

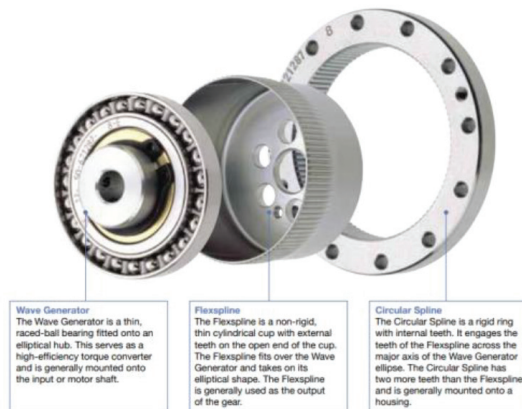
Basics of Design

# Strain Wave Gear

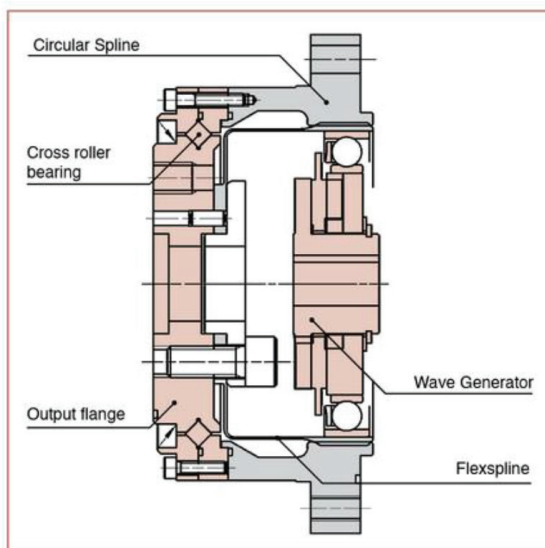
## Part 2

In Part 1 of Fundamentals of Strain Wave Gearing, it was shown how strain wave gear components deliver precision motion, excellent dynamic response and reliability. These performance characteristics are delivered even at high torques for a wide range of applications.

When coupled with a suitable servo system, the precision and backlash-free characteristics of strain wave gears have provided users with superb motion control and dynamic response in motion control applications.



### Components



### Assembled condition

The compactness and outstanding output torque-to-weight performance of strain wave gears make them ideal for users to integrate them into designs such as robot arms, humanoid joints, and many designs where space and weight are severely limited.

Strain wave gears consist of three separate elements: Circular Spline, Flexspline and Wave Generator.

When assembled, these three elements are in contact with each other but not positively fixed to each other.

As is the case with any precision motion control product, fundamental mounting requirements of Strain Wave gears must be maintained to achieve the required performance characteristics. These mounting requirements are specified in supplier catalogs and installation drawings or can be discussed with the gear manufacturer's experts.

The Circular Spline is usually a fixed element and must be rigidly attached to a housing. The housing should be designed to retain the shape and position of the Circular Spline and not allow deformation underload as this could seriously affect the capability of the gears and cause vibration.

The output support bearing must be selected to resist not only radial and axial loads but also overhung moment loads to prevent excessive deflection.

The Flexspline is the output member and must be properly supported by a bearing to resist not only axial and radial forces but also moment deflection under all load conditions.

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This can be achieved with the use of preloaded angular contact bearings, precision cross roller bearings for extra compactness, or with 4-point contact X bearings for smaller sizes and lighter loads.

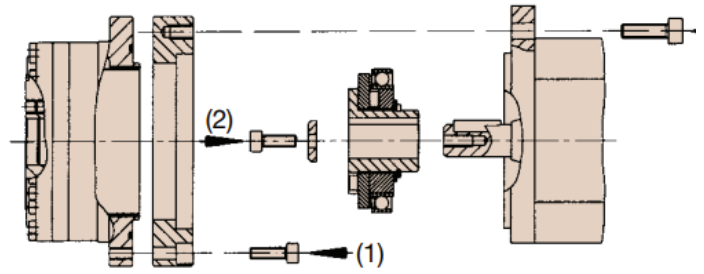
For many engineers who do not have the resources or development bandwidth to design a system from scratch, complete housed units are readily available with a multitude of options. These housed units are available with ratios from 30:1 to 160:1 in a single stage.

The gears are pre-lubricated and can be supplied with input adaptation to suit almost any properly sized motor, eliminating design time and development effort.

**QUICK CONNECT GEARHEADS**

Quick Connect gearheads housing strain wave gears can be selected for simple solutions and quick turnaround.

