$$ni_{av} = no_{av} \cdot R$$

根据最高输出转速 (no_{max})

和减速比 (R) 计算出最高

输入转速： ni_{max} (r/min)

Calculate the maximum input rotational speed from the max. output rotational speed (no_{max}) and the reduction ratio (R): ni_{max} (r/min)

$$ni_{max} = no_{max} \cdot R$$

NG

确认暂时选定的型号是否在额定表数值以内。

Check whether the temporarily selected model number satisfies the following condition from the ratings.

$ni_{av} \leq$ 容许平均输入转速 (r/min)
 $ni_{av} \leq$ Permissible average input rotational speed (r/min)
 $ni_{max} \leq$ 容许最高输入转速 (r/min)
 $ni_{max} \leq$ Permissible max. input rotational speed (r/min)

OK

NG

确认 T_1, T_3 是否处于额定表起动停止时的容许峰值转矩 (Nm) 数值以内。

Check whether T_1 and T_3 are equal to or less than the permissible peak torque (Nm) value at start and stop from the ratings.

OK

NG

确认 T_s 是否处于额定表的瞬间容许最大转矩 (Nm) 数值以内。

Check whether T_s is equal to or less than the permissible maximum momentary torque (Nm) value from the ratings.

OK

NG

根据施加冲击转矩时的输出转速 n_s 和时间 t_s ，计算出容许次数，并确认是否符合使用条件。

Calculate the permissible number of times from output rotational speed n_s and time t_s when the impact torque is applied, and check whether it satisfies the usage conditions.

$$N_s = \frac{10^4}{2 \cdot \frac{T_r}{T_{av}} \cdot \frac{nr}{ni_{av}}} \cdot \frac{1}{t_s} \quad (转/次) \quad N_s \leq 1.0 \times 10^4 \quad (转/次)$$

OK

计算出使用寿命时间。

Calculate the lifetime.

$$L_{10} = 7000 \cdot \left(\frac{T_r}{T_{av}} \right)^3 \cdot \left(\frac{nr}{ni_{av}} \right) \quad (时间)$$

NG

确认计算出的使用寿命时间是否高于波发生器的使用寿命时间。（参照第011页）

Check whether the calculated lifetime is equal to or more than the lifespan of the wave generator (see Page 011).

OK

型号选定

The model number is determined.

■型号选定示例

Example of model number selection

各负载转矩模式的值

Value of each load torque pattern.

负载转矩 T_n (Nm)

Load torque

时间 t_n (sec)

Time

输出转速 n_n (r/min)

Output rotational speed

<通常运转模式>

<Normal operation pattern>

启动时 $T_1=400\text{Nm}$ 、 $t_1=0.3\text{sec}$ 、 $n_1=7\text{r/min}$

Starting time

正常运转时 $T_2=320\text{Nm}$ 、 $t_2=3\text{sec}$ 、 $n_2=14\text{r/min}$

Steady operation time

停止(减速)时 $T_3=200\text{Nm}$ 、 $t_3=0.4\text{sec}$ 、 $n_3=7\text{r/min}$

Stopping (slowing) time

停机时 $T_4=0\text{Nm}$ 、 $t_4=0.2\text{sec}$ 、 $n_4=0\text{r/min}$

Break time

<最高转速>

<Maximum rotational speed>

最高输出转速

 $no_{max} = 14\text{r/min}$

Max. output rotational speed

最高输入转速

 $ni_{max} = 1800\text{r/min}$

(通过电动机等进行限制。)

Max. input rotational speed
(Restricted by motors)

<冲击转矩>

<Impact torque>

施加冲击转矩时

When impact torque is applied

 $T_s=500\text{Nm}$ 、 $t_s=0.15\text{sec}$ 、 $n_s=14\text{r/min}$

<要求使用寿命>

 $L_{10}=7000$ (时间)

<Required lifespan>

 $L_{10}=7000$ (hours)根据负载转矩模式计算出向Harmonic Drive输出侧施加的平均负载转矩: T_{av} (Nm)Calculate the average load torque applied on the output side of Harmonic Drive from the load torque pattern: T_{av} (Nm).

$$T_{av} = \sqrt[3]{\frac{7\text{r/min} \cdot 0.3\text{sec} \cdot |400\text{Nm}|^3 + 14\text{r/min} \cdot 3\text{sec} \cdot |320\text{Nm}|^3 + 7\text{r/min} \cdot 0.4\text{sec} \cdot |200\text{Nm}|^3}{7\text{r/min} \cdot 0.3\text{sec} + 14\text{r/min} \cdot 3\text{sec} + 7\text{r/min} \cdot 0.4\text{sec}}}$$

根据以下条件暂时选定型号。 $T_{av}=319\text{Nm} \leq 451\text{Nm}$ (型号CSF-40-120平均负载转矩的容许最大值: 参照额定表、第037页)、暂时选定**CSF-40-120-2UH**。Select a model number temporarily with the following conditions. $T_{av} = 319\text{Nm} \leq 451\text{Nm}$ (Permissible maximum value of the average load torque for model number CSF-40-120: See the ratings on Page 037.) Thus, **CSF-40-120-2UH** is temporarily selected.计算出平均输出转速: no_{av} (r/min)Calculate the average output rotational speed: no_{av} (r/min)

$$no_{av} = \frac{7\text{r/min} \cdot 0.3\text{sec} + 14\text{r/min} \cdot 3\text{sec} + 7\text{r/min} \cdot 0.4\text{sec}}{0.3\text{sec} + 3\text{sec} + 0.4\text{sec} + 0.2\text{sec}} = 12\text{r/min}$$

确定减速比 (R)。

Obtain the reduction ratio (R).

$$\frac{1800\text{r/min}}{14\text{r/min}} = 128.6 \geq 120$$

根据平均输出转速 (no_{av}) 和减速比 (R)计算出平均输入转速: ni_{av} (r/min)Calculate the average input rotational speed from the average output rotational speed (no_{av}) and the reduction ratio (R): ni_{av} (r/min)

$$ni_{av} = 12\text{r/min} \cdot 120 = 1440\text{r/min}$$

根据最高输出转速 (no_{max}) 和减速比 (R)计算出最高输入转速: ni_{max} (r/min)Calculate the maximum input rotational speed from the maximum output rotational speed (no_{max}) and the reduction ratio (R): ni_{max} (r/min)

$$ni_{max} = 14\text{r/min} \cdot 120 = 1680\text{r/min}$$

确认暂时选定的型号是否在额定表数值以内。

Check whether the temporarily selected model number satisfies the following condition from the ratings.

$$ni_{av} = 1440\text{r/min} \leq 3600\text{r/min} \quad (\text{型号40的容许平均输入转速})$$

$$ni_{av} = 1440\text{r/min} \leq 3600\text{r/min} \quad (\text{Permissible average input rotational speed of model No. 40})$$

$$ni_{max} = 1680\text{r/min} \leq 5600\text{r/min} \quad (\text{型号40的容许最高输入转速})$$

$$ni_{max} = 1680\text{r/min} \leq 5600\text{r/min} \quad (\text{Permissible max. input rotational speed of model No. 40})$$

NG

OK

确认 T_1 、 T_3 是否处于额定表起动、停止时的容许峰值转矩 (Nm) 数值以内。Check whether T_1 and T_3 are equal to or less than the permissible peak torque (Nm) value at start and stop from the ratings.

$$T_1 = 400\text{Nm} \leq 617\text{Nm} \quad (\text{型号40起动、停止时的容许峰值转矩})$$

$$T_1 = 400\text{Nm} \leq 617\text{Nm} \quad (\text{Permissible peak torque at start and stop of model number 40})$$

$$T_3 = 200\text{Nm} \leq 617\text{Nm} \quad (\text{型号40起动、停止时的容许峰值转矩})$$

$$T_3 = 200\text{Nm} \leq 617\text{Nm} \quad (\text{Permissible peak torque at start and stop of model number 40})$$

NG

OK

确认 T_s 是否处于额定表的瞬间容许最大转矩 (Nm) 数值以内。
Check whether T_s is equal to or less than the permissible maximum momentary torque (Nm) value from the ratings.

$$T_s = 500\text{Nm} \leq 1180\text{Nm} \quad (\text{型号40的瞬间容许最大转矩})$$

$$T_s = 500\text{Nm} \leq 1180\text{Nm} \quad (\text{Permissible maximum momentary torque of model number 40})$$

NG

OK

根据施加冲击转矩时的输出转速 n_s 和时间 t_s , 计算出容许次数, 并确认是否符合使用条件。Calculate the permissible number of times from output rotational speed n_s and time t_s when the impact torque is applied, and check whether it satisfies the usage conditions.

$$N_s = \frac{10^4}{2 \cdot \frac{14\text{r/min} \cdot 120}{60} \cdot 0.15\text{sec}} = 1190 \leq 1.0 \times 10^4 \quad (\text{转})$$

$$N_s = 1190 \leq 1.0 \times 10^4 \quad (\text{times})$$

NG

OK

计算出使用寿命时间。

Calculate the lifespan.

$$L_{10} = 7000 \cdot \left(\frac{294\text{Nm}}{319\text{Nm}} \right)^3 \cdot \left(\frac{2000\text{r/min}}{1440\text{r/min}} \right) \quad (\text{时间})$$

$$L_{10} = 7610 \text{ (hours)}$$

确认计算出的使用寿命时间是否高于波发生器的使用寿命时间。(参照第011页)

Check whether the calculated lifespan is equal to or more than the lifespan of the wave generator (see Page 11).

$$L_{10} = 7610 \geq 7000 \quad (\text{波发生器的使用寿命时间: } L_{10})$$

$$L_{10} = 7610 \text{ hours} \geq 7000 \quad (\text{lifespan of the wave generator: } L_{10})$$

NG

OK

根据上述结果选定**CSF-40-120-2UH**Model number **CSF-40-120-2UH** is determined from the result described above.再次研究运转条件或型号
Review of the operation conditions and model number

组件型的润滑方法包括润滑脂润滑和油润滑2种。

组合型、齿轮箱型的标准润滑方法为润滑脂润滑。出厂前已封入润滑脂，因此组装时无需注入、涂抹润滑脂。但是，请注意简易组合型出厂时未封入润滑脂。

关于在右述的温度范围以外使用的润滑剂，请参照第017页。

Grease lubricant and oil lubricant are available for lubricating the component type. Grease lubricant is standard for lubricating the unit type and the gear head type. You do not need to apply grease during assembly as the product is lubricated and shipped. See Page 017 for using lubricant beyond the temperature range described in the right-hand figure.

※因维护等原因需要使用粘度为0的（NLGI No.0）润滑脂时，请咨询本公司授权代理商。
Contact the sales division if you want consistency zero (NLGI No.0) for maintenance reasons.

润滑剂的名称

润滑脂 Grease	Harmonic润滑脂 SK-1A Harmonic grease SK-1A
	Harmonic润滑脂 SK-2 Harmonic grease SK-2
	Harmonic润滑脂 4B No.2 Harmonic grease 4B No.2
油液 Oil	工业用齿轮油2种（极压）ISO VG68 Industrial gear oil class-2 (extreme pressure) ISO VG68

表016-1
Table 016-1

使用工况温度范围

Temperature range of the operating environment	
润滑脂 Grease	SK-1A 0℃～+40℃
	SK-2 0℃～+40℃
	4B No.2 -10℃～+70℃
油液 Oil	ISO VG68 0℃～+40℃

表016-2
Table 016-2

（注）对比工况温度，高温侧请在温度上升40℃以内使用。
Keep the hot section up to 40℃ above the ambient temperature.

润滑脂润滑剂 Grease lubricant

■ 润滑脂的种类

Types of lubricant

Harmonic润滑脂 SK-1A Harmonic grease SK-1A

专为Harmonic Drive开发的专用润滑脂，与市场上销售的常用润滑脂相比具有耐久性强、效率特性佳的优点。

This has been developed as grease exclusively for Harmonic Drive and is excellent in durability and efficiency compared to commercial general-purpose grease.

Harmonic润滑脂 SK-2 Harmonic grease SK-2

专为小型Harmonic Drive开发的专用润滑脂，通过将极压添加剂液化，可以在波发生器旋转时获得极佳的润滑效果。

This has been developed exclusively for the compact Harmonic Drive and is excellent in smoothness during wave generator rotation by liquefying extreme pressure additive.

Harmonic润滑脂 4B No.2 Harmonic grease 4B No.2

为CSF・CSG系列开发的专用润滑脂，具有可适应较长使用寿命的流动特性，此外还能够在更大的温度范围内使用。

This has been developed exclusively for the CSF and CSG series, has the fluid characteristic suited to longer operating life and is used for a wide temperature range.

（注）

1. 采用润滑脂润滑时必须密封机构。

请按照以下对策对旋转部和连接接触面进行润滑。

特别是使用Harmonic润滑脂4B No.2时，请务必严格实施密封机构润滑。

旋转部…请使用弹簧压入式油封进行润滑。

连接接触部…请注意平面是否歪斜、是否存在伤痕，并使用O型环或密封剂进行润滑。

2. 使用4B No.2润滑脂时即便是在运转初期，润滑脂在切断部位（波发生器周边部位）也会变软。润滑脂的硬度需根据运转条件而定，NLGI粘度从No.0至00不等。

（Note）

1. A seal mechanism is required for grease lubrication.

Take the following actions for the rotor and the surface-contacting joints.

In particular, a strong seal mechanism is required in using Harmonic grease 4B No.2.

Rotor: Use an oil seal with a spring.

Parts-contacting joints: Use an O-ring or sealing agent paying attention to the warp and flaw on the plain surface.

2. Harmonic grease 4B No.2 becomes soft at the portion (near the wave generator) that is subject to shear. Although the consistency varies depending on the operating conditions, it is about JIS consistency No.0 up to 00.

表016-3
Table 016-3

NLGI粘度No. JIS consistency No.	混合粘度范围 Mixing consistency range
0	355～385
00	400～430

润滑脂规格

Grease specification

表016-4
Table 016-4

润滑脂 Grease	SK-1A	SK-2	4B No.2
基础油 Base oil	精制矿物油 Refined oil	精制矿物油 Refined oil	合成烃油 Composite hydrocarbon oil
增稠剂 Thickening agent	锂皂基 Lithium soap base	锂皂基 Lithium soap base	尿素 Urea
添加剂 Additive	极压添加剂、其他 Extreme-pressure additive, others	极压添加剂、其他 Extreme-pressure additive, others	极压添加剂、其他 Extreme-pressure additive, others
NLGI粘度No. NLGI consistency No.	No.2	No.2	No.1.5
粘度（25℃） Consistency (25℃)	265～295	265～295	290～320
滴点 Drop point	197℃	198℃	247℃
外观 Appearance	黄色 Yellow	绿色 Green	淡黄色 Light yellow
保存寿命 Storage life	密闭状态5年 5 years in sealed condition	密闭状态5年 5 years in sealed condition	密闭状态5年 5 years in sealed condition

■ 不同机型适合润滑脂

Compatible grease by model

根据型号、速比的不同，适合润滑脂也有所不同。请参照下表。作为一般使用，推荐SK-1A以及SK-2。

Compatible grease varies depending on the model number and reduction ratio. See the following compatibility table. We recommend SK-1A and SK-2 for general use.

适合减速比30的润滑脂

Compatible grease for a reduction ratio of 30

表016-5
Table 016-5

型号 Model	8	11	14	17	20	25	32
SK-1A	—	—	—	—	○	○	○
SK-2	○	○	○	○	—	—	—
4B No.2	△	△	△	△	□	□	□

适合减速比50以上的润滑脂

Compatible grease for a reduction ratio of 50 or more

表016-6
Table 016-6

型号 Model	8	11	14	17	20	25	32
SK-1A	—	—	—	—	○	○	○
SK-2	○	○	○	○	△	△	△
4B No.2	—	—	□	□	□	□	□

型号 Model	40	45	50	58	65	80	90	100
SK-1A	○	○	○	○	○	○	○	○
SK-2	△	—	—	—	—	—	—	—
4B No.2	□	□	□	□	□	□	□	□

※带○符号：标准润滑脂

○ mark: Standard grease

带△符号：标准准润滑脂

△ mark: Semi-standard grease

带□符号：较长使用寿命以及高负载时的推荐润滑脂

□ mark: Recommended grease for long life and high load

润滑脂特性

Grease characteristics

表016-7
Table 016-7

润滑脂 Grease	SK-1A	SK-2	4B No.2
耐久性 Durability	○	○	◎
耐微振磨损 Fretting resistance	○	○	◎
低温性 Low-temperature performance	△	△	◎
润滑脂泄漏 Grease leakage	◎	◎	△

※优越：◎

Excellent

适用：○

Appropriate

需注意：△

Doubtful

■ 润滑脂更换时间

When to replace grease

Harmonic Drive的各运动部的磨耗很大程度上会受到润滑脂性能的影响。

润滑脂的性能会根据温度变化，温度越高劣化越快，因此需要尽早进行润滑脂更换。如下图017-1所示，当平均负载转矩低于额定转矩时，根据润滑脂温度与波发生器总转数间的关系可确定润滑脂的更换时间基准。平均负载转矩超出额定转矩时，则通过以下计算公式计算出润滑脂的更换时间基准。

Abrasion of the sliding parts of HarmonicDrive is influenced by grease performance. Grease performance changes by temperature and deteriorates rapidly as the temperature rises. Therefore, the grease needs to be replaced earlier than usual. Graph 017-1 below indicates the time to replace the grease from the relation between the grease temperature and the total number of rotations when the average load torque is equal to or less than the rated torque. Obtain the time to replace the grease from the following calculation formula when the average load torque exceeds the rated torque.

平均负载转矩超出额定转矩时的计算公式

Calculation formula when the average load torque exceeds the rated torque

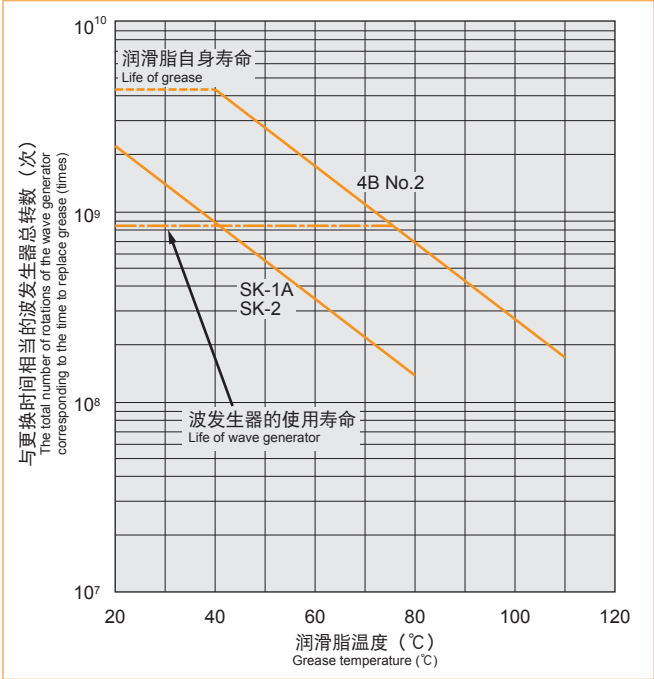
公式017-1
Formula 017-1

$$L_{GT} = L_{GTn} \times \left(\frac{Tr}{T_{av}} \right)^3$$

润滑脂更换时间：L_{GTn}（平均负载转矩低于额定转矩时）

When to replace grease: L_{GTn} (when the average load torque is equal to or less than the rated torque)

图017-1
Graph 017-1



※波发生器的使用寿命表示破损率为10%。
Life of wave generator indicates the 10% of damage possibility.

计算公式的符号

Symbols of the calculation formula

表017-1
Table 017-1

L _{GT}	超出额定转矩时的更换时间 Replacement timing if it is equal to rated torque or more	转数 Number of rotation	—
L _{GTn}	低于额定转矩时的更换时间 Replacement timing if it is equal to rated torque or less	转数 Number of rotation	参照右图 See the right-hand figure
Tr	额定转矩 Rated torque	Nm, kgfm	参照各系列的“额定表” See the “Ratings” of each series
T _{av}	输出侧的平均负载转矩 Average load torque on the output side		计算公式：参照第012页 Calculation formula: See Page 012

■ 其他注意事项

Other precautions

1. 请避免与其他润滑脂混用。此外，组装到装置上时请将Harmonic Drive置于单独的壳体内。
Avoid using it with other grease. HarmonicDrive should be placed in an independent case to be built into the equipment.
2. 在波发生器处于朝上（参照第048页 图050-2）的状态，且朝单方向以固定负载低速旋转（输入转速：低于1000r/min）时使用Harmonic Drive，可能引起润滑不良，此时使用请咨询本公司授权代理商。
When you use HarmonicDrive with the wave generator facing upward (see Figure 050-2 on Page 048) at low-speed rotation (input rotational speed: 1000 r/min or less) and in one direction, you should contact our branch office as it may cause lubrication problems.
3. 关于组合型的润滑脂泄漏
虽然组合型已在设计构造时针对润滑脂泄漏采取了相应的措施，但请根据使用环境进行密封机构的强化。
Grease leakage of unit type
Although appropriate measures are applied in unit structure design to deal with grease leakage, please strengthen the sealing mechanism depending on operation conditions.

■ “壳体内壁推荐尺寸”、“涂沫要领”、“涂沫量”请参照各系列的设计指南相关章节。

See the corresponding pages of the design guide of each series for “Recommended dimensions of the inner wall of the case,” “Coating guide” and “Application quantity.”

Harmonic润滑脂4B No.2的使用注意事项 Precaution for using Harmonic grease 4B No.2

运用Harmonic润滑脂4B No.2所具备的适合Harmonic Drive的流动特性（通过剪应力软化和电解着色均匀性），并通过实施下述项目提升润滑寿命。

Based on the fluid characteristic (by means of shearing stress softening and regular electrolytic coloring) of Harmonic grease 4B No.2 which suited to HarmonicDrive, carry out the following operations to increase lubricant lifespan.

- ①向运转初期的各接触部切实涂抹润滑脂
Apply grease on contacting parts during initial running stage
- ②除去各接触部密封阶段产生的初期磨损粉末
Remove the initial abrasion powder from contacting parts during sealing stage
- ③为接触部补充涂抹润滑脂
Reapply grease on contacting parts

■实施上述机构作业时的注意事项

Precaution for performing the mechanism operations above

- ①填充润滑脂时
When applying grease

保管容器中的4B No.2润滑脂随着静置时间的延长粘稠度会变硬。

填充前，请将保管容器内的润滑脂充分混合使其变软，然后再进行填充。

The 4B No.2 grease in container will become harder as its static placing time extends.

Please mix the grease intensively to make it soft before applying.

- ②关于老化处理（密封运转）

On aging treatment (sealing running)

通过真正运转前实施老化处理，可以使填充的润滑脂变软，令润滑脂流动至Harmonic Drive的各接触部，从而获得更好的润滑性能。

因此，推荐使用以下老化处理方法。

With the real aging handling before running, the grease becomes soft and flows to every contacting part of HarmonicDrive so as to perform its higher lubricity. Therefore, it is recommended to use the following aging treatment method.

- 请确保内部温度低于80℃（不可实施急剧的高温老化处理）。
Make sure the internal temperature is lower than 80℃ (rapid high-temperature aging treatment is not allowed).
- 输入转数：转数为1000r/min~3000r/min，在左示范围内，以尽可能低的转数运转将获得良好的效果。
Input revolution: 1000r/min~3000r/min. With possible lower revolution within this range, the effect is better.
- 老化处理时间：请保持20分钟以上。
Aging treatment time: keep it more than 20 minutes.
- 老化处理动作范围：请尽可能扩大输出旋转角。
Operation region of aging treatment: expand its output rotating angle as much as possible.

如有其它不清楚之处，请咨询授权代理商。

Contact us if you have other questions.

油润滑剂 Oil lubricant

■润滑油的种类

Types of oil

标准指定润滑油为『工业用齿轮油2种（极压）ISO VG68』。

市场上销售的润滑油推荐使用以下品牌。

The specified standard lubricant is "Industrial gear oil class-2 (extreme pressure) ISO VG68."

We recommend the following brands as a commercial lubricant.

表018-1
Table 018-1

标准 Standard	美孚石油 Mobil Oil	埃索 ESSO	昭和壳牌石油 Showa Shell	科斯莫石油 COSMO Oil	日本能源 Japan Energy	新日本石油 NIPPON Oil	出光兴产 Idemitsu Kosan	General石油 General Oil	NOK克鲁勃 KOK KLUBER
工业用齿轮油2种 (极压) Industrial gear oil class-2 (extreme pressure) ISO VG68	美孚齿轮油 Mobil gear 600XP68	SPARTAN EP68	奥玛拉润滑油 Omala Oil 68	科斯莫齿轮油 Cosmo gear SE68	ES齿轮油 ES gear G68	Bonnok M68 Bonnok AX68	出光兴产齿轮油 Daphne super gear LW68	General石油 General Oil SP齿轮 SP gear ROL68	Sintesso D-68EP

■润滑油更换时间

When to replace oil

第一次.....运转开始后100小时

First time 100 hours after starting operation

第二次以后.....每运转1000小时或每6个月

Second time or after Every 1000 operation hours or every 6 months

但是，使用条件恶劣时请提前更换。

Note that you should replace the oil earlier than specified if the operating condition is demanding.

■“油面位置”“柔轮的油槽加工尺寸”“油量”请参照各系列的设计指南相关页面。

See the corresponding pages of the design guide of each series for "Oil level," "Oil groove working size of the flexspline" and "Oil quantity."

■其他注意事项

Other precautions

1. 请避免与其他润滑油混用。此外，组装到装置上时请将Harmonic Drive置于单独的壳体内。

Avoid using it with other grease. HarmonicDrive should be put in an independent case to be built into the equipment.

2. 型号50以上、在额定表容许输入转速附近使用时，根据使用条件的不同可能会发生润滑不良的情况，此时请咨询授权代理商。

When you use model number 50 or upper level at around the permissible input rotational speed from the ratings, you should contact our branch office as it may cause lubrication problems.

特殊气体环境用润滑剂 Lubricant for special environments

工况温度特殊时（处于表016-2“使用工况温度范围”以外），在选择润滑剂时请考虑下述润滑剂的使用温度范围以及使用条件。

When the ambient temperature is special (except the "temperature range of the operating environment" on Page 016-2), you should select a lubricant taking the operating temperature range shown below into consideration.

Harmonic润滑脂4B No.2
Harmonic grease 4B No.2表019-1
Table 019-1

润滑的种类 Type of lubricant	使用温度范围 Operating temperature range	使用可能温度范围 Available temperature range
润滑脂 Grease	-10℃~+110℃	-50℃~+130℃

高温用润滑剂

High temperature lubricant

表019-2
Table 019-2

润滑的种类 Type of lubricant	润滑剂和制造商 Lubricant and manufacturer	使用可能温度范围 Available temperature range
润滑脂 Grease	美孚润滑脂28: 美孚石油 (株) Mobil grease 28: Mobil Oil	-5℃~+160℃
油液 Oil	美孚SHC-626: 美孚石油 (株) Mobil SHC-626: Mobil Oil	-5℃~+140℃

低温用润滑剂

Low temperature lubricant

表019-3
Table 019-3

润滑的种类 Type of lubricant	润滑剂和制造商 Lubricant and manufacturer	使用可能温度范围 Available temperature range
润滑脂 Grease	Multemp SH-KII: 协同油脂 (株) Maltemp SH-KII: Kyodo Oil	-30℃~+50℃
	ISOFLEX LDS-18 Special A: NOK克鲁勃 Isoflex LDS18 special: NOK KLUBER	-25℃~+80℃
油液 Oil	SH-200-100CS: TORAY (株) SH-200-100CS: Toray Silicon	-40℃~+140℃
	Sintesso D-32EP: NOK克鲁勃 Sintesso D-32EP: NOK KLUBER	-25℃~+90℃

- Harmonic润滑脂4B NO.2的使用温度范围是考虑Harmonic Drive的性能及特性确定的润滑部温度。（不是工况温度。）

The operating temperature range of Harmonic grease 4B No.2 is the temperature at the lubricating section with the performance and characteristics of Harmonic Drive taken into consideration. (It is not ambient temperature.)

- 使用可能温度范围是指润滑剂单独使用的温度，会受Harmonic Drive的运转条件（负载转矩、转速、运转周期等）限制。此外，当工况温度为极度低温或极度高温时，需要对Harmonic Drive各部分的材质进行重新考虑，届时请咨询授权代理商。

As the available temperature range indicates the temperature of the independent lubricant, restriction is added on operating conditions (such as load torque, rotational speed and operating cycle) of Harmonic Drive. When the ambient temperature is very high or low, the materials of the parts of Harmonic Drive need to be reviewed. Contact us in this case.

- 如果能考虑到Harmonic润滑脂4B No.2在低温时会由于粘度上升导致Harmonic Drive的运转转矩增加、高温时会由于酸化劣化缩短润滑脂使用寿命，那么可以在使用可能温度范围内使用。

You can use Harmonic grease 4B No.2 in the available temperature range if you consider increase in the running torque of Harmonic Drive due to increase in viscosity at low temperature and the grease life due to oxidization and deterioration at high temperature.

在伺服系统中，驱动系的刚性、齿隙会对系统的性能产生较大影响。在装置设计及型号选定时，有必要针对这些项目进行详细的研究。Rigidity and backlash of the drive system greatly affects the performance of the servo system. A detailed review of these items is required before designing the equipment and selecting a model number.

刚性 Rigidity

将输入侧（波发生器）固定，向输出侧（柔轮）施加转矩后，输出轴会产生几乎与转矩呈正比的扭转。

图020-1是根据在输出轴上施加的转矩从0开始，在正负侧分别增减到 $+T_0/-T_0$ 时输出侧的扭转角变化绘制而成的。将其称为“转矩-扭转角线形图”，通常描绘为0-A-B-A'-B'-A的环线。对于Harmonic Drive的刚性，“转矩-扭转角线形图”的倾斜程度即表述为弹簧常数。（单位：Nm/rad）

如图020-2所示，将该“转矩-扭转角线形图”分为3个区间，各区间时的弹簧常数分别表述为 K_1 、 K_2 、 K_3 。

Fixing the input side (wave generator) and applying torque to the output side (flexspline) generates torsion almost proportional to the torque on the output side.

Figure 020-1 shows the torsional angle quantity on the output side when the torque applied on the output side starts from zero, increases up to $+T_0$ and decreases down to $-T_0$. This is called the "Torque - torsional angle diagram," which normally draws a loop of 0-A-B-A'-B'-A. The slope described in the "Torque - torsional angle diagram" is represented as the spring constant for the rigidity of Harmonic Drive (unit: Nm/rad).

As shown in Figure 020-2, this "Torque - torsional angle diagram" is divided into 3 partitions, and the spring constants in the area are represented as K_1 , K_2 and K_3 .

K_1 ……转矩从“0”至“ T_1 ”的弹簧常数

The spring constant when the torque changes from [zero] to [T_1]

K_2 ……转矩从“ T_1 ”至“ T_2 ”的弹簧常数

The spring constant when the torque changes from [T_1] to [T_2]

K_3 ……转矩在“ T_2 ”以上区间的弹簧常数

The spring constant when the torque changes from [T_2] to [T_3]

■各弹簧常数（ K_1 、 K_2 、 K_3 ）的数值以及转矩-扭转角（ T_1 、 T_2 — θ_1 、 θ_2 ）的数值请参见各系列的相关章节。

See the corresponding pages of each series for values of the spring constants (K_1 , K_2 , K_3) and the torque-torsional angles (T_1 , T_2 — θ_1 , θ_2).

扭转量的计算示例

Example of calculating torsional quantity

以CSF-25-100-2A-GR为例，计算出扭转量（ θ ）。

The torsional quantity (θ) is obtained from the example of CSF-25-100-2A-GR.

负载转矩极小 $T_{L1}=2.9\text{Nm}$ 时 When the load torque is extremely small ($T_{L1}=2.9\text{Nm}$)

由于转矩为 T_1 以下，因此扭转量 θ_{L1} 的计算公式如下所示，As the torque is T_1 or less, torsional quantity θ_{L1} is represented as follows.

$$\theta_{L1} = T_{L1}/K_1$$

$$= 2.9/3.1 \times 10^4$$

$$= 9.4 \times 10^{-5} \text{rad} (0.33 \text{arc min})$$

负载转矩为 $T_{L2}=39\text{Nm}$ 时 When the load torque is $T_{L2}=39\text{Nm}$

由于转矩处于 T_1 和 T_2 之间，扭转量 θ_{L2} 的计算公式如下所示，As the torque between T_1 and T_2 , torsional quantity θ_{L2} is represented as follows.

$$\theta_{L2} = \theta_1 + (T_{L2} - T_1)/K_2$$

$$= 4.4 \times 10^{-4} + (39 - 14)/5.0 \times 10^4$$

$$= 9.4 \times 10^{-4} \text{rad} (3.2 \text{arc min})$$

此外，正反施加负载时的总扭转量为上述所求得的数值的2倍，加上齿隙量的值。

The total torsional quantity when the load is applied the other way round will be double the quantity obtained above plus the backlash quantity.

※这一扭转量是组件型单机的数值。

请注意此时不包括输出轴等的扭转量。

The torsional quantity indicates the value of the stand-alone component.

Note that the torsional quantity of the output shaft is not included.

滞后损失

Hysteresis loss

如图020-1的线形图所示，施加转矩直至达到额定转矩后，转矩恢复为“0”时，扭转角将不会完全变为“0”，会留有细微的间隙量（B—B'）。

这个间隙量被称为滞后损失。

As shown in Figure 020-1, when the torque is applied up to the rated value and is brought back to [zero], the torsional angle does not become absolutely [zero] and a small amount remains. This is called hysteresis loss.

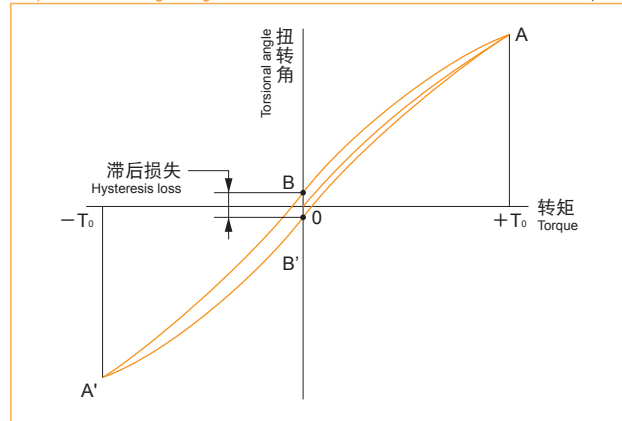
■齿滞后损失量请参见各系列的相关章节。

See the corresponding pages of each series for hysteresis loss quantity.

转矩-扭转角线形图

Torque - torsional angle diagram

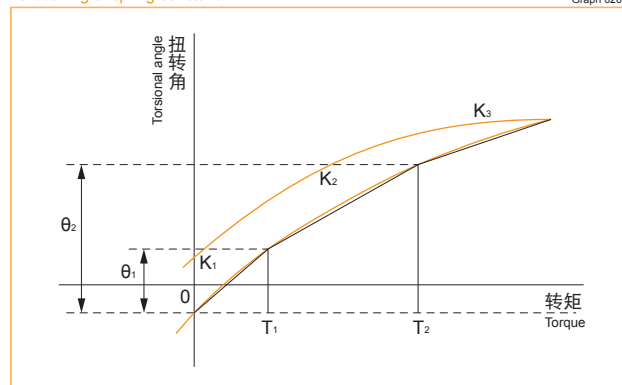
图020-1
Graph 020-1



弹簧常数的分类

Partitioning of spring constant

图020-2
Graph 020-2



齿隙

Backlash

滞后损失主要由于内部摩擦产生，因此转矩极小的情况下几乎不存在滞后损失，仅有的细微间隙由线形图表示。该量即表述为齿隙量。

由于Harmonic Drive齿轮啮合部的间隙控制为“0”，因此齿隙量是指波发生器的欧式联轴节（自动调芯机构）产生的间隙。如各系列的相关页面所示，固定住输入侧、在输出侧测定的值是极其微小的。

As hysteresis loss is mainly generated by internal abrasion, it is hardly generated, and only a small allowance is represented in the diagram when the torque is extremely small.

As the allowance of the tooth engagement is suppressed to [zero] for Harmonic Drive, the backlash quantity is caused by the clearance of Oldham's coupling (self-aligning mechanism) of the wave generator. The value measured on the output side by fixing the input side is very small as shown on the corresponding page of each series.

※齿隙量请参见各系列的相关章节。

See the corresponding pages of each series for the backlash quantity.

角度传达精度 Angle transmission accuracy

角度传达精度是指将任意的旋转角传递至输入时，理论上旋转输出的旋转角度与实际旋转输出的旋转角度之间的差值，即角度传达误差。
Angle transmission accuracy indicates the difference between the logical rotating angle and the actual rotating angle as the angle transmission error when any rotating angle is given as an input.

■角度传达精度的数值请参见各系列的相关章节。

See the corresponding pages of each series for angle transmission accuracy values.

测定示例

Example of measurement

图021-1
Graph 021-1

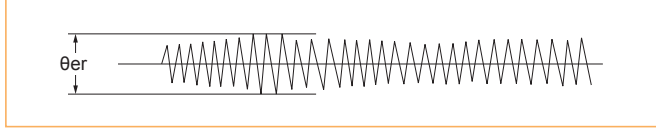


表021-1
Table 021-1

θ_{er}	角度传达误差 Angle transmission error
θ_1	输入旋转角度 Input rotating angle
θ_2	实际输出旋转角度 Actual output rotating angle
R	Harmonic Drive的减速比 ($i=1:R$) Reduction ratio of Harmonic Drive ($i=1:R$)

公式021-1
Formula 021-1

$$\theta_{er} = \theta_2 - \frac{\theta_1}{R}$$

关于振动 On vibration

Harmonic Drive的角度传达误差成分有时会作为负载侧惯量的旋转振动出现。

特别是由于包括Harmonic Drive在内的振动系的固有振动数和机箱或负载惯量的固有振动数互相重叠作用时会呈现出共振状态，Harmonic Drive的角度传达误差成分将会被放大增加，因此请严格遵守各系列的设计指南。

The angle transmission error elements of Harmonic Drive may appear as rotating vibration of the load side inertia.

Especially when the characteristic frequency of the vibration system including Harmonic Drive overlaps that of the chassis or load inertia, it generates a resonant condition that amplifies angle transmission error elements of Harmonic Drive. Observe the design guide of each series.

此外，Harmonic Drive的角度传达误差成分主要是指输入轴自Harmonic Drive机构上方每旋转1次产生2次的误差成分。因此，误差主要成分的频率是输入频率的2倍。

Two angle transmission error elements of Harmonic Drive correspond to a cycle of the input shaft from the mechanical viewpoint of Harmonic Drive. Therefore, the frequency is double the input frequency as it is the main element of the error.

假设包括Harmonic Drive在内的振动系的固有振动数为 $f=15\text{Hz}$ ，则此时的输入转速 (N) 为

If the characteristic frequency of the vibration system including Harmonic Drive is $F=15\text{ Hz}$, the input rotating speed (N) is expressed as shown below.

公式021-2
Formula 021-2

$$N = \frac{15}{2} \cdot 60 = 450\text{r/min}$$

此转速区间 (450r/min) 内将发生共振。

The resonant condition is generated in the rotating speed area (450 r/min).

包括Harmonic Drive在内的振动系固有振动数的计算方法 (概要)
How to obtain the characteristic frequency of the vibration system including Harmonic Drive

公式021-3
Formula 021-3

$$f = \frac{1}{2\pi} \sqrt{\frac{K}{J}}$$

计算公式的符号

Symbol of the calculation formula

表021-2
Table 021-2

f	包括Harmonic Drive在内的振动系的固有振动数 The characteristic frequency of the vibration system including Harmonic Drive	Hz	
K	Harmonic Drive的弹簧常数 Spring constant of Harmonic Drive	Nm/rad	参照各系列的相关章节 See pages of each series.
J	负载惯量 Load inertia	kgm ²	

关于起动转矩 On starting torque

起动转矩是指将Harmonic Drive组装至壳体，向输入侧（高速侧）施加转矩时，输出侧（低速侧）开始旋转一瞬间产生的“起动开始转矩”。各系列表上所示的数值为最大值，下限值约为最大值的 $1/2 \sim 1/3$ 。
Starting torque means the instantaneous "starting torque" with which the output side (low-speed side) starts rotation when a torque is applied on the input side (high-speed side) of Harmonic Drive built into the case. The values in the table of each series indicate the maximum value, and the lower-limit value indicates approximately $1/2$ - $1/3$ of the maximum value.

测定条件 无负载，环境温度：+20℃
Measuring condition: No-load, ambient temperature: +20℃

■ 起动转矩的数值请参见各系列的相关章节。
See the corresponding pages of each series for starting torque values.

※ 各系列表上数值会根据使用条件的不同而发生变化，请作为参考值使用。
Use the values in the table of each series as reference values as they vary depending on the usage conditions.

关于增速起动转矩 On overdrive starting torque

增速起动转矩是指将 Harmonic Drive 组装至壳体，向输出侧（低速侧）施加转矩时，输入侧（高速侧）开始旋转一瞬间产生的“起动开始转矩”。各系列表上所示的数值为最大值，下限值约为最大值的 $1/2$ 。
Overdrive starting torque means the instantaneous "starting torque" with which the input side (high-speed side) starts rotation when a torque is applied on the output side (low-speed side) of Harmonic Drive built into the case. The values in the table of each series indicate the maximum value, and the lower-limit value indicates approximately $1/2$ of the maximum value.

测定条件 无负载，环境温度：+20℃
Measuring condition: No-load, ambient temperature: +20℃

■ 增速起动转矩的数值请参见各系列的相关章节。
See the corresponding pages of each series for starting torque values.

※ 各系列表上数值会根据使用条件的不同而发生变化，请作为参考值使用。
Use the values in the table of each series as reference values as they vary depending on the usage conditions.

无负载运行转矩 On no-load running torque

无负载运行转矩是指在无负载状态下，使Harmonic Drive转动的必要的输入侧（高速轴侧）转矩。本产品目录上所示的无负载运行转矩的图表是根据表023-1测定条件确定的。

关于100以外的减速比，请加上各系列所示的修正量进行计算。

No-load running torque means the torque required to put Harmonic Drive under a no-load condition. The graph of the no-load running torque shown in this catalog depends on the measuring condition shown in Table 023-1.

Add the correction values shown by each series to all reduction ratios except those of 100.

■无负载运行转矩的数值请参见各系列的相关章节。

See the corresponding pages of on each series for no-load running torque values.

测定条件

Measuring condition

表023-1
Table 023-1

减速比100 Reduction ratio			
润滑条件 Lubrication condition	润滑脂润滑 Grease lubrication	名称 Name	Harmonic润滑脂 SK-1A Harmonic grease SK-1A
			Harmonic润滑脂 SK-2 Harmonic grease SK-2
		涂沫量 Application qty.	正确涂沫量（参照各系列的相关章节） Appropriate application qty. (See pages of each series)
转矩值是指在输入为2000r/min的情况下磨合运转2小时以上的数值 The torque value is the value after a trial run for two hours or longer at an input of 2000 r/min.			

※使用油润滑时请咨询授权代理商。

Contact us for oil lubrication.

效率特性 Efficiency characteristics

效率会因以下条件而有所差异。

The efficiency varies depending on the following conditions.

■减速比

Reduction ratio

■输入转速

Input rotational speed

■负载转矩

Load torque

■温度

Temperature

■润滑条件（润滑的种类及其使用量）

Lubrication condition (Type of lubricant and the quantity)

本产品目录上所示的各系列效率特性是根据表023-2测定条件确定的。

The efficiency characteristics of each series shown in this catalog depends on the measuring condition shown in Table on the table 023-2.

■效率的数值请参照各系列的相关章节。

See the corresponding pages of on each series for efficiency values.

测定条件

Measuring condition

表023-2
Table 023-2

组装 Built-in	推荐组装精度下的组装测定 Measurement by building the recommended built-in precision into the product		
负载转矩 Load torque	额定表所示的额定转矩（参照各系列的相关章节） The rated torque shown in the ratings (see the corresponding pages on each series)		
润滑条件 Lubricating condition	润滑脂润滑 Grease lubrication	名称 Name	Harmonic润滑脂 SK-1A Harmonic grease SK-1A
			Harmonic润滑脂 SK-2 Harmonic grease SK-2
		涂沫量 Application qty.	正确涂沫量（参照各系列的相关章节） Appropriate application qty. (see the pages on each series)

※使用油润滑时请咨询授权代理商。

Contact us for oil lubrication.

■效率修正系数

Efficiency correction coefficient

负载转矩小于额定转矩时，效率值降低。

请根据各系列的效率修正系数表计算出修正系数 K_e ，并参考以下计算示例计算出效率。

If the load torque is smaller than the rated torque, the efficiency value lowers. Obtain correction coefficient K_e from the efficiency correction coefficient graph of each series to obtain the efficiency using the following example of calculation.

计算示例 Example of calculation

以CSF-20-80-2UH为例，计算出以下条件下的效率 η (%)。

输入转速：1000r/min

负载转矩19.6Nm

润滑方法：润滑脂润滑（Harmonic润滑脂 SK-1A）

润滑剂温度：20℃

型号20·减速比80的额定转矩为34Nm（额定表：第037页），因此转矩比 α 为0.58。（ $\alpha = 19.6/34 = 0.58$ ）

Efficiency η (%) under the following condition is obtained from the example of CSF-20-80-2UH.

Input rotational speed: 1000 r/min

Load torque: 19.6 Nm

Lubrication method: Grease lubrication (Harmonic grease SK-1A)

Lubricant temperature: 20℃

Since the rated torque of model number 20 with a reduction ratio of 80 is 34 Nm (Ratings: Page 037), the torque ratio α is 0.58. ($\alpha = 19.6/34 = 0.58$)

■根据表023-1，计算出效率修正系数 $K_e = 0.93$

The efficiency correction coefficient is $K_e = 0.93$ from Graph 023-1.

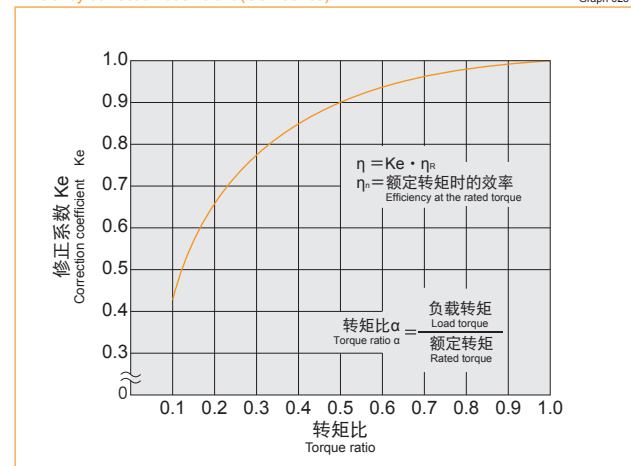
■负载转矩为19.6Nm时的效率 $\eta = K_e \cdot \eta_R = 0.93 \times 78 = 73\%$ 。

Efficiency η at load torque 19.6 Nm: $\eta = K_e \cdot \eta_R = 0.93 \times 78 = 73\%$

效率修正系数（CSF系列）

Efficiency correction coefficient (CSF series)

图023-1
Graph 023-1



※负载转矩大于额定转矩时的效率修正系数 $K_e = 1$

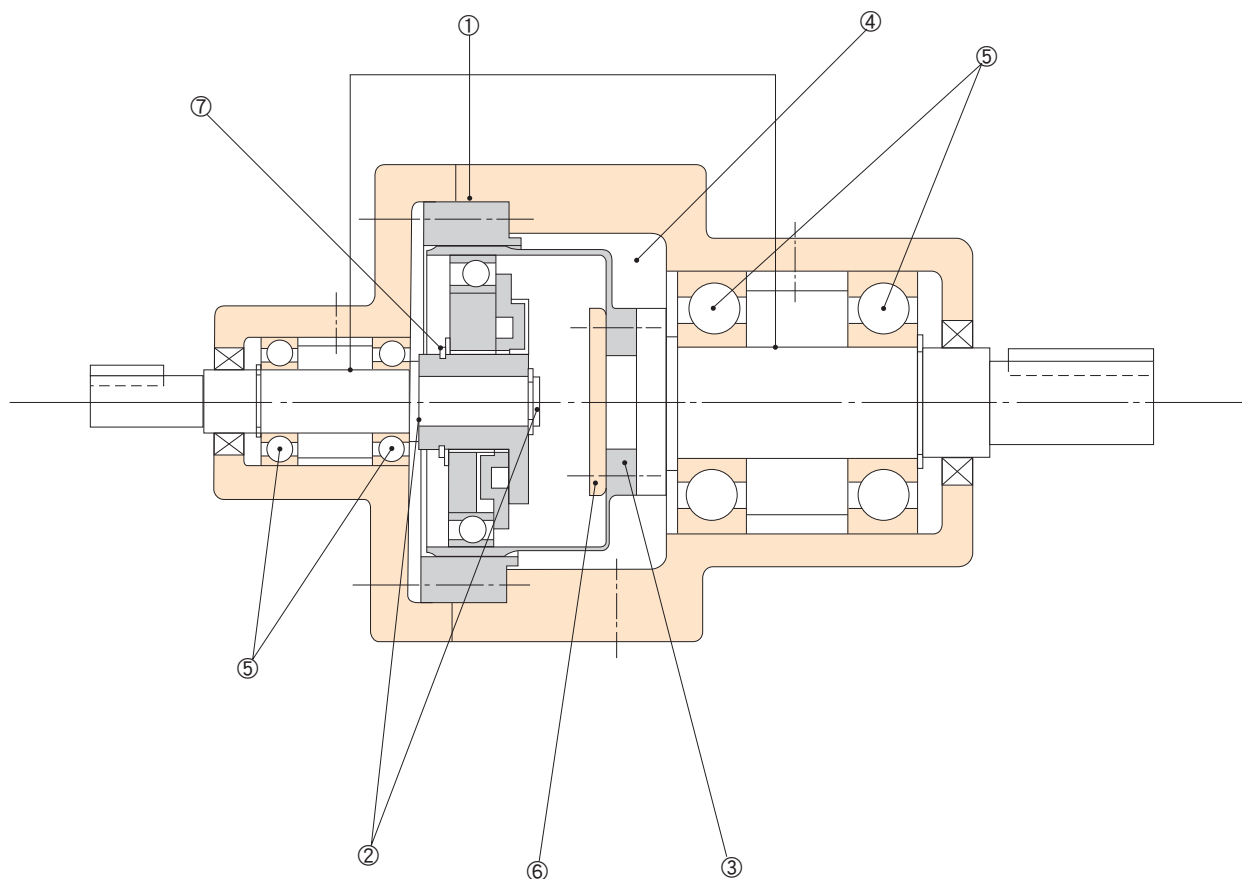
Efficiency correction coefficient $K_e = 1$ holds when the load torque is greater than the rated torque.

设计指南 Design guideline

为充分发挥Harmonic Drive的性能，请注意以下几点。
Pay attention to the following points to bring out the performance of Harmonic Drive.

- ① 请将输入轴、刚轮、输出轴及壳体设为同心。
The input shaft, the circular spline, the output shaft and the case shall be concentric.
- ② 波发生器上会发生细微的轴向力，因此需要阻止轴向动作。
As thrust force is generated to a small degree on the wave generator, movement in the shaft direction should be stopped.
- ③ 由于Harmonic Drive是一种小型、且能传递较大转矩的装置，因此请对连接柔轮和输出轴的螺栓部采取相适应的拧紧转矩进行紧固。
Even though Harmonic Drive is compact, it transmits a large torque. Therefore, join the flexspline and the output shaft with a bolt and compatible tightening torque.
- ④ 柔轮会发生弹性形变，因此壳体内壁的尺寸请按照推荐尺寸设计。
As the flexspline is subject to elastic distortion, the recommended size should be applied to the inner wall of the case.
- ⑤ 输入轴和输出轴必须采用匹配的轴承留有间隔做2点支撑，并可承受轴上作动的所有径向负载、轴向负载的结构，请不要向波发生器和柔轮施加多余的力。
The input shaft and the output shaft should be supported with two points with appropriate bearing space. It should be structured to bear all radial loads and thrust loads so that no extra force is applied to the wave generator and the flexspline.
- ⑥ 请确保柔轮的安装法兰直径不会超出柔轮的轮毂孔直径，并在与膜片连接的法兰部上加工圆角。各部分的尺寸请按照推荐尺寸设计。
The mounting flange diameter of the flexspline shall not exceed the boss diameter of the flexspline. Attach "R" on the flange that is in contact with the diaphragm. Use the recommended size for parts.
- ⑦ 使用C型卡环固定波发生器轮毂，请确保卡环的钩部不会与壳体接触。
A C-type retaining ring is used to hold the hub of the wave generator. The hook of the retaining ring shall not interfere with the case.

图024-1
Fig. 024-1



输入输出轴的轴承支撑 Bearing support of the input and output shafts

图025-1
Fig. 025-1

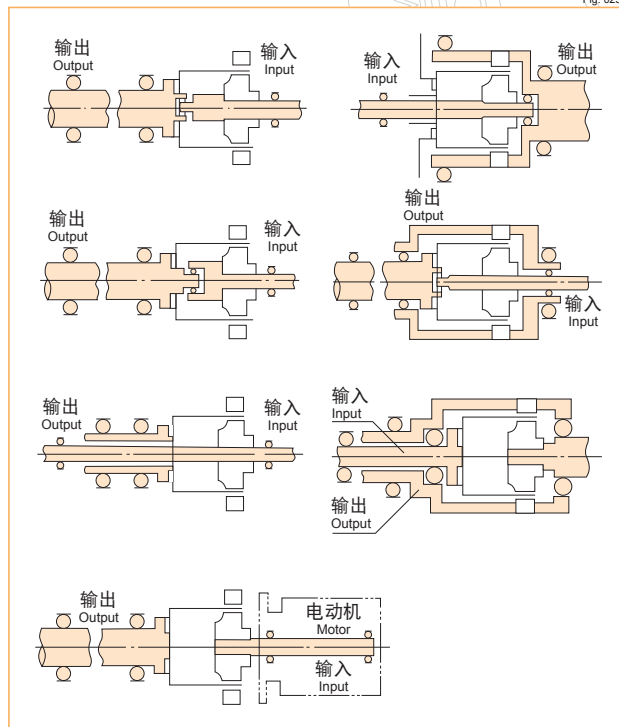
由于组件型会承受来自外部的负载，因此输入轴和输出轴必须采用匹配的轴承留有间隔做2点支撑，并可承受轴上作动的所有径向负载、轴向负载的结构，请不要向波发生器和柔轮施加多余的力。此外，为消除轴承间隙，请使用向径向及轴向加过压的轴承。

图025-1所示的是轴承的配置示例。

As the component type endures external load, the input shaft and the output shaft should be supported with two points with appropriate bearing space. It should be structured to bear all radial loads and thrust loads so that no extra force is applied to the wave generator and the flexspline.

Use the bearing pressurized to the radial and thrust directions to remove the gap.

An example of bearing layout is shown in Figure 025-1.



关于波发生器 On the wave generator

■波发生器的结构

Structure of the wave generator

Harmonic Drive的波发生器包括带自动调芯结构的欧式联轴节型和不带自动调芯结构的一体型两种类型，根据各系列的不同也有所差异。详情请参照各系列的外形图。

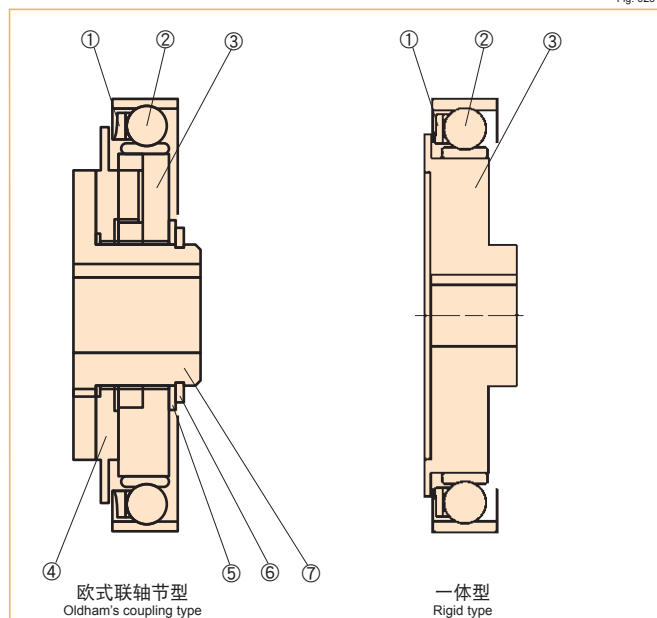
波发生器的基本结构及形状如下所示。

The wave generators of Harmonic Drive include an Oldham's coupling type with a self-aligning structure and an integrated rigid type without a self-aligning structure, and which is used depends on the series.

See the diagram of the appearance of each series for details.

The basic structure of the wave generator and the shape are shown below.

图026-1
Fig. 026-1

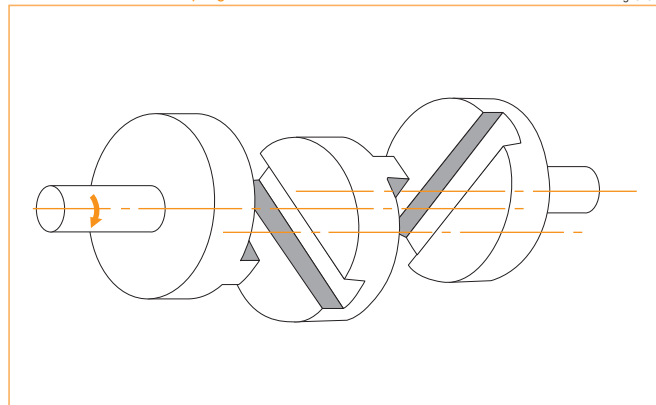


- ① 轴承保持架
Retainer
- ② 波发生器轴承
Wave generator bearing
- ③ 波发生器凸轮
Wave generator plug
- ④ 镶块
Insert
- ⑤ 摩擦垫圈
Rubwasher®
- ⑥ C型卡环
C-type retaining ring
- ⑦ 波发生器轮毂
Wave generator hub

欧式联轴节的结构

Structure of Oldham's coupling

图026-2
Fig. 026-2



■ 组件型的最大孔径尺寸

Maximum hole diameter size of the component type

波发生器的标准孔径如各外形尺寸图所示，但可以在表上所示的最大尺寸范围内进行变更。

此时的键槽尺寸推荐使用JIS规格。键的有效长度尺寸，请设计成可以完全承受传达转矩的值。

The standard hole diameter of the wave generator is as shown in the dimensional outline drawing and may be changed in the range up to the maximum dimension shown in the table.

The JIS standard is recommended for the key groove size. The valid length of the key shall be the value fully durable for the transmission torque.

※形状可更改为锥形孔等特殊形状。

The shape can be changed into special forms for taper holes and so on.

希望孔径大于最大尺寸时，可采用拆除欧氏联轴节机构的方法。

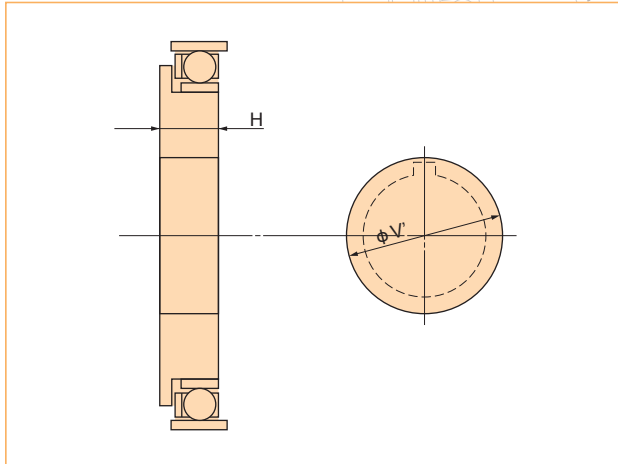
考虑由于负载转矩作用波发生器凸轮发生变形等情况，此时最大孔径的值如下表所示。（这个数值是包含键槽深度等尺寸的数值。）

Oldham's coupling mechanism may be eliminated to make a hole diameter larger than the maximum size.

The maximum hole diameter can be up to the value shown in the table below taking deformation of the wave generator plug by load torque into consideration. (This is the value including the dimension of the key groove depth.)

波发生器的孔径

Hole diameter of the wave generator

图027-1
Fig. 027-1表027-1
Table 027-1
单位: mm
Unit: mm

波发生器轮毂的孔径

Hole diameter of the wave generator hub

型号 Model number	8	11	14	17	20	25	32	40	45	50	58	65	80	90	100
标准尺寸 (H7) Standard dim. (H7)	3	5	6	8	9	11	14	14	19	19	22	24	28	28	28
底孔尺寸 Prepared hole size	—	—	3	4	5	6	6	10	10	10	13	16	16	19	22
最大尺寸 Maximum size	—	—	8	10	13	15	15	20	20	20	25	30	35	37	40

将波发生器凸轮直接安装至输入轴时凸轮的最大孔径

Plug maximum diameter of installing the wave generator plug directly on the input shaft

表027-2
Table 027-2
单位: mm
Unit: mm

型号 Model number	8	11	14	17	20	25	32	40	45	50	58	65	80	90	100
最大孔径 φV' Max. hole dia. φV'	10	14	17	20	23	28	36	42	47	52	60	67	72	84	95
最小凸轮厚度 Min. plug thick. 0 -0.1	5.7	6.7	7.2	7.6	11.3	11.3	13.7	15.9	17.8	19	21.4	23.5	28.5	31.3	34.9

■ 波发生器的轴向力与轴的固定

Thrust force of the wave generator and shaft fixation

由于柔轮的弹性变形，运转中Harmonic Drive的波发生器上轴向力发生作动。作为减速机（第008页的①、②、③）使用时的轴向力向柔轮膜片方向作动。（图052-2）

此外，作为增速机（第008页的④、⑤、⑥）使用的轴向力向与减速机相反的方向作动。（图052-2）

波发生器轴向力（最大值）可通过下述计算公式计算得出。此外，轴向力会根据运转条件的不同而发生变化。高转矩时、极低速时以及固定连续旋转时显示轴向力有变大的倾向，基本为计算公式计算出的数值。无论在何种使用条件下，都请采用阻止波发生器轴向力的设计。

Thrust force is applied on the wave generator during operation due to elastic deformation of the flexspline of Harmonic Drive.

The thrust force used as a reducer (①, ② and ③ on Page 008) works in the diaphragm direction of the flexspline (Figure 052-2), while the thrust force used as an overdrive (④, ⑤ and ⑥ on Page 008) works in the opposite direction (Figure 052-2).

You can obtain the thrust force (maximum value) of the wave generator with the following calculation formula. Thrust force varies depending on the operating condition. It tends to increase and shows almost the same value as that obtained by the calculation formula when the torque is high, when the speed is very low and when the rotation is constant and continuous. Work out a design to eliminate the thrust force of the wave generator in either case.

(注)

在波发生器轮毂设置止动螺钉并与输入轴固定时，请务必咨询授权代理商。

(Note)

Contact us when you fix the wave generator hub and the input shaft with a retaining screw.

轴向力的计算公式

Calculation formula of thrust force

表027-3
Table 027-3

减速比 Reduction ratio	计算公式 Calculation formula
30	$F = 2 \times \frac{T}{D} \times 0.07 \times \tan 32^\circ$
50	$F = 2 \times \frac{T}{D} \times 0.07 \times \tan 30^\circ$
80以上 80 or more	$F = 2 \times \frac{T}{D} \times 0.07 \times \tan 20^\circ$

计算公式的符号

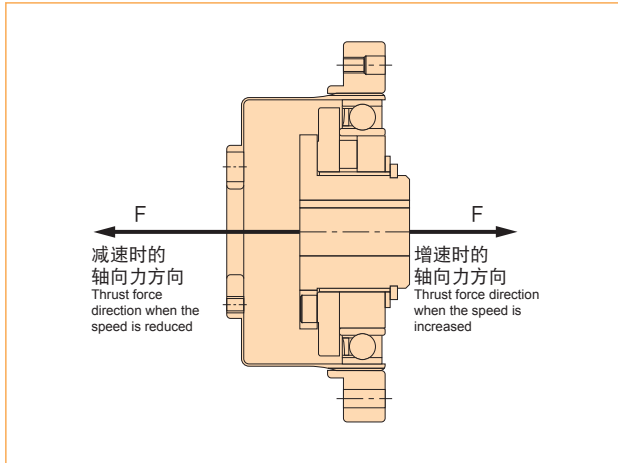
Symbols of the calculation formula

表027-4
Table 027-4

F	轴向力 Thrust force	N	参照图027-2 See Figure 027-2
D	(型号) × 0.00254 (Model Number) × 0.00254	m	
T	输出转矩 Output torque	Nm	

波发生器的轴向力方向

Thrust force direction of the wave generator

图027-2
Fig. 027-2

计算示例

Example of calculation

公式027-1
Formula 027-1

机型名称: CSF系列

Model name: CSF series

型号: 32

Model number: 32

减速比: 50

Reduction ratio: 50

输出转矩: 382Nm (瞬间容许最大转矩)

Output torque: 382 Nm (maximum permissible momentary torque)

$$F = 2 \times \frac{382}{(32 \times 0.00254)} \times 0.07 \times \tan 30^\circ$$

$$F = 380N$$

密封机构 Sealing mechanism

为防止润滑脂泄漏，以及维持HarmonicDrive的高耐久性，必须使用以下密封机构。
The following sealing mechanism is required to prevent grease leakage and maintain the high durability of HarmonicDrive.

- 旋转运动部 油封（弹簧嵌入式）。此时，请注意轴侧是否存在划痕等。
Rotating and sliding area Oil seal (with a spring). Take care regarding flaws on the shaft.
- 法兰装配面、嵌合 O型环、密封剂。此时请注意平面是否歪斜以及O形环的啮合情况。
Flange mating face and mating O-ring and seal agent. Take care regarding distortion on the plane and how the O-ring is engaged.
- 螺孔部 使用有密封效果的螺钉锁固剂（推荐使用Loctite 242）或密封胶带。
Screw hole area Use a screw lock agent (Loctite 242 is recommended) or seal tape.

（注）特别是使用Harmonic润滑脂4B No.2时，请严格执行上述事项。

(Note) Observe the description above for the particular use of Harmonic grease 4B No.2.

组合型的密封部位和推荐密封方法

Sealing area and the recommended sealing method for the unit type

表028-1

Table 028-1

必要密封部位 Area requiring sealing		推荐密封方法 Recommended sealing method
输出侧 Output side	输出法兰中央的贯穿孔以及输出法兰装配面 Pass-through hole in the center of the output flange and the output flange mating face	使用O型环（附本公司产品） Use O-ring (attached to our product)
	安装螺钉部 Spanner screw area	有密封效果的螺钉锁固剂（推荐使用Loctite 242） Screw lock agent with sealing effect (Loctite 242 is recommended)
输入侧 Input side	法兰装配面 Flange mating face	使用O型环（附本公司产品） Use O-ring (attached to our product)
	电动机输出轴 Motor output shaft	请选用带油封的。无油封时，请在电动机安装法兰上安装油封。 Select one with an oil seal. Those without an oil seal should be structured so that an oil seal is attached to the motor mounting flange.

组装注意事项 Precautions on assembly

由于组装时的错误，Harmonic Drive在运转时可能发生振动、异响等。请遵守下述注意事项实施组装。

HarmonicDrive may generate vibration and abnormal sound due to problems during assembly. Perform assembly based on the following precautions.

波发生器的注意事项

Precautions on the wave generator

- 请在组装时避免向波发生器轴承部位施加过度的力。可通过使波发生器旋转顺畅地实施插入。
Avoid such assembly where excessive force is applied to the wave generator bearing. You can smoothly insert the wave generator by turning it.
- 使用无欧氏联轴节结构的波发生器时，请特别注意把中心偏移、歪斜的影响控制在推荐值内（参照各系列的“组装精度”）。
Pay attention so that the effect of misalignment and turnover is within the recommended value (see "Built-in precision" of each series) for the wave generator without Oldham's coupling mechanism.

刚轮的注意事项

Precautions on the circular spline

- 确认安装面的平坦度是否良好，是否有歪斜。
Is flatness of the mounting surface poor or distorted?
- 确认螺钉孔部是否隆起、有残余毛边或有异物啮入。
Is any embossment of the screw hole area, burr or trapped foreign matter found?
- 确认是否对壳体组装部实施了倒角加工以及避让加工，以避免与刚轮干涉。
Have chamfering and relief working of the corner been conducted to prevent interference of the corner of the circular spline in the house built-in area?
- 当刚轮组装至壳体后，确认其是否能够旋转，是否有些部位存在干涉、卡紧。
Can the circular spline rotate built in the house? Does it interfere with or catch on any part?
- 朝安装用螺栓孔插入螺栓时，确认螺栓孔的位置是否正确、是否由于螺栓孔歪斜加工等原因致使螺栓与刚轮发生接触，使螺栓旋转变沉重。
Does any bolt inserted into the mounting bolt hole interfere with the circular spline and rotate irregularly due to the bolt hole being misaligned or oblique?
- 请不要一次性按照规定转矩拧紧螺栓。请先使用约为规定转矩1/2的力实施暂时拧紧，然后再按照规定转矩拧紧。此外，通常请按照对角线顺序依次拧紧螺栓。
Do not tighten the bolts with the specified torque all at once. Tighten the bolts temporarily with about half the specified torque, and then tighten them with the specified torque. Tighten them in an even, crisscross pattern.
- 向刚轮打销子可能造成旋转精度低下，因此请尽可能避免。
Avoid pinning the circular spline if possible as it may reduce the rotational precision.

柔轮的注意事项

Precautions on the flexspline

- 确认安装面的平坦度是否良好，是否有歪斜。
Is flatness of the mounting surface poor or distorted?
- 确认螺钉孔部是否隆起、有残余毛边或有异物啮入。
Is any embossment of the screw hole area, burr or trapped foreign matter found?
- 确认是否对壳体组装部实施了倒角加工以及避让加工，以避免与柔轮干涉。
Have chamfering and relief working of the corner been conducted to prevent the interference of the corner of the circular spline in the house built-in area?
- 朝安装用螺栓孔插入螺栓时，确认螺栓孔的位置是否正确、是否由于螺栓孔歪斜加工等原因致使螺栓与柔轮发生接触，使螺栓旋转变沉重。
Does any bolt inserted into the mounting bolt hole interfere with the circular spline and rotate irregularly due to the bolt hole being misaligned or oblique?
- 请不要一次性按照规定转矩拧紧螺栓。请先使用约为规定转矩1/2的力实施暂时拧紧，然后再按照规定转矩拧紧。此外，通常请按照对角线顺序依次拧紧螺栓。
Do not tighten the bolts with the specified torque all at once. Tighten the bolts temporarily with about half the specified torque, and then tighten them with the specified torque. Tighten them in an even, crisscross pattern.
- 确认与刚轮组合时，是否存在极端的单侧啮合。发生单侧偏移时，可能是由于两个部件发生中心偏移或歪斜。
Does it engage with the circular spline in an extremely unbalanced way when it is combined? If it is unbalanced, they could be misaligned or not upright.
- 柔轮组装时，请不要叩击开口部的齿轮前端或以过度力实施按压。
Avoid hitting the tip of the teeth on the opening and inserting the circular spline with excessive force in assembling it

关于防锈措施

On anti-rust provision

Harmonic Drive的表面没有实施防锈处理。

需要实施防锈时请向表面涂抹防锈剂。此外，需要本公司实施表面防锈处理时，请咨询授权代理商。

The surface of HarmonicDrive is not anti-rust treated. Apply antirust agent to the surface if required. Contact us if you would like us to provide the surface with anti-rust treatment.

齿轮啮合偏移状态 “dedoi-dal” state

如图029-1所示，柔轮和刚轮的齿轮对称啮合状态为正常状态。但是，当出现如第011页所述的棘爪现象，或把三部件勉强挤压安装在一起时，有可能会出现如图029-2所示的齿轮啮合朝单侧偏移的情况。此时的状态被称为齿轮啮合偏移状态。发生齿轮啮合偏移后如果继续运转，则有可能引起柔轮的早期疲劳破坏，请注意。

It is normal for the flexspline to engage with the circular spline symmetrically as shown in Figure 029-1. However, if the ratcheting phenomenon, which is described on Page 011, is caused or if three parts are forcibly inserted and assembled, engagement of the teeth may be out of alignment as shown in Figure 029-2. This is called “dedoi-dal”. Note that the flexspline will be exhausted and damaged earlier if it continues operating without the problem being fixed.

■ 齿轮啮合偏移的检查方法 How to check “dedoi-dal”

请采用下述方法确认是否发生齿轮啮合偏移。

By performing the following methods, check whether “dedoi-dal” is caused or not.

① 根据转动波发生器时的转矩不均匀性进行判别的方法

Judging by the irregular torque generated when the wave generator turns

- 1) 无负载状态下请用手轻轻转动输入轴。如果使用平均的力即可使其旋转则视为正常。如果存在极为不均匀的情况，则表示有可能发生齿轮啮合偏移。

Lightly turn the input shaft with your hand in a no-load condition. If you can turn it with average force, it is normal. If it turns irregularly, “dedoi-dal” could have been caused.

- 2) 波发生器安装在电动机上时，请在无负载状态下使其旋转。电动机的平均电流值为正常啮合时电流值的约2~3倍时，则表示有可能发生齿轮啮合偏移。

Turn the wave generator in a no-load condition if it is attached to a motor. If the average current value of the motor is about 2-3 times the normal value, “dedoi-dal” could have been caused.

② 测定柔轮中部振动的判别方法

Judging by measuring vibration on the body of the flexspline

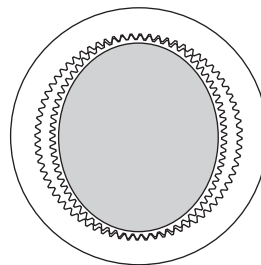
如图029-1所示，正常组装时千分表的振动为实线描绘的正弦波，但发生齿轮啮合偏移时，柔轮会向单侧偏移，因此其振动可用虚线进行描绘。

The scale deflection of the dial gauge draws a sine wave as shown by the solid line in Graph 029-1 when it is normally assembled. When “dedoi-dal” is caused, the gauge draws a deflected wave shown by the dotted line as the flexspline is out of alignment.

正常啮合的状态

Normally engaged status

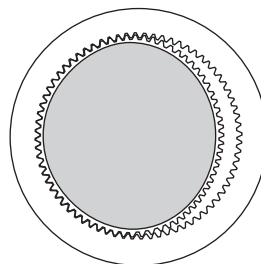
图029-1
Fig. 029-1



齿轮啮合偏移的状态

“Dedoi-dal” status

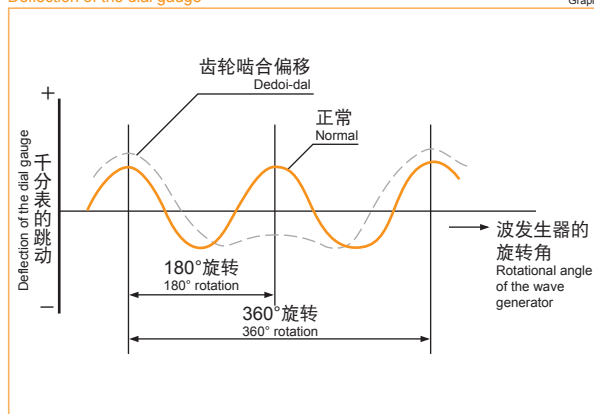
图029-2
Fig. 029-2



测微仪的跳动

Deflection of the dial gauge

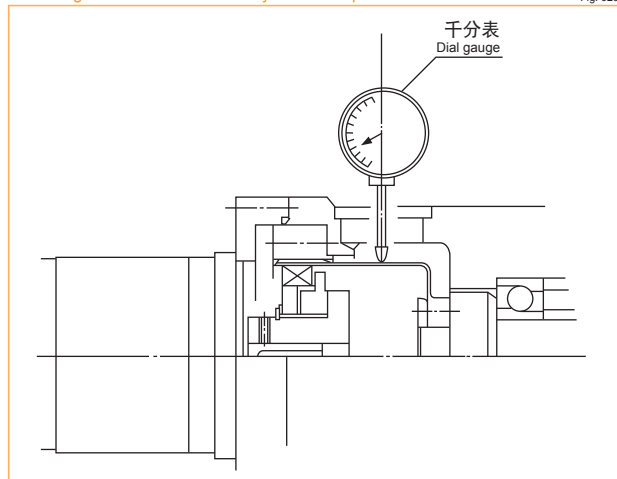
表029-1
Graph 029-1



测定柔轮的中部跳动

Measuring the deflection on the body of the flexspline

图029-3
Fig. 029-3



主轴承的确认 Checking main roller bearing

组合型及齿轮箱型组装有精密交叉滚子轴承用于直接支撑外部负载（输出法兰部）。

（CSF-mini系列采用4点接触滚珠轴承）

为充分发挥组合型的性能，请确认最大负载静力矩、轴承的使用寿命以及静态安全系数。

A precision cross roller bearing is built in the unit type and the gear head type to directly support the external load (output flange) (precision 4-point contact ball bearing for the CSF-mini series).

Check the maximum load moment load, life of the bearing and static safety coefficient to fully bring out the performance of the unit type.

■主轴承的规格请参照各系列的相关章节。

See the corresponding pages on each series for main shaft bearing.

确认步骤 Checking procedure

① 确认最大负载静力矩 (M_{max})

Checking the maximum load moment load

计算最大负载静力矩 (M_{max})

Obtain the maximum load moment load (M_{max}).

最大负载静力矩 (M_{max}) $\leq$ 容许力矩 (M_c)

Maximum load moment load (M_{max}) $\leq$ permissible moment (M_c)

② 确认使用寿命

Checking the life

计算平均径向负载 (F_{rav})、平均轴向负载 (F_{aav})

Obtain the average radial load (F_{rav}) and the average axial load (F_{aav}).

计算径向负载系数 (X)、轴向负载系数 (Y)

Obtain the radial load coefficient (X) and the axial load coefficient (Y).

计算确认使用寿命

Calculate the life and check it.

③ 确认静态安全系数

Checking the static safety coefficient

计算径向当量静负荷 (P_o)

Obtain the static equivalent radial load coefficient (P_o).

确认静态安全系数 (f_s)

Check the static safety coefficient. (f_s)

最大负载静力矩的计算方法 How to obtain the maximum load moment load

最大负载静力矩 (M_{max}) 的计算方法如下。

请确认 $M_{max} \leq M_c$

Maximum load moment load (M_{max}) is obtained as follows.

Make sure that $M_{max} \leq M_c$.

公式030-1
Formula 030-1

$$M_{max} = F_{rmax} (L_r + R) + F_{amax} \cdot L_a$$

公式030-1符号

Symbol of formula 030-1

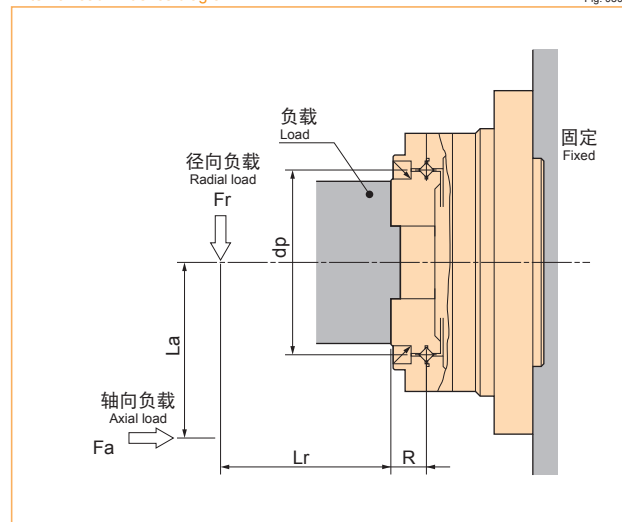
表030-1
Table 030-1

F_{rmax}	最大径向负载 Max. radial load	N (kgf)	参照图030-1 See Fig. 030-1.
F_{amax}	最大轴向负载 Max. axial load	N (kgf)	参照图030-1 See Fig. 030-1.
L_r, L_a	—	m	参照图030-1 See Fig. 030-1.
R	偏置量 Offset amount	m	参照图030-1及各系列的 “主轴承的规格”。 See Fig. 030-1 and “Specification of the main roller bearing” of each series.

外部负载作用图

External load influence diagram

图030-1
Fig. 030-1



平均负载的计算方法 How to obtain the average load

(平均径向负载 · 平均轴向负载 · 平均输出转数)

(Average radial load, average axial load, average output rotational frequency)

径向负载和轴向负载变动时，换算为平均负载，确认轴承的使用寿命。
If the radial load and the axial load fluctuate, they should be converted into the average load to check the life of the bearing.

平均径向负载 (Frav) 的计算方法

How to obtain the average radial load (Frav)

公式031-1
Formula 031-1

(交叉滚子轴承 Cross roller bearing)

$$Fr_{av} = \sqrt[10/3]{\frac{n_1 t_1 (|Fr_1|)^{10/3} + n_2 t_2 (|Fr_2|)^{10/3} + \dots + n_n t_n (|Fr_n|)^{10/3}}{n_1 t_1 + n_2 t_2 + \dots + n_n t_n}}$$

(4点接触滚珠轴承 4-point contact ball bearing)

$$Fr_{av} = \sqrt[3]{\frac{n_1 t_1 (|Fr_1|)^3 + n_2 t_2 (|Fr_2|)^3 + \dots + n_n t_n (|Fr_n|)^3}{n_1 t_1 + n_2 t_2 + \dots + n_n t_n}}$$

但，取 t_1 区间内的最大径向负载为 Fr_1 ，取 t_3 区间内的最大径向负载为 Fr_3 。
Note that the maximum radial load within the t_1 section is Fr_1 and the maximum radial load within the t_3 section is Fr_3 .

平均轴向负载 (Frav) 的计算方法

How to obtain the average axial load (Frav)

公式031-2
Formula 031-2

(交叉滚子轴承 Cross roller bearing)

$$Fa_{av} = \sqrt[10/3]{\frac{n_1 t_1 (|Fa_1|)^{10/3} + n_2 t_2 (|Fa_2|)^{10/3} + \dots + n_n t_n (|Fa_n|)^{10/3}}{n_1 t_1 + n_2 t_2 + \dots + n_n t_n}}$$

(4点接触滚珠轴承 4-point contact ball bearing)

$$Fa_{av} = \sqrt[3]{\frac{n_1 t_1 (|Fa_1|)^3 + n_2 t_2 (|Fa_2|)^3 + \dots + n_n t_n (|Fa_n|)^3}{n_1 t_1 + n_2 t_2 + \dots + n_n t_n}}$$

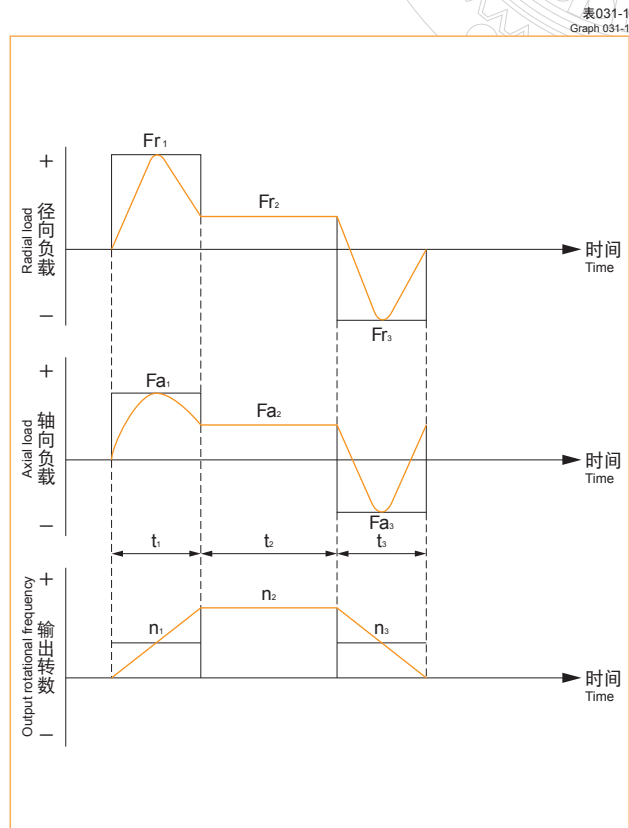
但，取 t_1 区间内的轴向负载为 Fa_1 ，取 t_3 区间内的最大轴向负载为 Fa_3 。
Note that the maximum axial load within the t_1 section is Fa_1 and the maximum axial load within the t_3 section is Fa_3 .

平均输出转数 (Fnav) 的计算方法

How to obtain the average output rotational frequency (Fnav)

公式031-3
Formula 031-3

$$N_{av} = \frac{n_1 t_1 + n_2 t_2 + \dots + n_n t_n}{t_1 + t_2 + \dots + t_n}$$



径向负载系数 (X)、轴向负载系数 (Y) 的计算方法 How to obtain the radial load coefficient (X) and thrust load coefficient (Y)

公式031-4
Formula 031-4

负载系数的计算方法 How to obtain the load coefficient	X	Y
$\frac{Fa_{av}}{Fr_{av} + 2 (Fr_{av} (Lr + R) + Fa_{av} \cdot La) / dp} \leq 1.5$	1	0.45
$\frac{Fa_{av}}{Fr_{av} + 2 (Fr_{av} (Lr + R) + Fa_{av} \cdot La) / dp} > 1.5$	0.67	0.67

公式031-4的符号

Symbol of formula 031-4

表031-1
Table 031-1

F_{rmax}	平均径向负载 Average radial load	N (kgf)	参照“平均负载的计算方法” (参照公式031-1) See “How to obtain the average load.” See Formula 031-1.
F_{amax}	平均轴向负载 Average axial load	N (kgf)	参照“平均负载的计算方法” (参照公式031-2) See “How to obtain the average load.” See Formula 031-2.
Lr, La	—	m	参照图030-1 See Fig. 030-1.
R	偏置量 Offset amount	m	参照图030-1及各系列的“主轴承的规格”。 See Fig. 030-1 and “Specification of the main roller bearing” of each series.
dp	滚子的节圆直径 Pitch circle diameter of a roller	m	参照图030-1及各系列的“主轴承的规格”。 See Fig. 030-1 and “Specification of the main roller bearing” of each series.

使用寿命的计算方法 How to obtain the life

轴承的使用寿命可通过公式 032-1 计算得出。
 径向当量动负荷 (Pc) 可通过公式 032-2 计算得出。
 Obtain the life of the bearing by Formula 032-1.
 You can obtain the dynamic equivalent radial load (Pc) by Formula 032-2.

公式032-1
Formula 032-1

(交叉滚子轴承 Cross roller bearing)

$$L_{10} = \frac{10^6}{60 \times N_{av}} \times \left(\frac{C}{f_w \cdot P_c} \right)^{10/3}$$

(4点接触滚珠轴承 4-point contact ball bearing)

$$L_{10} = \frac{10^6}{60 \times N_{av}} \times \left(\frac{C}{f_w \cdot P_c} \right)^3$$

公式032-1的符号

Symbols of Formula 032-1

表032-1
Table 032-1

L ₁₀	使用寿命 Life	hour	—
N _{av}	平均输出转速 Average output rotational speed	r/min	参照“平均负载的计算方法” See "How to obtain the average load."
C	基本额定动负载 Basic dynamic load rating	N (kgf)	参照各系列的“主轴承的规格” See "Specification of the main roller bearing" of each series.
P _c	径向当量动负荷 Dynamic equivalent radial load coefficient	N (kgf)	参照公式 032-2 See Formula 032-2.
f _w	负载系数 Load coefficient	—	参照表 032-3 See Formula 032-3.

负载系数

Load coefficient

表032-3
Table 032-3

负载状态 Load status	f _w
无冲击和振动、平滑运转时 During smooth operation without shock or vibration	1~1.2
通常运转时 During normal operation	1.2 ~ 1.5
伴随冲击、振动运转时 During operation with shock and vibration	1.5~3

公式032-2
Formula 032-2

$$P_c = X \cdot \left(F_{rav} + \frac{2 (F_{rav} (L_r + R) + F_{aav} \cdot L_a)}{d_p} \right) + Y \cdot F_{aav}$$

公式032-2的符号

Symbols of Formula 032-2

表032-2
Table 032-2

F _{rav}	平均径向负载 Average radial load	N (kgf)	参照“平均负载的计算方法”(参照公式031-1) See "How to obtain the average load." See Formula 031-1.
F _{aav}	平均轴向负载 Average axial load	N (kgf)	参照“平均负载的计算方法”(参照公式031-2) See "How to obtain the average load." See Formula 031-2.
d _p	滚子的节圆直径 Pitch circle diameter of a roller	m	参照图030-1及各系列的“主轴承的规格” See Fig. 030-1 and "Specification of the main roller bearing" of each series.
X	径向负载系数 Radial load coefficient	—	参照公式031-4 See Formula 031-4.
Y	轴向负载系数 Axial load coefficient	—	参照公式031-4 See Formula 031-4.
L _r , L _a	—	m	参照图030-1 See Formula 030-1.
R	偏置量 Offset amount	m	参照图030-1及各系列的“主轴承的规格” See Fig. 030-1 and "Specification of the main roller bearing" of each series.

摆动运动时使用寿命的计算方法 How to obtain the life under oscillating movement

图033-1
Fig. 033-1

摆动运动时轴承的使用寿命可通过公式033-1计算得出。
Obtain the life of the bearing under oscillating movement by Formula 033-1.

公式033-1
Formula 033-1

(交叉滚子轴承 Cross roller bearing)

$$Loc = \frac{10^6}{60 \times n1} \times \frac{90}{\theta} \times \left(\frac{C}{fw \cdot Pc} \right)^{10/3}$$

(4点接触滚珠轴承 4-point contact ball bearing)

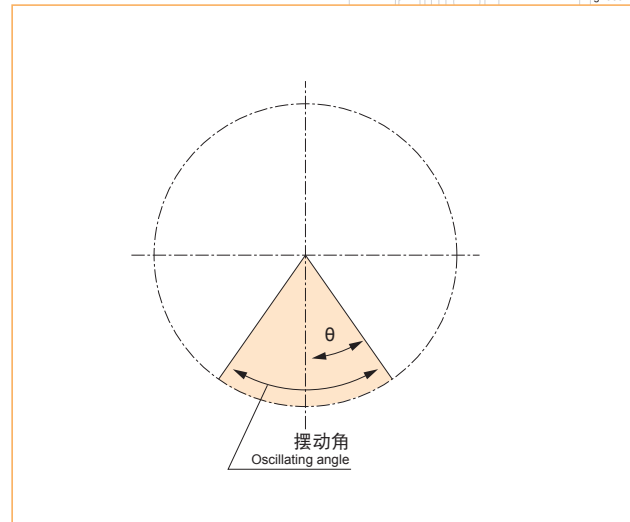
$$Loc = \frac{10^6}{60 \times n1} \times \frac{90}{\theta} \times \left(\frac{C}{fw \cdot Pc} \right)^3$$

公式033-1的符号

Symbols of Formula 033-1

表033-1
Table 033-1

Loc	摆动运动时的额定使用寿命 Rated life under oscillating movement	hour	—
n1	每分钟的往复摆动次数 No. of reciprocating oscillation per min.	cpm	—
C	基本额定动载荷 Basic dynamic load rating	N (kgf)	参照各系列的“主轴承的规格” Rated life under oscillating movement
Pc	径向当量动负荷 Dynamic equivalent radial load coefficient	N (kgf)	参照公式032-2 See Formula 032-2
fw	负载系数 Load coefficient	—	参照公式032-3 See Formula 032-3
q	负载系数 Oscillating angle/2	度 Deg.	参照图033-1 See Fig. 033-1



(注)

摆动角较小(5°以下)时,轨道轮和转动体的接触面不易形成油膜,会产生微振磨损,详细情况请咨询授权代理商。

(Note)

When the oscillating angle is small (less than 5°), it is difficult to generate an oil film on the contact surface of the orbit ring, and the rolling element and fretting may be generated. Contact us if this happens.

静态安全系数的计算方法 How to obtain the static safety coefficient

一般情况下将基本额定静负载（Co）认定为当量静负荷的容许限度，但可根据使用条件及要求条件确定其限度。
此时的轴承的静态安全系数（fs）使用公式034-1计算得出。表034-3为使用条件的一般数值。径向当量静负荷（Po）可根据公式034-2计算得出。

In general, the basic static load rating (Co) is considered to be the permissible limit of the static equivalent load. However, obtain the limit based on the operating and required conditions.

Obtain the static safety coefficient of the roller bearing by Formula 034-1. General values under the operating condition are shown in Table 034-3. You can obtain the static equivalent radial load (Po) by Formula 034-2.

公式034-1
Formula 034-1

$$f_s = \frac{C_o}{P_o}$$

公式034-2
Formula 034-2

$$P_c = F_{rmax} + \frac{2M_{max}}{d_p} + 0.44F_{amax}$$

公式034-1的符号

Symbols of Formula 034-1

表034-1
Table 034-1

Co	基本额定静负载 Basic static load rating	N (kgf)	参照各系列的“主轴承的规格” See "Specification of the main roller bearing" of each series.
Po	径向当量静负荷 Static equivalent radial load coefficient	N (kgf)	参照公式034-2 See Formula 034-2.

公式034-1的符号

Symbols of Formula 034-1

表034-2
Table 034-2

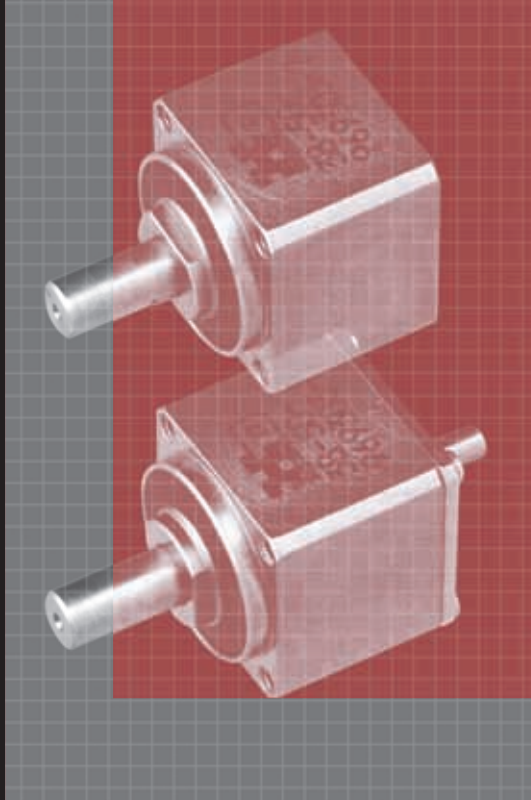
F_{rmax}	最大径向负载 Max. radial load	N (kgf)	参照第028页“最大负载静力矩的计算方法” See "How to obtain the maximum load moment load" on Page 028.
F_{amax}	最大轴向负载 Max. axial load	N (kgf)	
M_{max}	最大负载静力矩 Max. load moment load	Nm (kgfm)	
d_p	滚子的节圆直径 Pitch circle diameter of a roller	m	参照图030-1及各系列的“主轴承的规格”。 See Fig. 030-1 and "Specification of the main roller bearing" of each series.

静态安全系数

Static safety coefficient

表034-3
Table 034-3

轴承的使用条件 Operating condition of the roller bearing	f_s
需要较高旋转精度时 When high rotation precision is required	≥ 3
伴随振动、冲击时 When shock and vibration are expected	≥ 2
通常运转条件时 Under normal operating condition	≥ 1.5

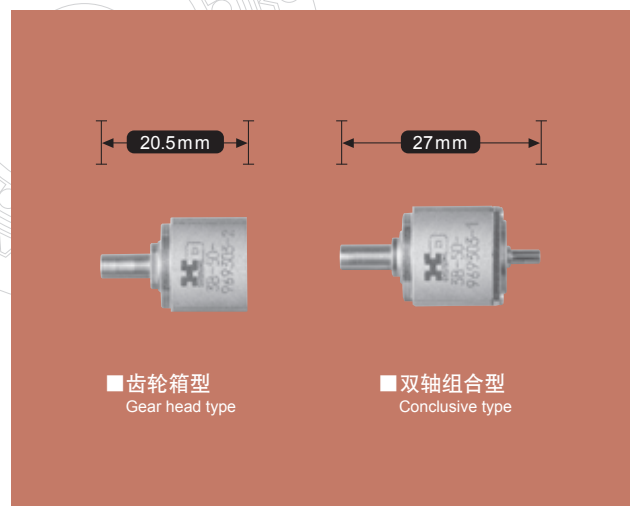


CSF supermini系列

CSF supermini Series

Unit Type CSF supermini

特点 Features	034
型号·符号 Model and symbol	035
技术数据 Technical data	035
•额定表 Rating table	035
•角度传达精度 Angle transmission accuracy	036
•滞后损失 Hysteresis loss	036
•起动转矩 Starting torque	036
•增速起动转矩 Overdrive starting torque	036
•棘爪扭矩 Ratcheting torque	036
•屈曲转矩 Buckling torque	036
•主轴承的规格 Checking main roller bearing	037
•润滑 Lubrication	037
技术数据 轴输入型 Technical data of input shaft type	038
•双轴型1U外形图 Outline drawing of concluvic type 1U	038
•齿轮箱型1U-CC外形图 Outline drawing of Gear head type 1U-CC	038
•刚性（弹簧常数） Rigidity (Spring constant)	039
•机械精度 Mechanical precision	039
•效率特性 Efficiency characteristics	040
•无负载运行转矩 On no-load running torque	042
•输入部容许负载 Permissible load of the input part	043
•安装和传递转矩 Installation and transmission torque	044
技术数据 电动机安装型 Technical data Motor mounting type	045
•安装示例 Example of installation	045
•组装精度 Drawing of the appearance of the motor mounting flange output	046



※图片为实际尺寸。
Exact sized photograph

CSF supermini系列组合型

CSF-mini series unit type

CSF supermini系列是将Harmonic Drive的最小型号便于使用的组合型产品。主轴采用了本公司独立开发的“小型4点接触滚珠轴承”，可直接支撑外部负载。

CSF supermini系列包括直接安装至伺服电动机的齿轮箱型（1U-CC）和同时具备输入轴和输出轴的双轴组合型（1U）两种类型，请根据机械装置的设计需要选择最适合的机型。

The CSF-mini series is a unitized product to facilitate the smallest model of Harmonic Drive. Our proprietary “4-point contact ball bearing” has been adopted for the main roller bearing to enable direct support of the external load.

The CSF supermini series comes in two types - Gear head type (1U-CC) that is mounted directly onto a servo motor and dual-shaft unit type (1U) equipped with an input shaft and output shaft. Select a model that is optimum for your design needs for machines and equipment.

CSF supermini系列的特点 Features of CSF series

- 小型、轻量
Compact and lightweight
- 紧凑简洁的设计
Compact and simple design
- 高转矩容量
High torque capacity
- 高刚性
High stiffness
- 无齿隙
Non-backlash
- 优良的定位精度和旋转精度
High positioning and rotational accuracies
- 输入输出同轴
Coaxial input and output

CSF supermini系列组合型的结构

Structure of the CSF-supermini series unit type

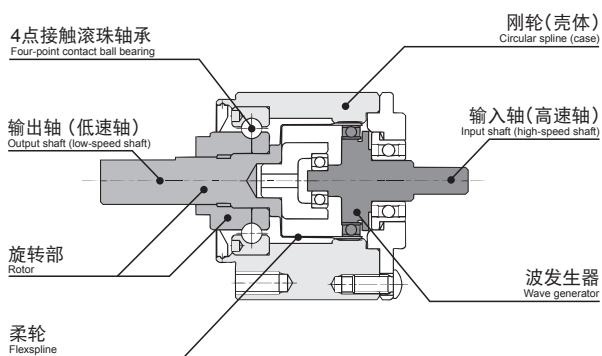
图220-1
Fig. 220-1

双轴组合型（1U）

Conclusive type (1U)

拥有输入轴和输出轴完结型的双轴型组合。即使是不习惯使用Harmonic Drive的人员也能够简单操作，实现高精度的定位。

This is a conclusive-type, double-shaft unit with an input shaft and an output shaft. Even if you are not familiar with handling Harmonic Drive, you can easily handle it and can obtain high-precision positioning.

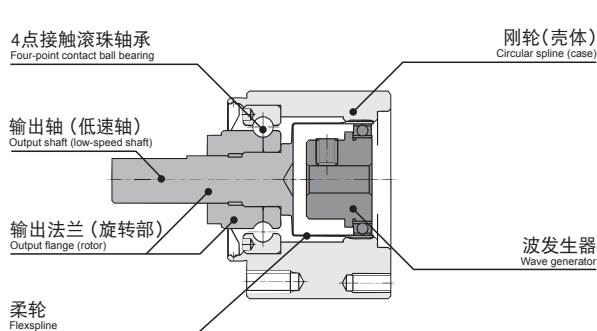


齿轮箱型（1U-CC）

Gear head type (1U-CC)

与高性能小型伺服电动机组合而成的减速机。相同尺寸的齿轮条件下，拥有最高的输出特性。

This is a gear head designed to be combined with a high-performance compact servo motor. It sports the ultimate output characteristics among gears of the same size. We have prepared two types of output part: flange output and shaft output.



※固定刚轮（壳体）时输出轴的旋转方向与输入轴（波发生器）的旋转方向相反。
When the circular spline (casing) is fixed, the output shaft and input shaft (wave generator) rotate in opposite directions.

型号·符号 Model and symbol

Harmonic Drive CSF supermini系列根据型号可分为3类。根据型号分为2种，可变选项丰富。订货时请参考下述符号。

The Harmonic Drive CSF-mini series consists of wide variety of products including four model numbers and three models. Place an order using the following symbols as a reference.

CSF - 3 B - 50 - 1U - CC - 规格 SP

表221-1
Table 221-1

机型名称 Model name	型号 Model No.	版本符号 Version symbol	减速比 注1 Reduction ratio Note 1			型式 Model	特殊规格 Special specification
CSF系列 CSF series	3	B	30	50	100	1U=双轴组合型 1U-CC=齿轮箱型 1U = Conclusive type 1U-CC = Gear head type	SP=形状、性能等特殊规格 空白=标准品 SP = special specifications such as shapes and performance None = standard product

注1：减速比表示的是输入：波发生器（输入轴），固定：刚轮（壳体），输出：输出轴时的情况。

Note 1 The reduction ratio indicates the value for the following condition. Input: wave generator, fixed: circular spline, output: flexspline

技术数据 Technical Data

额定表 Rating table

表221-2
Table 221-2

型号 Model	减速比 Reduction ratio	输入2000r/min时的 额定转矩 Rated torque at input 2000r/min		起动停止时的 容许峰值转矩 Peak torque at start/stop		平均负载转矩的 容许最大值 Permissible max. value of ave. load torque		瞬间容许最大转矩 Instantaneous permissible max. torque		容许最高 输入转速 Permissible max. input rotational speed	容许平均 输入转速 Permissible ave. input rotational speed	转动惯量 (1/4GD ²) Inertia moment (1/4GD ²)
		Nm	kgfm	Nm	kgfm	Nm	kgfm	Nm	kgfm	r/min	r/min	kgcm ²
3	30	0.06	0.006	0.13	0.013	0.10	0.010	0.22	0.022	10000	6500	1U:5.3×10 ⁻⁷ 1U-CC:7.0×10 ⁻⁷
	50	0.11	0.011	0.21	0.021	0.13	0.013	0.41	0.040			
	100	0.15	0.015	0.30	0.029	0.23	0.023	0.57	0.056			

※1 转动惯量的上段为1U型、下段为1U-CC型的数值。

The upper value of inertia moment is for 1U type, whereas, the lower value of it is for 1U-CC type.

角度传达精度 Angle transmission accuracy

(用语说明请参照“技术资料”。)
See "Engineering data" for a description of terms.

表222-1
Table 222-1

减速比 Reduction ratio	单位 Specification	型号 Model	3
全减速比 Total reduction ratio	$\times 10^{-3}$ rad		2.9
	arc min		10

滞后损失 Hysteresis loss

(用语说明请参照“技术资料”。)
See "Engineering data" for a description of terms.

表222-2
Table 222-2

减速比 Reduction ratio	型号 Model	3
30	$\times 10^{-4}$ rad	1.3
	arc min	4.5
50	$\times 10^{-4}$ rad	1.2
	arc min	4
100	$\times 10^{-4}$ rad	1.2
	arc min	4

起动转矩 Starting torque

(用语说明请参照“技术资料”。) 下表的数值会根据使用条件的不同而有所变化，请作为参考值使用。
See "Engineering data" for a description of terms. As the values in the table below vary depending on the use conditions, use them as reference values.

表222-3
单位: cNm
Table 222-3
Unit: cNm

减速比 Reduction ratio	型号 Model	3	
		1U	1U-CC
30		0.34	0.32
50		0.30	0.28
100		0.26	0.24

增速起动转矩 Overdrive starting torque

(用语说明请参照“技术资料”。) 下表的数值会根据使用条件的不同而有所变化，请作为参考值使用。
See "Engineering data" for a description of terms. As the values in the table below vary depending on the use conditions, use them as reference values.

表222-4
单位: Nm
Table 222-4
Unit: Nm

减速比 Reduction ratio	型号 Model	3	
		1U	1U-CC
30		0.14	0.12
50		0.14	0.11
100		0.16	0.13

棘爪扭矩 Ratcheting torque

(用语说明请参照“技术资料”。)
See "Engineering data" for a description of terms.

表222-5
单位: Nm
Table 222-5
Unit: Nm

减速比 Reduction ratio	型号 Model	3
30		0.88
50		0.83
100		0.74

屈曲转矩 Buckling torque

(用语说明请参照“技术资料”。)
See "Engineering data" for a description of terms.

表222-6
单位: Nm
Table 222-6
Unit: Nm

型号 Model	3
全减速比 Total reduction ratio	3.7

主轴承的规格 Checking main roller bearing

CSF supermini系列组装有精密4点接触滚珠轴承用于直接支撑外部负载（输出部）。

为充分发挥CSF supermini系列的性能，请确认最大负载静力矩、4点接触滚珠轴承的使用寿命以及静态安全系数。

各数值的计算公式请参照第028~032页的“技术资料”。

A precision cross roller bearing is built in the unit type and the gear head type to directly support the external load (output flange) (precision 4-point contact ball bearing for the CSF-mini series).

Check the maximum load moment load, life of the bearing and static safety coefficient to fully bring out the performance of the unit type.

See the page 028 to 032 of "Engineering data" for each calculation formula.

■ 确认步骤

Checking procedure

① 确认最大负载静力矩 (M_{max})

Checking the maximum load moment load

计算最大负载静力矩 (M_{max})

Obtain the maximum load moment load (M_{max}).

最大负载静力矩 (M_{max}) $\leq$ 容许力矩 (M_c)

Maximum load moment load (M_{max}) $\leq$ permissible moment (M_c)

② 确认使用寿命

Checking the life

计算平均径向负载 (F_{rav})、平均轴向负载 (F_{aav})

Obtain the average radial load (F_{rav}) and the average axial load (F_{aav}).

计算径向负载系数 (X)、轴向负载系数 (Y)

Obtain the radial load coefficient (X) and the axial load coefficient (Y).

计算确认使用寿命

Calculate the life and check it.

③ 确认静态安全系数

Checking the static safety coefficient

计算径向当量静负荷 (P_o)

Obtain the static equivalent radial load coefficient (P_o).

确认静态安全系数 (f_s)

Check the static safety coefficient. (f_s)

■ 主轴承规格

Main roller bearing specifications

规格

Specifications

表223-1
Table 223-1

型号 Model	滚子的节圆直径 Pitch circle dia. of a roller	偏置量 Offset amount	基本额定负载 Basic rated load		容许静力矩 Permissible moment load	力矩刚性 Moment rigidity	容许径向负载※ Permissible radial load※	容许轴向负载 Permissible thrust load
	dp	R	基本额定动负载 Basic dynamic rated load	基本额定静负载 Basic static rated load				
	mm	mm	$\times 10^3 \text{ N}$	$\times 10^3 \text{ N}$				
3	7.7	4.1	6.65	4.24	0.27	0.9×10^2	36	130

※ 容许径向负载是指双轴型 (1U) 输出轴侧以及齿轮箱轴输出型 (1U-CC) 轴承中央部的数值。力矩刚性的数值为平均值。

Permissible radial load is the value on the center of output shaft side of both shaft type (1U) and that of gear head shaft output type (1U-CC).

润滑 Lubrication

表223-2
Table 223-2

CSF supermini系列的标准润滑方法为润滑脂润滑。

出厂前已封入润滑脂，因此组装时无需注入、涂抹润滑脂。此外，使用下述润滑脂进行润滑。

Grease lubrication is the standard lubrication of the CSF-mini series.

As products are greased and shipped, you are not required to apply grease during assembly. The following kinds of grease are used for lubricant.

润滑部 Lubricated area	减速机部 Reducer
使用润滑剂名称 Lubricant name used	Harmonic润滑脂 SK-2 Harmonic grease SK-2
制造商 Manufacturer	日本Harmonic Drive Systems Inc.公司 Harmonic Drive Systems
基础油 Base oil	精制矿物油 Refined oil
增稠剂 Puffing agent	锂皂 Lithium soap
混合粘度 (25℃) Consistency (25℃)	265~295 265 to 295
油点 Drop point	198℃
外观 Appearance	绿色 Green

双轴型1U外形图 Outline drawing of conclusive type 1U

拥有输入轴和输出轴完结型的双轴型组合。

本产品的CAD数据 (DXF) 可从本公司主页下载。

URL: <http://www.hds.co.jp/>

Conclusive type unit of full connection with input and output shaft.

You can download the CAD data (DXF) of this product from the following homepage.

URL: <http://www.hds.co.jp/>

图224-1

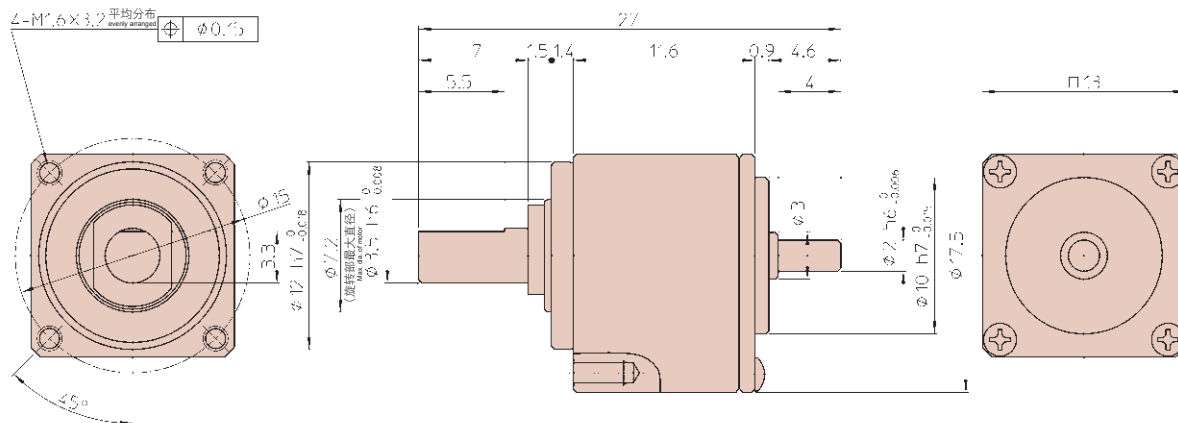
单位: mm

Fig. 224-1

Unit: mm

重量: 13.7g

Mass: 13.7g



※尺寸及形状的详细情况, 请使用交货规格图进行确认。
Check the delivered specifications for details of the sizes.

齿轮箱型1U-CC外形图 Outline drawing of Gear head type 1U-CC

与高性能小型伺服电动机组合而成的减速机。

本产品的CAD数据 (DXF) 可从本公司主页下载。

URL: <http://www.hds.co.jp/>

A gear head based on the concept featuring a combination with a high-performance compact servo motor.

You can download the CAD data (DXF) of this product from the following homepage.

URL: <http://www.hds.co.jp/>

图224-2

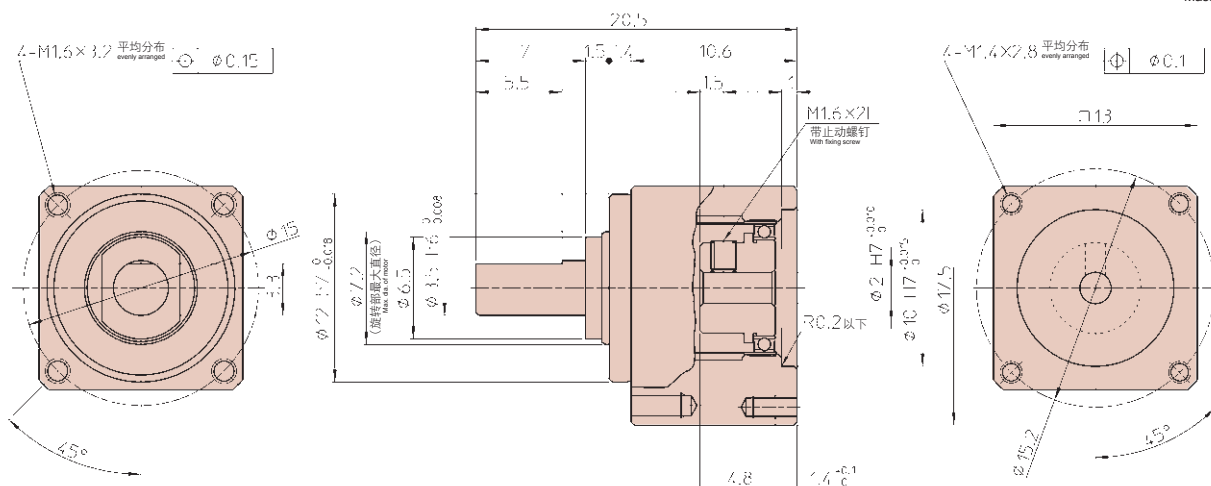
单位: mm

Fig. 224-2

Unit: mm

重量: 11.4g

Mass: 11.4g



※尺寸及形状的详细情况, 请使用交货规格图进行确认。
Check the delivered specifications for details of the sizes.

刚性（弹簧常数） Rigidity (Spring constant)

(用语说明请参考“技术资料”。)
See "Engineering data" for a description of terms.

表225-1
Table 225-1

符号 Symbol	型号 Model	3
T ₁	Nm	0.16
	kgfm	0.0016
T ₂	Nm	0.05
	kgfm	0.005
减速比 Reduction ratio 30	Nm/rad	27
	×10 ⁻⁴ kgfm/arc min	8
	Nm/rad	40
	×10 ⁻⁴ kgfm/arc min	12
	Nm/rad	51
	×10 ⁻⁴ kgfm/arc min	15
	×10 ⁻⁴ rad	5.9
	arc min	2.0
	×10 ⁻⁴ rad	12.5
	arc min	4.2
减速比 Reduction ratio 50	Nm/rad	30
	×10 ⁻⁴ kgfm/arc min	9
	Nm/rad	47
	×10 ⁻⁴ kgfm/arc min	14
	Nm/rad	57
	×10 ⁻⁴ kgfm/arc min	17
	×10 ⁻⁴ rad	5.3
	arc min	1.8
	×10 ⁻⁴ rad	10.6
	arc min	3.6
减速比 Reduction ratio 100	Nm/rad	34
	×10 ⁻⁴ kgfm/arc min	10
	Nm/rad	54
	×10 ⁻⁴ kgfm/arc min	16
	Nm/rad	67
	×10 ⁻⁴ kgfm/arc min	20
	×10 ⁻⁴ rad	4.7
	arc min	1.6
	×10 ⁻⁴ rad	9.3
	arc min	3.1

机械精度 Mechanical precision

CSF supermini系列的主轴采用高精度的4点接触滚珠轴承，实现了输出部的高机械精度。输出轴的机械精度如下所示。
CSF-supermini series have four-point contact ball bearing of high precision on main shaft bearing, and realized the high mechanical precision of output part. The mechanical precision of the output shaft is shown below.

安装壳体的推荐精度
Recommended precision for the mounting case

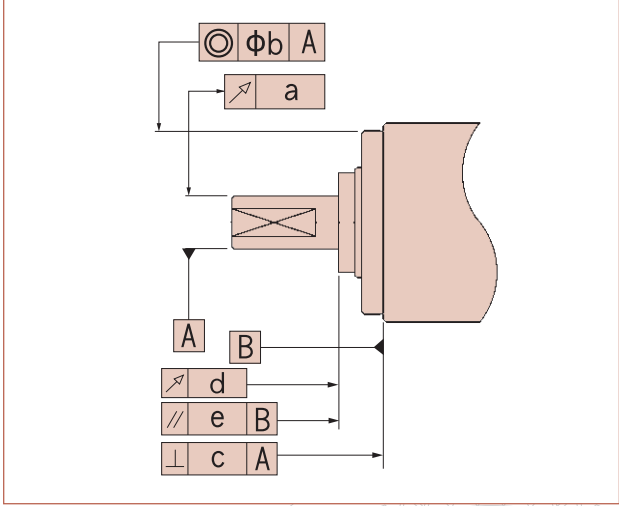
表225-2
※T.I.R. 单位：mm
Table 225-2
※T.I.R. Unit: mm

符号 Symbol	精度项目 Precision item	型号 Model	3
a	输出轴前端跳动 Fluctuation on the edge of the output shaft		0.030
b	安装凹圆同轴度 Concentricity of the mounting spigot		0.020
c	安装面直角 Squareness of the mounting face		0.020
d	输出法兰面跳动 Fluctuation on the output flange face		0.005
e	安装面和输出法兰面的平行度 Parallelism of the mounting face and the output flange face		0.015

※T.I.R.：表示测定部旋转1次时千分表读数的总量。
T.I.R.: This indicates the total reading of the dial gauge when the measuring part is rotated once.

轴输入型的输出轴图
The output shaft of the input shaft type

图225-1
Fig. 225-1



效率特性 Efficiency characteristics

效率会因以下条件而有所差异。

The efficiency varies depending on the following conditions.

■ 减速比

Reduction ratio

■ 输入转速

Input rotational speed

■ 负载转矩

Load torque

■ 温度

Temperature

■ 润滑条件（润滑剂的种类及其使用量）

Lubrication condition (Type of lubricant and the quantity)

测定条件

Measuring condition

表226-1
Table 226-1

负载转矩 Built-in	额定表所示的额定转矩（参照第035页） Measurement by building the recommended built-in precision into the product		
润滑条件 Lubricating condition	润滑脂 Grease lubrication	名称 Name	Harmonic润滑脂 SK-2 Harmonic grease SK-2
		涂沫量 Application qty.	正确涂沫量 Appropriate application quantity

■ 效率修正系数

Efficiency correction coefficient

负载转矩小于额定转矩时，效率值降低。

请根据图226-1计算出修正系数 K_e ，并参考以下计算示例计算出效率。

If the load torque is smaller than the rated torque, the efficiency value lowers.

Obtain correction coefficient K_e from the efficiency correction coefficient graph 226-1 to obtain the efficiency using the following example of calculation.

例：以CSF-8-100-1U为例，计算出以下条件下的效率 η （%）。

输入转速：1000r/min 润滑方法：润滑脂润滑

负载转矩2.0Nm 润滑剂温度：20℃

Example of calculation: Efficiency η (%) under the following condition is obtained from the example of CSF-8-100-1U.

Input rotational speed: 1000r/min Lubrication method: Grease lubrication

Load torque: 2.0Nm Lubricant temperature: 20℃

型号8·减速比100的额定转矩为2.4Nm（额定表：第035页），因此转矩比 α 为0.83。（ $\alpha = 2.0/2.4 \approx 0.83$ ）

Since the rated torque of model number 8 with a reduction ratio of 100 is 2.4 Nm (Ratings: Page 221), the torque ratio α is 0.83. ($\alpha = 2.0/2.4 \approx 0.83$)

■ 根据图226-1，计算出效率修正系数 $K_e = 0.99$

The efficiency correction coefficient is $K_e = 0.99$ from Graph 226-1.

■ 负载转矩为2.0Nm时的效率 η 为： $\eta = K_e \cdot \eta_R = 0.99 \times 77\% = 76\%$ 。

Efficiency η at load torque 2.0 Nm: $\eta = K_e \cdot \eta_R = 0.99 \times 77 = 76\%$

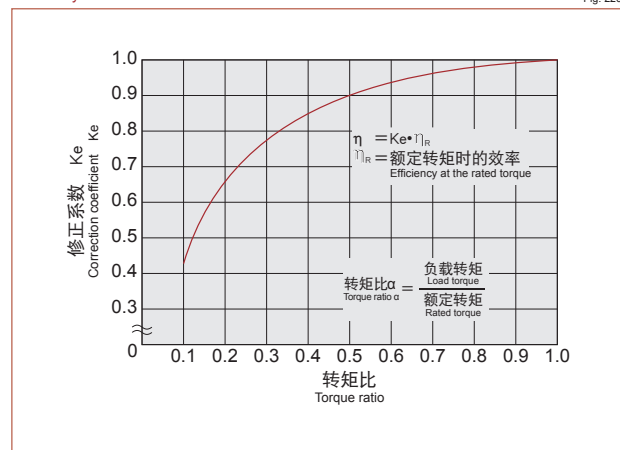
※负载转矩大于额定转矩时的效率修正系数 $K_e = 1$ 。

Efficiency correction coefficient $K_e = 1$ holds when the load torque is greater than the rated torque.

效率修正系数

Efficiency correction coefficient

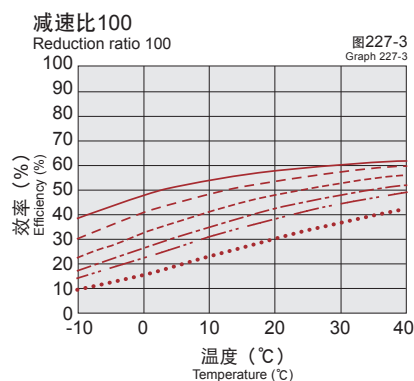
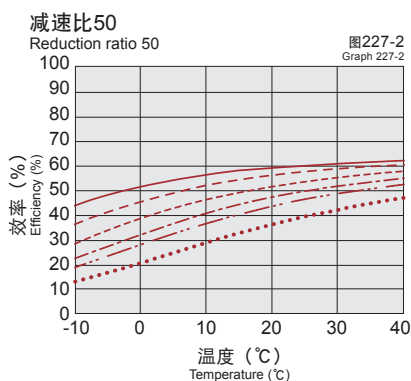
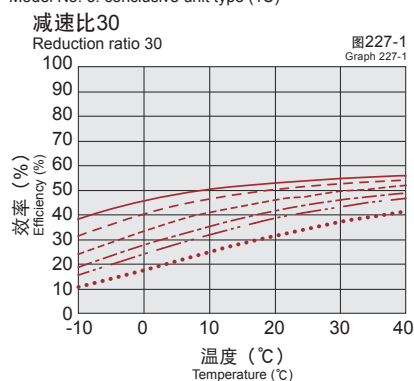
图226-1
Fig. 226-1



■ 额定转矩时的效率 Efficiency at rated torque

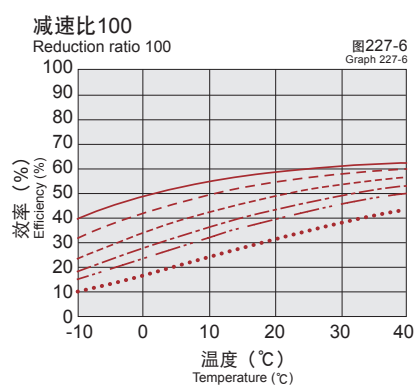
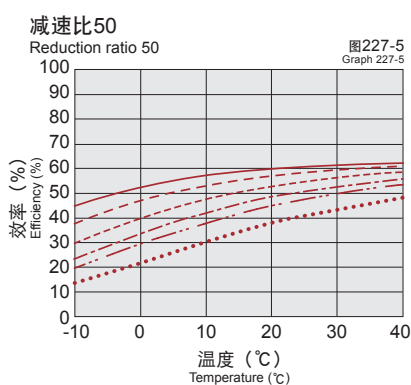
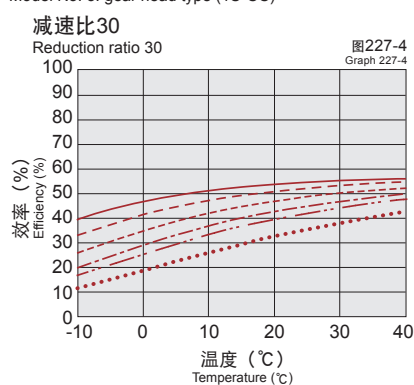
双轴组合型 (1U) 型号3

Model No. 3: conclusive unit type (1U)



齿轮箱型 (1U-CC) 型号3

Model No. 3: gear head type (1U-CC)



输入转速
Input rotational speed

500r/min 1000r/min 2000r/min 3500r/min 5000r/min 10000r/min

无负载运行转矩 On no-load running torque

无负载运行转矩是指在无负载状态下，使Harmonic Drive转动的必要的输入侧（高速轴侧）转矩。

No-load running torque means the torque required to put Harmonic Drive under a no-load condition.

※详细数值请咨询本公司授权代理商。

Contact us for detailed value.

测定条件

Measuring condition

表228-1
Table 228-1

CSF-3-100-1U-CC (齿轮箱型) CSF-3-100-1U-CC (Gear head type)			
减速比100 Reduction ratio 100			
润滑条件 Lubrication condition	润滑脂润滑 Grease lubrication	名称 Name	Harmonic润滑脂 SK-2 Harmonic grease SK-2
转矩值是指在输入为2000r/min的情况下磨合运转2小时以上的数值 The torque value is the value after a trial run for two hours or longer at an input of 2000 r/min.			

不同速比修正量

Correction quantity by reduction

Harmonic Drive的无负载运行转矩会根据速比而发生改变。图228-1为齿轮箱型（1U-CC）减速比100的数值。其他减速比，请加上表228-2所示的修正量进行计算。

The no-load running torque of Harmonic Drive varies depending on the reduction ratio. Graphs 228-1 show the values for a reduction ratio of 100. Obtain other reduction ratios by adding the correction quantity shown in the right-hand table (Table 228-2).

无负载运行转矩修正量

Correction quantity for the no-load running torque

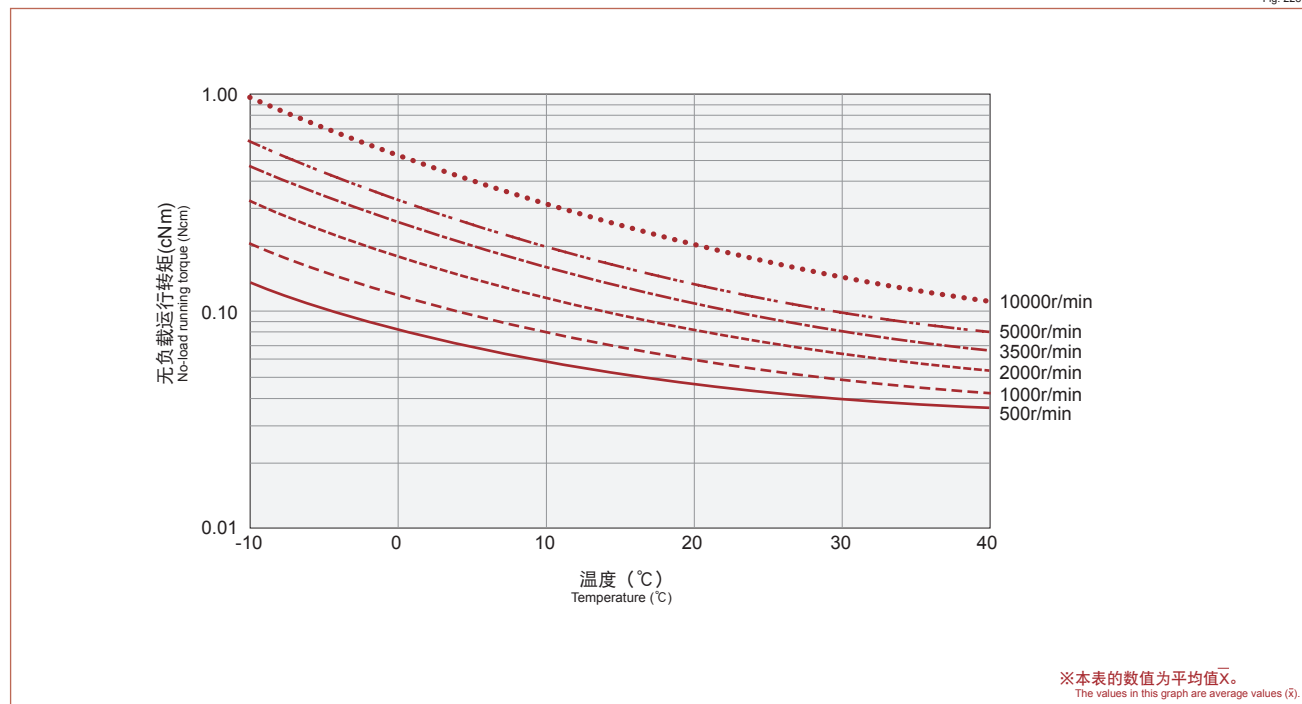
表228-2
Table 228-2
Unit: cNm

型号 Model	减速比 Reduction ratio	30	50	100
双轴型 (1U) Conclusive type (1U)		0.026	0.023	0.006
齿轮箱型 (1U-CC) Gear head type (1U-CC)		0.020	0.017	—

齿轮箱型（1U-CC、减速比100）的无负载运行转矩

No-load running torque for Gear head type (1U-CC, reduction ratio of 100)

图228-1
Fig. 228-1



输入部容许负载 Permissible load of the input part

■双轴组合型(1U)输入轴的容许负载

Permissible load of conclusive unit type (1U)

双轴组合轴型的输入部由2个单列深槽轴承支撑。为充分发挥双轴组合型的性能,请确认向输入部施加的负载。

下图所示的是轴承的支撑点。『a』『b』的尺寸请参照下表。此外,下表表示的是型号3的容许最大径向负载和轴向负载的关系。

此外,下表的数值是平均输入转速为2,000r/min,基本额定使用寿命 $L_{10}=7,000$ h时的数值。

The input part of conclusive unit type is supported by two single-row deepgroove bearings. Check the load applied to the input part to fully bring out the performance of conclusive unit type.

The following figure shows the supporting point of the bearing. See the following table for the size of (a) and (b). The following graph shows the relation between the maximum permissible radial load and the thrust load of model number 3.

The values in the following graph are those assuming that the average input rotational speed is 2000 r/min and the basic rated life, L_{10} , is 7000 hours

例: 向输入轴施加3N的轴向负载(F_a)时,容许最大径向负载(F_r)的数值为3.75N。

Example: When an 3-N thrust load (F_a) is applied to the input shaft, the value of the maximum permissible radial load (F_r) is 3.75 N.

输入部的轴承规格

Bearing specifications of the input part

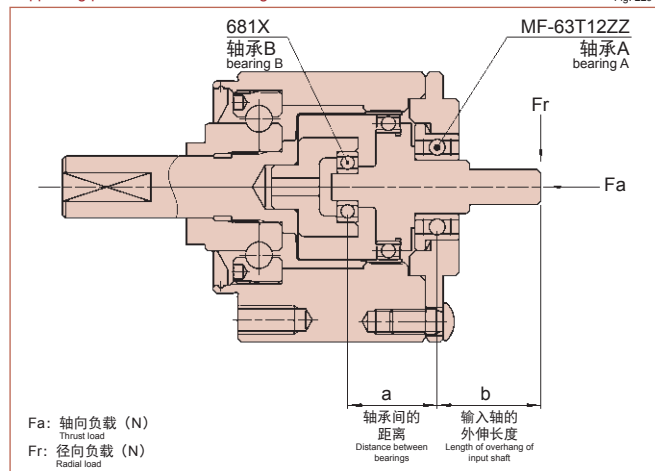
表229-1
Table 229-1

型号 Model	轴承A Bearing A			轴承B Bearing B			轴承间的距离a Distance between bearings	输入轴的外伸长度b Overhang length of the input shaft	最大径向负载 Maximum radial load
	型号 Model	基本额定动负载 Basic dynamic rated load	基本额定静负载 Basic static rated load	型号 Model	基本额定动负载 Basic dynamic rated load	基本额定静负载 Basic static rated load			
		C_r (N)	C_{or} (N)		C_r (N)	C_{or} (N)			
3	MF-63T12ZZ	242	94	681X	102	29	5.05	5.85	6

轴承的支点

Supporting point of the roller bearing

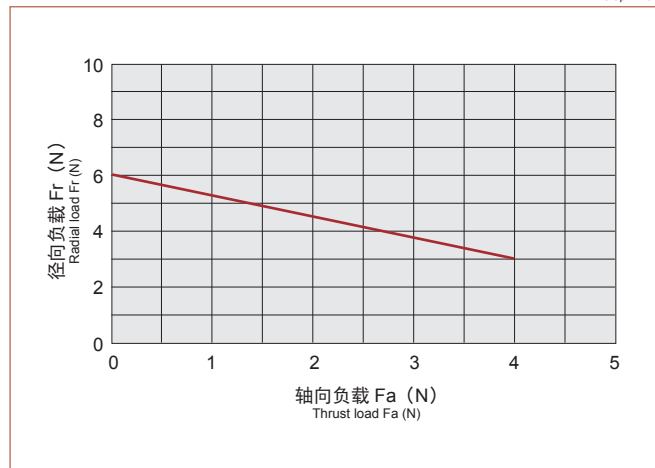
图229-1
Fig. 229-1



轴向负载和径向负载的关系

Relation between the radial load and the thrust load

图229-1
Graph 229-1



安装和传递转矩 Installation and transmission torque

■往装置上安装

Installation on the equipment

将CSF supermini系列安装到装置上时，请在确认安装面的平坦度以及螺孔部是否存在毛刺后再将安装法兰（图230-1的A部）与螺栓拧紧。

Check the flatness of the mounting face and burrs on the tap to install the CSF-supermini series on the equipment, and tighten the mounting flange (A in Figure 230-1) with bolts.

安装法兰（图230-1的A部）螺栓^{*}的拧紧转矩

Tightening torque of the bolt^{*} of the mounting flange (A in Figure 230-1)

表230-1
Table 230-1

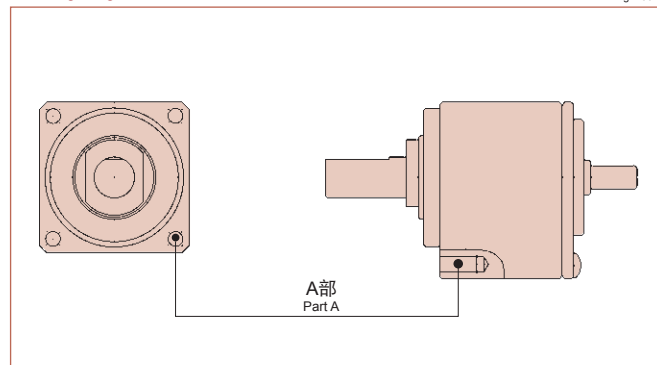
项目 Item	型号 Model	3
螺栓数量 Number of bolts		4
螺栓规格 Bolt size		M1.6
安装P.C.D. Mounting P.C.D.	mm	15
拧紧转矩 Tightening torque	Nm	0.26
	kgfm	0.03
螺钉部装配的最短长度 Min. length of engagement of the screw	mm	1.9
传递转矩 Transmission torque	Nm	3.0
	kgfm	0.3

※推荐螺栓名称：JIS B 1176内六角螺栓、强度分类：JIS B 1051 12.9以上
Recommended bolt name: JIS B 1176 hexagonal bolt, intensity type: JIS B 1051 12.9 or higher.

安装法兰

Mounting flange

图230-1
Fig. 230-1



■输出轴的安装

Installation of the output shaft

安装皮带轮、小齿轮等时，不要对输出轴施加冲击。否则可能会引起减速机的精度下降或故障。

Do not allow the output shaft to receive a shock when you install a pulley and pinion. It can deteriorate the precision of the reducer and cause failure.

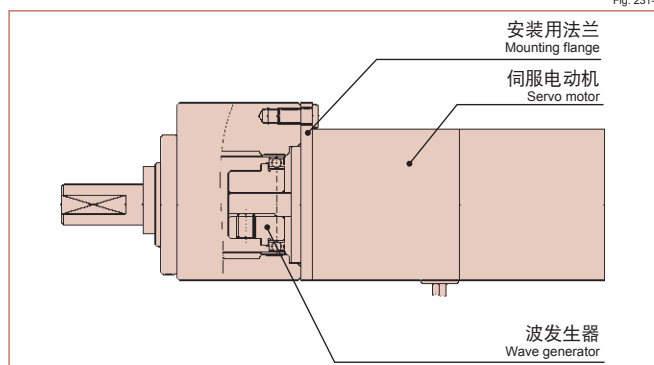
技术数据电动机安装型 Technical data of motor mounting type

安装示例 Example of installation

以下是齿轮箱型（1U-CC）具有代表性的安装示例。

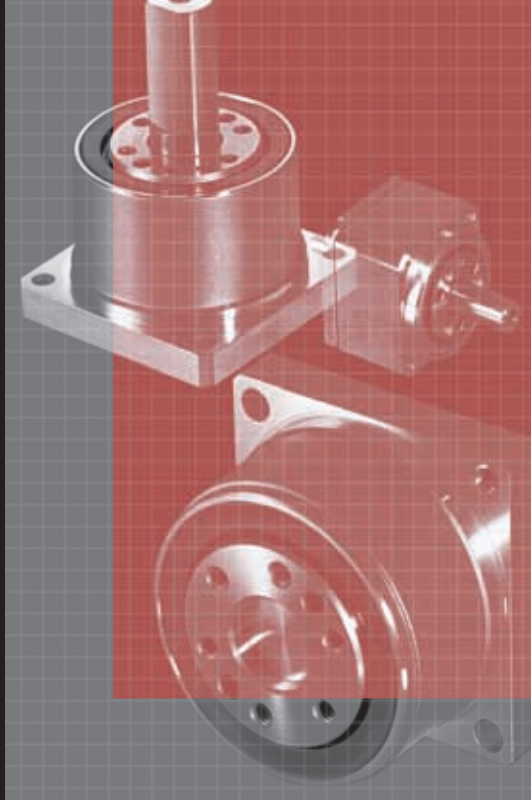
The following shows an example of the representative installation of gear head type (1U-CC).

图231-1
Fig. 231-1



注) 电动机安装时请参照“CSF-3系列的技术资料”。

Note: Refer to the "CSF-3 Series Technical Information" when mounting onto a servo motor.



CSF-mini系列

CSF-mini Series

Unit Type CSF-mini

特点 Features 048

型号·符号 Model and symbol 049

技术数据
Technical data

•额定表 Rating table 049

•角度传达精度 Angle transmission accuracy 050

•滞后损失 Hysteresis loss 050

•最大齿隙量 Max. backlash quantity 050

•起动转矩 Starting torque 050

•增速起动转矩 Overdrive starting torque 050

•棘爪扭矩 Ratcheting torque 050

•屈曲转矩 Buckling torque 050

•主轴承的规格 Checking main roller bearing 051

•润滑 Lubrication 051

技术数据
轴输入型
Technical data
of input shaft type

•轴输出: 1U外形图 Shaft output: outline drawing of 1U 052

•尺寸表 Rating table 052

•法兰输出: 1U-F外形图 Flange output: outline drawing of 1U-F 053

•尺寸表 Rating table 053

•刚性(弹簧常数) Rigidity (Spring constant) 054

•机械精度 Mechanical precision 054

•效率特性 Efficiency characteristics 055

•无负载运行转矩 On no-load running torque 057

•输入部容许负载 Permissible load of the input part 058

•安装和传递转矩 Installation and transmission torque 058

技术数据

电动机安装型

Technical data

Motor mounting type

•轴输出: 1U-CC外形图 Shaft output: outline drawing of 1U-CC 060

•尺寸表 Rating table 060

•法兰输出: 1U-CC-F外形图
Flange output: outline drawing of 1U-CC-F 061

•尺寸表 Rating table 061

•法兰输出: 2XH-F外形图 Flange output: outline drawing of 2XH-F 062

•尺寸表 Rating table 062

•轴输出: 2XH-J外形图 Shaft output: outline drawing of 2XH-J 063

•尺寸表 Rating table 063

•电动机安装型的波发生器孔径尺寸
Hole diameter size of the wave generator of the motor mounting type 064

•刚性(弹簧常数) Rigidity (Spring constant) 064

•机械精度 Mechanical precision 065

•效率特性 Efficiency characteristics 065

•无负载运行转矩 On no-load running torque 067

•安装示例 Example of installation 068

•组装精度 Installation precision 069

•安装和传递转矩 Installation and transmission torque 070

•密封机构 Sealing mechanism 072



CSF-mini系列组合型

CSF-mini series unit type

CSF-mini系列是将Harmonic Drive的最小型号便于使用的组合型产品。主轴承采用了本公司独立开发的“小型4点接触滚珠轴承”，可直接支撑外部负载。

CSF-mini系列包括电动机安装型(2XH)和可支持皮带、齿轮、联轴节等输入形态的轴输入型(1U)两种类型，请根据机械装置的设计需要选择最适合的机型。

The CSF-mini series is a unitized product to facilitate the smallest model of Harmonic Drive. Our proprietary "4-point contact ball bearing" has been adopted for the main roller bearing to enable direct support of the external load.

The CSF-mini series includes the input shaft type (1U) that is compatible with such input types as the motor mounting type (2XH) and belt gear coupling. Select a model that is optimum for your design needs for machines and equipment.

CSF-mini系列的特点 Features of CSF series

- 小型、轻量
Compact and lightweight
- 紧凑简洁的设计
Compact and simple design
- 高转矩容量
High torque capacity
- 高刚性
High stiffness
- 无齿隙
Non-backlash
- 优良的定位精度和旋转精度
High positioning and rotational accuracies
- 输入输出同轴
Coaxial input and output

CSF supermini系列的结构和种类

Structure of the CSF-supermini series unit type

图220-1
Fig. 220-1

轴输入型

Input shaft type

拥有输入轴的完结型组合。可支持皮带、齿轮、联轴节等输入形态。

This is a conclusive-type, double-shaft unit with an input shaft and an output shaft. It also can be used with the input, such as belt, gear, couplings.

双轴型: 1U

Conclusive type: 1U

4点接触滚珠轴承

Four-point contact ball bearing

输出轴(低速轴)

Output shaft (low-speed shaft)

旋转部

Rotor

柔轮

Flexspline

刚轮(壳体)

Circular spline (case)

输入轴(高速轴)

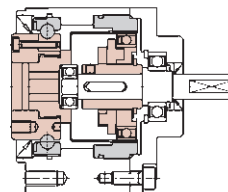
Input shaft (high-speed shaft)

波发生器

Wave generator

法兰输出型: 1U-F

Flange output type: 1U-F



电动机安装型

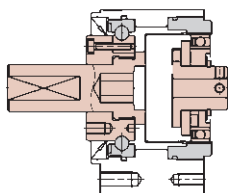
Motor mounting type

与高性能小型伺服电动机组合而成的减速机。相同尺寸的齿轮条件下，拥有最高的输出特性。

This is a gear head designed to be combined with a high-performance compact servo motor. It sports the ultimate output characteristics among gears of the same size.

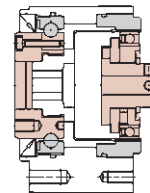
1U形状轴输出型: 1U-CC

1U shape shaft output type: 1U-CC



1U形状法兰输出型: 1U-CC-F

1U shape flange output type: 1U-CC-F



轴输出型: 2HX-J

Shaft output type: 2HX-J

4点接触滚珠轴承

Four-point contact ball bearing

输出轴(低速轴)

Output shaft (low-speed shaft)

输出法兰(旋转部)

Output flange (rotor)

柔轮

Flexspline

刚轮(壳体)

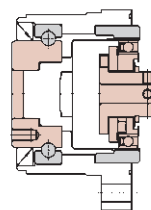
Circular spline (case)

波发生器(输入部)

Wave generator (input part)

法兰输出型: 2XH-F

Flange output type: 2XH-F



※固定刚轮(壳体)时输出轴的旋转方向与输入轴(波发生器)的旋转方向相反。

When the circular spline (case) is fixed, the output shaft and input shaft (wave generator) rotate in opposite directions.

型号·符号 Model and symbol

Harmonic Drive CSF- mini系列根据型号可分为4类。根据型号分为6种，可变选项丰富。订货时请参考下述符号。

The Harmonic Drive CSF-mini series consists of wide variety of products including four model numbers and three models. Place an order using the following symbols as a reference.

CSF - 14 - 100 - 2XH - F - 规格 SP

表235-1
Table 235-1

机型名称 Model name	型号 Model No.	减速比 注1 Reduction ratio Note 1				型式 Model	特殊规格 Special specification
CSF系列 CSF series	5	30	50	—	100	1U=轴输入型、轴输出（双轴型） 1U-F=轴输入型、法兰输出 1U-CC=1U形状的电动机安装型、轴输出 1U-CC-F=1U形状的电动机安装型、法兰输出 2XH-J=电动机安装型、轴输出 2XH-F=电动机安装型、法兰输出	SP=形状、性能等特殊规格 空白=标准品 SP= special specifications such as shapes and performance None= standard product
	8	30	50	—	100	1U=Input shaft type, shaft output type 1U-F=Input shaft type, flange output type 1U-CC=1U shape motor mounting type, shaft output type 1U-CC-F=1U shape motor mounting type, flange output type 2XH-J= Motor mounting type, shaft output 2XH-F= Motor mounting type, flange output	
	11	30	50	—	100		
	14	30	50	80	100		

注1: 减速比表示的是输入: 波发生器（输入轴），固定: 刚轮（壳体），输出: 输出轴、输出法兰时的情况。

Note 1 The reduction ratio indicates the value for the following condition. Input: wave generator, fixed: circular spline, output: flexspline

技术数据 Technical Data

额定表 Rating table

表235-2
Table 235-2

型号 Model	减速比 Reduction ratio	输入2000r/min时的 额定转矩 Rated torque at input 2000r/min	起动停止时的 容许峰值转矩 Peak torque at start/stop	平均负载转矩的 容许最大值 Permissible max. value of ave. load torque	瞬间容许最大转矩 Instantaneous permissible max. torque	容许最高 输入转速 Permissible max. input rotational speed	容许平均 输入转速 Permissible ave. input rotational speed	转动惯量 (1/4GD ²) Inertia moment (1/4GD ²)
		Nm	Nm	Nm	Nm	r/min	r/min	kgcm ²
5	30	0.25	0.5	0.38	0.9	10000	6500	2.5×10 ⁻⁴ 2.5×10 ⁻⁴
	50	0.4	0.9	0.53	1.8			
	100	0.6	1.4	0.94	2.7			
8	30	0.9	1.8	1.4	3.3	8500	3500	3.2×10 ⁻³ 3.0×10 ⁻³
	50	1.8	3.3	2.3	6.6			
	100	2.4	4.8	3.3	9.0			
11	30	2.2	4.5	3.4	8.5	8500	3500	1.4×10 ⁻² 1.2×10 ⁻²
	50	3.5	8.3	5.5	17			
	100	5.0	11	8.9	25			
14	30	4.0	9.0	6.8	17	8500	3500	3.4×10 ⁻¹ 3.3×10 ⁻¹
	50	5.4	18	6.9	35			
	80	7.8	23	11	47			
	100	7.8	28	11	54			

※1 转动惯量的上段为1U型、下段为2XH型的数值。

The upper value of inertia moment is for 1U type, whereas, the lower value of it is for 2XH type.

角度传达精度 Angle transmission accuracy

(用语说明请参照“技术资料”。)
See "Engineering data" for a description of terms.表 236-1
Table 236-1

减速比 Reduction ratio	单位 Specification	型号 Model	5	8	11	14
30		$\times 10^{-3}\text{rad}$	1.20	0.58	0.58	0.58
		arc min	4.00	2.00	2.00	2.00
50以上 50 or more		$\times 10^{-3}\text{rad}$	0.87	0.58	0.44	0.44
		arc min	3.00	2.00	1.50	1.50

滞后损失 Hysteresis loss

(用语说明请参照“技术资料”。)
See "Engineering data" for a description of terms.表 236-2
Table 236-2

减速比 Reduction ratio	型号 Model	5	8	11	14
30	$\times 10^{-4}\text{rad}$	8.7	8.7	8.7	8.7
	arc min	3.0	3.0	3.0	3.0
50	$\times 10^{-4}\text{rad}$	8.7	5.8	5.8	5.8
	arc min	3.0	2.0	2.0	2.0
80以上 80 or more	$\times 10^{-4}\text{rad}$	8.7	5.8	5.8	2.9
	arc min	3.0	2.0	2.0	1.0

最大齿隙量 Max. backlash quantity

(用语说明请参照“技术资料”。)
See "Engineering data" for a description of terms.表 236-3
Table 236-3

减速比 Reduction ratio	型号 Model	8	11	14
30	$\times 10^{-5}\text{rad}$	28.6	23.8	29.1
	arc sec	59	49	60
50	$\times 10^{-5}\text{rad}$	17	14.1	17.5
	arc sec	35	24	36
80	$\times 10^{-5}\text{rad}$	—	—	11.2
	arc sec	—	—	23
100	$\times 10^{-5}\text{rad}$	8.7	7.3	8.7
	arc sec	18	15	18

起动转矩 Starting torque

(用语说明请参照“技术资料”。) 下表的数值会根据使用条件的不同而有所变化, 请作为参考值使用。
See "Engineering data" for a description of terms. As the values in the table below vary depending on the use conditions, use them as reference values.表 236-4
单位: cNm
Table 236-4
Unit: cNm

减速比 Reduction ratio	型号 Model	5	8	11	14
30		0.53	1.3	3.4	6.4
50		0.40	0.80	2.0	4.1
80		—	—	—	2.8
100		0.30	0.59	1.5	2.5

增速起动转矩 Overdrive starting torque

(用语说明请参照“技术资料”。) 下表的数值会根据使用条件的不同而有所变化, 请作为参考值使用。
See "Engineering data" for a description of terms. As the values in the table below vary depending on the use conditions, use them as reference values.表 236-5
单位: Nm
Table 236-5
Unit: Nm

减速比 Reduction ratio	型号 Model	5	8	11	14
30		0.29	0.70	1.7	2.4
50		0.21	0.55	1.2	1.6
80		—	—	—	1.6
100		0.27	0.75	1.5	1.8

棘爪扭矩 Ratcheting torque

(用语说明请参照“技术资料”。)
See "Engineering data" for a description of terms.表 236-6
单位: Nm
Table 236-6
Unit: Nm

减速比 Reduction ratio	型号 Model	5	8	11	14
30		2.7	11	29	59
50		3.2	12	34	88
80		—	—	—	110
100		3.5	14	43	84

屈曲转矩 Buckling torque

(用语说明请参照“技术资料”。)
See "Engineering data" for a description of terms.表 236-7
单位: Nm
Table 236-7
Unit: Nm

型号 Model	5	8	11	14
全减速比 Total reduction ratio	9.8	35	90	190

主轴承的规格 Checking main roller bearing

CSF-mini系列组装有精密4点接触滚珠轴承用于直接支撑外部负载（输出部）。

为充分发挥CSF-mini系列的性能，请确认最大负载静力矩、4点接触滚珠轴承的使用寿命以及静态安全系数。

各数值的计算公式请参照第028~032页的“技术资料”。

A precision cross roller bearing is built in the unit type and the gear head type to directly support the external load (output flange) (precision 4-point contact ball bearing for the CSF-mini series).

Check the maximum load moment load, life of the bearing and static safety coefficient to fully bring out the performance of the unit type.

See the page 028 to 032 of "Engineering data" for each calculation formula.

■ 确认步骤

Checking procedure

① 确认最大负载静力矩 (M_{max})

Checking the maximum load moment load

计算最大负载静力矩 (M_{max})

Obtain the maximum load moment load (M_{max}).

最大负载静力矩 (M_{max}) $\leq$ 容许力矩 (M_c)

Maximum load moment load (M_{max}) $\leq$ permissible moment (M_c)

② 确认使用寿命

Checking the life

计算平均径向负载 (F_{rav})、平均轴向负载 (F_{aav})

Obtain the average radial load (F_{rav}) and the average axial load (F_{aav}).

计算径向负载系数 (X)、轴向负载系数 (Y)

Obtain the radial load coefficient (X) and the axial load coefficient (Y).

计算确认使用寿命

Calculate the life and check it.

③ 确认静态安全系数

Checking the static safety coefficient

计算径向当量静负荷 (P_o)

Obtain the static equivalent radial load coefficient (P_o).

确认静态安全系数 (f_s)

Check the static safety coefficient. (f_s)

■ 主轴承规格

Main roller bearing specifications

规格

Specifications

表237-1
Table 237-1

型号 Model	滚子的节圆直径 Pitch circle dia. of a roller	偏置量 Offset amount	基本额定负载 Basic rated load		容许静力矩 Permissible moment load	力矩刚性 Moment rigidity	容许径向负载※ Permissible radial load※	容许轴向负载 Permissible thrust load
	dp	R	基本额定动负载 Basic dynamic rated load	基本额定静负载 Basic static rated load				
	mm	mm	$\times 10^3 \text{ N}$	$\times 10^3 \text{ N}$				
5	13.5	4.85	9.14	7.63	0.89	7.41×10^2	90	270
8	20.5	7.3	21.6	19.0	3.46	2.76×10^3	200	630
11	27.5	9	38.9	35.4	6.6	7.41×10^3	300	1150
14	35	11.4	61.2	58.5	13.2	1.34×10^4	550	1800

※ 容许径向负载是指双轴型 (1U) 输出轴侧以及齿轮箱轴输出型 (2XH-J) 轴承中央部的数值。力矩刚性的数值为平均值。

Permissible radial load is the value on the center of output shaft side of both shaft type (1U) and that of gear head shaft output type (2XH-J).

润滑 Lubrication

表237-2
Table 237-2

CSF-mini系列的标准润滑方法为润滑脂润滑。

出厂前已封入润滑脂，因此组装时无需注入、涂抹润滑脂。此外，使用下述润滑脂进行润滑。

Grease lubrication is the standard lubrication of the CSF-mini series.

As products are greased and shipped, you are not required to apply grease during assembly. The following kinds of grease are used for lubricant.

润滑部 Lubricated area	减速机部 Reducer	主轴承部 Main roller bearing
使用润滑剂名称 Lubricant name used	Harmonic润滑脂 SK-2 Harmonic grease SK-2	Mul temp HL-D
制造商 Manufacturer	日本Harmonic Drive Systems Inc.公司 Harmonic Drive Systems	协同油脂 Kyodo Yushi
基础油 Base oil	精制矿物油 Refined oil	合成烃油 Composite hydrocarbon oil
增稠剂 Puffing agent	锂皂 Lithium soap	锂皂 Lithium soap
混合粘稠度 (25℃) Consistency (25℃)	295	280
油点 Drop point	198℃	210℃
外观 Appearance	绿色粘稠状 Green sticky state	白色粘稠状 White sticky state

轴输出: 1U外形图 Shaft output: outline drawing of 1U

拥有输入轴和输出轴完结型的双轴型组合。

本产品的CAD数据 (DXF) 可从本公司主页下载。

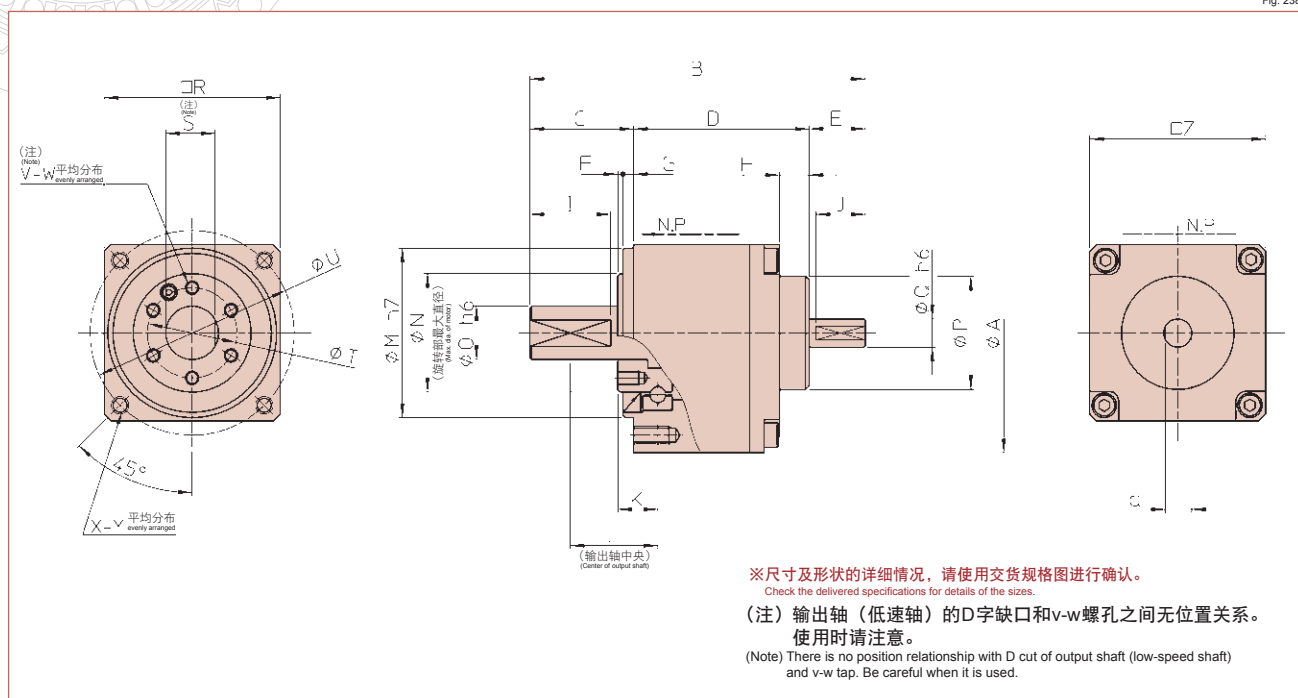
URL: <http://www.hds.co.jp/>

Conclusive type unit of full connection with input and output shaft.

You can download the CAD data (DXF) of this product from the following homepage.

URL: <http://www.hds.co.jp/>

图238-1
Fig. 238-1



尺寸表 Measurement table

表238-1
单位: mm
Table 238-1
Unit: mm

符号 Symbol	型号 Model	5	8	11	14
φ A		26.5	40	54	68
B		37	65.5	82.5	95.4
C		13	23	29.5	29.5
D		16	29.5	37	49.9
E		8	13	16	16
F		0.5	0.5	0.5	1.5
G		2.5	2.5	3	3
H		0.8	2.6	3.9	8.4
I		9	18	21.5	23
J		7	11	14	14
K		4.85	7.3	9	11.4
L		9.85	17.3	22	23.9
φ M h7		19.5	29	39	48
φ N		13	20	26.5	33.5
φ O h6		5	9	12	15
φ P		9	16	24	32
φ Q h6		3	5	6	8
□ R		20.4 ± 0.42	30.7 ± 0.46	40.9 ± 0.50	51.1 ± 0.50
S		4.6	8	10.5	14
φ T		9.8	15.5	20.5	25.5
φ U		23	35	46	58
V		3	4	6	6
W		M2 × 3	M3 × 4	M3 × 5	M4 × 6
X		4	4	4	4
Y		M2 × 3	M3 × 6	M4 × 8	M5 × 10
□ Z		20 ± 0.42	30 ± 0.46	40 ± 0.50	50 ± 0.50
a		2.6	4.5	5.5	7.5
重量 Mass (g)		35	130	240	440

法兰输出：1U-F外形图 Flange output: outline drawing of 1U-F

带输入轴的法兰输出完结型组合。

本产品的CAD数据（DXF）可从本公司主页下载。

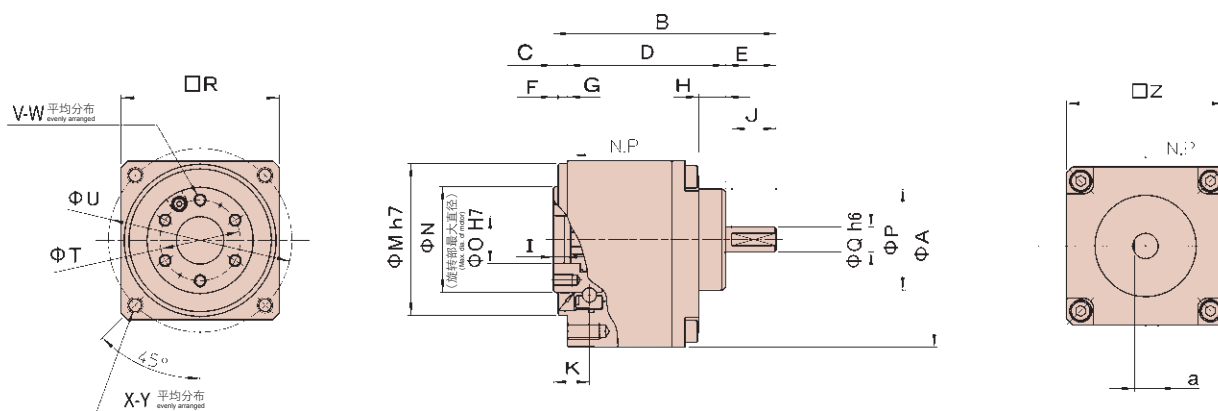
URL: <http://www.hds.co.jp/>

Flange output type unit of full connection with input and output shaft.

You can download the CAD data (DXF) of this product from the following homepage.

URL: <http://www.hds.co.jp/>

图239-1
Fig. 239-1



※尺寸及形状的详细情况，请使用交货规格图进行确认。
Check the delivered specifications for details of the sizes.

尺寸表 Measurement table

表239-1
单位: mm
Table 239-1
Unit: mm

符号 Symbol	型号 Model	5	8	11	14
Φ A		26.5	40	54	68
B		27	45.5	56.5	70.4
C		3	3	3.5	4.5
D		16	29.5	37	49.9
E		8	13	16	16
F		0.5	0.5	0.5	1.5
G		2.5	2.5	3	3
H		0.8	2.6	3.9	8.4
I		1.7	2.2	2.5	3.5
J		7	11	14	14
K		4.85	7.3	9	11.4
Φ M h7		19.5	29	39	48
Φ N		13	20	26.5	33.5
Φ O H7		5	9	12	15
Φ P		9	16	24	32
Φ Q h6		3	5	6	8
□ R		20.4±0.42	30.7±0.46	40.9±0.5	51.1±0.5
Φ T		9.8	15.5	20.5	25.5
Φ U		23	35	46	58
V		3	4	6	6
W		M2×3	M3×4	M3×5	M4×6
X		4	4	4	4
Y		M2×3	M3×6	M4×8	M5×10
□ Z		20.4±0.42	30±0.46	40±0.5	50±0.5
a		2.6	4.5	5.5	7.5
重量 Mass (g)		34	120	220	405

刚性 (弹簧常数) Rigidity (Spring constant)

(用语说明请参考“技术资料”。)
See "Engineering data" for a description of terms.

表240-1

Table 240-1

符号 Symbol		型号 Model	5		8		11		14	
			1U	1U-F	1U	1U-F	1U	1U-F	1U	1U-F
T ₁		Nm	0.075		0.29		0.80		2.0	
		kgfm	0.0077		0.030		0.082		0.20	
T ₂		Nm	0.22		0.75		2.0		6.9	
		kgfm	0.022		0.077		0.20		0.70	
减速比 Reduction ratio 30	K ₁	×10 ⁴ Nm/rad	0.009	0.010	0.031	0.034	0.077	0.084	0.172	0.188
		kgfm/arc min	0.003	0.003	0.009	0.010	0.023	0.025	0.051	0.056
	K ₂	×10 ⁴ Nm/rad	0.011	0.013	0.039	0.044	0.109	0.124	0.210	0.235
		kgfm/arc min	0.003	0.004	0.012	0.013	0.032	0.037	0.063	0.070
	K ₃	×10 ⁴ Nm/rad	0.012	0.016	0.046	0.054	0.134	0.158	0.286	0.335
		kgfm/arc min	0.004	0.005	0.014	0.016	0.040	0.047	0.085	0.100
	θ ₁	×10 ⁻⁴ rad	8.7	7.5	9.5	8.6	10	9.5	12	11
		arc min	3.0	2.6	3.2	3.0	3.6	3.3	4.0	3.6
	θ ₂	×10 ⁻⁴ rad	22	19	21	19	21	19	35	31
		arc min	7.5	6.4	7.3	6.6	7.4	6.6	12	11
减速比 Reduction ratio 50	K ₁	×10 ⁴ Nm/rad	0.011	0.013	0.039	0.044	0.177	0.221	0.286	0.335
		kgfm/arc min	0.003	0.004	0.012	0.013	0.053	0.066	0.085	0.100
	K ₂	×10 ⁴ Nm/rad	0.014	0.018	0.056	0.067	0.225	0.300	0.378	0.468
		kgfm/arc min	0.004	0.005	0.017	0.020	0.067	0.089	0.113	0.140
	K ₃	×10 ⁴ Nm/rad	0.017	0.025	0.067	0.084	0.236	0.320	0.440	0.568
		kgfm/arc min	0.005	0.007	0.020	0.025	0.070	0.095	0.131	0.170
	θ ₁	×10 ⁻⁴ rad	6.9	5.6	7.5	6.6	4.5	3.6	7.0	6.0
		arc min	2.4	2.0	2.6	2.3	1.6	1.2	2.4	2.0
	θ ₂	×10 ⁻⁴ rad	18	14	16	14	9.9	7.6	20	16
		arc min	6.0	4.8	5.4	4.7	3.4	2.6	6.8	5.6
减速比 Reduction ratio 80以上 80 or more	K ₁	×10 ⁴ Nm/rad	0.015	0.020	0.072	0.090	0.206	0.267	0.378	0.468
		kgfm/arc min	0.004	0.006	0.021	0.027	0.061	0.079	0.113	0.140
	K ₂	×10 ⁴ Nm/rad	0.018	0.027	0.080	0.104	0.243	0.333	0.460	0.601
		kgfm/arc min	0.005	0.008	0.024	0.031	0.072	0.099	0.137	0.179
	K ₃	×10 ⁴ Nm/rad	0.020	0.030	0.089	0.120	0.291	0.432	0.516	0.700
		kgfm/arc min	0.006	0.009	0.027	0.036	0.086	0.128	0.154	0.209
	θ ₁	×10 ⁻⁴ rad	5.0	3.7	4.1	3.2	3.9	3.0	5.3	4.3
		arc min	1.7	1.3	1.4	1.1	1.3	1.0	1.8	1.5
	θ ₂	×10 ⁻⁴ rad	13	9.2	9.8	7.7	8.8	6.6	16	12
		arc min	4.4	3.1	3.4	2.6	3.0	2.3	5.4	4.2

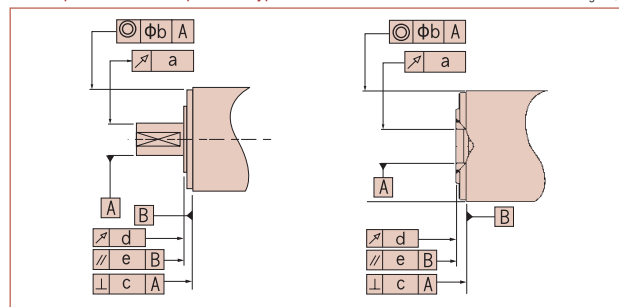
机械精度 Mechanical precision

CSF-mini系列的主轴承采用高精度的4点接触滚珠轴承, 实现了输出部的高机械精度。输出轴的机械精度如下所示。

CSF-mini series have four-point contact ball bearing of high precision on main shaft bearing, and realized the high mechanical precision of output part. The mechanical precision of the output shaft is shown below.

轴输入型的输出轴

The output shaft of the input shaft type

图240-1
Fig. 240-1

安装壳体的推荐精度

Recommended precision for the mounting case

表240-2
※T.I.R.单位: mm
Table 240-2
※T.I.R. Unit: mm

符号 Symbol	精度项目 Precision item	5		8		11		14	
		1U	1U-F	1U	1U-F	1U	1U-F	1U	1U-F
a	1U 输出轴前端跳动 1U Fluctuation on the edge of the output shaft	0.030	—	0.030	—	0.030	—	0.030	—
	1U-F 输出轴内径面跳动 1U-F Fluctuation on the inner diameter of the output shaft	—	0.005	—	0.005	—	0.005	—	0.005
b	安装凹圆同轴度 Concentricity of the mounting spigot	0.040		0.040		0.055		0.055	
c	安装面直角 Squareness of the mounting face	0.020		0.020		0.025		0.025	
d	输出法兰面跳动 Fluctuation on the output flange face	0.005		0.005		0.005		0.005	
e	安装面和输出法兰面的平行度 Parallelism of the mounting face and the output flange face	0.015		0.020		0.030		0.030	

※T.I.R.: 表示测定部旋转1次时千分表读数的总量。
T.I.R.: This indicates the total reading of the dial gauge when the measuring part is rotated once.

效率特性 Efficiency characteristics

效率会因以下条件而有所差异。

The efficiency varies depending on the following conditions.

■ 减速比

Reduction ratio

■ 输入转速

Input rotational speed

■ 负载转矩

Load torque

■ 温度

Temperature

■ 润滑条件（润滑剂的种类及其使用量）

Lubrication condition (Type of lubricant and the quantity)

测定条件

Measuring condition

表241-1
Table 241-1

负载转矩 Built-in	额定表所示的额定转矩（参照第049页） Measurement by building the recommended built-in precision into the product		
润滑条件 Lubricating condition	润滑脂 Grease lubrication	名称 Name	Harmonic润滑脂 SK-2 Harmonic grease SK-2
		涂沫量 Application qty.	正确涂沫量 Appropriate application quantity

■ 效率修正系数

Efficiency correction coefficient

负载转矩小于额定转矩时，效率值降低。

请根据图241-1计算出修正系数 K_e ，并参考以下计算示例计算出效率。

If the load torque is smaller than the rated torque, the efficiency value lowers.

Obtain correction coefficient K_e from the efficiency correction coefficient graph 241-1 to obtain the efficiency using the following example of calculation.

例：以CSF-8-100-1U为例，计算出以下条件下的效率 η （%）。

输入转速：1000r/min 润滑方法：润滑脂润滑

负载转矩2.0Nm 润滑剂温度：20℃

Example of calculation: Efficiency η (%) under the following condition is obtained from the example of CSF-8-100-1U.

Input rotational speed: 1000r/min Lubrication method: Grease lubrication

Load torque: 2.0Nm Lubricant temperature: 20℃

型号8·减速比100的额定转矩为2.4Nm（额定表：第049页），因此转矩比 α 为0.83。（ $\alpha = 2.0/2.4 \div 0.83$ ）

Since the rated torque of model number 8 with a reduction ratio of 100 is 2.4 Nm (Ratings: Page 049), the torque ratio α is 0.83. ($\alpha = 2.0/2.4 \div 0.83$)

■ 根据图241-1，计算出效率修正系数 $K_e = 0.99$

The efficiency correction coefficient is $K_e = 0.99$ from Graph 241-1.

■ 负载转矩为2.0Nm时的效率 η 为： $\eta = K_e \cdot \eta_R = 0.99 \times 77\% = 76\%$ 。

Efficiency η at load torque 2.0 Nm: $\eta = K_e \cdot \eta_R = 0.99 \times 77 = 76\%$

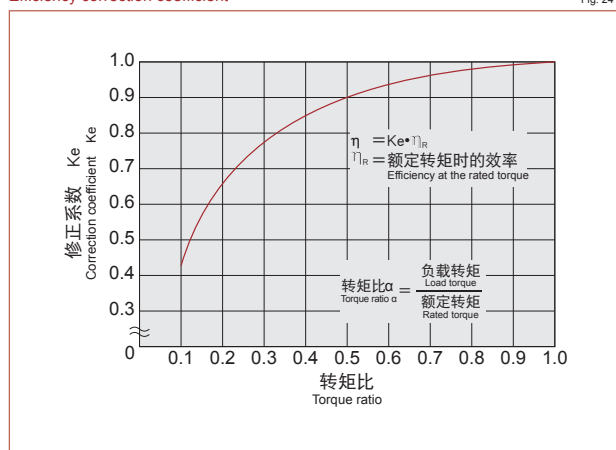
※负载转矩大于额定转矩时的效率修正系数 $K_e = 1$ 。

Efficiency correction coefficient $K_e = 1$ holds when the load torque is greater than the rated torque.

效率修正系数

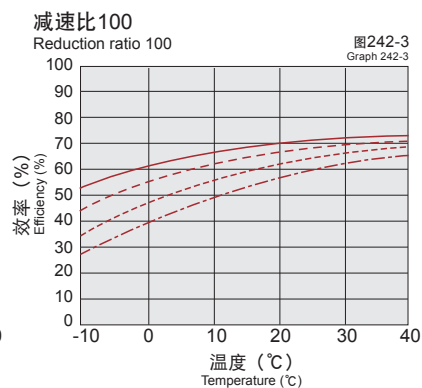
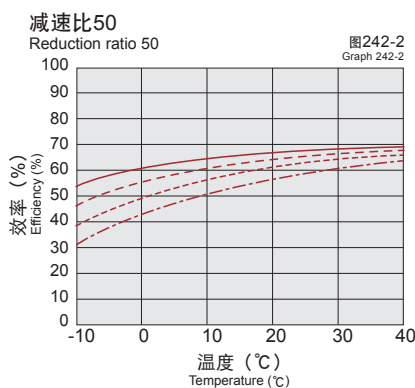
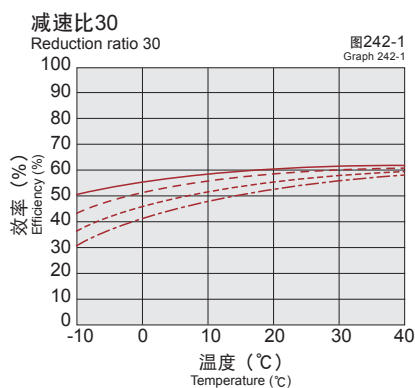
Efficiency correction coefficient

图241-1
Fig. 241-1

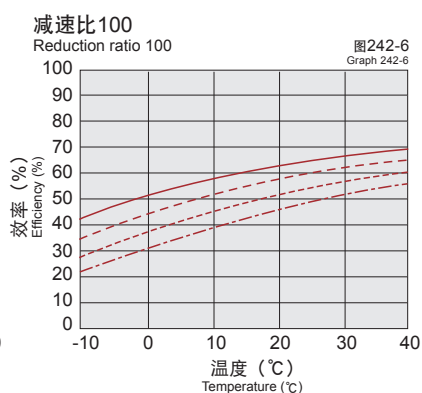
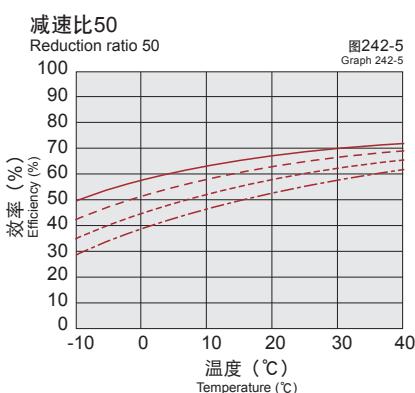
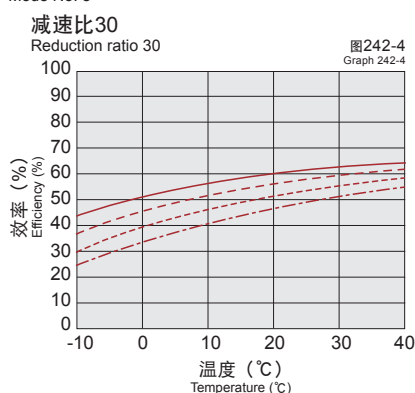


■ 额定转矩时的效率 Efficiency at rated torque

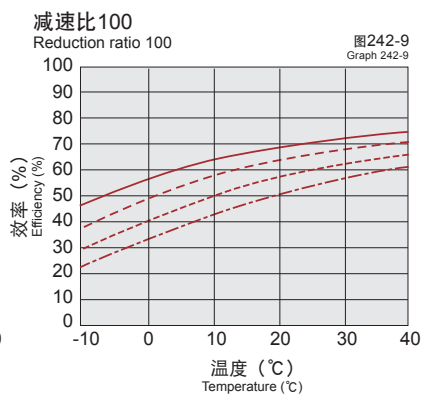
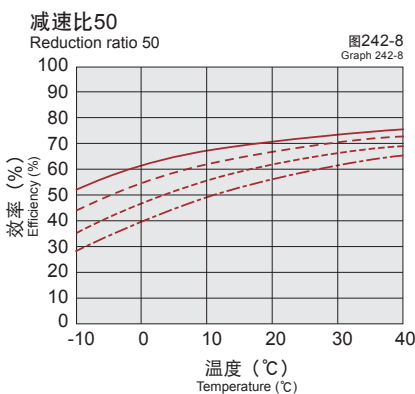
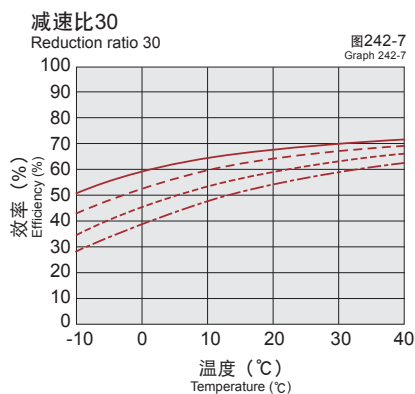
型号: 5
Mode No. 5



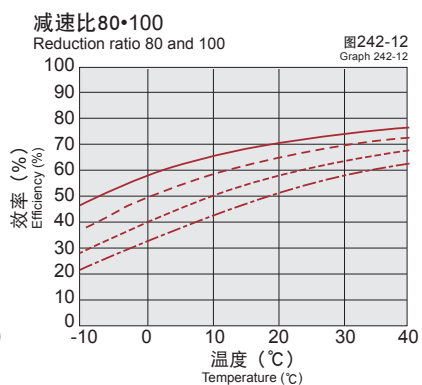
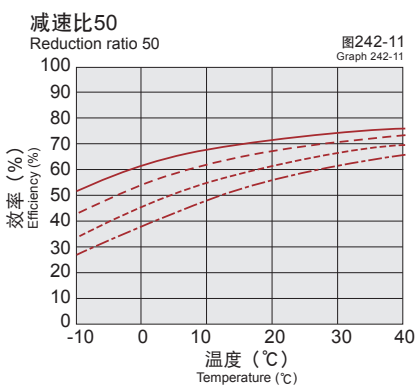
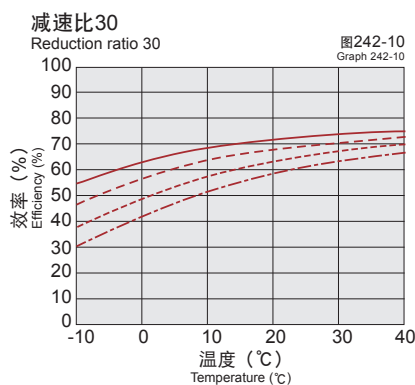
型号: 8
Mode No. 8



型号: 11
Mode No. 11



型号: 14
Mode No. 14



输入转速 ————— 500r/min - - - - - 1000r/min 2000r/min - . - . - 3500r/min
Input rotational speed

无负载运行转矩 On no-load running torque

无负载运行转矩是指在无负载状态下，使Harmonic Drive转动的必要的输入侧（高速轴侧）转矩。

No-load running torque means the torque required to put Harmonic Drive under a no-load condition.

※详细数值请咨询本公司授权代理商。

Contact us for detailed value.

不同速比修正量

Correction quantity by reduction

Harmonic Drive的无负载运行转矩会根据速比而发生改变。图243-1~243-4为减速比100的数值。其他减速比，请加上表243-2所示的修正量进行计算。

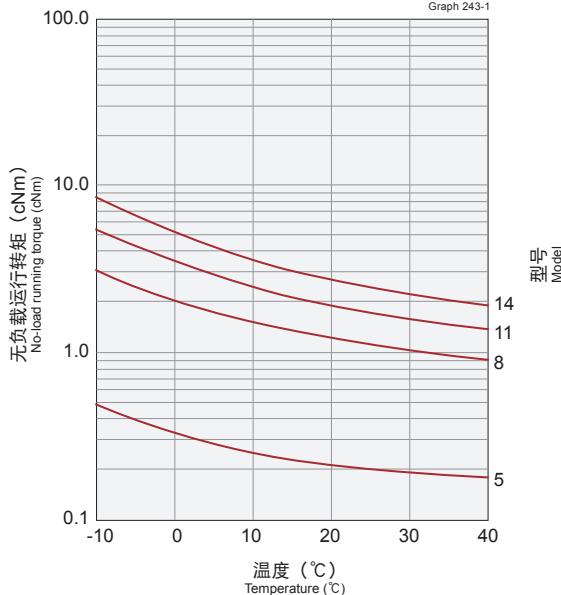
The no-load running torque of Harmonic Drive varies depending on the reduction ratio. Graphs 243-1 to 243-4 show the values for a reduction ratio of 100. Obtain other reduction ratios by adding the correction quantity shown in the right-hand table (Table 243-2).

减速比100的无负载运行转矩

No-load running torque for a reduction ratio of 100

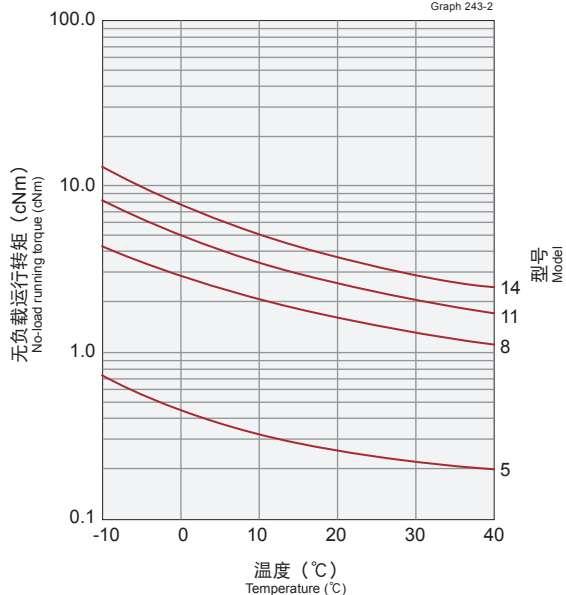
输入转速500r/min
Input rotational speed: 500r/min

图243-1
Graph 243-1



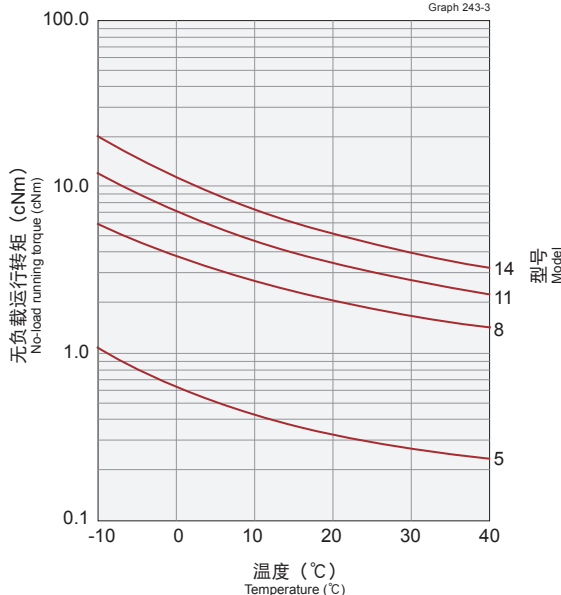
输入转速1000r/min
Input rotational speed: 1000r/min

图243-2
Graph 243-2



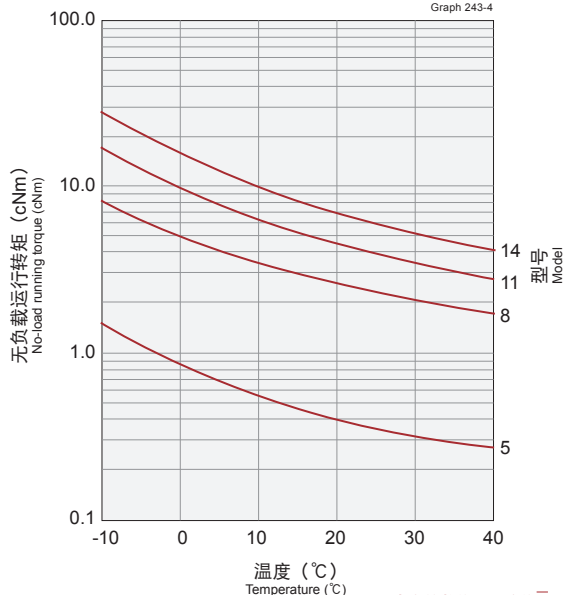
输入转速2000r/min
Input rotational speed: 2000r/min

图243-3
Graph 243-3



输入转速3500r/min
Input rotational speed: 3500r/min

图243-4
Graph 243-4



※本表的数值为平均值X。
The values in this graph are average values (X).

测定条件

Measuring condition

表243-1
Table 243-1

减速比100 Reduction ratio 100			
润滑条件 Lubrication condition	润滑脂润滑 Grease lubrication	名称 Name	Harmonic润滑脂 SK-2 Harmonic grease SK-2
转矩值是指在输入为2000r/min的情况下磨合运转2小时以上的数值 The torque value is the value after a trial run for two hours or longer at an input of 2000 r/min.			

无负载运行转矩修正量

Correction quantity for the no-load running torque

表243-2
单位: cNm
Table 243-2
Unit: cNm

型号 Model	减速比 Reduction ratio	30	50	80
5		0.26	0.11	—
8		0.44	0.19	—
11		0.81	0.36	0.1
14		1.33	0.58	—

输入部容许负载 Permissible load of the input part

■输入轴的容许负载

Permissible load of the input shaft

轴输入型的输入部由2个单列深槽轴承支撑。为充分发挥轴输入型的性能，请确认向输入部施加的负载。

图244-1表示轴承的支撑点。『a』『b』的尺寸请参照表244-1。此外，图244-1表示的是各型号的容许最大径向负载和轴向负载的关系。表244-1的数值是平均输入转速为2,000r/min，基本额定使用寿命 $L_{10}=7,000$ h时的数值。

The input part of the input shaft type is supported by two single-row deepgroove bearings. Check the load applied to the input part to fully bring out the performance of the input shaft type.

Figure 244-1 shows the supporting point of the bearing. See Table 244-1 for the size of (a) and (b). Graph 244-1 shows the relation between the maximum permissible radial load and the thrust load by the model number.

The values in Graph 244-1 are those assuming that the average input rotational speed is 2,000 r/min and the basic rated life, L_{10} , is 7,000 hours.

例：向型号14的输入轴施加8N的轴向负载（Fa）时，容许最大径向负载（Fr）的数值为20N。

Example: When an 8-N thrust load (Fa) is applied to the input shaft of model number 14, the value of the maximum permissible radial load (Fr) is 20 N.

输入部的轴承规格

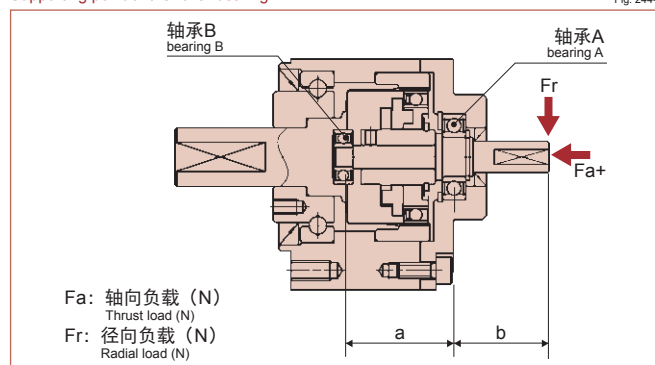
Bearing specifications of the input part

表244-1
Table 244-1

型号 Model	轴承A Bearing A			轴承B Bearing B			轴承间的距离a Distance between bearings	输入轴的外伸长度b Overhang length of the input shaft	最大径向负载 Maximum radial load
	型号 Model	基本额定动负载 Basic dynamic rated load	基本额定静负载 Basic static rated load	型号 Model	基本额定动负载 Basic dynamic rated load	基本额定静负载 Basic static rated load			
		Cr (N)	Cor (N)		Cr (N)	Cor (N)			
5	SSLF-630DD	196	59	L-520WO2	176	54	10.8	9.25	8
8	MR126	715	292	MR83	560	170	16.65	18	10
11	689	1330	665	624	1300	485	20.6	21.9	20
14	6900ZZ	2700	1270	605ZZ	1330	505	28.25	24.25	30

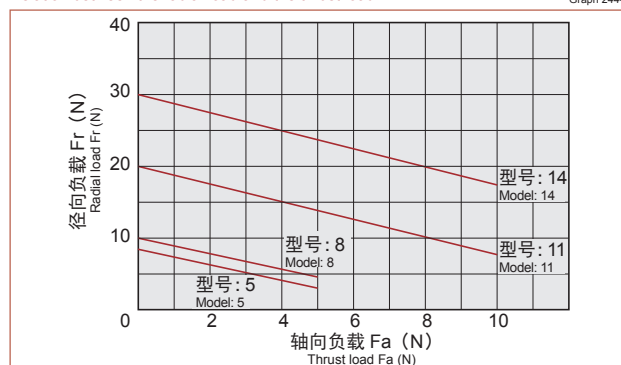
轴承的支点

Supporting point of the roller bearing

图244-1
Fig. 244-1

轴向负载和径向负载的关系

Relation between the radial load and the thrust load

图244-1
Graph 244-1

安装和传递转矩 Installation and transmission torque

■往装置上安装

Installation on the equipment

将CSF-mini系列安装到装置上时，请在确认安装面的平坦度以及螺孔部是否存在毛刺后再将安装法兰（图245-1的A部）与螺栓拧紧。

Check the flatness of the mounting face and burrs on the tap to install the CSF-mini series on the equipment, and tighten the mounting flange (A in Figure 245-1) with bolts.

安装法兰（图245-1的A部）螺栓*的拧紧转矩

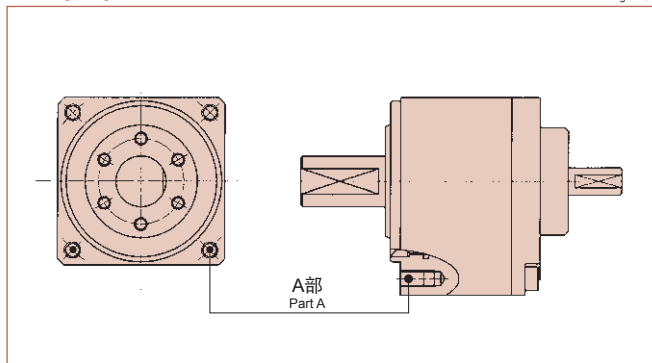
Tightening torque of the bolt* of the mounting flange (A in Figure 245-1)

表244-2
Table 244-2

项目 Item	型号 Model	5	8	11	14
螺栓数量 Number of bolts		4	4	4	4
螺栓规格 Bolt size		M2	M3	M4	M5
安装P.C.D. Mounting P.C.D.	mm	23	35	46	58
拧紧转矩 Tightening torque	Nm	0.25	0.85	2.0	3.96
	kgfm	0.03	0.09	0.20	0.40
螺钉部装配的最短长度 Min. length of engagement of the screw	mm	2.4	3.6	4.8	6.0
传递转矩 Transmission torque	Nm	3.5	12	29	57
	kgfm	0.4	1.3	2.9	5.9

※推荐螺栓名称：JIS B 1176内六角螺栓、强度分类：JIS B 1051 12.9以上
Recommended bolt name: JIS B 1176 hexagonal bolt, intensity type: JIS B 1051 12.9 or higher.

安装法兰 Mounting flange

图245-1
Fig. 245-1

■安装输出部的负载

Installation of the load on the output part

向输出部安装负载时，请考虑主轴承的规格（参照第051页）实施安装。
Install the load on the output part taking the specifications of the main roller bearing (see Page 051) into consideration.

安装法兰（图245-2的B部）螺栓*的拧紧转矩

Tightening torque of the bolt* of the mounting flange (B in Figure 245-2)

表245-1
Table 245-1

项目 Item	型号 Model	5	8	11	14
螺栓数量 Number of bolts		3	4	6	6
螺栓规格 Bolt size		M2	M3	M3	M4
安装P.C.D. Mounting P.C.D.	mm	9.8	15.5	20.5	25.5
拧紧转矩 Tightening torque	Nm	0.54	2.0	2.0	4.6
	kgfm	0.06	0.20	0.20	0.47
传递转矩 Transmission torque	Nm	2	13	26	55
	kgfm	0.3	1.3	2.6	5.6

输出法兰由于有防止漏油措施，因此不需要涂抹密封剂。

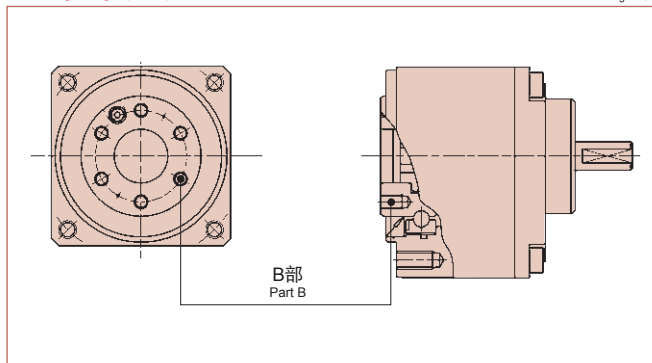
As measures have been taken against oil leakage of the output flange, no sealing agent needs to be applied.

*推荐螺栓名称：JIS B 1176内六角螺栓、强度区分：JIS B 1051 12.9以上

Recommended bolt name: JIS B 1176 hexagonal bolt, intensity type: JIS B 1051 12.9 or higher.

安装法兰（1U-F）

Mounting flange (1U-F)

图245-2
Fig. 245-2

在轴输出上安装皮带轮、小齿轮时，不要对输出轴施加冲击。否则可能会引起减速机的精度下降或故障。

Do not allow the output shaft to receive a shock when you install a pulley and pinion. It can deteriorate the precision of the reducer and cause failure.

轴输出: 1U-CC外形图 Shaft output: outline drawing of 1U-CC

外形为1U形状、输出部为轴输出的电动机安装型。

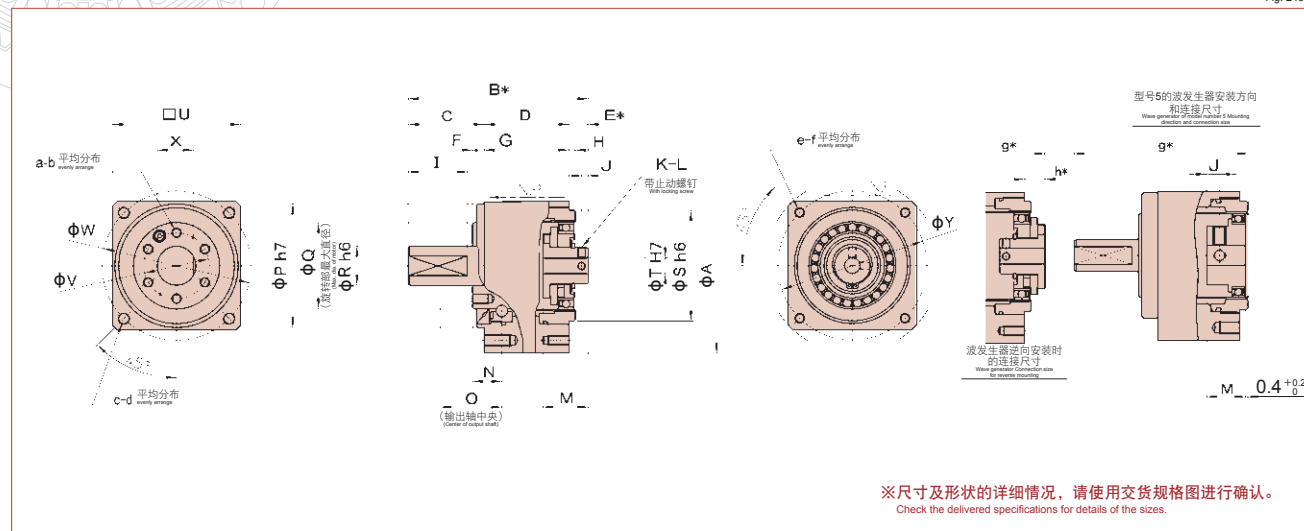
本产品的CAD数据(DXF)可从本公司主页下载。

URL: <http://www.hds.co.jp/>

The motor mounting type: the outline is 1U shape, and the output part is the shaft output. You can download the CAD data (DXF) of this product from the following homepage.

URL: <http://www.hds.co.jp/>

图246-1
Fig. 246-1



※尺寸及形状的详细情况, 请使用交货规格图进行确认。
Check the delivered specifications for details of the sizes.

尺寸表 Measurement table

表246-1
单位: mm
Table 246-1
Unit: mm

符号 Symbol	型号 Model	5	8	11	14
φA		26.5	40	54	68
B*		30.5	51	64.3	70
C		13	23	29.5	29.5
D		12.7	21.5	26.5	33
E*		4.8 ^{0.2}	6.5 ^{0.3}	8.3 ^{0.7}	7.5 ^{0.8}
F		0.5	0.5	0.5	1.5
G		2.5	2.5	3	3
H		1.3	1.5	2	2.5
I		9	18	21.5	23
J		2	2	3	2.5
K		2	2	2	2
L		M2×3	M2×3	M3×4	M3×4
M		6	12	16	17.6
N		4.85	7.3	9	11.4
O		9.85	17.3	22	23.9
φP h7		19.5	29	39	48
φQ		13	20	26.5	33.5
φR h6		5	9	12	15
φS h6		17	26	35	43
φT H7		3	3	5	6
□U		20.4±0.42	30.7±0.46	40.9±0.5	51.1±0.5
φV		9.8	15.5	20.5	25.5
φW		23	35	46	58
X		4.6	8	10.5	14
φY		22.5	34	46	58
a		3	4	6	6
b		M2×3	M3×4	M3×5	M4×6
c		4	4	4	4
d		M2×3	M3×6	M4×8	M5×10
e		4	4	4	4
f		M2×3	M2.5×5	M3×6	M4×8
g*		27	48.7	62.1	70.4
h*		—	4.2 ^{0.3}	6.1 ^{0.7}	7.9 ^{0.8}
重量 Mass (g)		27	111	176	335

●带*符号的B·E·g·h尺寸是指构成Harmonic Drive的三个部件(波发生器、柔轮、刚轮)轴向的连接位置以及容许公差。尺寸会对性能、强度造成影响, 因此请严格遵守。

The B, E, g and h sizes indicated by an asterisk are the mounting positions in the shaft direction and allowance of the three parts (wave generator, flexspline, circular spline) comprising Harmonic Drive. Strictly observe these sizes as they affect the performance and intensity.

●产品交货时, 波发生器是独立包装的。

Wave generator is removed when the product is delivered.

法兰输出：1U-CC-F外形图 Flange output: outline drawing of 1U-CC-F

外形为1U形状，输出部为法兰输出的电动机安装型。

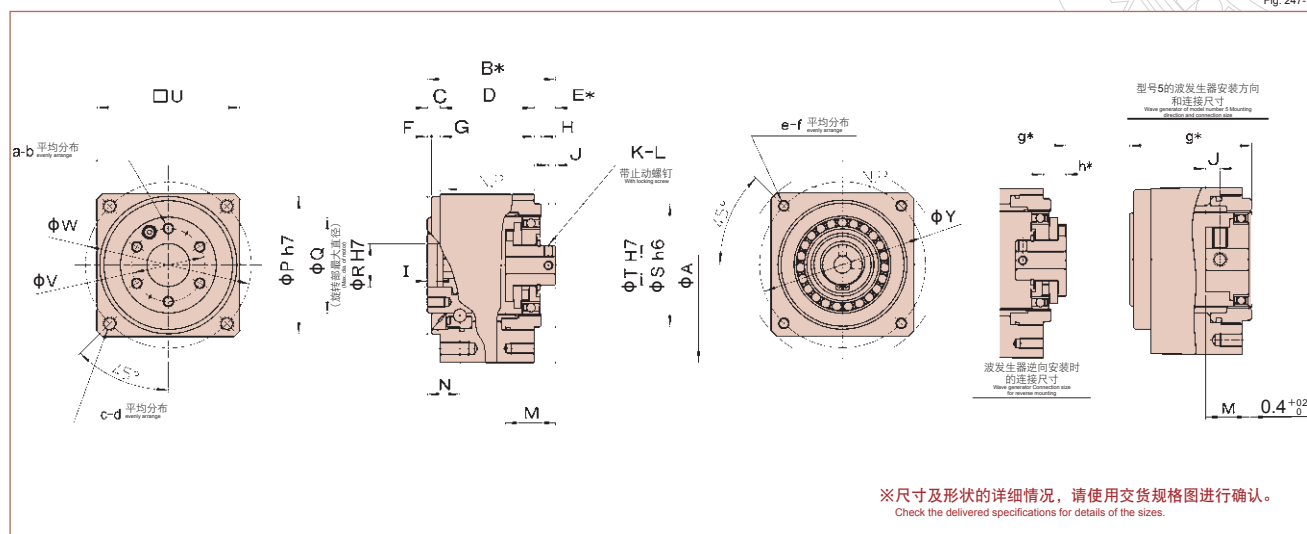
本产品的CAD数据（DXF）可从本公司主页下载。

URL: <http://www.hds.co.jp/>

The motor mounting type: the outline is 1U shape, and the output part is the flange output.

You can download the CAD data (DXF) of this product from the following homepage.

URL: <http://www.hds.co.jp/>

图247-1
Fig. 247-1

尺寸表 Measurement table

表247-1
单位: mm
Table 247-1
Unit: mm

符号 Symbol	型号 Model	5	8	11	14
φA		26.5	40	54	68
B*		20.5	31	38.3	45
C		3	3	3.5	4.5
D		12.7	21.5	26.5	33
E*		4.8 ^{0.2} _{-0.2}	6.5 ^{0.3} _{-0.3}	8.3 ^{0.7} _{-0.7}	7.5 ^{0.8} _{-0.8}
F		0.5	0.5	0.5	1.5
G		2.5	2.5	3	3
H		1.3	1.5	2	2.5
I		1.7	2.2	2.5	3.5
J		2	2	3	2.5
K		2	2	2	2
L		M2×3	M2×3	M3×4	M3×4
M		6	12	16	17.6
N		4.85	7.3	9	11.4
φP h7		19.5	29	39	48
φQ		13	20	26.5	33.5
φR H7		5	9	12	15
φS h6		17	26	35	43
φT H7		3	3	5	6
□U		20.4±0.42	30.7±0.46	40.9±0.5	51.1±0.5
φV		9.8	15.5	20.5	25.5
φW		23	35	46	58
φY		22.5	34	46	58
a		3	4	6	6
b		M2×3	M3×4	M3×5	M4×6
c		4	4	4	4
d		M2×3	M3×6	M4×8	M5×10
e		4	4	4	4
f		M2×3	M2.5×5	M3×6	M4×8
g*		17	28.7	36.1	45.4
h*		—	4.2 ^{0.3} _{-0.3}	6.1 ^{0.7} _{-0.7}	7.9 ^{0.8} _{-0.8}
重量 Mass (g)		25	100	150	295

●带*符号的B·E·g·h尺寸是指构成Harmonic Drive的三个部件（波发生器、柔轮、刚轮）轴向的连接位置以及容许公差。尺寸会对性能、强度造成影响，因此请严格遵守。

The B, E, g and h sizes indicated by an asterisk are the mounting positions in the shaft direction and allowance of the three parts (wave generator, flexspline, circular spline) comprising Harmonic Drive. Strictly observe these sizes as they affect the performance and intensity.

●产品交货时，波发生器是独立包装的。

Wave generator is removed when the product is delivered.

法兰输出: 2XH-F外形图 Flange output: outline drawing of 2XH-F

输出部为法兰输出的电动机安装型。

本产品的CAD数据 (DXF) 可从本公司主页下载。

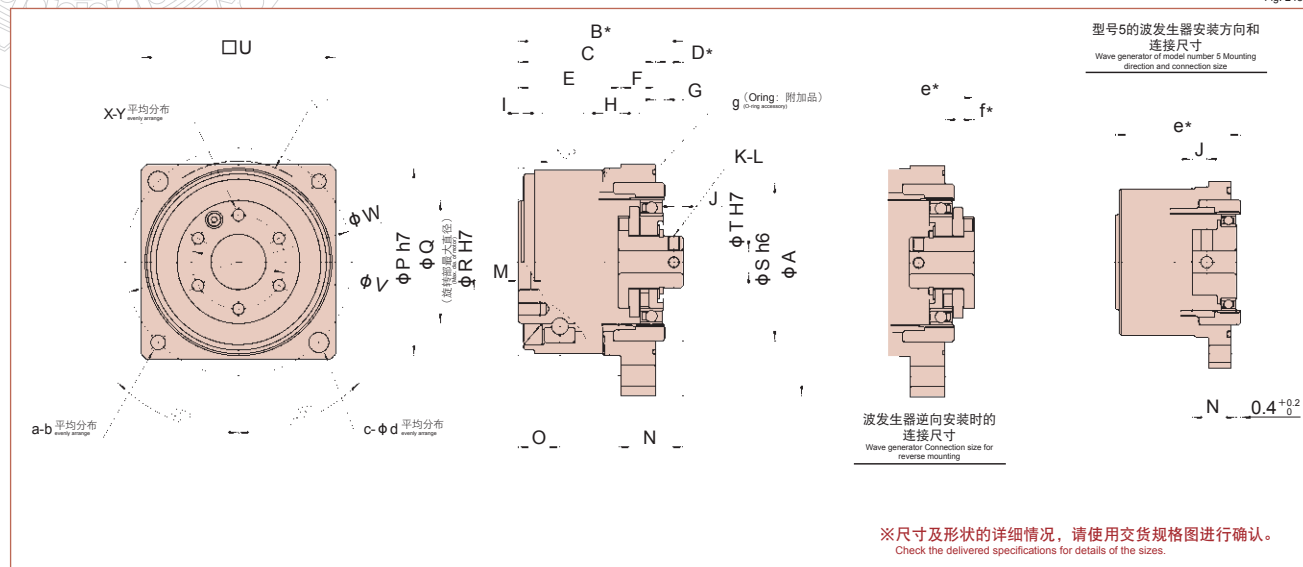
URL: <http://www.hds.co.jp/>

The output part is the flange output.

You can download the CAD data (DXF) of this product from the following homepage.

URL: <http://www.hds.co.jp/>

图248-1
Fig. 248-1



尺寸表 Measurement table

表248-1
单位: mm
Table 248-1
Unit: mm

符号 Symbol	型号 Model	5	8	11	14
ΦA		29	43.5	58	73
B*		20.5	31	38.3	45
C		15.7	24.5	30	37.5
D*		4.8 $_{-0.2}^{+0.1}$	6.5 $_{-0.3}^{+0.2}$	8.3 $_{-0.7}^{+0.6}$	7.5 $_{-0.8}^{+0.7}$
E		12.7	19	23.5	28
F		3	5.5	6.5	9.5
G		1.3	1.5	2	2.5
H		2	3	3	5
I		0.5	0.5	0.5	1.5
J		2	2	3	2.5
K		2	2	2	2
L		M2×3	M2×3	M3×4	M3×4
M		1.7	2.2	2.5	3.5
N		6	12	16	17.6
O		4.85	7.3	9	11.4
ΦP h7		20.5	31	40.5	51
ΦQ		13	20	26.5	33.5
ΦR H7		5	9	12	15
ΦS h6		17	26	35	43
ΦT H7		3	3	5	6
□U		22±0.42	32±0.46	43±0.50	53±0.50
ΦV		9.8	15.5	20.5	25.5
ΦW		25	37.5	50	62
X		3	4	6	6
Y		M2×3	M3×4	M3×5	M4×6
a		2	2	2	2
b		M2	M3	M4	M5
c		2	2	2	2
Φd		2.3	3.4	4.5	5.5
e*		17	28.7	36.1	45.4
f*		—	4.2 $_{-0.3}^{+0.2}$	6.1 $_{-0.7}^{+0.6}$	7.9 $_{-0.8}^{+0.7}$
g (附加品 accessory)		18.90×0.70	28.20×1.00	38.00×1.50	48.00×1.00
重量 Mass (g)		25	100	150	295

●带*符号的B·E·g·h尺寸是指构成Harmonic Drive的三个部件(波发生器、柔轮、刚轮)轴向的连接位置以及容许公差。尺寸会对性能、强度造成影响, 因此请严格遵守。

The B, E, g and h sizes indicated by an asterisk are the mounting positions in the shaft direction and allowance of the three parts (wave generator, flexspline, circular spline) comprising Harmonic Drive. Strictly observe these sizes as they affect the performance and intensity.

●产品交货时, 波发生器是独立包装的。

Wave generator is removed when the product is delivered.

轴输出: 2XH-J外形图 Shaft output: outline drawing of 2XH-J

输出部为轴输出的电动机安装型。

本产品的CAD数据 (DXF) 可从本公司主页下载。

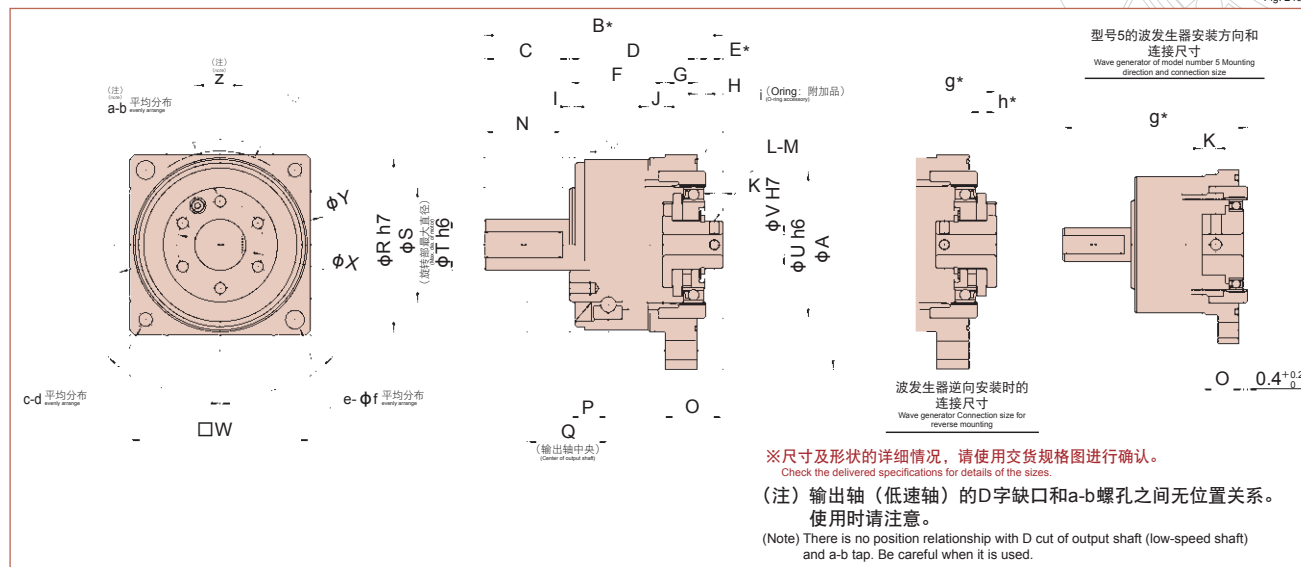
URL: <http://www.hds.co.jp/>

The output part is the shaft output.

You can download the CAD data (DXF) of this product from the following homepage.

URL: <http://www.hds.co.jp/>

图249-1
Fig. 249-1



尺寸表 Measurement table

表249-1
单位: mm
Table 249-1
Unit: mm

符号 Symbol	型号 Model	5	8	11	14
ΦA		29	43.5	58	73
B*		30.5	51	64.3	70
C		10	20	26	25
D		15.7	24.5	30	37.5
E*		4.8 $\frac{0}{-0.2}$	6.5 $\frac{0}{-0.3}$	8.3 $\frac{0}{-0.7}$	7.5 $\frac{0}{-0.8}$
F		12.7	19	23.5	28
G		3	5.5	6.5	9.5
H		1.3	1.5	2	2.5
I		0.5	0.5	0.5	1.5
J		2	3	3	5
K		2	2	3	2.5
L		2	2	2	2
M		M2×3	M2×3	M3×4	M3×4
N		9	18	21.5	23
O		6	12	16	17.6
P		4.85	7.3	9	11.4
Q		9.85	17.3	22	23.9
ΦR h7		20.5	31	40.5	51
ΦS		13	20	26.5	33.5
ΦT h6		5	9	12	15
ΦU h6		17	26	35	43
ΦV H7		3	3	5	6
□W		22±0.42	32±0.46	43±0.50	53±0.50
ΦX		9.8	15.5	20.5	25.5
ΦY		25	37.5	50	62
Z		4.6	8	10.5	14
a		3	4	6	6
b		M2×3	M3×4	M3×5	M4×6
c		2	2	2	2
d		M2	M3	M4	M5
e		2	2	2	2
Φf		2.3	3.4	4.5	5.5
g*		27	48.7	62.1	70.4
h*		—	4.2 $\frac{0}{-0.3}$	6.1 $\frac{0}{-0.7}$	7.9 $\frac{0}{-0.8}$
i (附加品 accessory)		18.90×0.70	28.20×1.00	38.00×1.50	48.00×1.00
重量 Mass (g)		27	111	176	335

- 带*符号的B、E、g、h尺寸是指构成Harmonic Drive的三个部件（波发生器、柔轮、刚轮）轴向的连接位置以及容许公差。尺寸会对性能、强度造成影响，因此请严格遵守。
The B, E, g and h sizes indicated by an asterisk are the mounting positions in the shaft direction and allowance of the three parts (wave generator, flexspline, circular spline) comprising Harmonic Drive. Strictly observe these sizes as they affect the performance and intensity.
- 产品交货时，波发生器是独立包装的。
Wave generator is removed when the product is delivered.

电动机安装型的波发生器孔径尺寸 Hole diameter size of the wave generator of the motor mounting type

电动机安装型的波发生器孔径尺寸可根据安装电动机的轴径在下表范围内进行变更。

You can change the hole diameter size of the wave generator of the motor mounting type within the range shown in the following table to match the shaft diameter of the mounting motor.

表250-1
单位: mm
Table 250-1
Unit: mm

符号 Symbol	型号 Model	5	8	11	14
2XH-F: ϕ T H7					
2XH-J: ϕ V H7					
1U-CC-F: ϕ T H7					
1U-CC: ϕ T H7					

注1) () 内的数值是波发生器为一体型时的数值(一体型、特殊规格)。标准品的波发生器带欧氏联轴节结构(自动调芯结构)。但是, 型号5的一体型为标准品。

注2) 止动螺钉的尺寸也会根据孔径发生改变。

注3) 可根据孔径实施键槽加工。

注4) 孔径尺寸变更后均为特殊规格。有关尺寸的详细情况, 请咨询本公司授权代理商。

Note-1: The parenthesized value indicates the value for the rigid-type (integral type, special specifications) wave generator. The standard wave generator is equipped with Oldham's coupling (self-aligning) mechanism. Note that the rigid type is standard for model number 5.

Note-2: The size of the locking screw may be changed due to the hole diameter.

Note-3: The key groove may be fabricated depending on the hole diameter.

Note-4: Special specifications apply to all changes of the hole diameter size. Contact our office for details of the sizes.

刚性(弹簧常数) Rigidity (Spring constant)

(用语说明请参考“技术资料”。)

See "Engineering data" for a description of terms.

表250-2
Table 250-2

符号 Symbol		型号 Model	5		8		11		14	
			2XH-J/1U-CC	2XH-F/1U-CC-F	2XH-J/1U-CC	2XH-F/1U-CC-F	2XH-J/1U-CC	2XH-F/1U-CC-F	2XH-J/1U-CC	2XH-F/1U-CC-F
T ₁		Nm	0.075		0.29		0.80		2.0	
		kgfm	0.0077		0.030		0.082		0.20	
T ₂		Nm	0.22		0.75		2.0		6.9	
		kgfm	0.022		0.077		0.20		0.70	
减速比 Reduction ratio 30	K ₁	$\times 10^4 \text{Nm/rad}$	0.009	0.010	0.031	0.034	0.077	0.084	0.172	0.188
		kgfm/arc min	0.003	0.003	0.009	0.010	0.023	0.025	0.051	0.056
	K ₂	$\times 10^4 \text{Nm/rad}$	0.011	0.013	0.039	0.044	0.109	0.124	0.210	0.235
		kgfm/arc min	0.003	0.004	0.012	0.013	0.032	0.037	0.063	0.070
	K ₃	$\times 10^4 \text{Nm/rad}$	0.012	0.016	0.046	0.054	0.134	0.158	0.286	0.335
		kgfm/arc min	0.004	0.005	0.014	0.016	0.040	0.047	0.085	0.100
	θ_1	$\times 10^{-4} \text{rad}$	8.7	7.5	9.5	8.6	10	9.5	12	11
		arc min	3.0	2.6	3.2	3.0	3.6	3.3	4.0	3.6
	θ_2	$\times 10^{-4} \text{rad}$	22	19	21	19	21	19	35	31
		arc min	7.5	6.4	7.3	6.6	7.4	6.6	12	11
减速比 Reduction ratio 50	K ₁	$\times 10^4 \text{Nm/rad}$	0.011	0.013	0.039	0.044	0.177	0.221	0.286	0.335
		kgfm/arc min	0.003	0.004	0.012	0.013	0.053	0.066	0.085	0.100
	K ₂	$\times 10^4 \text{Nm/rad}$	0.014	0.018	0.056	0.067	0.225	0.300	0.378	0.468
		kgfm/arc min	0.004	0.005	0.017	0.020	0.067	0.089	0.113	0.140
	K ₃	$\times 10^4 \text{Nm/rad}$	0.017	0.025	0.067	0.084	0.236	0.320	0.440	0.568
		kgfm/arc min	0.005	0.007	0.020	0.025	0.070	0.095	0.131	0.170
	θ_1	$\times 10^{-4} \text{rad}$	6.9	5.6	7.5	6.6	4.5	3.6	7.0	6.0
		arc min	2.4	2.0	2.6	2.3	1.6	1.2	2.4	2.0
	θ_2	$\times 10^{-4} \text{rad}$	18	14	16	14	9.9	7.6	20	16
		arc min	6.0	4.8	5.4	4.7	3.4	2.6	6.8	5.6
减速比 Reduction ratio 80以上 80 or more	K ₁	$\times 10^4 \text{Nm/rad}$	0.015	0.020	0.072	0.090	0.206	0.267	0.378	0.468
		kgfm/arc min	0.004	0.006	0.021	0.027	0.061	0.079	0.113	0.140
	K ₂	$\times 10^4 \text{Nm/rad}$	0.018	0.027	0.080	0.104	0.243	0.333	0.460	0.601
		kgfm/arc min	0.005	0.008	0.024	0.031	0.072	0.099	0.137	0.179
	K ₃	$\times 10^4 \text{Nm/rad}$	0.020	0.030	0.089	0.120	0.291	0.432	0.516	0.700
		kgfm/arc min	0.006	0.009	0.027	0.036	0.086	0.128	0.154	0.209
	θ_1	$\times 10^{-4} \text{rad}$	5.0	3.7	4.1	3.2	3.9	3.0	5.3	4.3
		arc min	1.7	1.3	1.4	1.1	1.3	1.0	1.8	1.5
	θ_2	$\times 10^{-4} \text{rad}$	13	9.2	9.8	7.7	8.8	6.6	16	12
		arc min	4.4	3.1	3.4	2.6	3.0	2.3	5.4	4.2

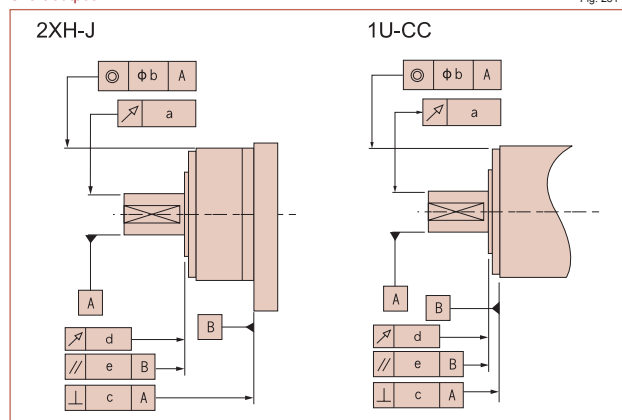
机械精度 Mechanical precision

CSF-mini系列的主轴承采用高精度的4点接触滚珠轴承，实现了输出部的高机械精度。输出轴的机械精度如下所示。

CSF-mini series have four-point contact ball bearing of high precision on main shaft bearing, and realized the high mechanical precision of output part. The mechanical precision of the output shaft is shown below.

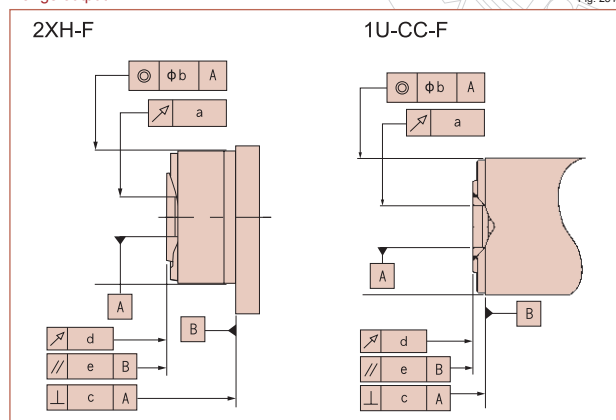
输出轴

Shaft output

图251-1
Fig. 251-1

法兰输出

Flange output

图251-2
Fig. 251-2

机械精度

Mechanical precision

表251-1
※T.I.R. 单位: mm
Table 251-1
※T.I.R. Unit: mm

符号 Symbol	精度项目 Precision item	型号 Model	5		8		11		14	
			2XH-J/1U-CC	2XH-F/1U-CC-F	2XH-J/1U-CC	2XH-F/1U-CC-F	2XH-J/1U-CC	2XH-F/1U-CC-F	2XH-J/1U-CC	2XH-F/1U-CC-F
a	输出轴前端跳动 Fluctuation on the edge of the output shaft		0.030	—	0.030	—	0.030	—	0.030	—
	输出轴内径面跳动 Fluctuation on the inner diameter of the output shaft		—	0.005	—	0.005	—	0.005	—	0.005
b	安装凹圆同轴度 Concentricity of the mounting spigot		0.040		0.040		0.055		0.055	
c	安装面直角 Squareness of the mounting face		0.020		0.020		0.025		0.025	
d	输出法兰面跳动 Fluctuation on the output flange face		0.005		0.005		0.005		0.005	
e	安装面和输出法兰面的平行度 Parallelism of the mounting face and the output flange face		0.015		0.020		0.030		0.030	

※T.I.R.: 表示测定部旋转1次时千分表读数的总量。

T.I.R.: This indicates the total reading of the dial gauge when the measuring part is rotated once.

效率特性 Efficiency characteristics

效率会因以下条件而有所差异。

The efficiency varies depending on the following conditions.

■减速比

Reduction ratio

■输入转速

Input rotational speed

■负载转矩

Load torque

■温度

Temperature

■润滑条件 (润滑剂的种类及其使用量)

Lubrication condition (Type of lubricant and the quantity)

■效率修正系数

Efficiency correction coefficient

负载转矩小于额定转矩时，效率值降低。

请根据图251-1计算出修正系数 K_e ，并参考以下计算示例计算出效率。

If the load torque is smaller than the rated torque, the efficiency value lowers.

Obtain correction coefficient K_e from the efficiency correction coefficient graph 251-1 to obtain the efficiency using the following example of calculation.

例：以CSF-8-100-2XH为例，计算出以下条件下的效率 η (%)。

输入转速：1000r/min 润滑方法：润滑脂润滑

负载转矩2.0Nm 润滑剂温度：20℃

Example of calculation: Efficiency η (%) under the following condition is obtained from the example of CSF-8-100-2XH.

Input rotational speed: 1000r/min Lubrication method: Grease lubrication

Load torque: 2.0Nm Lubricant temperature: 20℃

型号8·减速比100的额定转矩为2.4Nm (额定表：第049页)，因此转矩比 α 为0.83。 ($\alpha = 2.0/2.4 \div 0.83$)

Since the rated torque of model number 8 with a reduction ratio of 100 is 2.4 Nm (Ratings: Page 049), the torque ratio α is 0.83. ($\alpha = 2.0/2.4 \div 0.83$)

■根据图251-1，计算出效率修正系数 $K_e = 0.99$

The efficiency correction coefficient is $K_e = 0.99$ from Graph 251-1.

■负载转矩为2.0Nm时的效率 η 为： $\eta = K_e \cdot \eta_r = 0.99 \times 77\% = 76\%$ 。

Efficiency η at load torque 2.0 Nm: $\eta = K_e \cdot \eta_r = 0.99 \times 77\% = 76\%$

※负载转矩大于额定转矩时的效率修正系数 $K_e = 1$ 。

Efficiency correction coefficient $K_e = 1$ holds when the load torque is greater than the rated torque.

测定条件

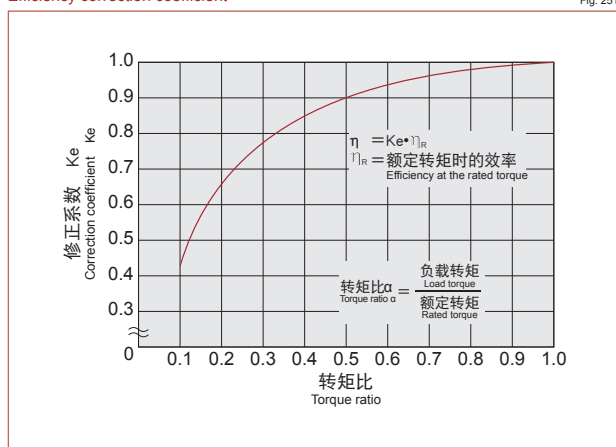
Measuring condition

表251-1
Table 251-1

负载转矩 Built-in	测定表所示的额定转矩 (参照第049页) Measurement by building the recommended built-in precision into the product		
润滑条件 Lubricating condition	润滑脂 Grease lubrication	名称 Name	Harmonic润滑脂 SK-2 Harmonic grease SK-2
		涂油量 Application qty.	正确涂油量 Appropriate application quantity

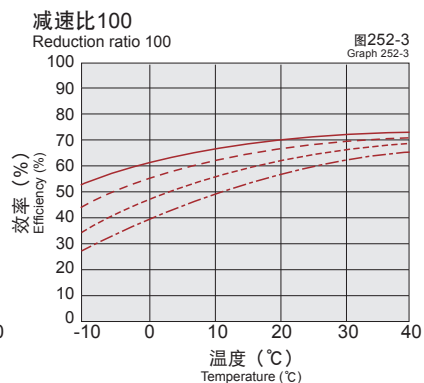
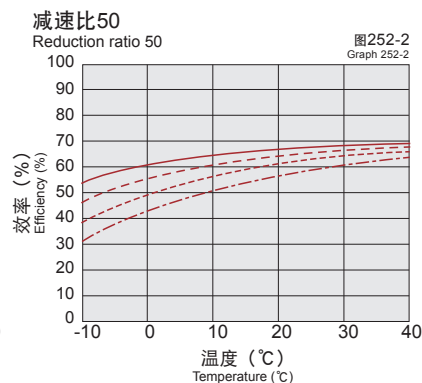
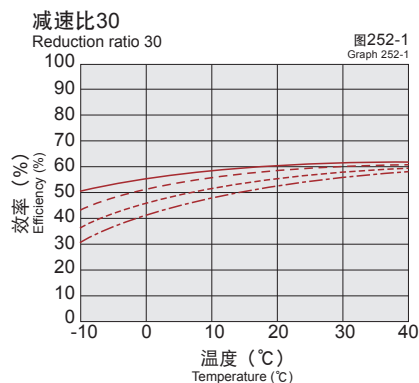
效率修正系数

Efficiency correction coefficient

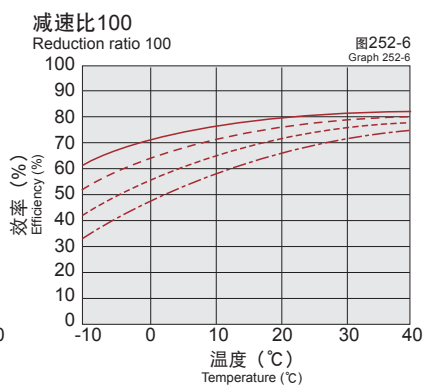
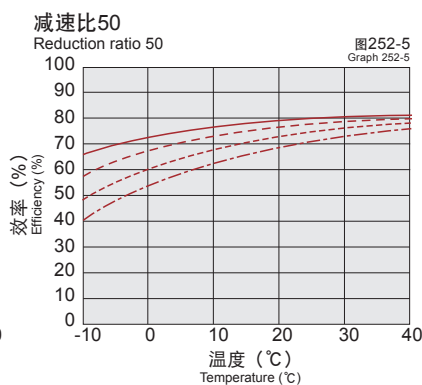
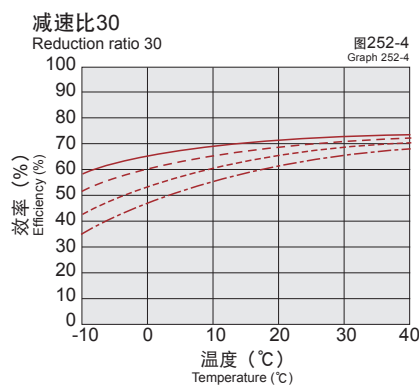
图251-1
Fig. 251-1

■ 额定转矩时的效率 Efficiency at rated torque

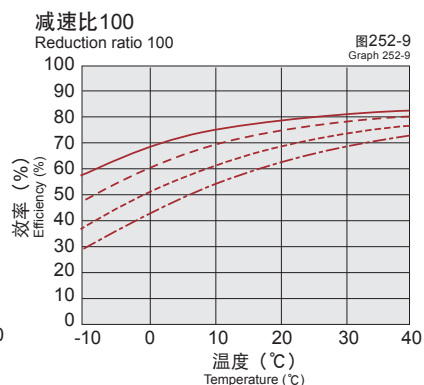
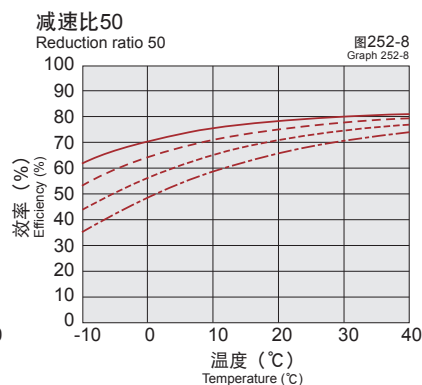
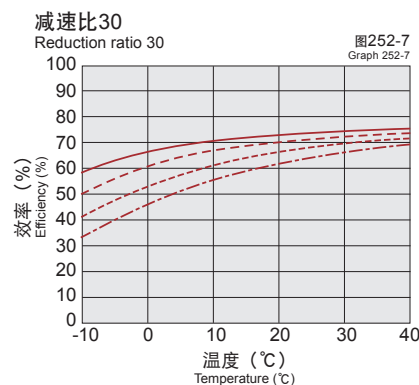
型号: 5
Mode No. 5



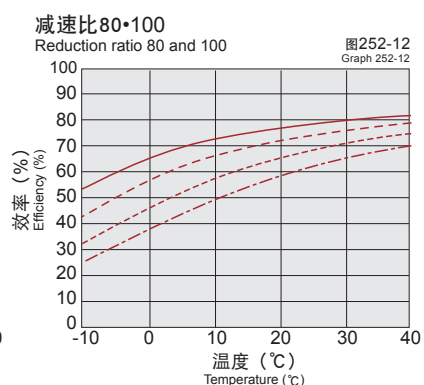
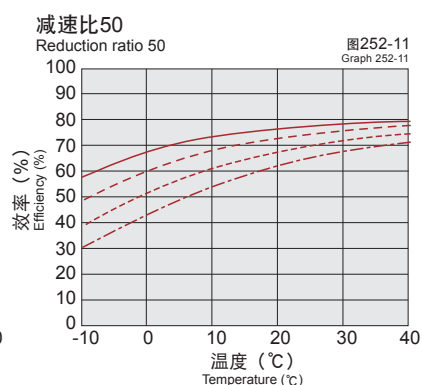
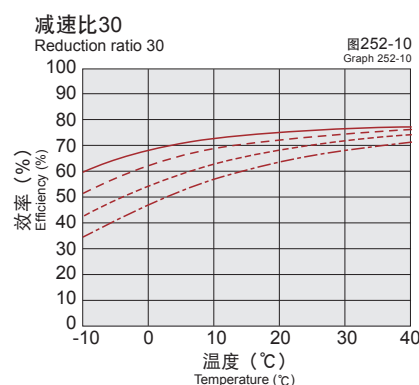
型号: 8
Mode No. 8



型号: 11
Mode No. 11



型号: 14
Mode No. 14



输入转速 ————— 500r/min ———— 1000r/min ———— 2000r/min ———— 3500r/min
Input rotational speed

无负载运行转矩 On no-load running torque

无负载运行转矩是指在无负载状态下，使Harmonic Drive转动的必要的输入侧（高速轴侧）转矩。

No-load running torque means the torque required to put Harmonic Drive under a no-load condition.

※详细数值请咨询本公司授权代理商。
Contact us for detailed value.

不同速比修正量

Correction quantity by reduction

Harmonic Drive的无负载运行转矩会根据速比而发生改变。图253-1~253-4为减速比100的数值。其他减速比，请加上表253-2所示的修正量进行计算。

The no-load running torque of Harmonic Drive varies depending on the reduction ratio. Graphs 253-1 to 253-4 show the values for a reduction ratio of 100. Obtain other reduction ratios by adding the correction quantity shown in the right-hand table (Table 253-2).

测定条件

Measuring condition

表253-1

Table 253-1

减速比100 Reduction ratio 100			
润滑条件 Lubrication condition	润滑脂润滑 Grease lubrication	名称 Name	Harmonic润滑脂 SK-2 Harmonic grease SK-2
转矩值是指在输入为2000r/min的情况下磨合运转2小时以上的数值 The torque value is the value after a trial run for two hours or longer at an input of 2000 r/min.			

无负载运行转矩修正量

Correction quantity for the no-load running torque

表253-2

单位: cNm

Table 253-2

Unit: cNm

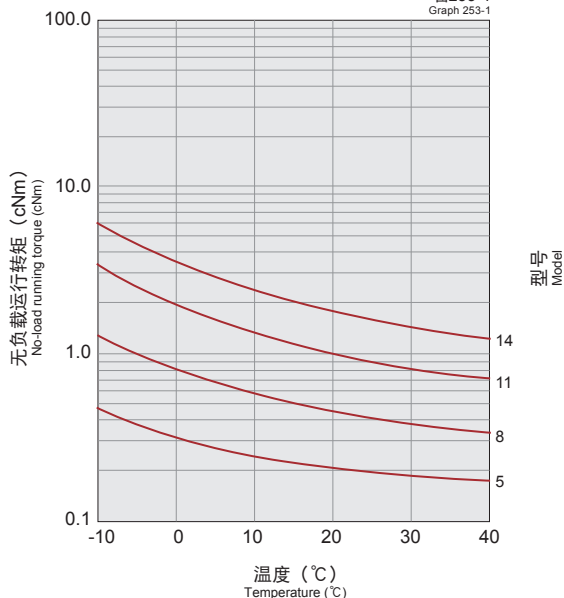
型号 Model	减速比 Reduction ratio	30	50	80
5		0.26	0.11	—
8		0.44	0.19	—
11		0.81	0.36	—
14		1.33	0.58	0.1

减速比100的无负载运行转矩

No-load running torque for a reduction ratio of 100

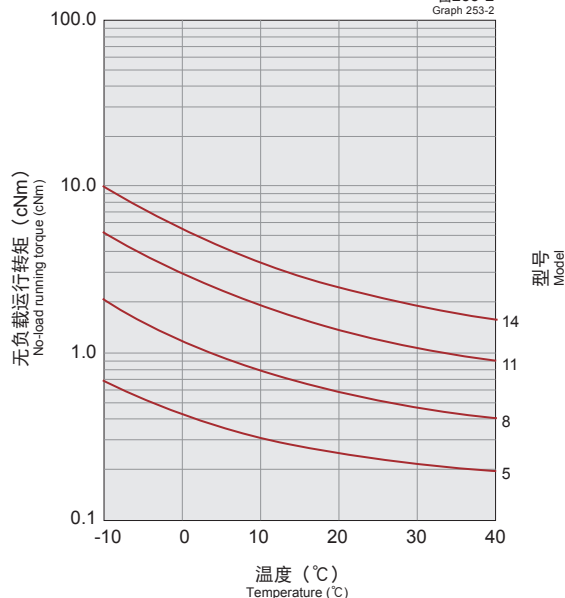
输入转速500r/min

Input rotational speed: 500r/min

图253-1
Graph 253-1

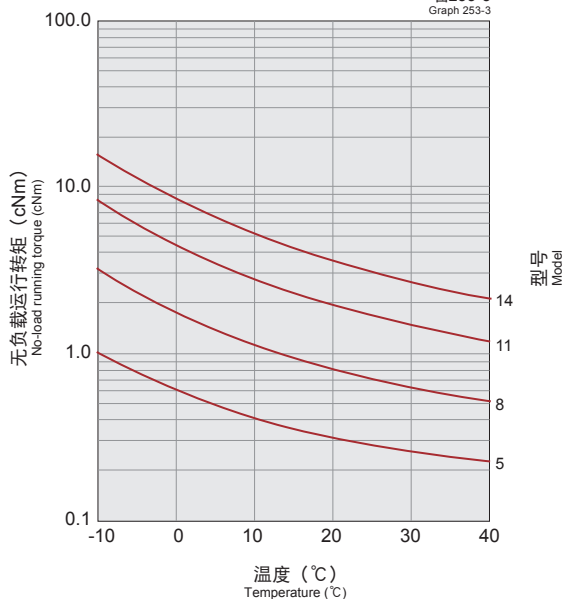
输入转速1000r/min

Input rotational speed: 1000r/min

图253-2
Graph 253-2

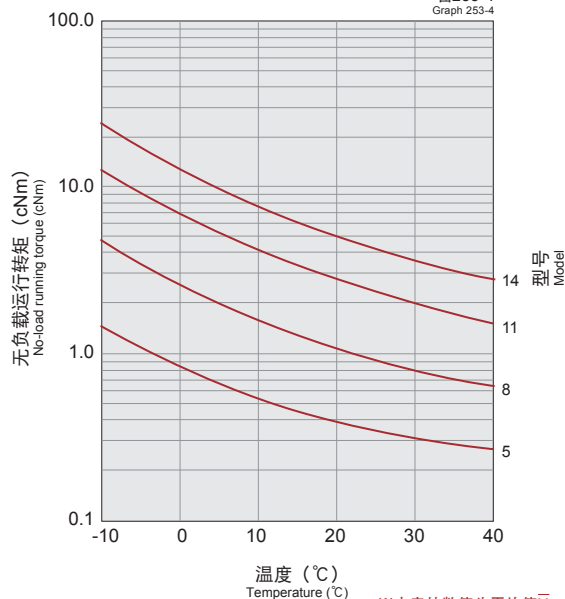
输入转速2000r/min

Input rotational speed: 2000r/min

图253-3
Graph 253-3

输入转速3500r/min

Input rotational speed: 3500r/min

图253-4
Graph 253-4

※本表的数值为平均值X。
The values in this graph are average values (X).

安装示例 Example of installation

以下是电动机安装型具有代表性的安装示例。

The following shows an example of the representative installation of the motor mounting type.

图254-1
Fig. 254-1

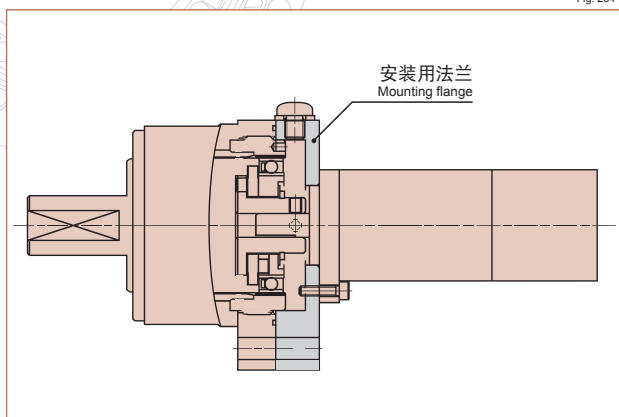
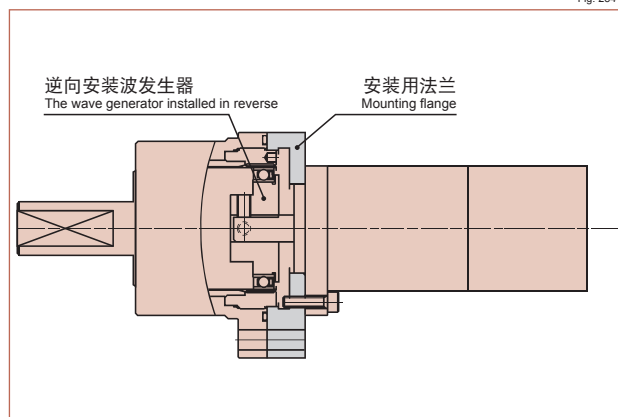


图254-2
Fig. 254-2



电动机匹配表

Motor matching table

以下由电动机安装型与小型伺服电动机组合而成，作为参考使用。

关于详细的型号选定，请参照第012~013页的“技术资料”。

A combination of the motor mounting type and the small servo motor is shown below as a reference.

See "Engineering data" on Pages 012 to 013 for selecting detailed model numbers.

表254-1
Table 254-1

制造商系列名称 Manufacturer series name		安川电机制造Σ Mini系列 Σ mini series made by Yaskawa Electric				三菱电机制造HC-AQ系列 HC-AQ series made by Mitsubishi Electric			松下电器制造MINAS S系列 Minasu-S series made by Matsushita Electric
电动机容量 Motor capacity	型号 Model	3W+5W	10W	20W	30W	10W	20W	30W	30W
	5	○							
	8		○			○			
	11			○	○		○	○	○
	14				○			○	○

(注) 根据电动机的轴径，有时也会出现与标准品的波发生器孔径不相符的情况。此时，应采取对应措施变更孔径（孔径尺寸：参照第064页）。此外，孔径变更后均为特殊规格。

(Note) The shaft diameter of some motors may not fit the hole diameter of the standard wave generator. In this case, the hole diameter should be changed (hole diameter size: see Page 064). Changes to the hole diameter should be performed using special specifications.

组装精度 Installation precision

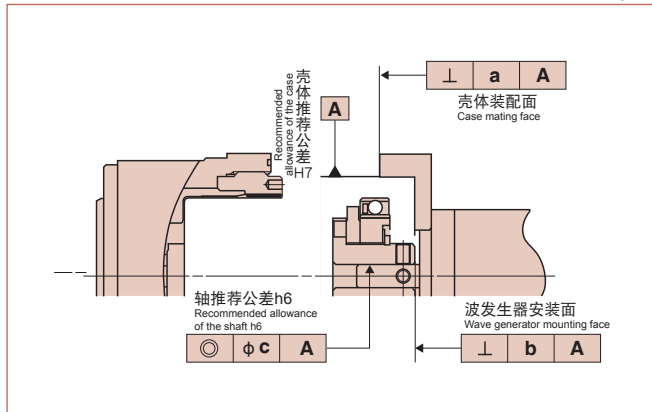
在组装设计时，为充分发挥CSF-mini系列所具备的优良性能，请确保使用图255-1，表255-1所示的推荐精度。

Maintain the recommended precision shown in Figure 255-1 and Table 255-1 to fully bring out the excellent performance of HarmonicDrive for built-in design.

安装的推荐精度

Recommended precision for mounting

图255-1
Fig. 255-1



安装壳体的推荐精度

Recommended precision of the mounting case

表255-1
单位: mm
Table 255-1
Unit: mm

符号 Symbol	精度项目 Precision item	型号 Model	5	8	11	14
a	壳体装配面直角 Squareness of the case mating face		0.008	0.010	0.011	0.011
b	波发生器安装面 Mounting face of the wave generator		0.005	0.012 (0.006)	0.012 (0.007)	0.017 (0.008)
c	输入轴同轴度 Concentricity of the input shaft		0.005	0.015 (0.006)	0.015 (0.007)	0.030 (0.016)

※ () 内的数值是波发生器为一体型时的数值 (一体型、特殊规格)。此外，标准规格的波发生器带欧氏联轴节结构 (自动调芯结构)。但是，型号5为一体型为标准规格。
The parenthesized value indicates the value for the rigid-type (integral type, special specifications) wave generator. The standard wave generator is equipped with Oldham's coupling (self-aligning) mechanism. Note that the rigid type is standard for model number 5.

安装和传递转矩 Installation and transmission torque

■往装置上安装

Installation on the equipment

将CSF-mini系列安装到装置上时，请在确认安装面的平坦度以及螺孔部是否存在毛刺后再将安装法兰与螺栓拧紧。

Check the flatness of the mounting face and burrs on the tap to install the CSF-mini series on the equipment, and tighten the mounting flange with bolts.

安装法兰（图257-1的A部）螺栓*的拧紧转矩/2XH型

Tightening torque of the bolt* of the mounting flange (A in Figure 257-1) /2XH type

表256-1

Table 256-1

项目 Item	型号 Model	5	8	11	14
螺栓数量 Number of bolts		2	2	2	2
螺栓规格 Bolt size		M2	M3	M4	M5
安装P.C.D. Mounting P.C.D.	mm	25	37.5	50	62
拧紧转矩 Tightening torque	Nm	0.25	0.85	2.0	4.0
	kgfm	0.03	0.09	0.20	0.41
螺钉部装配的最短长度 Min. length of engagement of the screw	mm	2.4	3.6	4.8	6.0
传递转矩 Transmission torque	Nm	2	7	16	31
	kgfm	0.2	0.7	1.6	3.1

※推荐螺栓名称：JIS B 1176内六角螺栓、强度分类：JIS B 1051 12.9以上

Recommended bolt name: JIS B 1176 hexagonal bolt, intensity type: JIS B 1051 12.9 or higher

安装法兰（图257-2的A部/C部）螺栓*的拧紧转矩/1U-CC型

Tightening torque of the bolt* of the mounting flange (C in Figure 257-2) /1U-CC type

表256-2

Table 256-2

项目 Item	型号 Model	5		8		11		14	
		A部 Part A	C部 Part C	A部 Part A	C部 Part C	A部 Part A	C部 Part C	A部 Part A	C部 Part C
螺栓数量 Number of bolts		4	4	4	4	4	4	4	4
螺栓规格 Bolt size		M2	M2	M3	M2.5	M4	M3	M5	M4
安装P.C.D. Mounting P.C.D.	mm	23	22.5	35	34	46	46	58	58
	Nm	0.25	0.25	0.85	0.55	2.0	0.85	4.0	2.0
拧紧转矩 Tightening torque	kgfm	0.03	0.03	0.09	0.06	0.20	0.09	0.41	0.20
	mm	3	3	6	5	8	6	10	8
传递转矩 Transmission torque	Nm	3.5	—	12	—	29	—	57	—
	kgfm	0.4	—	1.3	—	2.9	—	5.9	—

※推荐螺栓名称：JIS B 1176内六角螺栓、强度分类：JIS B 1051 12.9以上

Recommended bolt name: JIS B 1176 hexagonal bolt, intensity type: JIS B 1051 12.9 or higher

■ 安装输出部的负载

Installation of the load on the output part

向CSF-mini系列的输出部安装负载时，请参考主轴承的规格（参照第051页）实施安装。

Install the load on the output part of the CSF-mini series taking the specifications of the main roller bearing (see Page 051) into consideration.

安装法兰（图257-1、图257-2的B部）螺栓*的拧紧转矩（法兰输出型）

Tightening torque of the bolt* of the mounting flange (B in Figure 257-1 and Figure 257-2) (flange output type)

表257-1
Table 257-1

项目 Item	型号 Model	5	8	11	14
螺栓数量 Number of bolts		3	4	6	6
螺栓规格 Bolt size		M2	M3	M3	M4
安装P.C.D. Mounting P.C.D.	mm	9.8	15.5	20.5	25.5
拧紧转矩 Tightening torque	Nm	0.54	2.0	2.0	4.6
	kgfm	0.06	0.20	0.20	0.47
传递转矩 Transmission torque	Nm	2	13	26	55
	kgfm	0.3	1.3	2.6	5.6

输出法兰由于有防止漏油措施，因此不需要涂抹密封剂。

As measures have been taken against oil leakage of the output flange, no sealing agent needs to be applied.

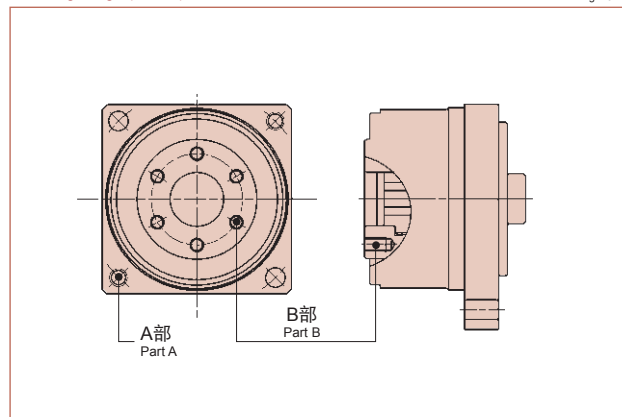
※推荐螺栓名称：JIS B 1176内六角螺栓、强度分类：JIS B 1051 12.9以上

Recommended bolt name: JIS B 1176 hexagonal bolt, intensity type: JIS B 1051 12.9 or higher

安装法兰（2XH-F）

Mounting flange (2XH-F)

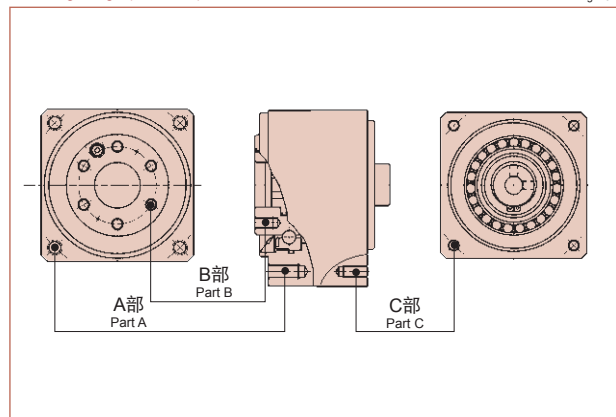
图257-1
Fig. 257-1



安装法兰（1U-CC-F）

Mounting flange (1U-CC-F)

图257-2
Fig. 257-2



在轴输出上安装皮带轮、小齿轮时，不要对输出轴施加冲击。否则可能会引起减速机的精度下降或故障。

Do not allow the output shaft to receive a shock when you install a pulley and pinion with the shaft output. It can deteriorate the precision of the reducer and cause failure.

密封机构 Sealing mechanism

为防止润滑脂泄漏以及维持Harmonic Drive的高耐久性，必须在电动机安装型上使用以下密封机构。

The following sealing mechanism is required to prevent grease leakage and maintain the high durability of Harmonic Drive for the motor mounting type (2XH).

- 法兰装配面、嵌合部 O型环、密封剂。此时请注意平面是否歪斜以及O形环的啮合情况。
Flange mating face and mating O-ring and seal agent. Be careful of distortion on the plane and how the O-ring is engaged.
- 螺孔部 使用有密封效果的螺钉锁固剂（推荐使用Loctite 242）或密封胶带。
Screw hole area Use a screw lock agent (Loctite 242 is recommended) or sealing tape.

密封部位和推荐密封方法

Area requiring sealing and recommended sealing methods

表 258-1
Table 258-1

必要密封部位 Area requiring sealing		推荐密封方法 Recommended sealing method
输入侧 Input side	法兰装配面 Flange mating face	O型环的使用（附带本公司产品） Use O-ring (attached to our product)
	电动机输出轴 Motor output shaft	请选用带油封的O型环。无油封时，请在电动机安装法兰上安装油封。 Select one with an oil seal. Those without an oil seal should be structured so that an oil seal can be attached to the motor mounting flange.

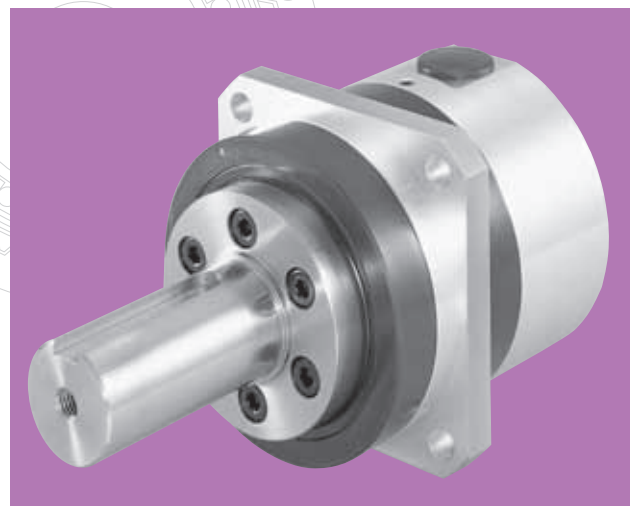


CSF-GH系列

CSF-GH Series

Gear Head Type CSF-GH

特点 Features	074	设计指南 Design guide	•电动机的组装步骤 Installation of a motor	089
旋转方向和结构 Rotational direction and structure	•旋转方向 Rotational direction	075	•安装传递转矩 Installation transmission torque	090
	•结构 Structure	075	•润滑 Lubrication	092
型号·符号 Model and symbol	075	伺服电动机 匹配表 Servo motor matching table	•型号: 14 Model No. 14	094
技术数据 Technical data	•额定表 Rating table	076	•型号: 20 Model No. 20	095
	•棘爪扭矩 Ratcheting torque	076	•型号: 32 Model No. 32	096
	•屈曲转矩 Buckling torque	076	•型号: 45 Model No. 45	098
	•外形图 型号14 Outline drawing of model No. 14	077	•型号: 65 Model No. 65	100
	•尺寸表 型号14 Measurement table of model No. 14	077	应用 Application	102
	•外形图 型号20 Outline drawing of model No. 20	078		
	•尺寸表 型号20 Measurement table of model No. 20	078		
	•外形图 型号32 Outline drawing of model No. 32	079		
	•尺寸表 型号32 Measurement table of model No. 32	079		
	•外形图 型号45 Outline drawing of model No. 45	080		
	•尺寸表 型号45 Measurement table of model No. 45	080		
	•外形图 型号65 Outline drawing of model No. 65	081		
	•尺寸表 型号65 Measurement table of model No. 65	081		
	•性能表 Performance table	082		
	•刚性 (弹簧常数) Rigidity (Spring constant)	083		
	•滞后损失 Hysteresis loss	083		
	•最大齿隙量 Max. backlash quantity	083		
	•效率特性 Efficiency characteristics	084		
	•主轴承的规格 Checking main roller bearing	087		
	•机械精度 Mechanical precision	088		



CSF-GH系列

CSF-GH series

CSF-GH系列是可最大程度发挥Harmonic Drive优良性能，并专用于伺服电动机的齿轮箱型。

即使是不习惯使用Harmonic Drive的人员也能够简单操作，实现高精度的定位。

This is a gear head specially designed for the servo motor by maximizing the excellent performance of Harmonic Drive.

Even if you are not familiar with handling Harmonic Drive, you can easily handle it to achieve high-precision positioning.

CSF-GH系列的特点 Features of the CSF-GH series

■ 可简便的安装到各公司伺服电动机上

Simple installation on the servo motors of various manufacturers

标准采用可用于各公司伺服电动机的安装法兰和一按式输入轴接头，使电动机安装变得简单。准备了适用于安川电机、松下电器、山洋电气、三菱电机、发那科（FANUC）等电动机的匹配表。可通过代码订购。

The mounting flange for the servo motors of various manufacturers and the one-touch input shaft joint have been adopted as standard for easy motor installation. We have prepared a matching table with motors provided by Yasukawa Electric, Matsushita Electric, Sanyo Electric, Mitsubishi Electric and Fanuc. You can place an order using codes only.

■ 丰富的可变选项

Wide variations

根据型号分为5种，根据减速比分为5种，根据输出规格可分为轴承型和法兰型2种。

We have prepared five model numbers, five reduction ratios, two shaft types and two flange types.

型号： 14、20、32、45、65 5种

减速比： 50、80、100、120、160 5种

输出规格： 法兰、轴、轴（带键&螺孔）3种

电动机容量： 可在小容量～中容量伺服30W～5000W的范围内使用。

Model number: five: 14, 20, 32, 45 and 65

Reduction ratio: five: 50, 80, 100, 120, 160

Output specifications: three: flange, shaft, shaft (with key and tap)

Motor capacity: Available from small-capacity to medium-capacity servos of 30 W to 5000 W

■ 无齿隙

Non-backlash

根据 Harmonic Drive 独创的工作原理，没有齿轮啮合而产生的齿隙。

The unique operating principle of Harmonic Drive causes no backlash due to teeth engagement.

■ 高静力矩容量

High moment capacity

主轴承采用高刚性交叉滚子轴承，通过高静力矩容量提升输出侧的端跳精度。

A highly rigid cross roller bearing has been adopted for the main roller bearing to improve wobbling precision on the output side with high moment capacity.

旋转方向和结构 Rotational direction and structure

旋转方向 Rotational direction

CSF-GH系列的输入为波发生器（电动机轴安装）、固定为刚轮（机壳）、输出为柔轮，输出旋转方向与电动机输出旋转方向相反。

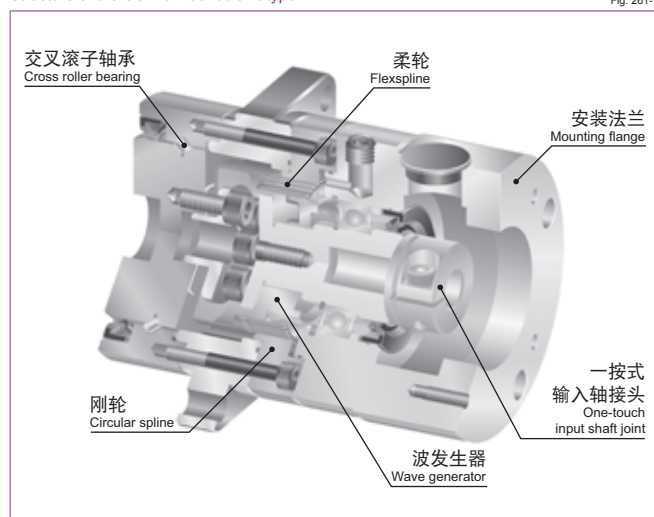
The CSF-GH series includes the wave generator (mounted on the motor shaft) as input, the fixed circular spline (casing) and the flexspline as output. The output rotational direction is opposite to the motor output rotational direction.

结构 Structure

CSF-GH系列组合型的结构

Structure of the CSF-GH series unit type

图261-1
Fig. 261-1



交叉滚子轴承 Cross roller bearing

高刚性交叉滚子轴承。

在输出侧轴承上采用了高刚性交叉滚子轴承，可直接承受负载，提升端跳精度等机械精度。

This is a highly rigid cross roller bearing.

As it is adopted as the output roller bearing, it can directly support the load and improves mechanical precision including wobbling.

一按式输入轴接头 One-touch input shaft joint

插入伺服电动机的输出轴，拧紧螺栓后则连接完成。

根据各公司的伺服电动机准备输入轴接头。

Insert the output shaft of the servo motor, and tighten the bolts to complete assembly.

We have prepared input shaft joints to meet the servo motors of major manufacturers.

交叉滚子轴承 Cross roller bearing

将符合各公司的伺服电动机（电动机匹配表第094~101页）的法兰设定为标准品，不需要其他装配品。

You do not need to make a separate arrangement as we have prepared a standard flange that meets the servo motors (motor matching table on Pages 094-101) of major manufacturers.

型号·符号 Model and symbol

CSF - 20 - 100 - GH - F0 XXX - 规格1 SP1

机型名称 Model name	型号 Model No.	减速比 Reduction ratio					输出形状 Output form	电动机法兰和输入轴 接头形状符号 Motor flange and input shaft joint form symbol	特殊规格 Special specification
CSF	14	50	80	100	—	—	F0=法兰输出 (无键)	符号会根据安装电动机的不同而有所差异。请参照第077~081页的尺寸表以及第094~101页的伺服电动机匹配表内的形状符号。此外，对于没有记录在册的伺服电动机，请咨询授权代理商。 The symbol varies depending the mounting motor. See the form symbol in the size table on Pages 077 to 081 and the servo-matching table on Pages 094 to 101. Contact us regarding the servo motor that is not listed.	空白=标准品 SP=特殊规格 None= standard product SP= special specifications
	20	50	80	100	120	160	J2=直轴 (带键、中心螺孔)		
	32	50	80	100	120	160	J2=直轴 (无键)		
	45	50	80	100	120	160	J6=直轴 (带键、中心螺孔)		
	65	—	80	100	120	160	J6=直轴 (无键)		

表261-1
Table 261-1

额定表 Rated table

表262-1
Table 262-1

型号 Model	减速比 Reduc. ratio	输出转矩 ^{※1} (2000r/min时) Output torque ^{※1} (at 2000r/min)		输出转矩 ^{※2} (3000r/min时) Output torque ^{※2} (at 3000r/min)		平均负载转矩 ^{※3} Average load torque ^{※3}		起动停止时的 峰值转矩 ^{※4} Peak torque for ^{※4} start and stop		瞬间最大转矩 ^{※5} Max. momentary torque ^{※5}		最高输入转速 ^{※6} Max. input rotational speed ^{※6}	重量(减速机单机) ^{※7} Mass (reducer) ^{※7}	
		Nm	kgf·m	Nm	kgf·m	Nm	kgf·m	Nm	kgf·m	Nm	kgf·m		轴输出 Shaft output	法兰输出 Flange output
													kg	kg
14	50	5.4	0.55	4.7	0.48	6.9	0.70	18	1.8	35	3.6	8500	0.62	0.50
	80	7.8	0.80	6.8	0.70	11	1.1	23	2.4	47	4.8			
	100	7.8	0.80	6.8	0.70	11	1.1	28	2.9	54	5.5			
20	50	25	2.5	22	2.2	34	3.5	56	5.7	98	10	6500	1.8	1.4
	80	34	3.5	30	3.1	47	4.8	74	7.5	127	13			
	100	40	4.1	35	3.6	49	5.0	82	8.4	147	15			
	120	40	4.1	35	3.6	49	5.0	87	8.9	147	15			
	160	40	4.1	35	3.6	49	5.0	92	9.4	147	15			
32	50	76	7.8	66	6.8	108	11	216	22	382	39	4800	4.6	3.2
	80	118	12	103	10	167	17	304	31	568	58			
	100	137	14	120	12	216	22	333	34	647	66			
	120	137	14	120	12	216	22	353	36	686	70			
	160	137	14	120	12	216	22	372	38	686	70			
45	50	176	18	154	16	265	27	500	51	950	97	3800	13	10
	80	313	32	273	28	390	40	706	72	1270	130			
	100	353	36	308	31	500	51	755	77	1570	160			
	120	402	41	351	36	620	63	823	84	1760	180			
	160	402	41	351	36	630	64	882	90	1910	195			
65	80	745	76	651	66	1040	106	2110	215	3720	380	2800	32	24
	100	951	97	831	85	1520	155	2300	235	4750	485			
	120	951	97	831	85	1570	160	2510	256	4750	485			
	160	951	97	831	85	1570	160	2630	268	4750	485			

※1 输出转矩是按照输入转速为普通伺服电动机的输入转速2000r/min时、使用寿命为L10=7000小时的数值进行设定的。请将其作为正常运转时的大致标准。
This is the output torque set assuming that the average input rotational speed of the general servo motor is 2000 r/min and the basic rated life, L10, is 7000 hours. Use this as a rough indication for steady operation.

※2 输出转矩是按照输入转速为普通伺服电动机的输入转速保持在3000r/min时、使用寿命为L10=7000小时的数值进行设定的。请将其作为正常运转时的大致标准。
This is the output torque set assuming that the average input rotational speed of the general servo motor is 3000 r/min and the basic rated life, L10, is 7000 hours. Use this as a rough indication for steady operation.

※3 根据负载转矩模式（第012页）计算出来的平均负载转矩的容许最大值。请注意，超过该数值时产品的使用寿命和耐久性均可能降低。
This is the maximum permissible value of the average load torque calculated from the load torque pattern (Page 012). Exceeding this value can reduce the life and durability of the product.

※4 运转循环中，起动停止时的转矩容许最大值。
This is the maximum permissible value of the torque applied at start and stop during an operation cycle.

※5 紧急停止时的冲击转矩以及来自外部的冲击转矩的容许最大值。请务必在此转矩范围内使用。此外，在型号选定过程中，请计算容许频率，确认是否符合使用条件。
This is the maximum permissible value of the impact torque at an emergency stop and external impact torque. Use the product within this torque range. Calculate the permissible frequency during selection of a model number, and check whether it meets the operating condition.

※6 非连续运转条件下的容许最高输入转速。转速会受动作环境、运转条件影响，但连续运转时的输入转速基准请保持在3000r/min以下。
This is the maximum permissible input rotational speed under non-continuous operation. A rough indication of the input rotational speed under continuous operation is 3000 r/min even though it may depend on the operating environment and conditions.

※7 表示减速机单机的重量。包括输入轴接头和电动机法兰等的数值，请参照尺寸表（第077~081页）。
This indicates the weight of a reducer. See the dimension table (Pages 077 to 081) for the values including the input shaft joint and the motor flange.

棘爪扭矩 Ratcheting torque

（用语说明请参照“技术资料”。）
See "Engineering data" for a description of terms.

表262-2
Table 262-2
单位: Nm
Unit: Nm

减速比 Reduction ratio	型号 Model	14	20	32	45	65
50		88	220	980	2700	—
80		110	350	1400	3900	11000
100		84	260	1000	3100	9400
120		—	240	980	2800	8300
160		—	220	980	2600	8000

屈曲转矩 Buckling torque

（用语说明请参照“技术资料”。）
See "Engineering data" for a description of terms.

表262-3
Table 262-3
单位: Nm
Unit: Nm

型号 Model	14	20	32	45	65
全减速比 Total reduction ratio	190	560	2200	5800	17000

外形图 型号 14 Outline drawing of Model No. 14

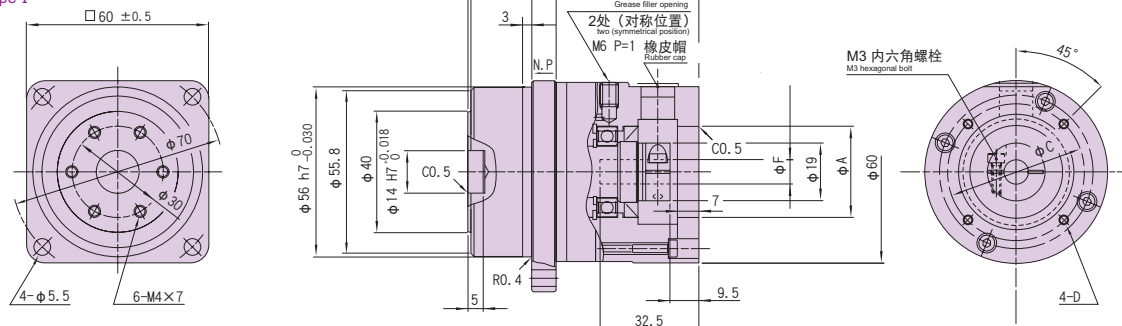
本产品的CAD数据（DXF）可从本公司主页下载。

You can download the CAD data (DXF) of this product from the following homepage.

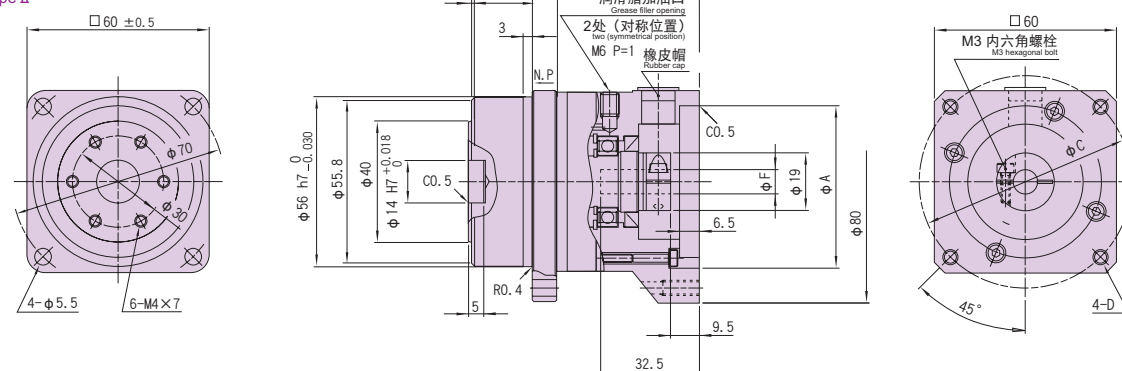
URL: <http://www.hds.co.jp/>

图263-1
单位: mm
Fig. 263-1
Unit: mm

法兰型 I Flange type I



法兰型 II Flange type II

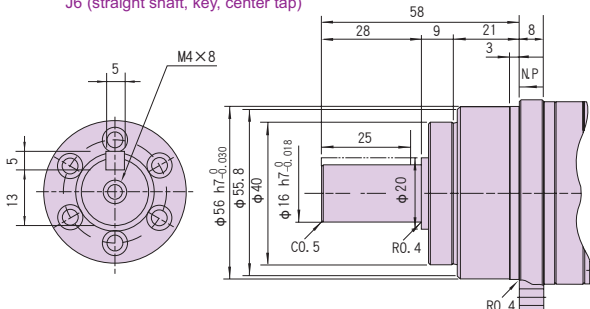


输出轴形状: J2 (直轴、无键)

J6 (直轴、带键、中心螺孔)

Output shaft form: J2 (straight shaft, no key)

J6 (straight shaft, key, center tap)



尺寸表 型号 14 Dimension table Model No. 14

表263-1
单位: mm
Table 263-1
Unit: mm

符号 Symbol	形状符号 Form symbol ※1	法兰型 I Flange type I			法兰型 II Flange type II		
		AB□	AC□	AD□	BA□	BB□	BC□
A (H7)		30	30	34	50	50	50
C		45	45	48	60	70	70
D		M3×8	M3×8	M3×8	M4×10	M4×10	M5×12
F (H7)	Min	6	6	6	6	6	6
	Max	8	8	8	8	8	8
重量 (kg) ※2 Mass (kg) ※2	轴输出 Shaft output	0.88	0.88	0.88	0.9	0.9	0.9
	法兰输出 Flange output	0.76	0.76	0.76	0.78	0.78	0.78

表示代表产品的尺寸表。上述产品以外的产品，请咨询授权代理商。尺寸及形状的详细情况，请使用本公司发行的交货规格图进行确认。采用特殊安装方法进行安装时请咨询授权代理商。

This shows the dimension table of the representative product. Contact us for products other than those described above. See our delivered specifications for details of the sizes and forms. Contact us for special installation.

※1 在形状符号的□内填写输入轴接头的符号。请参照伺服电动机匹配表（第094~101页）。

The square mark of the form symbol will be replaced by the symbol of an input shaft joint. See the servo motor matching table (Pages 094 to 101).

※2 重量因减速比及输入接头的内径尺寸而有些许差异。

The weight varies slightly depending on the reduction ratio and the inner diameter size of the input joint.

078 HarmonicDrive

外形图 型号45 Outline drawing of Model No. 45

本产品的CAD数据（DXF）可从本公司主页下载。

You can download the CAD data (DXF) of this product from the following homepage.

URL: <http://www.hds.co.jp/>

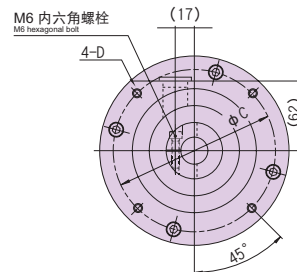
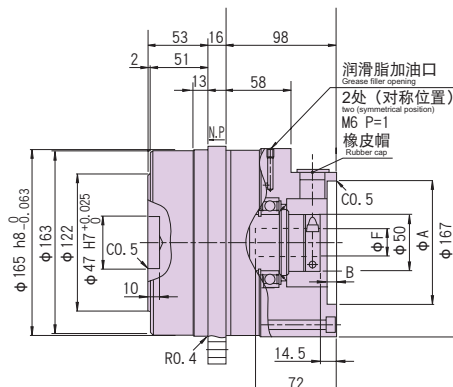
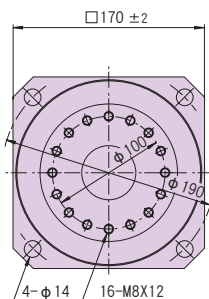
图266-1

单位: mm

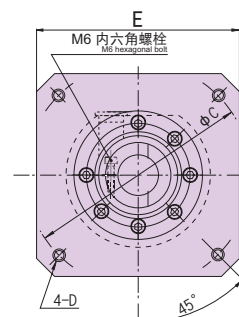
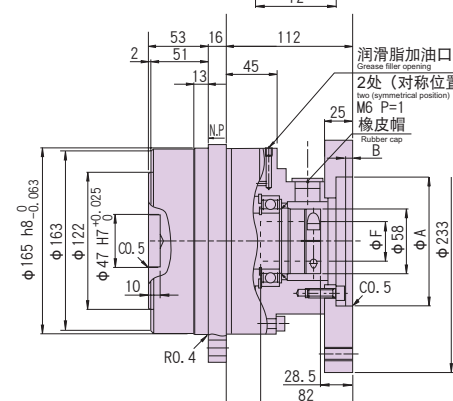
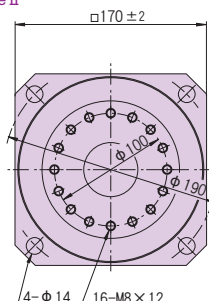
Fig.266-1

Unit: mm

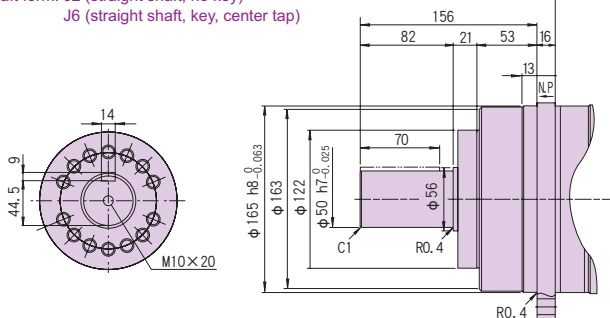
法兰型 I Flange type I



法兰型 II Flange type II



输出轴形状: J2 (直轴、无键)
J6 (直轴、带键、中心螺孔)
Output shaft form: J2 (straight shaft, no key)
J6 (straight shaft, key, center tap)



尺寸表 型号45 Dimension table Model No. 45

表266-1

单位: mm

Table 266-1

Unit: mm

符号 Symbol	形状符号 Form symbol ※1	法兰型 I Flange type I							法兰型 II Flange type II		
		PA□	PB□	PC□	PD□	PE□	PF□	PG□	PR□	PP□	PQ□
A (H7)		70	70	80	95	95	110	110	110	114.3	130
B		7	7	8	8	8	8	8	6.5	6.5	6.5
C		90	90	100	115	115	130	145	145	200	165
D		M5×12	M6×14	M6×14	M8×20	M6×14	M8×20	M8×20	M8×20	M12×25	M10×25
E		—	—	—	—	—	—	—	□130	□180	□180
F (H7)	Min	14	14	14	14	14	14	14	19	19	19
	Max	24	24	24	24	24	24	24	35	35	35
重量 (kg) ※2 Mass (kg) ※2	轴输出 Shaft output	17.3	17.3	17.3	17.3	17.3	17.3	17.3	16.7	17.7	17.7
	法兰输出 Flange output	14.3	14.3	14.3	14.3	14.3	14.3	14.3	13.7	14.7	14.7

表示代表产品的尺寸表。上述产品以外的产品，请咨询授权代理商。尺寸及形状的详细情况，请使用本公司发行的交货规格图进行确认。采用特殊安装方法进行安装时请咨询授权代理商。

This shows the dimension table of the representative product. Contact us for products other than those described above. See our delivered specifications for details of the sizes and forms. Contact us for special installation.

※1 在形状符号的口内填写输入轴接头的符号。请参照伺服电动机匹配表 (第094~101页)。
The square mark of the form symbol will be replaced by the symbol of an input shaft joint. See the servo motor matching table (Pages 094 to 101).

※2 重量因减速比及输入接头的内径尺寸而有些许差异。

The weight varies slightly depending on the reduction ratio and the inner diameter size of the input joint.

外形图 型号65 Outline drawing of Model No. 65

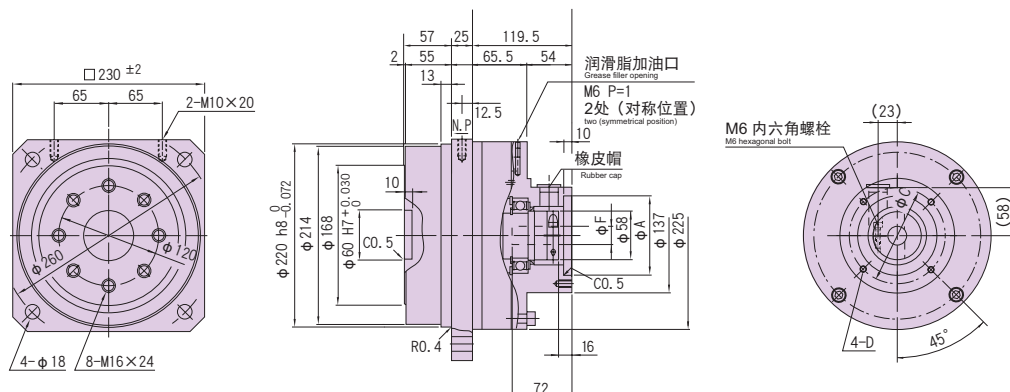
本产品的CAD数据（DXF）可从本公司主页下载。

You can download the CAD data (DXF) of this product from the following homepage.

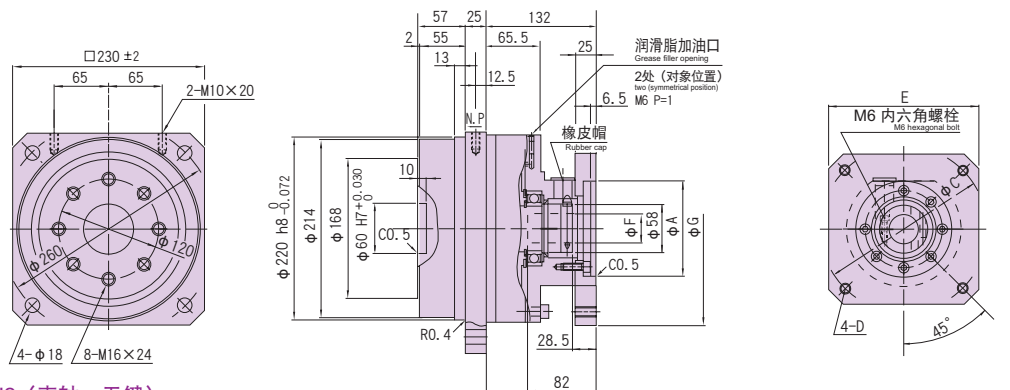
URL: <http://www.hds.co.jp/>

图267-1
单位: mm
Fig. 267-1
Unit: mm

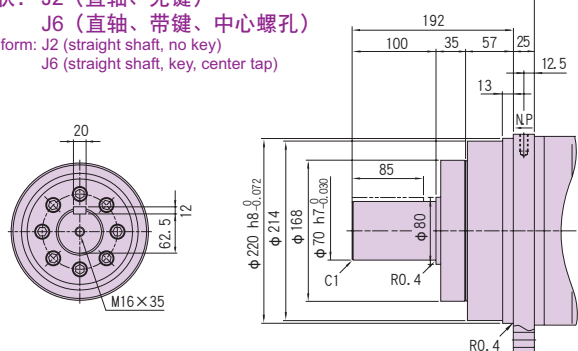
法兰型 I Flange type I



法兰型 II Flange type II



输出轴形状: J2 (直轴、无键)
J6 (直轴、带键、中心螺孔)
Output shaft form: J2 (straight shaft, no key)
J6 (straight shaft, key, center tap)



尺寸表 型号65 Dimension table Model No. 65

表267-1
单位: mm
Table 267-1
Unit: mm

符号 Symbol	形状符号 Form symbol ※1	法兰型 I Flange type I		法兰型 II Flange type II			
		UA□	UB□	UF□	UG□	UH□	UI□
A (H7)		95	95	110	114.3	130	200
C		115	115	145	200	165	235
D		M6×14	M8×20	M8×25	M12×25	M10×25	M12×25
E		—	—	□130	□180	□180	□220
F (H7)	Min	19	19	19	19	19	19
	Max	35	35	35	35	35	35
G		—	—	165	233	233	270
重量 (kg)※2 Mass (kg)※2	轴输出 Shaft output	36.2	36.2	36.3	37.3	37.3	38.3
	法兰输出 Flange output	27.6	27.6	27.7	28.7	28.7	29.7

表示代表产品的尺寸表。上述产品以外的产品，请咨询授权代理商。尺寸及形状的详细情况，请使用本公司发行的交货规格图进行确认。采用特殊安装方法进行安装时请咨询授权代理商。

This shows the dimension table of the representative product. Contact us for products other than those described above. See our delivered specifications for details of the sizes and forms. Contact us for special installation.

※1 在形状符号的□内填写输入轴接头的符号。请参照伺服电动机匹配表（第094～101页）。

The square mark of the form symbol will be replaced by the symbol of an input shaft joint. See the servo motor matching table (Pages 094 to 101).

※2 重量因减速比及输入接头的内径尺寸而有些许差异。

The weight varies slightly depending on the reduction ratio and the inner diameter size of the input joint.

性能表 Performance table

表268-1
Table 268-1

型号 Model	形状符号 Form symbol ^{※1}	减速比 Ratio	角度传达精度 ^{※2} Angle transmission precision ^{※2}		重复定位精度 ^{※3} Repetitive positioning precision ^{※3}	起动转矩 ^{※4} Starting torque ^{※4}		增速起动转矩 ^{※5} Overdrive starting torque ^{※5}		无负载运行转矩 ^{※6} No-load running Reduc. torque ^{※6}	
			arc min	x10 ⁻⁴ rad		cNm	kgfcm	Nm	kgfm	cNm	kgfcm
14	全部产品 All products	50	1.5	4.4	±10	8.2	0.8	2.9	0.3	5.6	0.6
		80				6.9	0.7	3.9	0.4	5.1	0.5
		100				6.6	0.7	4.7	0.5	4.6	0.5
20	E□□	50	1.0	2.9	±8	13	1.3	7.8	0.8	11	1.2
		80				10	1.0	9.6	1.0	10	1.0
		100				9.6	1.0	12	1.2	10	1.0
		120				9.1	0.9	13	1.3	9.8	1.0
		140				8.6	0.9	17	1.7	9.6	1.0
		160				20	2.0	12	1.2	11	1.2
	F□□ G□□	80	1.0	2.9	±8	17	1.7	16	1.6	10	1.0
		100				16	1.7	19	2.0	10	1.0
		120				16	1.6	23	2.3	9.8	1.0
		160				15	1.6	29	3.1	9.6	1.0
32	KP□ KQ□ KR□ KS□	50	1.0	2.9	±6	58	5.9	35	3.6	47	4.8
		80				46	4.7	44	4.5	42	4.3
		100				45	4.6	54	5.5	41	4.2
		120				42	4.3	61	6.2	40	4.1
		160				41	4.2	79	8.1	40	4.1
	上述产品 以外的产品 Products other than those described above	50	1.0	2.9	±6	50	5.1	30	3.1	47	4.8
		80				38	3.9	37	3.8	42	4.3
		100				37	3.8	45	4.6	41	4.2
		120				34	3.5	49	5.1	40	4.1
		160				33	3.4	64	6.6	40	4.1
45	全部产品 All products	50	1.0	2.9	±5	123	13	74	7.8	120	12
		80				95	9.7	92	9.3	109	11
		100				89	9.1	107	11	107	11
		120				85	8.7	123	13	105	11
		160				79	8.1	152	16	103	11
65	全部产品 All products	80	1.0	2.9	±4	186	19	179	18	297	30
		100				166	17	200	20	289	30
		120				156	16	226	23	285	29
		160				139	14	268	27	278	28

※1 形状符号表示型号（参照第075页）的电动机法兰形状和输入轴接头形状。（上2位为电动机法兰形状，下1位为输入轴接头形状）

The form symbol indicates the motor flange form and the input shaft joint form of the model (see Page 075). (The upper two digits indicate the motor flange form and the lowest digit indicates the input shaft joint form.)

※2 角度传达精度表示在输入端施加任意转角时，理论上旋转输出的旋转角度与实际旋转输出的旋转角度之差。此外，表中的数值表示最大值。

Angle transmission precision indicates the difference between the output rotational angle of the logical rotation when a rotational angle is given as the input and that of the actual rotation. The value in the table indicates the maximum value.

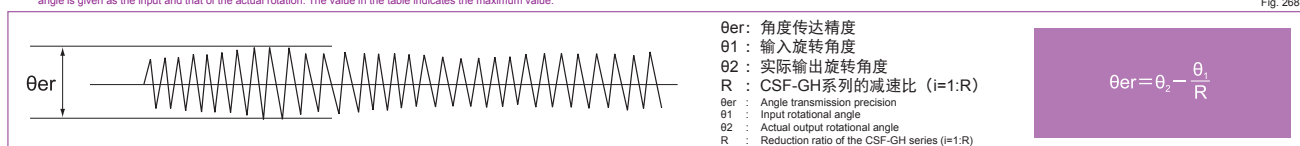


图268-1
Fig. 268-1

※3 重复定位精度是指反复7次在任意位置上同向定位，测定输出轴的停止位置，计算最大差值。测定值用角度表示，表示为±最大差的1/2。此外，表中的数值表示最大值。

The maximum value is obtained by repeating positioning from the same direction at any point seven times and measuring the stop position of the output shaft to determine the repetitive positioning precision. The measured value is shown as an angle and is indicated with a sign before the maximum difference multiplied by half.

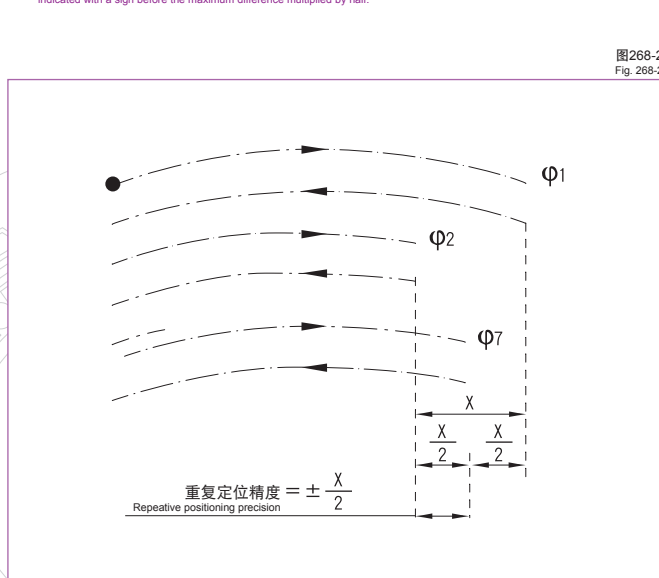


图268-2
Fig. 268-2

※4 起动转矩是指在输入侧施加转矩后，输出侧开始旋转瞬间的“起动开始转矩”。此外，表中的数值表示减速机单机的最大值。

Starting torque means the starting torque at the moment of starting rotation on the output side when a torque is applied to the input side. The value in the table indicates the maximum value of a single reducer.

测定条件
Measuring condition

负载 Load	无负载 No load
表面温度 Surface temperature	25℃

表268-2
Table 268-2

※5 增速起动转矩是指在输出侧施加转矩后，输入侧开始旋转瞬间的“起动开始转矩”。此外，表中的数值表示减速机单机的最大值。

Overdrive starting torque means the starting torque at the moment of starting rotation on the input side when a torque is applied to the output side. The value in the table indicates the maximum value of a single reducer.

测定条件
Measuring condition

负载 Load	无负载 No load
表面温度 Surface temperature	25℃

表268-3
Table 268-3

※6 无负载运行转矩是指在无负载状态下旋转减速机所需的输入侧的转矩。此外，表中的数值为减速机单机的平均值。

No-load running torque means the torque on the input side required to turn the reducer under the no-load condition. The value in the table indicates the average value of a single reducer.

测定条件
Measuring condition

输入转速 Input rotational speed	2000r/min
负载 Load	无负载 No load
表面温度 Surface temperature	25℃

表268-4
Table 268-4

刚性（弹簧常数） Rigidity (Spring constant)

（用语说明请参考“技术资料”。）
See "Engineering data" for a description of terms.

表269-1
Table 269-1

符号 Symbol	型号 Model	14	20	32	45	65
T_1	Nm	2.0	7.0	29	76	235
	kgfm	0.2	0.7	3.0	7.8	24
T_2	Nm	6.9	25	108	275	843
	kgfm	0.7	2.5	11	28	86
减速比 Reduction ratio 50	K_1	$\times 10^4 \text{ Nm/rad}$	0.34	1.3	5.4	15
		kgfm/arc min	0.1	0.38	1.6	4.3
	K_2	$\times 10^4 \text{ Nm/rad}$	0.47	1.8	7.8	2.0
		kgfm/arc min	0.14	0.52	2.3	6.0
	K_3	$\times 10^4 \text{ Nm/rad}$	0.57	2.3	9.8	26
		kgfm/arc min	0.17	0.67	2.9	7.6
	θ_1	$\times 10^{-4} \text{ rad}$	5.8	5.2	5.5	5.2
		arc min	2.0	1.8	1.9	1.8
	θ_2	$\times 10^{-4} \text{ rad}$	16	15.4	15.7	15.1
		arc min	5.6	5.3	5.4	5.2
减速比 80以上 Reduction ratio 80 or more	K_1	$\times 10^4 \text{ Nm/rad}$	0.47	1.6	6.7	18
		kgfm/arc min	0.14	0.47	2.0	5.4
	K_2	$\times 10^4 \text{ Nm/rad}$	0.61	2.5	11	29
		kgfm/arc min	0.18	0.75	3.2	8.5
	K_3	$\times 10^4 \text{ Nm/rad}$	0.71	2.9	12	33
		kgfm/arc min	0.21	0.85	3.7	9.7
	θ_1	$\times 10^{-4} \text{ rad}$	4.1	4.4	4.4	4.1
		arc min	1.4	1.5	1.5	1.4
	θ_2	$\times 10^{-4} \text{ rad}$	12	11.3	11.6	11.1
		arc min	4.2	3.9	4.0	3.8

※本表的数值为平均值。
The values in this table are average values.

滞后损失 Hysteresis loss

（用语说明请参考“技术资料”。）
See "Engineering data" for a description of terms.

减速比50: 约 $5.8 \times 10^{-4} \text{ rad}$ (2arc min)
Reduction ratio 50: About $5.8 \times 10^{-4} \text{ rad}$ (2arc min)
减速比80以上: 约 $2.9 \times 10^{-4} \text{ rad}$ (1arc min)
Reduction ratio 80 or more: About $2.9 \times 10^{-4} \text{ rad}$ (1arc min)

最大齿隙量 Max. backlash quantity

（用语说明请参考“技术资料”。）
See "Engineering data" for a description of terms.

表269-2
Table 269-2

减速比 Reduction ratio	型号 Model	14	20	32	45	65
50	$\times 10^{-5} \text{ rad}$	17.5	8.2	6.8	5.8	—
	arc sec	36	17	14	12	—
80	$\times 10^{-5} \text{ rad}$	11.2	5.3	4.4	3.9	2.9
	arc sec	23	11	9	8	6
100	$\times 10^{-5} \text{ rad}$	8.7	4.4	3.4	2.9	2.4
	arc sec	18	9	7	6	5
120	$\times 10^{-5} \text{ rad}$	—	3.9	2.9	2.4	1.9
	arc sec	—	8	6	5	4
160	$\times 10^{-5} \text{ rad}$	—	2.9	2.4	1.9	1.5
	arc sec	—	6	5	4	3

效率特性 Efficiency characteristics

减速机的效率一般来说会因减速比、输入转速、负载转矩、温度及润滑条件的不同而有所差异。在右记的测定条件下CSF-GH系列的效率如图270-2~272-9所示。此外，图的数值为平均值。

The efficiency of a reducer varies depending on the reduction ratio, input rotational speed, load torque, temperature and lubricating condition. The efficiency of the CSF-GH series is shown in Graphs 270-2 to 272-9 under the measuring condition shown on the righthand side.

测定条件

Measuring condition

表270-1

Table 270-1

环境温度 Ambient temperature	25℃
润滑剂 Lubricant	Harmonic润滑脂 SK-2 (型号14) Harmonic润滑脂 SK-1A (型号20以上) Harmonic grease SK-2 (model number 14) Harmonic grease SK-1A (model number 20 or higher)

低温效率修正值

Efficiency correction value at low temperature

环境温度在25℃以下时，效率值等于25℃时的效率值乘以低温效率修正值。不同环境温度和输入转矩（TRI※）对应的低温效率修正值，请根据下表进行计算。

Obtain the efficiency value when the ambient temperature is 25℃ or lower by multiplying the efficiency value at 25℃ and the efficiency correction value at low temperature. Obtain the efficiency correction value at low temperature corresponding to the ambient temperature and the input torque from the table below.

※TRI是25℃时输出转矩（参照第076页）所对应的输入转矩。

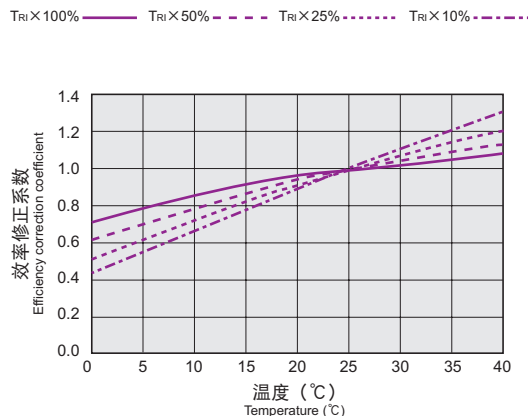
TRI indicates the input torque corresponding to the output torque at 25℃ (see Page 076).

低温效率修正值

Efficiency correction value at low temperature

图270-1

Graph 270-1



型号14

Model No. 14

润滑脂润滑 (Harmonic润滑脂 SK-2)

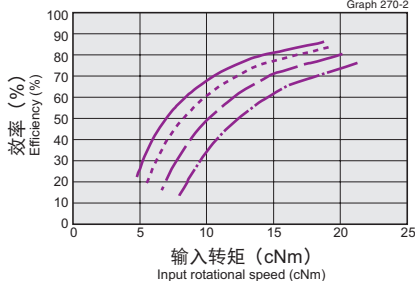
Grease lubrication (Harmonic grease SK-2)

减速比=50

Reduction ratio = 50

图270-2

Graph 270-2

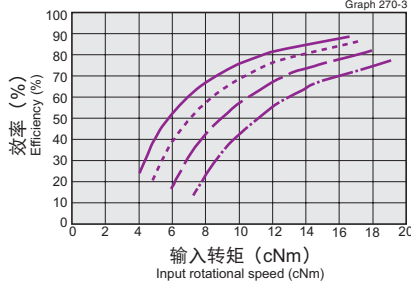


减速比=80

Reduction ratio = 80

图270-3

Graph 270-3

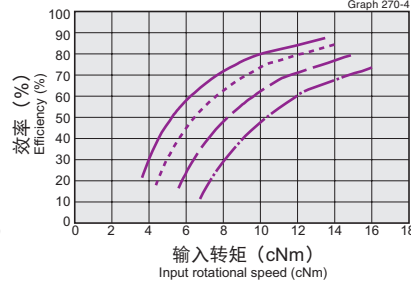


减速比=100

Reduction ratio = 100

图270-4

Graph 270-4



输入转速

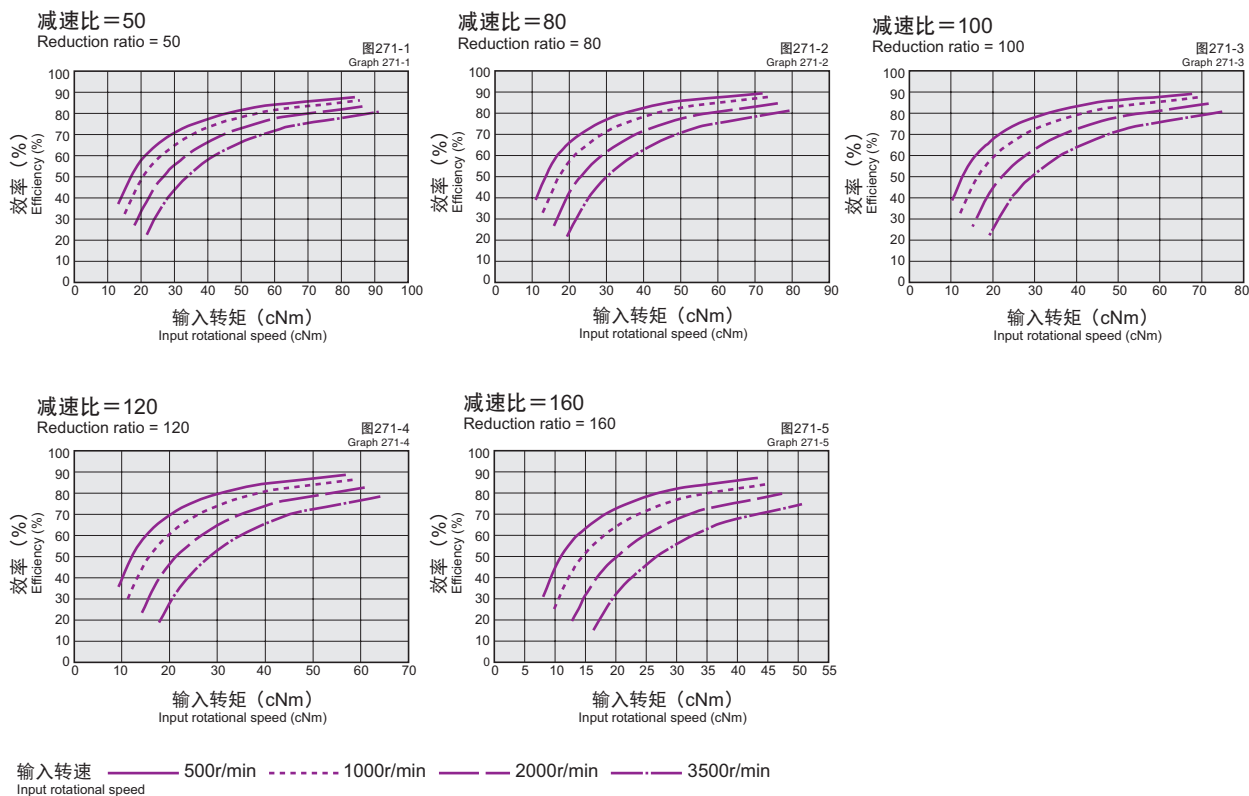
Input rotational speed

500r/min 1000r/min 2000r/min 3500r/min

■型号20

Model No. 20

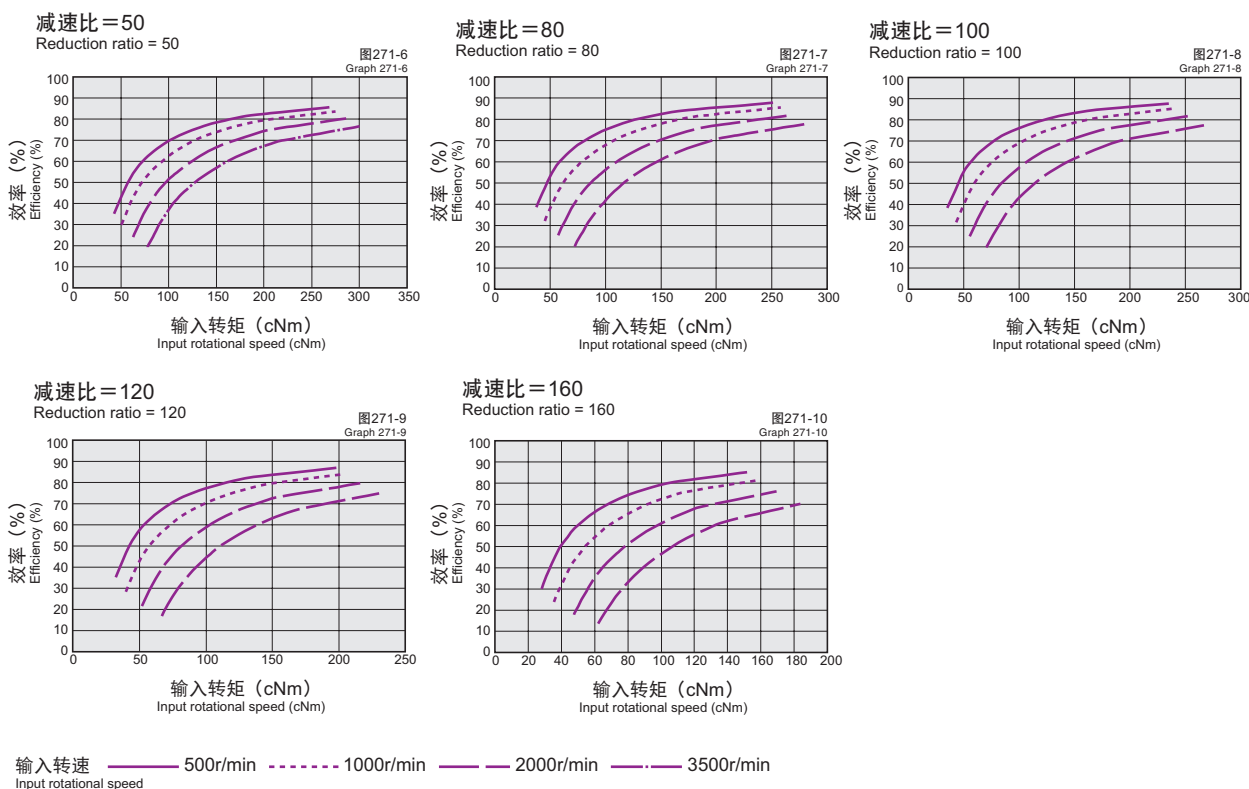
润滑脂润滑 (Harmonic润滑脂 SK-1A)
Grease lubrication (Harmonic grease SK-1A)



■型号32

Model No. 32

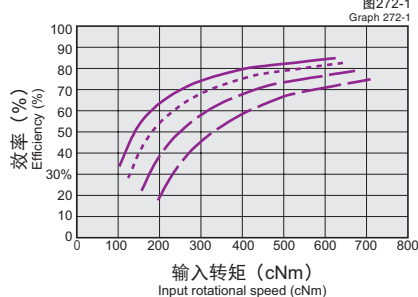
润滑脂润滑 (Harmonic润滑脂 SK-1A)
Grease lubrication (Harmonic grease SK-1A)



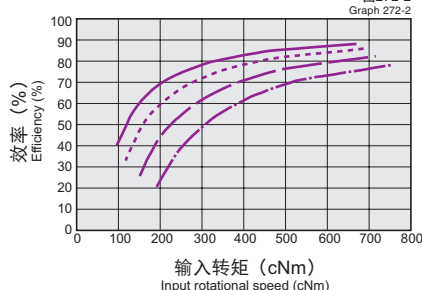
■ 型号45 Model No. 45

润滑脂润滑 (Harmonic润滑脂 SK-1A)
Grease lubrication (Harmonic grease SK-1A)

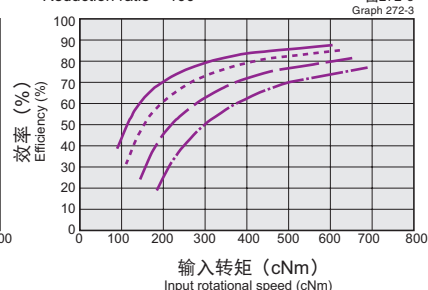
减速比=50
Reduction ratio = 50



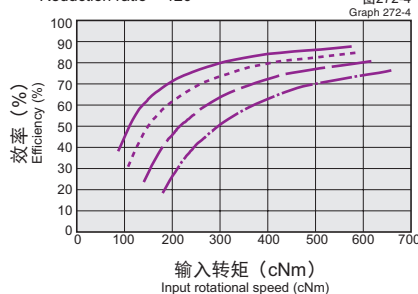
减速比=80
Reduction ratio = 80



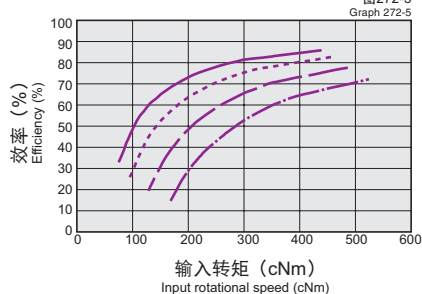
减速比=100
Reduction ratio = 100



减速比=120
Reduction ratio = 120



减速比=160
Reduction ratio = 160

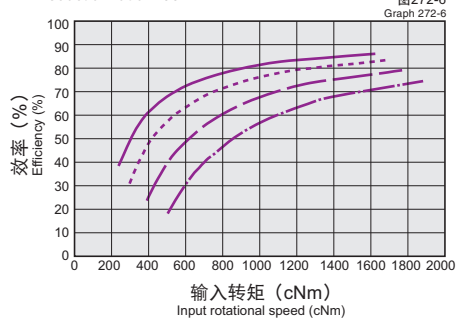


输入转速 — 500r/min - - - 1000r/min — — 2000r/min — · — 3500r/min
Input rotational speed

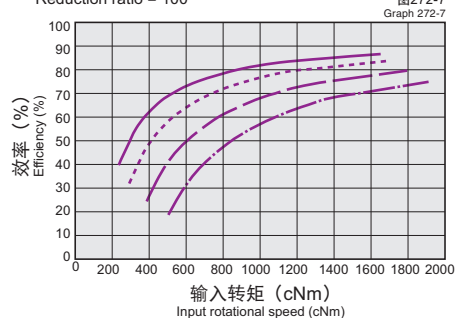
■ 型号65 Model No. 65

润滑脂润滑 (Harmonic润滑脂 SK-1A)
Grease lubrication (Harmonic grease SK-1A)

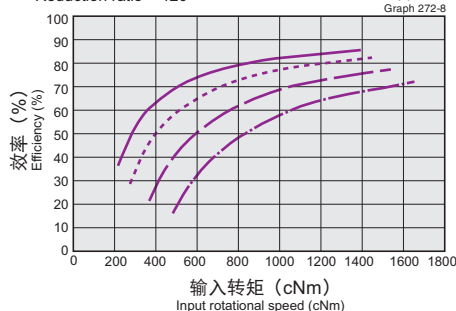
减速比=80
Reduction ratio = 80



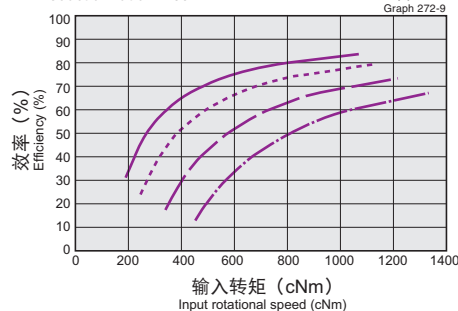
减速比=100
Reduction ratio = 100



减速比=120
Reduction ratio = 120



减速比=160
Reduction ratio = 160



输入转速 — 500r/min - - - 1000r/min — — 2000r/min — · — 3500r/min
Input rotational speed

主轴承的规格 Checking main roller bearing

CSF-GH系列组装有精密交叉滚子轴承用于直接支撑外部负载（输出法兰部）。

为充分发挥CSF-GH系列的性能，请确认最大负载静力矩、交叉滚子轴承的使用寿命以及静态安全系数。

各数值的计算公式请参照第028~031页的“技术资料”。

A precision cross roller bearing is built in the unit type and the gear head type to directly support the external load (output flange) (precision 4-point contact ball bearing for the CSF-mini series).

Check the maximum load moment load, life of the bearing and static safety coefficient to fully bring out the performance of the unit type.

See the page 028 to 031 of "Engineering data" for each calculation formula.

■ 确认步骤

Checking procedure

① 确认最大负载静力矩 (M_{max})

Checking the maximum load moment load

计算最大负载静力矩 (M_{max})
Obtain the maximum load moment load (M_{max}).

最大负载静力矩 (M_{max}) $\leq$ 容许力矩 (M_c)
Maximum load moment load (M_{max}) $\leq$ permissible moment (M_c)

② 确认使用寿命

Checking the life

计算平均径向负载 (F_{rav})、平均轴向负载 (F_{aav})
Obtain the average radial load (F_{rav}) and the average axial load (F_{aav}).

计算径向负载系数 (X)、轴向负载系数 (Y)
Obtain the radial load coefficient (X) and the axial load coefficient (Y).

计算确认使用寿命
Calculate the life and check it.

③ 确认静态安全系数

Checking the static safety coefficient

计算径向当量静负荷 (P_o)
Obtain the static equivalent radial load coefficient (P_o).

确认静态安全系数 (f_s)
Check the static safety coefficient (f_s)

■ 主轴承规格

Main roller bearing specifications

交叉滚子轴承的规格如表273-1所示。

The specifications of the cross roller are shown in Table 273-1.

主轴承规格

Specifications

表273-1
Table 273-1

型号 Model	滚子的 节圆直径 Pitch circle dia. of a roller	偏置量 Offset amount	基本额定负载 Basic rated load				容许静力矩 M_c Permissible moment load M_c		力矩刚性 K_m ^{※4} Moment rigidity K_m ^{※4}		容许径向 负载 $\times 3$ Permissible radial load $\times 3$	容许轴向 负载 $\times 3$ Permissible thrust load $\times 3$
	dp	R	基本额定动负载 C ^{※1} Basic dynamic rated load C ^{※1}		基本额定静负载 C_o ^{※2} Basic static rated load C_o ^{※2}				$\times 10^4$ Nm/rad	kgfm/ arc min	N	N
			N	kgf	N	kgf						
14	0.0405	0.011	5110	521	7060	720	27	2.76	3	0.89	1093	732
20	0.064	0.0115	10600	1082	17300	1765	145	14.8	17	5.0	2267	1519
32	0.085	0.014	20500	2092	32800	3347	258	26.3	42	12	4385	2938
45	0.123	0.019	41600	4245	76000	7755	797	81.3	100	30	8899	5962
65	0.170	0.0225	81600	8327	149000	15204	2156	220	323	96	17454	11693

※1 基本额定动负载是指使轴承的基本额定使用寿命维持到100万转的固定静止径向负载。

The basic dynamic rated load means a certain static radial load so that the basic dynamic rated life of the roller bearing is one million rotations.

※2 基本额定静负载是指在承受最大负载的转动体和轨道接触部的中央位置施加一定水平的接触应力 (4 kN/mm^2) 的静负载。

The basic static rated load means a static load that gives a certain level of contact stress (4 kN/mm^2) in the center of the contact area between the rolling element receiving the maximum load and the orbit.

※3 施加纯粹的轴向、径向负载时的容许负载 (轴向负载为 $L_r+R=0\text{ mm}$, 径向负载为 $L_a=0\text{ mm}$ 时)

Permissible load when the genuine axial radial load is applied (radial load: $L_r+R=0\text{ mm}$, axial load: $L_a=0\text{ mm}$)

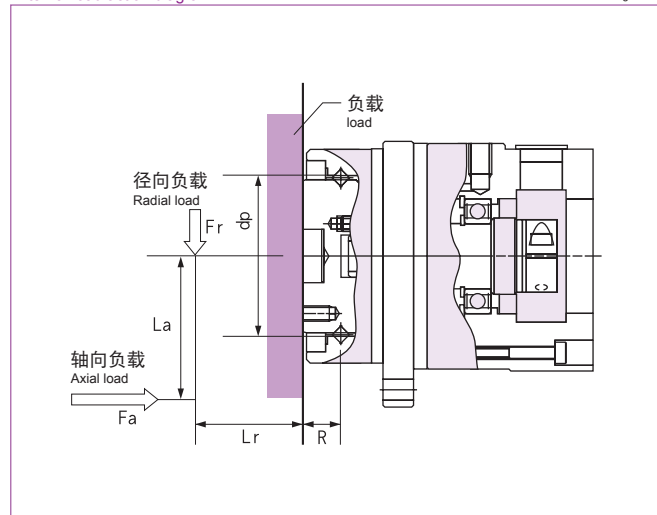
※4 力矩刚性的数值为平均值。

Values for moment rigidity are average values.

外部负载作用图

External load action diagram

图273-1
Fig. 273-1



机械精度 Mechanical precision

CSF-GH系列的主轴承采用高精度的交叉滚子轴承，实现了输出部的高机械精度。

输出轴以及安装法兰的机械精度如下所示。

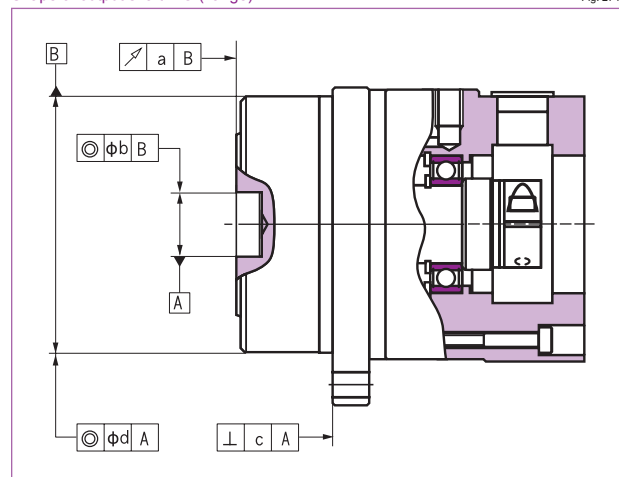
CSF-mini series have cross roller bearing of high precision on main shaft bearing, and realized the high mechanical precision of output part.

The mechanical precision of the output shaft and output flange is shown below.

输出轴的形状：FO（法兰）

Shape of output shaft: FO (flange)

图274-1
Fig. 274-1



输出形状：J2.J6（轴输出）

Shape of output: J2.J6 (shaft output)

图274-2
Fig. 274-2

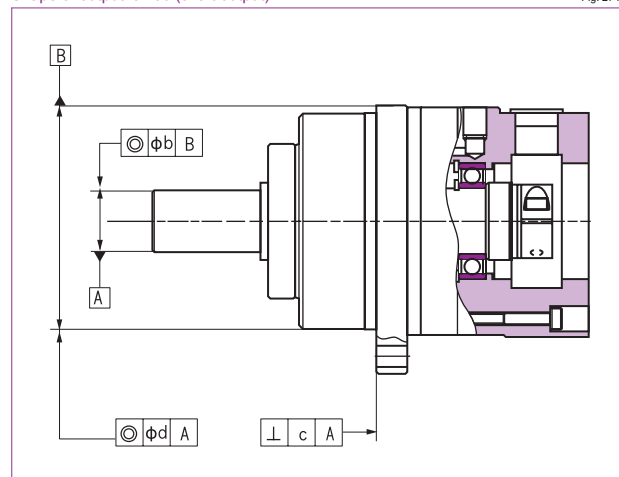


表274-1
T.I.R.单位：mm
Table 274-1
T.I.R. Unit: mm

型号 Model No.	输出法兰部的面跳动a Fluctuation on the output flange face a	输出法兰凹圆部或输出轴的跳动b Fluctuation on the output flange spigot or output shaft b.	安装法兰部的面跳动c Fluctuation on the mounting flange face c	安装凹圆部的跳动d Fluctuation on the mounting spigot d
14	0.020	0.040	0.060	0.050
20	0.020	0.040	0.060	0.050
32	0.020	0.040	0.060	0.050
45	0.020	0.040	0.060	0.050
65	0.020	0.040	0.060	0.050

※T.I.R. (Total Indicator Reading)：表示测定部旋转1次时千分表读数的总量。
T.I.R.: This indicates the total reading of the dial gauge when the measuring part is rotated once.

设计指南 Design guide

为充分发挥CSF-GH系列的优良性能，请正确实施组装和安装。

使用的螺栓和拧紧转距请遵守我公司建议。

Install the product correctly to fully bring out the performance of the CSF-GH series.
Observe our recommended bolts and tightening torque.

电动机的组装步骤 Installation procedure of a motor

请按照以下步骤实施CSF-GH系列和电动机的组装。

Install the CSF-GH series and motor according to the following procedure.

- ① 转动输入轴接头，使螺栓的头对准橡皮帽孔。

Turn the input shaft joint and match the head of the bolt with the rubber cap hole.

- ② 将电动机小心地插入到减速机主机。插入时请注意不要倾斜电动机。

Insert the motor into the reducer gently. Do not tilt it and insert the motor.

- ③ 电动机和减速机的法兰部用螺栓拧紧。

Tighten the motor and the flange of the reducer with bolts.

螺栓拧紧转矩

Tightening torque of bolts

螺栓规格 Bolt size		M3	M4	M5	M6	M8	M10	M12
拧紧转矩 Tightening torque	Nm	1.4	3.1	6.3	10.7	26.1	51.5	75.5
	kgfm	0.14	0.32	0.64	1.09	2.66	5.25	7.70

表275-1
Table 275-1

- ④ 拧紧输入轴接头的螺栓。

Tighten the bolt of the input shaft joint.

螺栓拧紧转矩

Tightening torque of bolts

螺栓规格 Bolt size		M3	M4	M6
拧紧转矩 Tightening torque	Nm	2.0	4.5	15.3
	kgfm	0.20	0.46	1.56

表275-2
Table 275-2

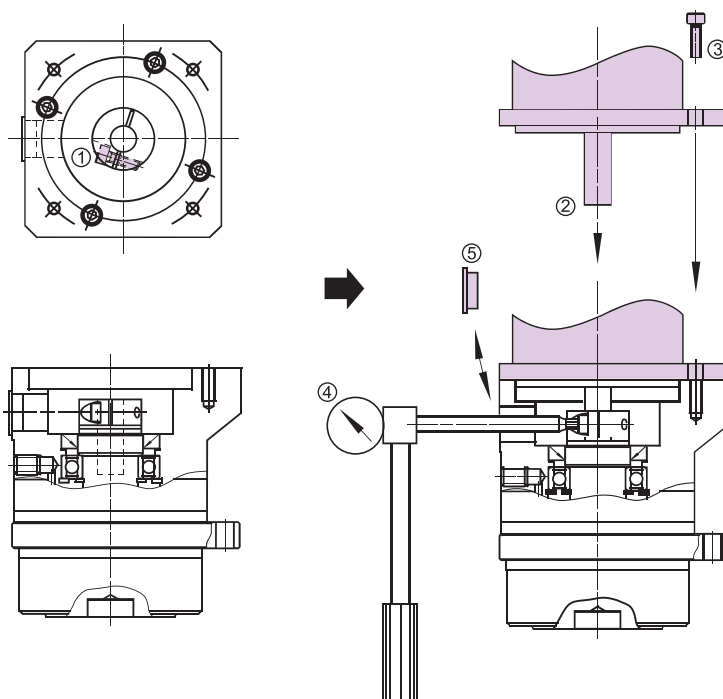
(注) 请务必按照上表中的拧紧转矩进行拧紧。

(Note) Tighten the bolts with the tightening torque shown above.

- ⑤ 安装附属零件橡胶帽后，组装完成。

Attach the appended rubber cap.

图275-1
Fig. 275-1



安装传递转矩 Installation transmission torque

■减速机的组装

Installation of a reducer

将CSF-GH系列安装到装置上时，请在确认安装面的平坦度以及螺孔是否存在毛刺后再将安装法兰（图277-1的A部）与螺栓拧紧。

Check the flatness of the mounting face and burrs on the tap to install the CSF-GH series on the equipment, and tighten the mounting flange (A in Figure 277-1) with bolts.

安装法兰（图277-1的A部）螺栓^{*}的拧紧转矩

Tightening torque of the bolt^{*} of the mounting flange (A in Fig. 277-1) (flange output type)

表276-1

Table 276-1

项目 Item	型号 Model	14	20	32	45	65
螺栓数量 Number of bolts		4	4	4	4	4
螺栓规格 Bolt size		M5	M8	M10	M12	M16
螺栓安装P.C.D. Mounting P.C.D.	mm	70	105	135	190	260
螺栓拧紧转矩 Bolt tightening torque	Nm	6.3	26.1	51.5	102.7	254
	kgfm	0.64	2.66	5.25	10.48	26
螺栓传递转矩 Bolt transmission torque	Nm	110	428	868	2033	5174
	kgfm	11.3	43.6	88.6	207.4	528

※推荐螺栓名称：JIS B 1176 内六角螺栓、强度分类：JIS B 1051 12.9以上

Recommended bolt name: JIS B 1176 hexagonal bolt, intensity type: JIS B 1051 12.9 or higher

■ 安装输出部的负载

Installation of the load on the output part

向CSF-GH系列的输出部安装负载时，请参考主轴的规格（参照第087页）实施安装。

Install the load on the output part of the CSF-GH series taking the specifications of the main roller bearing (see Page 087) into consideration.

输出法兰型产品 Output flange-type product

安装法兰（图277-1的B部）螺栓*的拧紧转矩

Tightening torque of the bolt* of the mounting flange (B in Fig. 277-1) (flange output type)

表277-1
Table 277-1

项目 Item	型号 Model	14	20	32	45	65
螺栓数量 Number of bolts		6	6	6	16	8
螺栓规格 Bolt size		M4	M6	M8	M8	M16
螺栓安装P.C.D. Mounting P.C.D.	mm	30	45	60	100	120
螺栓拧紧转矩 Bolt tightening torque	Nm	4.5	15.3	37.2	37.2	319
	kgfm	0.46	1.56	3.80	3.80	32.5
螺栓传递转矩 Bolt transmission torque	Nm	63	215	524	2326	5981
	kgfm	6.5	21.9	53.4	237.3	610.3

输出法兰由于有防止漏油措施，因此不需要涂抹密封剂。

As measures have been taken against oil leakage of the output flange, no sealing agent needs to be applied.

※推荐螺栓名称：JIS B 1176 内六角螺栓、强度分类：JIS B 1051 12.9以上

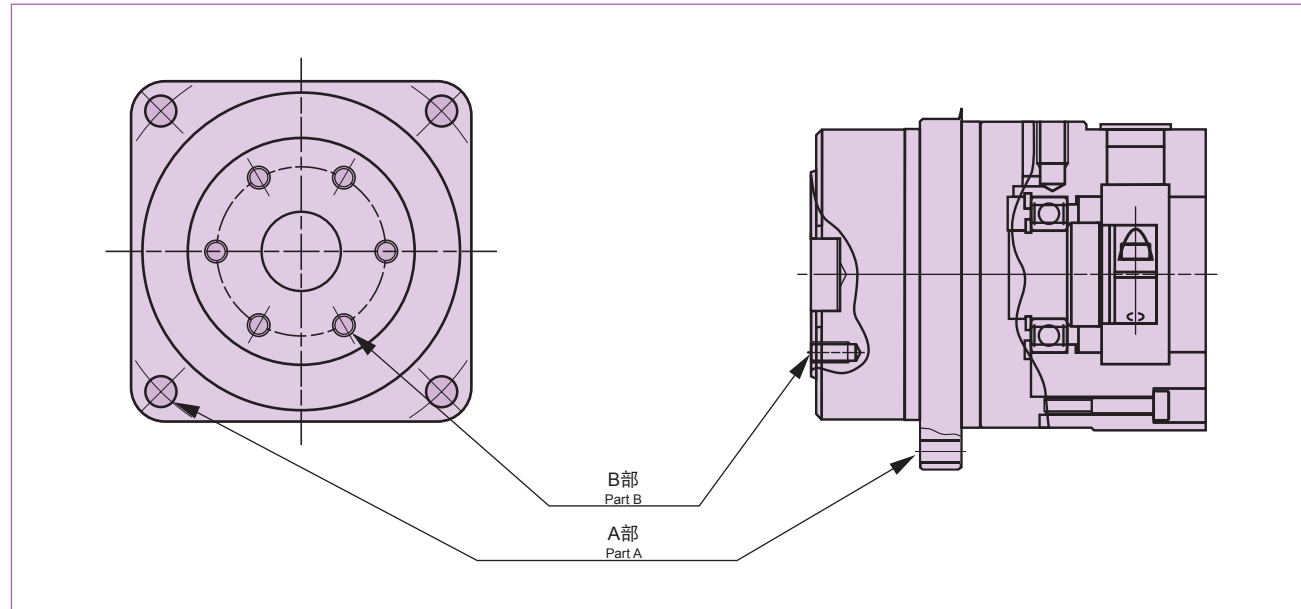
Recommended bolt name: JIS B 1176 hexagonal bolt, intensity type: JIS B 1051 12.9 or higher

输出轴型产品 Output shaft type product

安装皮带轮、小齿轮等时，不要对输出轴施加冲击。否则可能会引起减速机的精度下降或故障。

Do not allow the output shaft to receive a shock when you install a pulley and pinion. It can deteriorate the precision of the reducer and cause failure.

图277-1
Fig. 277-1



润滑 Grease lubricant

润滑脂的种类 Types of lubricant

Harmonic润滑脂 SK-1A: 型号20以上

Harmonic grease SK-1A: Model No. 20 or more

专为Harmonic Drive开发的专用润滑脂，与市场上销售的常用润滑脂相比具有耐久性强、效率特性佳的优点。

This has been developed as grease exclusively for Harmonic Drive and is excellent in durability and efficiency compared to commercial general-purpose grease.

Harmonic润滑脂 SK-2: 型号14

Harmonic grease SK-2: Model No. 14

专为小型Harmonic Drive开发的专用润滑脂，通过将极压添加剂液化，可以在波发生器旋转时获得极佳的润滑效果。

This has been developed exclusively for the compact Harmonic Drive and is excellent in smoothness during wave generator rotation by liquefying extreme pressure additive.

润滑脂规格

Grease specification

表 278-1
Table 278-1

润滑脂 Grease	SK-1A	SK-2
基础油 Base oil	精制矿物油 Refined oil	精制矿物油 Refined oil
增稠剂 Thickening agent	锂皂基 Lithium soap base	锂皂基 Lithium soap base
添加剂 Additive	极压添加剂、其他 Extreme-pressure additive, others	极压添加剂、其他 Extreme-pressure additive, others
NLGI粘度No. NLGI consistency No.	No.2	No.2
粘度 (25℃) Consistency (25℃)	265~295	265~295
滴点 Drop point	197℃	198℃
外观 Appearance	黄色 Yellow	绿色 Green
保存寿命 Storage life	密闭状态5年 5 years in sealed condition	密闭状态5年 5 years in sealed condition

使用工况温度范围

Temperature range of the operating environment

表 278-2
Table 278-2

润滑脂 Grease	SK-1A	SK-2
	0℃~+40℃	0℃~+40℃

(注) 高温侧，请在工作气体温度上升40℃以内时使用。
Keep the hot section up to 40℃ above the ambient temperature.

润滑脂的更换时间 When to replace grease

Harmonic Drive的各运动部的磨耗很大程度上会受到润滑脂性能的影响。

润滑脂的性能会根据温度变化，温度越高劣化越快，因此需要尽早进行润滑脂更换。如右表所示，当平均负载转矩低于2000r/min时的输出转矩时，根据润滑脂温度与波发生器总转数间的关系可确定润滑脂的更换时间大致标准。

平均负载转矩超出2000r/min时的输出转矩，则通过以下计算公式计算出润滑脂的更换时间大致标准。

Abrasion of the sliding parts of HarmonicDrive is influenced by grease performance. Grease performance changes by temperature and deteriorates rapidly as the temperature rises. Therefore, the grease needs to be replaced earlier than usual. The graph on the right indicates approximate timing to replace the grease from the relation between the grease temperature and the total number of wave generator rotations when the average load torque is output torque that is equal to or less than 2000r/min.

Obtain approximate timing to replace the grease from the following calculation formula when the average load torque exceeds output torque at 2000r/min.

平均负载转矩超出2000r/min时的输出转矩的计算公式

Calculation formula when the average load torque exceeds the output torque at 2000r/min

公式279-1
Formula 279-1

$$L_{GT} = L_{GTn} \times \left(\frac{T_r}{T_{av}} \right)^3$$

计算公式的符号

Symbols of the calculation formula

表279-1
Table 279-1

L_{GT}	超出输出转矩时的更换时间 Replacement timing if it is equal to rated torque or more	转数 Number of rotation	——
L_{GTn}	低于输出转矩时的更换时间 Replacement timing if it is equal to rated torque or less	转数 Number of rotation	参照图279-1 See Fig. 279-1.
T_r	2000r/min时的输出转矩 Output torque at 2000 r/min	Nm,kgfm	参照第076页的额定表 See the "Ratings" on page 076.
T_{av}	输出侧的平均负载转矩 Average load torque on the output side		计算公式：参照第012页 Calculation formula: See Page 012.

更换时的润滑脂补充量

Grease replenishment quantity for replacement

润滑脂补充量的大致标准如下所示。

A broad indication of grease replenishment quantities is shown below.

表279-2
Table 279-2

型号 Model	14	20	32	45	65
补充量g Replenishment qty g	0.8	3.2	6.6	11.6	78.6

补充润滑脂时的注意事项 Precautions on grease replenishment

由于润滑脂的补充量、排出量可能会造成润滑脂泄露、起动转矩增加等恶劣影响，因此请严格遵守以下事项。

Observe the following items as grease replenishment quantity and emission can cause negative effects such as grease leakage and an

- 1次的补充量以表279-2的补充量为基准，请不要大幅超出。

Use the replenishment quantity in Table 279-2 as a broad indication to avoid excess replenishment for the first replenishment quantity.

- 请在排出与补充量同份量的润滑脂后再进行补充。

此外，在进行前两次润滑脂补充时，即使不进行排出就实施补充也不会产生恶劣影响，但在第3次以后进行润滑脂补充时，请务必先排出与补充量相同份量的润滑脂后，再实施补充。请利用压力空气等排出润滑脂。

Discharge the same amount of grease as the replenished amount before replenishment. Although there will be no negative effects of replenishment without discharging the grease by the second grease replenishment, you should discharge same amount of grease as the replenished amount after the third grease replenishment or after. Use compressed air to discharge grease.

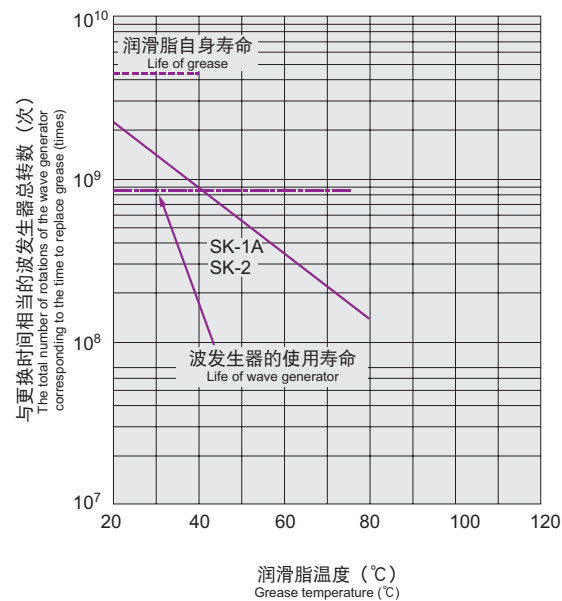
润滑脂更换时间：L_{GTn}（平均负载转矩低于2000r/min时的输出转矩）

When to replace grease: L_{GTn} (when the average load torque is equal to or less than the output torque at 2000 r/min)

图279-1
Fig. 279-1

润滑脂更换时间：L_{GTn}（平均负载转矩低于额定转矩时）

When to replace grease: L_{GTn} (when the average load torque is equal to or less than the rated torque)



※波发生器的使用寿命表示破损率为10%。
Life of wave generator indicates the 10% of damage possibility.

伺服电动机匹配表 Servo motor matching table

型号：14 Model No. 14

表280-1
Table 280-1

制造商 Manufacturer	电动机系列 Motor series	电动机容量 Motor capacity	额定转速 Rated rotational speed	减速机惯量 Reducer inertia	惯量比 Inertia ratio	形状符号 Form symbol		
		W	r/min	×10 ⁴ kgm ²		减速比50 Reduction ratio 50	减速比80 Reduction ratio 80	减速比100 Reduction ratio 100
安川电机 Yaskawa Electric.	SGMAH	30	3000	0.07	3.1	ACB	ACB	ACB
		50	3000	0.07	3.0	ACB	ACB	ACB
		100	3000	0.06	1.8	ACD	—	—
	SGMAS	50	3000	0.07	2.7	ACB	ACB	ACB
		100	3000	0.06	1.7	ACD	—	—
		SGMPH	100	3000	0.06	1.3	BCD	—
	SGMPS	100	3000	0.06	1.1	BCD	—	—
三菱电机 Mitsubishi Electric.	HA-FF	50	3000	0.06	1.0	BAD	BAD	BAD
		100	3000	0.06	0.7	BAD	—	—
	HC-KFS	50	3000	0.06	1.2	ACD	ACD	ACD
		100	3000	0.06	0.8	ACD	—	—
	HC-MF	50	3000	0.06	3.4	ACD	ACD	ACD
		100	3000	0.06	2.1	ACD	—	—
	HC-MFS	50	3000	0.06	3.4	ACD	ACD	ACD
		100	3000	0.06	2.1	ACD	—	—
	HC-PQ	30	3000	0.06	4.6	ACD	ACD	ACD
		50	3000	0.06	3.4	ACD	ACD	ACD
HC-UFS	100	3000	0.06	1.0	BCD	—	—	
山洋电气 Sanyo Electric.	P3	30	3000	0.07	2.7	ACB	ACB	ACB
		50	3000	0.06	2.1	ACD	ACD	ACD
		100	3000	0.06	1.3	ACD	—	—
	P50B04	60	3000	0.06	1.2	ADC	ADC	ADC
		100	3000	0.06	0.8	ADC	—	—
	P50B05	50	3000	0.06	1.0	BAD	BAD	BAD
		100	3000	0.06	0.6	BAD	—	—
松下电器 Matsushita Electric.	MQMA	100	3000	0.06	0.7	BBD	—	—
	MSMA	30	3000	0.06	4.0	ABC	ABC	ABC
		50	3000	0.06	2.6	ABD	ABD	ABD
		100	3000	0.06	1.0	ABD	—	—
欧姆龙 OMRON	R7M-A R88M-W	30	3000	0.07	3.1	ACB	ACB	ACB
		50	3000	0.07	3.0	ACB	ACB	ACB
		100	3000	0.06	1.8	ACD	—	—
	R7M-AP R88M-WP	100	3000	0.06	1.3	BCD	—	—
基恩士 KEYENCE	MV-M05	50	3000	0.06	2.1	ACD	ACD	ACD
	MV-M10	100	3000	0.06	1.3	ACD	—	—
富士电机 Fuji Electric.	GYS	50	3000	0.07	3.6	ACB	ACB	ACB
		100	3000	0.06	1.6	ACD	—	—
	GYC	100	3000	0.06	1.0	BCD	—	—
东荣电机 Toei Electric.	VLBSV-ZA	30	3000	0.06	6.0	ACD	ACD	ACD
		50	3000	0.06	3.0	ACD	ACD	ACD
		100	3000	0.06	2.0	ACD	—	—

(注1) 形状符号的匹配表为  时, 请限制电动机电流使用, 使电动机的输出转矩低于CSF-GH系列启动停止时的峰值转矩 (参照第076页“额定表”)。

(Note-1) If the form symbol matches the shaded area,  the motor current should be restricted so that the output torque of the motor is the peak torque (see "Rated table" on Page 076) at the start and stop of the CSFGH series or less.

(注2) 惯量比是指减速机惯量 / 电动机惯量的数值。惯量比会因对应的电动机的不同而有所差异, 选择时请特别注意。

(Note-2) The inertia ratio is the value of reducer inertia/motor inertia. Take care in selecting a motor as the inertia ratio varies depending on the corresponding motor.

■除上述伺服电动机以外的电动机详情, 请咨询本公司授权代理商。
Contact our office for servo motors other than described above.

制造商 Manufacturer	电动机系列 Motor series	电动机容量 Motor capacity	额定转速 Rated rotational speed	减速机惯量 Reducer inertia	惯量比 Inertia ratio	形状符号 Form symbol				
		W	r/min	×10 ⁻⁴ kgm ²		减速比50 Reduction ratio 50	减速比80 Reduction ratio 80	减速比100 Reduction ratio 100	减速比120 Reduction ratio 120	减速比160 Reduction ratio 160
安川电机 Yaskawa Electric.	SGMAH	100	3000	0.28	7.7	EBB	EBB	EBB	EBB	EBB
		200	3000	0.41	3.9	FCF	FCF	FCF	—	—
	SGMAS	100	3000	0.28	7.3	EBB	EBB	EBB	EBB	EBB
		150	3000	0.28	5.3	EBB	EBB	EBB	EBB	—
	SGMPH	200	3000	0.41	3.6	FCF	FCF	FCF	—	—
		100	3000	0.42	8.5	FCC	FCC	FCC	FCC	FCC
	SGMPS	200	3000	0.41	2.1	GBF	GBF	GBF	—	—
		100	3000	0.42	7.1	FCC	FCC	FCC	FCC	FCC
		200	3000	0.41	1.6	GBF	GBF	GBF	—	—
		100	3000	0.42	4.4	FAC	FAC	FAC	FAC	FAC
三菱电机 Mitsubishi Electric.	HA-FF	200	3000	0.42	1.2	GAE	GAE	GAE	—	—
		100	3000	0.28	3.3	EBB	EBB	EBB	EBB	EBB
	HC-KFS	200	3000	0.41	1.0	FCF	FCF	FCF	—	—
		100	3000	0.28	9.3	EBB	EBB	EBB	EBB	EBB
	HC-MF	200	3000	0.41	4.7	FCF	FCF	FCF	—	—
		100	3000	0.28	9.3	EBB	EBB	EBB	EBB	EBB
	HC-MFS	200	3000	0.41	4.7	FCF	FCF	FCF	—	—
		100	3000	0.28	9.3	EBB	EBB	EBB	EBB	EBB
	HC-PQ	200	3000	0.41	4.7	FCF	FCF	FCF	—	—
		100	3000	0.42	6.3	FCC	FCC	FCC	FCC	FCC
山洋电气 Sanyo Electric.	P3	200	3000	0.41	2.9	FCF	FCF	—	—	—
		100	3000	0.28	5.5	EBB	EBB	EBB	EBB	EBB
	P50B04	200	3000	0.28	5.2	ECA	ECA	ECA	ECA	ECA
		100	3000	0.28	3.5	ECA	ECA	ECA	ECA	ECA
	P50B05	200	3000	0.42	4.1	FAC	FAC	FAC	FAC	FAC
		100	3000	0.42	2.4	FAE	FAE	—	—	—
	P50B07	200	3000	0.41	1.1	GAF	GAF	—	—	—
松下电器 Matsushita Electric.	MQMA	200	3000	0.42	1.2	GAE	GAE	GAE	—	—
		100	3000	0.28	4.4	EAB	EAB	EAB	EAB	EAB
	MSMA	200	3000	0.42	2.4	FBE	FBE	FBE	—	—
		100	3000	0.28	7.7	EBB	EBB	EBB	EBB	EBB
欧姆龙 OMRON	R7M-A	200	3000	0.41	3.9	FCF	FCF	FCF	—	—
	R88M-W	100	3000	0.42	8.5	FCC	FCC	FCC	FCC	FCC
	R88M-WP	100	3000	0.42	8.5	FCC	FCC	FCC	FCC	FCC
基恩士 KEYENCE	MV-M10	200	3000	0.41	2.9	FCF	FCF	FCF	—	—
	MV-M20	100	3000	0.28	7.5	EBB	EBB	EBB	EBB	EBB
富士电机 Fuji Electric.	GYS	200	3000	0.41	3.0	FCF	FCF	FCF	—	—
		100	3000	0.42	7.3	FCC	FCC	FCC	FCC	FCC
	GYC	100	3000	0.28	9.3	EBB	EBB	EBB	EBB	EBB
东荣电机 Toei Electric.	VLBSV-ZA	200	3000	0.41	2.3	FCF	FCF	FCF	—	—
		100	3000	0.28	9.3	EBB	EBB	EBB	EBB	EBB

(注1) 形状符号的匹配表为  时，请限制电动机电流使用，使电动机的输出转矩低于CSF-GH系列启动停止时的峰值转矩（参照第076页“额定表”）。

(Note-1) If the form symbol matches the shaded area,  the motor current should be restricted so that the output torque of the motor is the peak torque (see "Rated table" on Page 076) at the start and stop of the CSFGH series or less.

(注2) 惯量比是指减速机惯量 / 电动机惯量的数值。惯量比会因对应的电动机的不同而有所差异，选择时请特别注意。

(Note-2) The inertia ratio is the value of reducer inertia/motor inertia. Take care in selecting a motor as the inertia ratio varies depending on the corresponding motor.

■除上述伺服电动机以外的电动机详情，请咨询本公司授权代理商。
Contact our office for servo motors other than described above.

型号：32 Model No. 32

表282-1
Table 282-1

制造商 Manufacturer	电动机系列 Motor series	电动机容量 Motor capacity	额定转速 Rated rotational speed	减速机惯量 Reducer inertia	惯量比 Inertia ratio	形状符号 Form symbol				
		W	r/min	×10 ⁻⁴ kgm ²		减速比50 Reduction ratio 50	减速比80 Reduction ratio 80	减速比100 Reduction ratio 100	减速比120 Reduction ratio 120	减速比160 Reduction ratio 160
安川电机 Yaskawa Electric.	SGMAH	400	3000	2.0	12	KBB	KBB	KBB	KBB	KBB
		750	3000	2.0	3.0	KEC	KEC	KEC	KEC	—
	SGMAS	400	3000	2.0	11	KBB	KBB	KBB	KBB	KBB
		600	3000	2.0	6.2	KBB	KBB	KBB	KBB	KBB
	SGMGH	400	3000	2.0	2.6	KEC	KEC	KEC	KEC	—
		750	3000	2.0	2.6	KEC	KEC	KEC	KEC	—
	SGMPH	300	1000	2.7	0.4	KRF	KRF	KRF	KRF	—
		450	1500	2.7	0.4	KRF	KRF	—	—	—
	SGMPS	200	3000	2.0	10	—	—	—	KEB	KEB
		400	3000	2.0	6.1	KEB	KEB	KEB	KEB	KEB
	SGMPS	750	3000	2.7	1.3	KRE	KRE	KRE	KRE	—
		200	3000	2.0	7.6	—	—	—	KEB	KEB
	SGMPS	400	3000	2.0	4.9	KEB	KEB	KEB	KEB	KEB
		750	3000	2.7	1.4	KRE	KRE	KRE	KRE	—
三菱电机 Mitsubishi Electric.	SGMSH	1000	3000	2.6	1.5	KPH	KPH	—	—	—
		300	3000	2.0	4.0	KDA	KDA	KDA	KDA	KDA
	HA-FF	400	3000	2.0	2.0	KHC	KHC	KHC	KHC	KHC
		600	3000	2.0	1.7	KHC	KHC	KHC	KHC	KHC
	HC-KFS	400	3000	2.0	3.0	KBB	KBB	KBB	KBB	KBB
		750	3000	2.0	1.3	KED	KED	KED	KED	—
	HC-MF	400	3000	2.0	14	KBB	KBB	KBB	KBB	KBB
		750	3000	2.0	3.3	KED	KED	KED	KED	—
	HC-MFS	400	3000	2.0	14	KBB	KBB	KBB	KBB	KBB
		750	3000	2.0	3.3	KED	KED	KED	KED	—
	HC-PQ	400	3000	2.0	14	KBB	KBB	KBB	KBB	KBB
		750	3000	2.0	14	KBB	KBB	KBB	KBB	KBB
	HC-RFS	1000	3000	2.6	1.8	KQH	KQH	KQH	KQH	—
		500	2000	2.6	0.4	KRH	KRH	KRH	KRH	—
山洋电气 Sanyo Electric.	HC-SFS52	500	2000	2.6	0.4	KRH	KRH	KRH	KRH	—
		500	3000	2.6	0.4	KRH	KRH	KRH	KRH	KRH
	HC-SFS53	500	3000	2.6	0.4	KRH	KRH	—	—	—
		1000	3000	2.6	0.4	KRH	KRH	—	—	—
	HC-SFS103	400	3000	2.0	5.5	KEB	KEB	KEB	KEB	KEB
		750	3000	2.7	0.5	KRF	KRF	KRF	KRF	—
	P1	300	2000	2.0	0.5	KHC	KHC	KHC	KHC	KHC
		500	2000	2.7	0.2	KRF	KRF	KRF	—	—
	P2	1000	3000	2.7	1.7	KQG	—	—	—	—
		200	3000	2.0	14	—	—	—	KBB	KBB
	P3	400	3000	2.0	7.9	KBB	KBB	KBB	KBB	KBB
		750	3000	2.0	3.1	KDC	KDC	KDC	KDC	—
	P5	200	3000	2.0	5.2	—	—	—	KDB	KDB
		300	3000	2.0	4.1	KDB	KDB	KDB	KDB	KDB
	P6	400	3000	2.0	2.7	KDB	KDB	KDB	KDB	KDB
		500	3000	2.0	1.7	KFC	KFC	KFC	KFC	KFC
	P8	750	3000	2.0	1.0	KFC	KFC	KFC	—	—
		500	2000	2.7	1.0	KRG	KRG	KRG	KRG	—
	P8	750	2000	2.7	0.5	KSG	KSG	—	—	—

(注1) 形状符号的匹配表为  时，请限制电动机电流使用，使电动机的输出转矩低于CSF-GH系列启动停止时的峰值转矩（参照第076页“额定表”）。

(Note-1) If the form symbol matches the shaded area,  the motor current should be restricted so that the output torque of the motor is the peak torque (see “Rated table” on Page 076) at the start and stop of the CSFGH series or less.

(注2) 惯量比是指减速机惯量 / 电动机惯量的数值。惯量比会因对应的电动机的不同而有所差异，选择时请特别注意。

(Note-2) The inertia ratio is the value of reducer inertia/motor inertia. Take care in selecting a motor as the inertia ratio varies depending on the corresponding motor.

■除上述伺服电动机以外的电动机详情，请咨询本公司授权代理商。
Contact our office for servo motors other than described above.

表283-1
Table 283-1

制造商 Manufacturer	电动机系列 Motor series	电动机容量 Motor capacity	额定转速 Rated rotational speed	减速机惯量 Reducer inertia	惯量比 Inertia ratio	形状符号 Form symbol				
		W	r/min	×10 ⁻⁴ kgm ²		减速比50 Reduction ratio 50	减速比80 Reduction ratio 80	减速比100 Reduction ratio 100	减速比120 Reduction ratio 120	减速比160 Reduction ratio 160
松下电器 Matsushita Electric.	MFMA	400	2000	2.7	1.1	KRF	KRF	KRF	KRF	KRF
	MGMA	300	1000	2.7	0.7	KRG	KRG	KRG	KRG	KRG
	MHMA	500	2000	2.7	0.2	KRG	KRG	KRG	KRG	KRG
	MQMA	400	3000	2.0	3.1	KDB	KDB	KDB	KDB	KDB
	MSMA	400	3000	2.0	5.6	KAB	KAB	KAB	KAB	KAB
		750	3000	2.0	1.5	KDD	KDD	KDD	KDD	—
		1000	3000	2.0	1.2	KFD	KFD	—	—	—
发那科 FANUC LTD.	β1	300	3000	2.0	0.6	KHB	KHB	KHB	KHB	KHB
	β2	500	3000	2.0	0.3	KHB	KHB	KHB	KHB	KHB
	β3	500	3000	2.7	0.1	KSF	KSF	KSF	KSF	—
欧姆龙 OMRON	R7M-A	400	3000	2.0	12	KBB	KBB	KBB	KBB	KBB
	R88M-W	750	3000	2.0	3.0	KEC	KEC	KEC	KEC	—
	R88M-W***15	450	1500	2.7	0.4	KRF	KRF	—	—	—
	R7M-AP R88M-WP	200	3000	2.0	10	—	—	—	KEB	KEB
		400	3000	2.0	6.1	KEB	KEB	KEB	KEB	KEB
		750	3000	2.7	1.3	KRE	KRE	KRE	KRE	—
	R88M-W	1000	3000	2.6	1.5	KPH	KPH	—	—	—
基恩士 KEYENCE	MV-M40	400	3000	2.0	7.9	KBB	KBB	KBB	KBB	KBB
	MV-M75	750	3000	2.0	3.1	KDC	KDC	KDC	KDC	—
富士电机 Fuji Electric.	GYS	400	3000	2.0	8.1	KBB	KBB	KBB	KBB	KBB
		750	3000	2.0	2.3	KEC	KEC	KEC	KEC	—
		1000	3000	2.6	1.5	KQH	KQH	—	—	—
	GYC	200	3000	2.0	9.4	—	—	—	KEB	KEB
		400	3000	2.0	4.9	KEB	KEB	KEB	KEB	KEB
		750	3000	2.0	1.7	KHC	KHC	KHC	KHC	—
		1000	3000	2.6	0.8	KRH	KRH	—	—	—
东荣电机 Toei Electric.	VLBSV-ZA	400	3000	2.0	5.9	KBB	KBB	KBB	KBB	KBB
		600	3000	2.0	2.0	KED	KED	KED	KED	KED
		750	3000	2.0	1.9	KED	KED	KED	KED	—
	VLBSV	1000	3000	2.7	0.4	KRF	KRF	—	—	—

(注1) 形状符号的匹配表为  时，请限制电动机电流使用，使电动机的输出转矩低于CSF-GH系列起动停止时的峰值转矩（参照第076页“额定表”）。

(Note-1) If the form symbol matches the shaded area,  the motor current should be restricted so that the output torque of the motor is the peak torque (see "Rated table" on Page 076) at the start and stop of the CSFGH series or less.

(注2) 惯量比是指减速机惯量 / 电动机惯量的数值。惯量比会因对应的电动机的不同而有所差异，选择时请特别注意。

(Note-2) The inertia ratio is the value of reducer inertia/motor inertia. Take care in selecting a motor as the inertia ratio varies depending on the corresponding motor.

■除上述伺服电动机以外的电动机详情，请咨询本公司授权代理商。
Contact our office for servo motors other than described above.

型号：45 Model No. 45

表284-1
Table 284-1

制造商 Manufacturer	电动机系列 Motor series	电动机容量 Motor capacity	额定转速 Rated rotational speed	减速机惯量 Reducer inertia	惯量比 Inertia ratio	形状符号 Form symbol				
		W	r/min	×10 ⁴ kgm ²		减速比50 Reduction ratio 50	减速比80 Reduction ratio 80	减速比100 Reduction ratio 100	减速比120 Reduction ratio 120	减速比160 Reduction ratio 160
安川电机 Yaskawa Electric.	SGMAS	750	3000	11	14	PBB	PBB	PBB	PBB	PBB
	SGMGH	450	1500	11	1.5	PRF	PRF	PRF	PRF	PRF
		600	1000	11	0.8	PRF	PRF	PRF	PRF	PRF
		850	1500	11	0.8	PRF	PRF	PRF	PRF	PRF
		900	1000	11	0.5	PRG	PRG	PRG	PRG	—
		1300	1500	11	0.5	PRG	—	—	—	—
	SGMPH	750	3000	11	5.1	PGB	PGB	PGB	PGB	PGB
		1500	3000	11	2.6	PGC	PGC	PGC	PGC	PGC
	SGMPS	750	3000	11	5.3	PGB	PGB	PGB	PGB	PGB
		1000	3000	11	6.1	PEE	PEE	PEE	PEE	PEE
		1500	3000	11	4.3	PEE	PEE	PEE	PEE	PEE
	SGMSH	2000	3000	11	3.3	PEE	PEE	PEE	PEE	—
三菱电机 Mitsubishi Electric.	HA-FF	600	3000	11	8.9	—	—	PDB	PDB	PDB
	HC-KFS	750	3000	11	7.0	PBC	PBC	PBC	PBC	PBC
		1000	3000	11	7.0	PDE	PDE	PDE	PDE	PDE
	HC-RFS	1500	3000	11	5.6	PDE	PDE	PDE	PDE	PDE
		2000	3000	11	4.6	PDE	PDE	PDE	PDE	PDE
		500	2000	11	1.6	PGE	PGE	PGE	PGE	PGE
	HC-SFS52	850	1000	11	0.5	PGE	—	—	—	—
	HC-SFS81	1000	2000	11	0.8	PGE	PGE	PGE	PGE	PGE
	HC-SFS102	1000	3000	11	1.6	PGE	PGE	PGE	PGE	PGE
	HC-SFS103	1500	2000	11	0.5	PGE	—	—	—	—
	HC-SFS152	1500	3000	11	0.5	PGE	PGE	PGE	PGE	PGE
	HC-SFS203	2000	3000	11	0.3	PPJ	PPJ	PPJ	PPJ	—
	HC-UFS72	750	2000	12	1.1	PPG	PPG	PPG	PPG	PPG
	HC-UFS73	750	3000	11	1.8	PGC	PGC	PGC	PGC	PGC
	HC-UFS152	1500	2000	12	0.5	PPG	—	—	—	—
山洋电气 Sanyo Electric.	P1	500	2000	11	0.8	PGC	PGC	PGC	PGC	PGC
		750	2000	11	0.9	PDB	PDB	PDB	PDB	PDB
		1000	2000	11	0.4	PGC	PGC	PGC	PGC	PGC
		1500	2000	11	0.3	PGD	PGD	PGD	PGD	—
	P2	1000	3000	11	6.8	PDD	PDD	PDD	PDD	PDD
		1500	3000	11	5.2	PDD	PDD	PDD	PDD	PDD
		2000	3000	11	3.7	PDD	PDD	PDD	PDD	—
		2500	3000	11	2.9	PDD	—	—	—	—
	P5	750	3000	11	5.5	PCB	PCB	PCB	PCB	PCB
		1000	3000	11	4.0	PCB	PCB	PCB	PCB	PCB
	P6	500	2000	11	3.8	PGD	PGD	PGD	PGD	PGD
		1000	2000	11	1.9	PGD	PGD	PGD	PGD	PGD
		1500	2000	11	1.3	PGD	PGD	PGD	PGD	—
	P8	750	2000	12	2.2	PQG	PQG	PQG	PQG	PQG
		1200	2000	12	1.0	PPI	PPI	PPI	PPI	PPI
松下电器 Matsushita Electric.	MDMA	750	2000	11	3.8	PGC	PGC	PGC	PGC	PGC
		1000	2000	11	1.7	PGD	PGD	PGD	PGD	PGD
		1500	2000	11	0.9	PGD	—	PGD	—	—
	MFMA	400	2000	11	4.3	—	—	PGC	PGC	PGC
		750	2000	12	1.2	PPG	PPG	PPG	PPG	PPG
		1500	2000	11	0.6	PPJ	—	PPJ	—	—
	MGMA	600	1000	11	1.7	PGD	PGD	PGD	PGD	PGD
		900	1000	11	0.9	PGD	PGD	PGD	PGD	—
	MHMA	500	2000	11	0.8	PGD	PGD	PGD	PGD	PGD
		1000	2000	11	0.4	PGD	PGD	PGD	PGD	PGD
		1500	2000	11	0.2	PGD	—	PGD	—	—
	MSMA	750	3000	11	8.1	PAC	PAC	PAC	PAC	PAC
		1000	3000	11	6.3	PCC	PCC	PCC	PCC	PCC
		1500	3000	11	4.1	PDC	PDC	PDC	PDC	PDC
		2000	3000	11	3.1	PDC	PDC	PDC	PDC	—
		2500	3000	11	2.5	PDC	—	—	—	—
发那科 FANUC LTD.	β2	500	3000	11	1.6	PDA	PDA	PDA	PDA	PDA
	β3	500	3000	12	0.6	PQF	PQF	PQF	PQF	PQF
	β6	900	2000	12	0.3	PQF	PQF	PQF	PQF	PQF

(注1) 形状符号的匹配表为  时，请限制电动机电流使用，使电动机的输出转矩低于CSF-GH系列起动停止时的峰值转矩（参照第076页“额定表”）。

(Note-1) If the form symbol matches the shaded area,  the motor current should be restricted so that the output torque of the motor is the peak torque (see "Rated table" on Page 076) at the start and stop of the CSFGH series or less.

(注2) 惯量比是指减速机惯量 / 电动机惯量的数值。惯量比会因对应的电动机的不同而有所差异，选择时请特别注意。

(Note-2) The inertia ratio is the value of reducer inertia/motor inertia. Take care in selecting a motor as the inertia ratio varies depending on the corresponding motor.

■除上述伺服电动机以外的电动机详情，请咨询本公司授权代理商。
Contact our office for servo motors other than described above.

表285-1
Table 285-1

制造商 Manufacturer	电动机系列 Motor series	电动机容量 Motor capacity	额定转速 Rated rotational speed	减速机惯量 Reducer inertia	惯量比 Inertia ratio	形状符号 Form symbol				
		W	r/min	$\times 10^{-4} \text{kgm}^2$		减速比50 Reduction ratio 50	减速比80 Reduction ratio 80	减速比100 Reduction ratio 100	减速比120 Reduction ratio 120	减速比160 Reduction ratio 160
欧姆龙 OMRON	R88M-W***15	450	1500	11	1.5	PRF	PRF	PRF	PRF	PRF
		850	1500	11	0.8	PRF	PRF	PRF	PRF	PRF
		1300	1500	11	0.5	PRG	—	—	—	—
	R7M-AP	750	3000	11	5.1	PGB	PGB	PGB	PGB	PGB
	R88M-WP	1500	3000	11	2.6	PGC	PGC	PGC	PGC	PGC
	R88M-W	1000	3000	11	6.1	PEE	PEE	PEE	PEE	PEE
		1500	3000	11	4.3	PEE	PEE	PEE	PEE	PEE
		2000	3000	11	3.3	PEE	PEE	PEE	PEE	—
基恩士 KEYENCE	MV-M75	750	3000	11	5.5	PAB	PAB	PAB	PAB	PAB
富士电机 Fuji Electric.	GYS	1000	3000	11	6.4	PDE	PDE	PDE	PDE	PDE
		1500	3000	11	4.6	PDE	PDE	PDE	PDE	PDE
		2000	3000	11	3.7	PDE	PDE	PDE	PDE	—
	GYC	1000	3000	11	3.4	PGE	PGE	PGE	PGE	PGE
		1500	3000	11	2.5	PGE	PGE	PGE	PGE	PGE
东荣电机 Toei Electric.	VLBSV	1000	3000	11	1.65.5	PGC	PGC	PGC	PGC	PGC
		1800	3000	11	0.8	PGC	PGC	PGC	PGC	—

(注1) 形状符号的匹配表为  时，请限制电动机电流使用，使电动机的输出转矩低于CSF-GH系列启动停止时的峰值转矩（参照第076页“额定表”）。

(Note-1) If the form symbol matches the shaded area,  the motor current should be restricted so that the output torque of the motor is the peak torque (see "Rated table" on Page 076) at the start and stop of the CSFGH series or less.

(注2) 惯量比是指减速机惯量 / 电动机惯量的数值。惯量比会因对应的电动机的不同而有所差异，选择时请特别注意。

(Note-2) The inertia ratio is the value of reducer inertia/motor inertia. Take care in selecting a motor as the inertia ratio varies depending on the corresponding motor.

■除上述伺服电动机以外的电动机详情，请咨询本公司授权代理商。
Contact our office for servo motors other than described above.

型号：65 Model No. 65

表286-1
Table 286-1

制造商 Manufacturer	电动机系列 Motor series	电动机容量 Motor capacity	额定转速 Rated rotational speed	减速机惯量 Reducer inertia	惯量比 Inertia ratio	形状符号 Form symbol			
		W	r/min	×10 ⁻⁴ kgm ²		减速比80 Reduction ratio 80	减速比100 Reduction ratio 100	减速比120 Reduction ratio 120	减速比160 Reduction ratio 160
安川电机 Yaskawa Electric.	SGMDH	2200	2000	51	0.9	UID	UID	UID	UID
		3200	2000	51	0.7	UID	UID	UID	—
	SGMGH	900	1000	51	2.5	UFB	UFB	UFB	UFB
		1200	1000	51	1.6	UGF	UGF	UGF	UGF
		1300	1500	51	2.5	UFB	UFB	UFB	UFB
		1800	1500	51	1.6	UGF	UGF	UGF	UGF
		2000	1000	51	1.1	UGF	UGF	UGF	UGF
		2900	1500	51	1.1	UGF	UGF	UGF	UGF
		3000	1000	51	0.8	UGF	UGF	—	—
	SGMSH	3000	3000	51	7.3	UFD	UFD	UFD	UFD
		4000	3000	51	5.3	UFD	UFD	UFD	UFD
		5000	3000	51	4.2	UFD	UFD	UFD	—
三菱电机 Mitsubishi Electric.	HC-RFS	3500	3000	51	6.0	UFD	UFD	UFD	UFD
		5000	3000	51	4.3	UFD	UFD	UFD	UFD
	HC-SFS	1200	1000	51	1.2	UGF	UGF	UGF	UGF
		1500	2000	51	2.6	UFC	UFC	UFC	UFC
	HC-SFS201	2000	1000	51	0.6	UGF	UGF	—	—
	HC-SFS202	2000	2000	51	1.2	UGF	UGF	UGF	UGF
	HC-SFS203	2000	3000	51	1.2	UGF	UGF	UGF	UGF
	HC-SFS352	3500	2000	51	0.6	UGF	UGF	UGF	—
	HC-SFS353	3500	3000	51	0.6	UGF	UGF	UGF	UGF
		1500	2000	51	2.3	UGD	UGD	UGD	UGD
		2000	2000	51	1.3	UIF	UIF	UIF	UIF
		3500	2000	51	0.7	UIF	UIF	UIF	—
		1500	2000	51	1.5	UFB	UFB	UFB	UFB
山洋电气 Sanyo Electric.	P1	2000	2000	51	0.7	UGF	UGF	UGF	UGF
		3500	2000	51	0.4	UGF	UGF	UGF	—
		2500	3000	51	14	UBB	UBB	UBB	UBB
	P2	3000	3000	51	7.2	UFD	UFD	UFD	UFD
		4000	3000	51	5.2	UFD	UFD	UFD	UFD
		5000	3000	51	4.1	UFD	UFD	UFD	—
		1500	2000	51	6.2	UFB	UFB	UFB	UFB
	P60B13	2000	2000	51	4.2	UFD	UFD	UFD	UFD
		3000	2000	51	2.5	UHD	UHD	UHD	UHD
	P60B15	2000	2000	51	2.3	UGF	UGF	UGF	UGF
		3500	2000	51	1.5	UGF	UGF	UGF	—
		1200	2000	51	4.2	UGD	UGD	UGD	UGD
	P60B18	2500	2000	51	1.9	UIF	UIF	UIF	UIF
		3500	2000	51	1.2	UIF	UIF	UIF	—
		1200	2000	51	4.2	UGD	UGD	UGD	UGD

(注1) 形状符号的匹配表为  时，请限制电动机电流使用，使电动机的输出转矩低于CSF-GH系列启动停止时的峰值转矩（参照第076页“额定表”）。

(Note-1) If the form symbol matches the shaded area,  the motor current should be restricted so that the output torque of the motor is the peak torque (see “Rated table” on Page 076) at the start and stop of the CSFGH series or less.

(注2) 惯量比是指减速机惯量 / 电动机惯量的数值。惯量比会因对应的电动机的不同而有所差异，选择时请特别注意。

(Note-2) The inertia ratio is the value of reducer inertia/motor inertia. Take care in selecting a motor as the inertia ratio varies depending on the corresponding motor.

■除上述伺服电动机以外的电动机详情，请咨询本公司授权代理商。
Contact our office for servo motors other than described above.

制造商 Manufacturer	电动机系列 Motor series	电动机容量 Motor capacity	额定转速 Rated rotational speed	减速机惯量 Reducer inertia	惯量比 Inertia ratio	形状符号 Form symbol			
		W	r/min	×10 ⁻⁴ kgm ²		减速比80 Reduction ratio 80	减速比100 Reduction ratio 100	减速比120 Reduction ratio 120	减速比160 Reduction ratio 160
松下电器 Matsushita Electric.	MDMA	1500	2000	51	4.6	UFB	UFB	UFB	UFB
		2000	2000	51	3.4	UFB	UFB	UFB	UFB
		2500	2000	51	2.7	UFC	UFC	UFC	UFC
		3000	2000	51	2.3	UFC	UFC	UFC	UFC
		3500	2000	51	1.4	UHD	UHD	UHD	—
		4000	2000	51	1.2	UHD	UHD	UHD	—
		4500	2000	51	1.0	UGF	UGF	—	—
	MFMA	1500	2000	51	2.5	UGF	UGF	UGF	UGF
		2500	2000	51	1.2	UIF	UIF	UIF	UIF
		3500	2000	51	1.0	UIF	UIF	UIF	UIF
		4500	2000	51	0.7	UIF	UIF	UIF	—
	MGMA	1200	1000	51	1.7	UGF	UGF	UGF	UGF
		2000	1000	51	1.4	UGF	UGF	UGF	UGF
		3000	1000	51	0.9	UGF	UGF	—	—
	MHMA	1500	2000	51	1.2	UFB	UFB	UFB	UFB
		2000	2000	51	0.8	UGF	UGF	UGF	UGF
		3000	2000	51	0.5	UGF	UGF	UGF	UGF
		4000	2000	51	0.4	UGF	UGF	UGF	—
	MSMA	2500	3000	51	12	UBA	UBA	UBA	UBA
		3000	3000	51	7.6	UFB	UFB	UFB	UFB
		3500	3000	51	6.5	UFB	UFB	UFB	UFB
		4000	3000	51	4.0	UFC	UFC	UFC	UFC
		4500	3000	51	3.4	UFC	UFC	UFC	UFC
		5000	3000	51	2.9	UFC	UFC	UFC	—
发那科 FANUC LTD.	β6	900	2000	51	1.3	UHA	UHA	UHA	UHA
欧姆龙 OMRON	R88M-W***15	1300	1500	51	2.5	UFB	UFB	UFB	UFB
		1800	1500	51	1.6	UGG	UGG	UGG	UGG
		2900	1500	51	1.1	UGG	UGG	UGG	UGG
	R88M-W	3000	3000	51	7.3	UFD	UFD	UFD	UFD
		4000	3000	51	5.3	UFD	UFD	UFD	UFD
		5000	3000	51	4.2	UFD	UFD	UFD	—
富士电机 Fuji Electric.	GYS	3000	3000	51	6.1	UFD	UFD	UFD	UFD
		4000	3000	51	4.7	UFD	UFD	UFD	UFD
		5000	3000	51	4.0	UFD	UFD	UFD	—
东荣电机 Toei Electric.	VLBSV	2400	3000	51	2.7	UFC	UFC	UFC	UFC
		3000	3000	51	1.5	UGG	UGG	UGG	UGG

(注1) 形状符号的匹配表为  时，请限制电动机电流使用，使电动机的输出转矩低于CSF-GH系列起动停止时的峰值转矩（参照第076页“额定表”）。

(Note-1) If the form symbol matches the shaded area,  the motor current should be restricted so that the output torque of the motor is the peak torque (see "Rated table" on Page 076) at the start and stop of the CSFGH series or less.

(注2) 惯量比是指减速机惯量 / 电动机惯量的数值。惯量比会因对应的电动机的不同而有所差异，选择时请特别注意。

(Note-2) The inertia ratio is the value of reducer inertia/motor inertia. Take care in selecting a motor as the inertia ratio varies depending on the corresponding motor.

■除上述伺服电动机以外的电动机详情，请咨询本公司授权代理商。
Contact our office for servo motors other than described above.

应用 Application

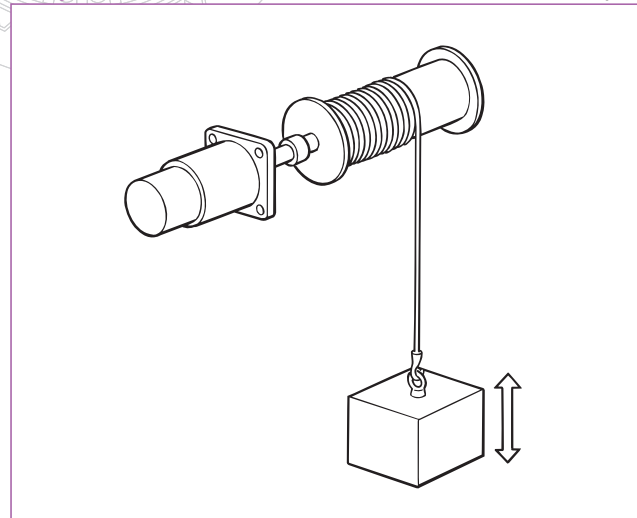
应用示例 Example of application

HarmonicDrive CSF-GH系列在半导体·液晶制造设备、机器人、机床等需要精密运动控制的前沿领域得到广泛应用。

The Harmonic Drive CSF-GH series is available in a wide range of advanced fields that require accurate motion control such as semiconductor LCD devices, robots and metal-cutting machines.

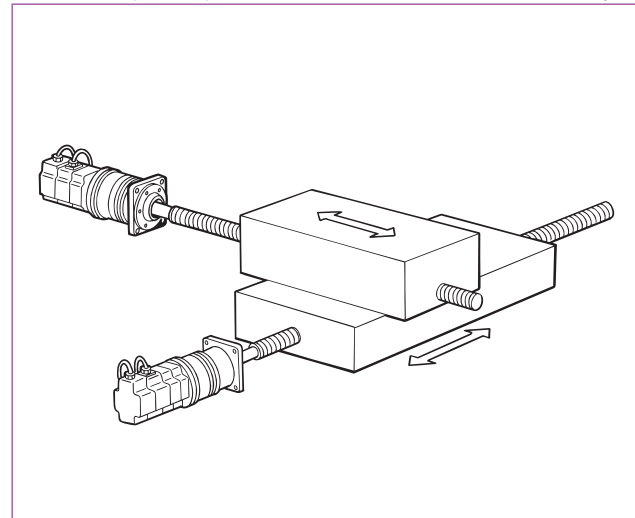
卷起 Hoisting

图288-1
Fig. 288-1



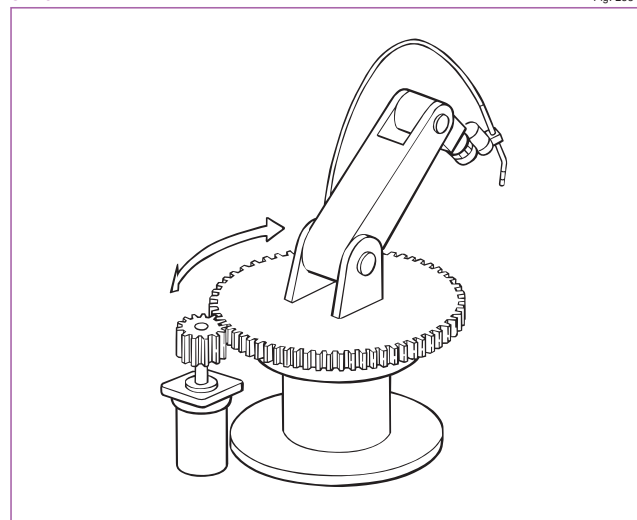
两轴控制 (XY工作台) Two-axle control (X, Y table)

图288-2
Fig. 288-2



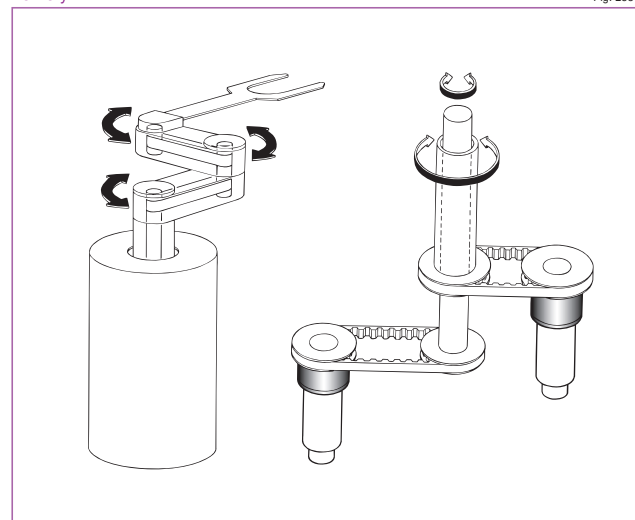
旋转 Swivel

图288-3
Fig. 288-3



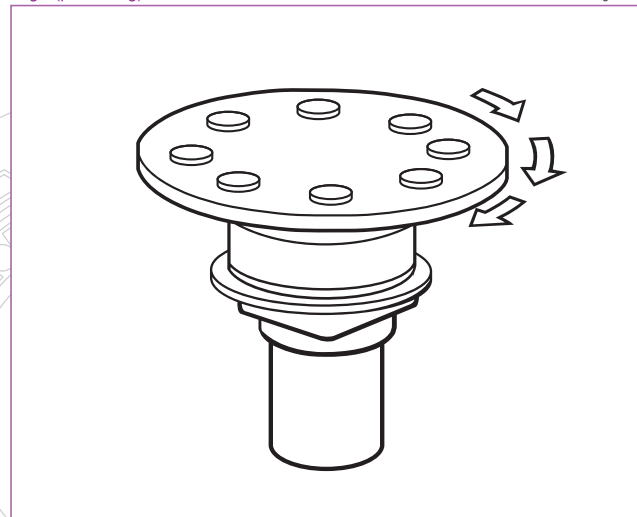
搬送 Delivery

图288-4
Fig. 288-4



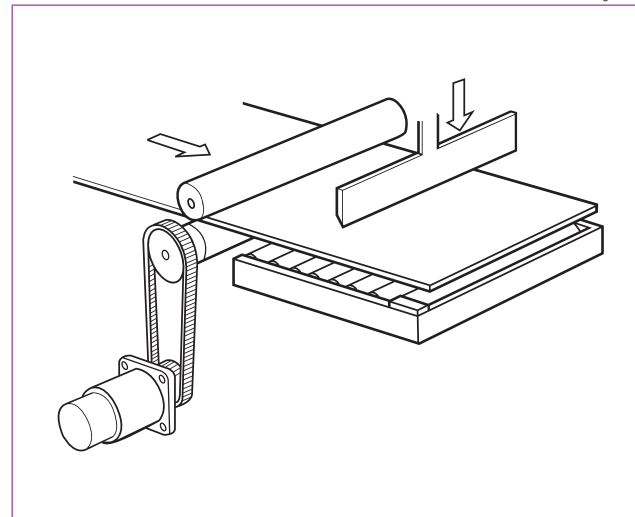
角度 (定位) 控制 Angle (positioning) control

图288-5
Fig. 288-5



辊驱动 Roller drive

图288-6
Fig. 288-6



关于保修 Warranty period and terms

Harmonic Drive的保修期及保修范围规定如下：

Products that are described in this catalog are warranted as follows:

■ 保修期

Warranty period

以产品目录记载的正常组装状态及润滑状态下使用为前提，保修期为交货后的一年时间或该产品运行时间达到2,000小时两者中最先达到的时间。

Under the condition that the products are handled, used and maintained properly followed each item of the technical materials, the manuals, and this catalog, all the products are warranted against defects in workmanship and materials for the shorter period of either one year after delivery or 2,000 hours of operation time.

■ 保修范围

Warranty terms

在上述保修期内，因本公司制造缺陷导致故障时，由本公司负责对本产品进行维修或更换。但以下情况不在保修范围内。

All the products are warranted against defects in workmanship and materials for the warranted period.

This limited warranty does not apply to any product that has been subject to:

① 因客户不当操作或违规使用导致故障的。

User's misapplication, improper installation, inadequate maintenance, or misuse.

② 非本公司实施的改造或修理导致故障的。

Disassembling, modification or repair by others than Harmonic Drive Systems, Inc.

③ 非本产品原因导致故障的。

Imperfection caused by the other than the products.

④ 天灾等非本公司责任导致故障的。

Disaster or others that does not belong to the responsibility of Harmonic Drive Systems, Inc.

而且，这里所说的保修是指对本产品的保修。

对于因本产品故障引发的其它损失、与在设备上进行拆装相关的工时、费用等，不在本公司负责范围内。

Our liability shall be limited exclusively to repairing or replacing the product only found by Harmonic Drive Systems, Inc. to be defective.

Harmonic Drive Systems, Inc. shall not be liable for consequential damages of other equipment caused by the defective products, and shall not be liable for the incidental and consequential expenses and the labor costs for detaching and installing to the driven equipment

关于商标 Trademark

“Harmonic Drive”的学术、一般名称为“谐波齿轮传动”，以下商标在日本国内已注册。

The academic and general nomenclature for “Harmonic Drive” is “wave motion gearing”.

HarmonicDrive® ハーモニックドライブ	HarmonicPlanetary® ハーモニックプラネタリー	Harmonicsyn® ハーモニシン
HarmonicLinear® ハーモニックライン	AccuDrive® アキュドライブ	BEAM SERVO® ビームサーボ

Harmonic Drive精密控制用减速机 HarmonicDrive Reducer for precision control

安全使用Harmonic Drive组件型&组合型的注意事项 For Safe Use of Harmonic drive component and unit



警告：

Warning:

表示操作错误可能会导致人员死亡或负重伤。

Means that improper use or handling could result in a risk of death or serious injury.



注意：

Caution:

表示操作错误可能会导致人员受伤及财产损失。

Means that improper use or handling could result in personal injury or damage to property.

用途限制： 本产品不能用于以下用途。

Limited Applications: This product cannot be used for the following applications.

*航天设施

*真空设备

*以运送人为目的的设备

*Space equipment

*Vacuum equipment

*Equipment for transport of humans

*航空设施

*汽车设备

*特殊环境用设备

*Aircraft equipment

*Automotive equipment

*Equipment for use in a special environment

*原子能设施

*游戏设施

*Nuclear power equipment

*Game equipment

*家用电器、设备

*直接作用于人体的设备

*Equipment and apparatus used in domestic homes

*Equipment that directly works on human bodies

用于上述用途时，请预先咨询授权代理商。

将本产品用于与人的生命相关的设备及可能会产生重大损失的设备时，请安装即使因破坏而导致不能控制输出端，也不会发生事故的安全装置。

Please consult Harmonic Drive Systems beforehand when intending to use one of its product for the aforementioned applications.

Install a safety device that avoids an accident even if output of this product becomes uncontrollable due to breakdown when using it in equipment that affects human lives and that may trigger serious damage.

设计注意事项 进行设计时，请务必阅读产品目录。 Design Precaution: Be certain to read the catalog when designing the equipment.

 注意 Caution	请在规定环境下使用。 Use only in a specified environment. ●使用Harmonic Drive时，请遵守以下条件。 Please ensure the following environmental conditions are complied with: 环境温度：0~40℃ Ambient temperature 0 to 40℃ 不溅到水、油等 No splashing of water or oil 无腐蚀性、爆炸性气体 Do not expose to corrosive or explosive gas 无金属粉等灰尘 No dust such as metal powder	 注意 Caution	请使用规定的方法进行安装。 Install the equipment in a specified manner. ●组装方法、顺序，请按产品目录正确实施。 Carry out assembly precisely in the specified order according to the catalog. ●拧紧方法（使用螺栓等），请遵守本公司建议。 Observe our recommended tightening methods (such as bolts used). ●如未正确组装，运转时可能会导致振动、缩短使用寿命、精度下降、损坏等故障。 Operating the equipment without precise assembly can cause troubles such as generation of vibration, reduction of life, deterioration of precision and breakdown.
 注意 Caution	请根据规定精度实施安装。 Use only in a specified environment. ●请正确设计、组装各种部件，确保其能够达到产品目录中的推荐安装精度。 Design and assemble parts to keep the recommended installation precision on the catalog. ●达不到规定精度可能会导致振动、缩短使用寿命、精度下降、损坏等故障。 Failure to keep the precision can cause troubles such as generation of vibration, reduction of life, deterioration of precision and breakdown.	 注意 Caution	请使用规定的润滑剂。 Use the specified lubricant. ●不使用本公司推荐的润滑剂，可能会缩短产品的使用寿命。此外，请按规定的条件更换润滑剂。 Using other lubricant than our recommended products can reduce the life. Replace the lubricant in a specified condition. ●组合型产品已预先封入润滑脂。请不要混入其它润滑脂。 Grease is sealed in a unit product. Do not mix other kinds of grease.

使用注意事项 执行运转时，请务必阅读产品目录。 Operational Precaution: Be certain to read the catalog before operating the equipment.

 注意 Caution	请小心取用产品及部件。 Be careful in handling products and parts. ●请勿使用锤子等用力敲打各部件及组合单元。此外，请确保不会因坠落等原因导致裂纹、疤痕等。否则会导致产品破损。 Do not give strong shock to parts and units with a hammer. Do not scratch or bruise them. Possible damage is assumed. ●在破损状态下使用时，无法保证其性能。还可能会导致损坏等故障。 If you use the equipment in a damaged condition, the specified performance may not be retained. It can also cause troubles such as breakdown.	 注意 Caution	使用时，请勿超出容许转矩。 Apply torque within the allowable range. ●施加转矩请不要超出瞬间容许最大转矩。否则可能会出现拧紧部螺栓松动、产生晃动、破坏等，导致产品故障。 Do not apply torque exceeding the instantaneous allowable max. torque. Applying excess torque can cause troubles such as loose tightening bolts, generation of backlash and breakdown. ●如果对空容器直接连接关节臂等，有可能因关节臂碰撞而导致破损，输出轴不能控制。 Striking an arm directly attached to the output shaft can damage the arm and make the output shaft uncontrollable.
 注意 Caution	请勿变更部件配套。 Do not change a set of parts. ●本产品的各部件是配套加工而成。 混同其它套件使用时，无法保证其能够发挥特定性能。 The product is manufactured with sets of parts. The specified performance may not be retained if you have used mixed sets of parts.	 注意 Caution	请勿拆解组合型产品。 Do not break down unit products. ●严禁对组合型产品实施拆解、重新组装。否则，将无法恢复其原有性能。 Do not break down and reassemble unit products. Original performance may not be reproduced.

润滑剂的使用 Handling lubricant

 警告 Warning	安装注意事项 Precautions on handling lubricant ●溅入眼睛可能会引起炎症。操作时，请佩戴防护眼镜等，避免溅入眼睛。 Lubricant got in the eye can cause an inflammation. Wear protective glasses to prevent it from getting in your eye when you handle it. ●接触皮肤可能会引起炎症。操作时，请佩戴防护手套等，避免接触到皮肤。 Lubricant coming in contact with the skin can cause an inflammation. Wear protective gloves to prevent it from contacting your skin when you handle it. ●请勿吞食（会引起腹泻、呕吐等）。 Do not eat it (to avoid diarrhea and vomiting). ●打开容器时，请注意不要划伤手指。请戴好防护手套。 When you open the container, you might have your hand cut by it. Wear protective gloves. ●请放在儿童够不到的地方。 Keep lubricant off children.	 注意 Caution	废油、废容器的处理 Treatment of waste oil and containers ●法令规定了使用者有义务实施的处理方法。请按照相关法律法规进行正确处理。不清楚时，请先咨询授权代理商，然后再做处理。 Treatment methods are obliged by law. Treat wastes appropriately according to the law. If you are unsure how to treat them, you should consult with the dealer before treating them. ●请勿对空的容器施加压力。施加压力可能会导致其破裂。 Do not apply pressure on an empty container. The container may blow up. ●请勿对容器进行焊接、加热、开孔或裁切。否则，可能会发生爆炸，里面的残留物会起火燃烧。 Do not weld, heat, drill or cut the container. The remainder may ignite with an explosion.
 警告 Warning	应急处理 First-aid ●万一溅入眼睛，请立即使用清水冲洗15分钟，并接受医生的治疗。 If lubricant gets in your eye, you should wash your eye with clean water for 15 minutes and submit to medical treatment. ●万一接触到皮肤，请使用水及肥皂充分清洗。 If lubricant comes in contact with your skin, you should thoroughly wash it with water and soap. ●万一发生吞食，请不要用力让其呕吐，应立即接受医生的治疗。 If you swallowed it, you should immediately submit to medical treatment without throwing it up by constraint.	 注意 Caution	勿拆解组合型 Storage ●使用后，请将其密封好，防止灰尘、水分等混入。请在背阴处保存，避免阳光直射。 Tightly plug the container after use to prevent intrusion of dusts and water. Avoid direct sunlight to store lubricant in a dark place.

关于报废 When Discarding Actuator and Servo Driver



请按工业废弃物标准进行处理。
Please discard as industrial waste.

●报废时，请按工业废弃物进行处理。
Please discard as industrial waste when discarding.

主要采用市场

The main adoption markets



金属机床
Metal Working Machine



金属加工机械
Processing Machines



测定·分析·试验设备
Measurement, Analytical and Test Systems

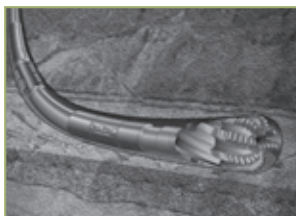


医疗机械
Medical Equipment



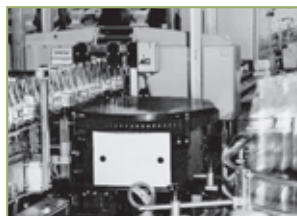
望远镜
Telescopes

提供：大学共同利用机关法人国立天文台
Source: National observatory of Inter-University Research Institute Corporation



能量相关
Energy

Courtesy of Halliburton/Sperry Drilling Services



包装·装箱设备
Crating and Packaging Machines

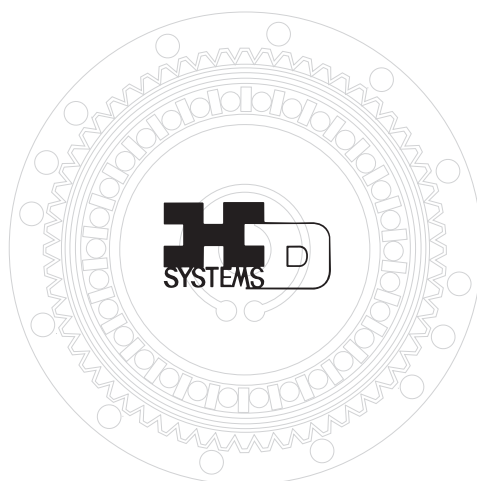


通信设备
Communication Equipment



航天设备
Space Equipment

Rover image created by Dan Maas, copyrighted to Cornell and provided courtesy NASA/ JPL-Caltech.



玻璃·陶瓷制造装置
Glass and Ceramic Manufacturing Systems



机器人
Robots

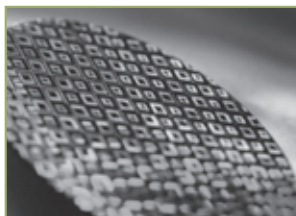


人型机器人
Humanoid Robots

提供：本田技研工业株式会社
Source: Honda Motor Co., Ltd.



印刷·装订·纸品加工机械
Printing, Bookbinding and Paper



半导体制造装置
Semiconductor Manufacturing Systems



光学相关机械
Optical Machines



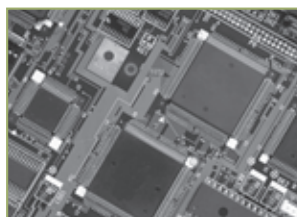
木材·轻金属·塑料加工机床
Wood, Light Metal and Plastic Machine Tools



制纸机械
Paper-making Machines



FPD制造装置
Flat Panel Display Manufacturing Systems



印刷电路制造装置
Printed Circuit Board Manufacturing Machines



航空器相关
Aircraft

精密控制领域的专家

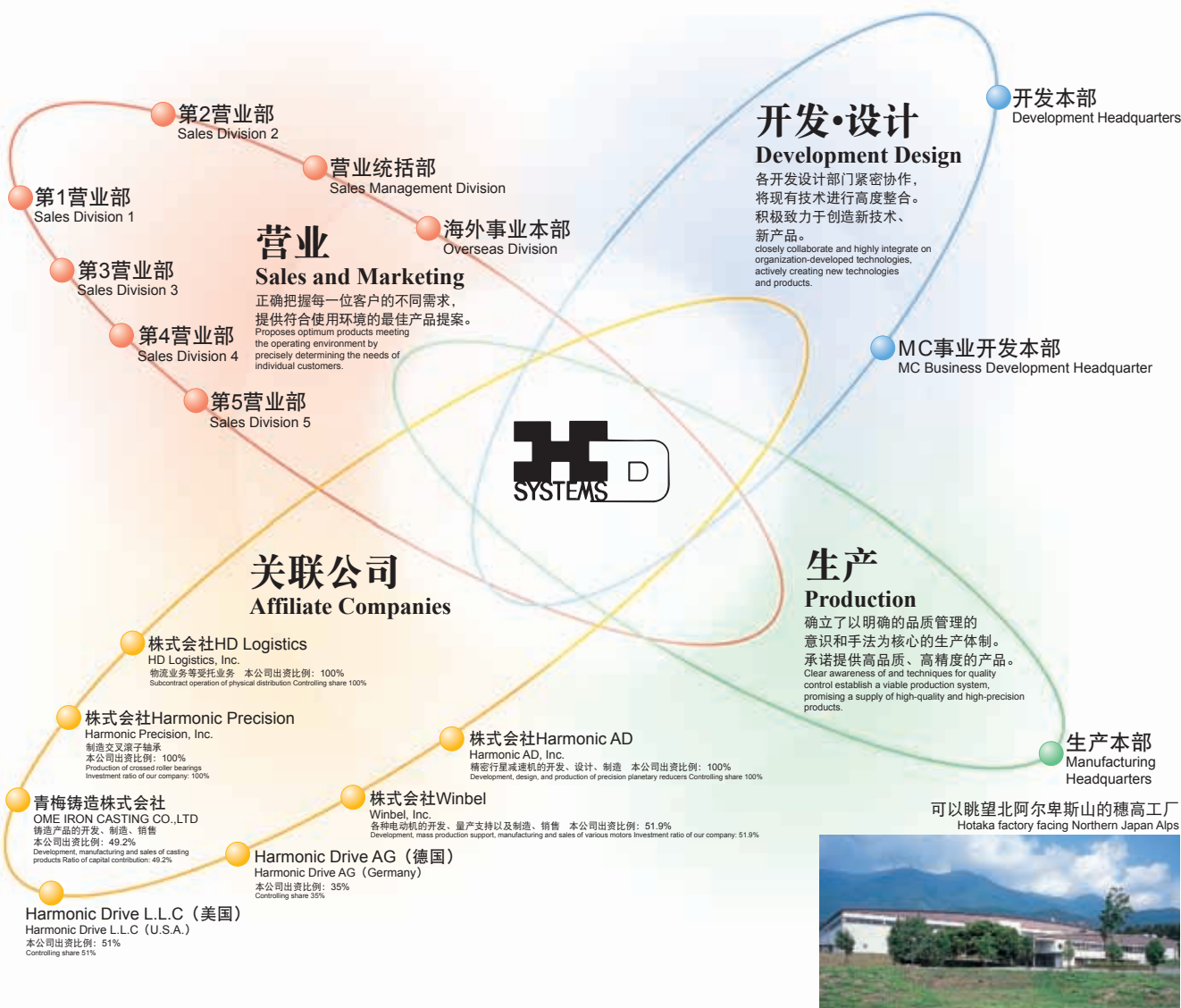
As a Specialist in Precision Control Field

开发、设计、生产、营业各部门紧密协作，
打造出满足客户需求且独具特色的产品。
Through close cooperation in areas of development, design,
production and marketing, Harmonic Drive Systems creates
unique products tailored to customer needs.



本公司在1995年获得了德国认证机构TUV Product Service的[ISO 9001]质量管理体系和质量保证的国际标准认证，并在1998年通过了TUV Product Service的[ISO14001]环境管理体系的国际标准认证。本公司的质量保证体制和环境管理体系得到世界各国广泛认可。

In 1995 and 1998, Harmonic Drive Systems respectively obtained approvals for ISO 9001 (International Quality Management Standard) and for ISO 14001 (International Environmental Management Systems) from TÜV Product Service, a German accreditation organization. The approvals signify global recognition of the quality assurance and environment management systems of Harmonic Drive Systems.



OTHER PRODUCTS

Harmonic Drive

仅由3个基本部件构成的Harmonic Drive减速机通过独特的机理实现了精密的运动控制。

Composed of only three basic components, the Harmonic Drive speed reducer features more precision motion control through a unique mechanism.



Harmonic Planetary®

将累积的Harmonic Drive精密加工技术运用到低速减速机领域而研制出的高精度、高刚性的行星减速机Harmonic Planetary®。具备独特的齿隙去除机构，实现了较高的旋转精度。

Harmonic Planetary® is a planetary speed reducer featuring high precision and stiffness, created by utilizing expertise in precision machining technology of Harmonic Drives in the field of low speed reduction ratio. A high rotational accuracy is achieved by a unique backlash removal mechanism.



线性运动 Linear motion

将精密螺钉和Harmonic Drive进行紧凑组合而成的线性执行元件。包括高精度定位用产品、高推力用产品以及丰富的系列产品。

The linear actuators compactly combining a precision screw and Harmonic Drive. Versatile series are available for ultra precision positioning and high driving force positioning.



Galvano式扫描仪 Galvano scanner

以本公司独有的小型电动机以及光学传感器技术为基础开发出的Galvano式扫描仪。通过高响应、高精度的扫描仪实现了顺畅的光学扫描。

Galvano scanners are developed based on the small motors and optical sensor technology, which are researched by Harmonic Drives. Smooth operation is realized by high response and precision of optical scanning.





哈默纳科（上海）商贸有限公司

上海市长宁区天山路641号上海慧谷白猫科技园1号楼206室 邮编：200336

电话：021-6237-5656 传真：021-3250-7268

<http://www.harmonicdrive.net.cn/>



1856-1 Hotakamaki, Azumino-shi,

Nagano 399-8305 JAPAN

PHONE: +81-(0)263-83-6935 FAX: +81-(0)263-83-6901

<http://www.hds.co.jp/>

以下商标在日本国内已注册。

HarmonicDrive® ハーモニクスドライブ	HarmonicPlanetary® ハーモニクスプラネタリー	Harmonicsyn® ハーモニクスシン
HarmonicLinear® ハーモニクスライン	AccuDrive® アキュドライブ	BEAM SERVO® ビームサーボ

ISO 14001（穗高工厂）/ 取得ISO 9001认证（TÜV SÜD Management Service GmbH）

本公司保留在不预先通知的情况下更改本产品目录中记载的规格、尺寸等的权利。
“Harmonic Drive”的学术、一般名称为“谐波齿轮传动”，

本产品目录数据截止于2012年12月。