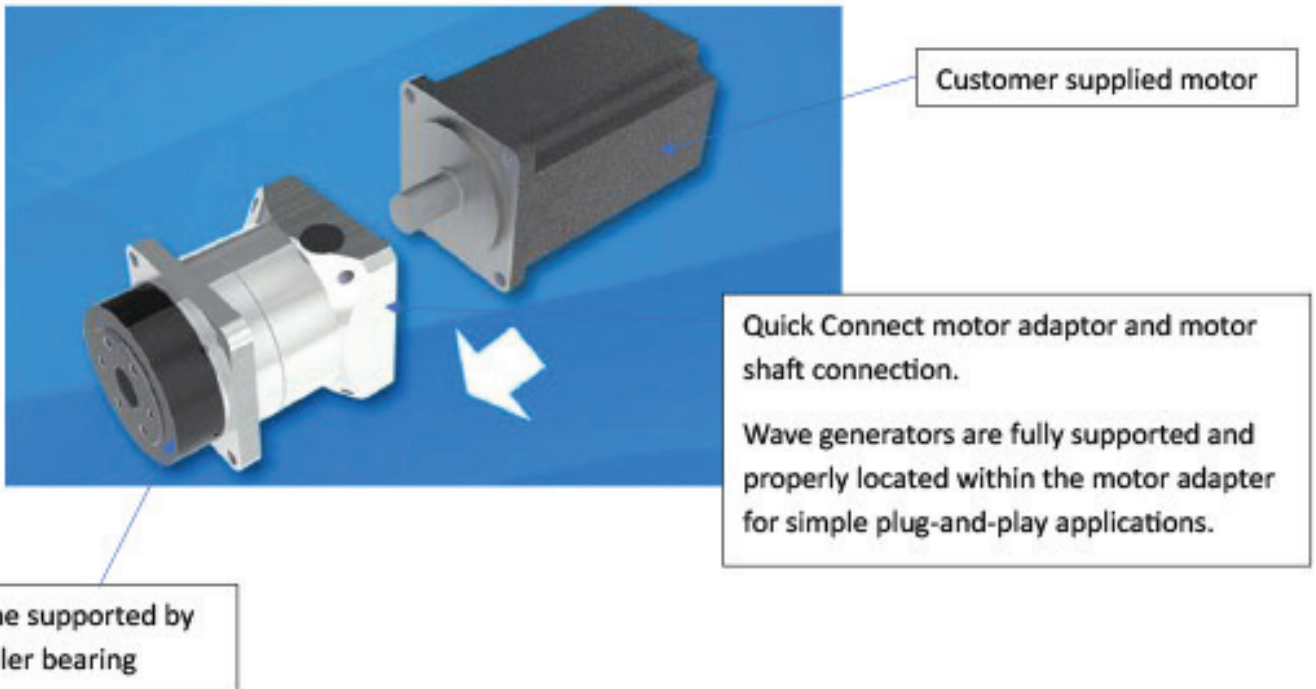
The axial force on the wave generator is resisted by the motor bearings. Calculations for the magnitude



*Typical UH type assembly of motor with oil seal keyway.*

of the axial forces imposed on these bearings are available in various publications.

Axial restraint of the wave generator must be secured in both directions. In the example shown, a screw and washer (2) are used. The wave generator bearing is used to create the required motion of the Flexspline and should not be used as a support bearing.



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### UH STYLE HOUSED UNIT

UH style strain wave gears are a compact fully lubricated housed unit. The circular spline teeth are machined into the extremely rigid housing to ensure structural rigidity.

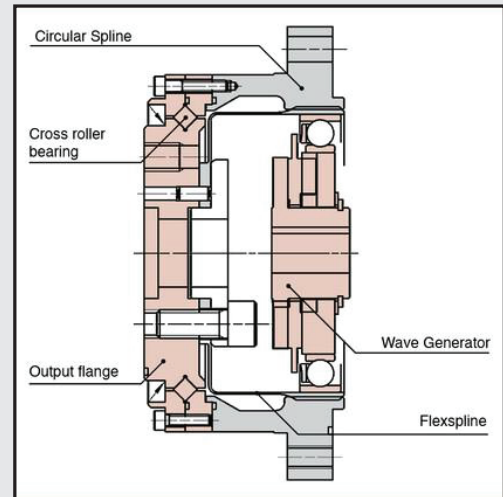
The Flexspline is mounted on a precision cross roller bearing to support radial, axial and overhung moment loads on the output under all load conditions.

Severe moment loads should be carefully analyzed to avoid undue deflection.

A suitable motor adapter plate must be added by the customer or could be supplied upon request with the gearhead.

Note that in these designs, the wave generator is separate from the main assembly and should be rigidly attached to the motor shaft and retained axially in the specified position for final assembly.

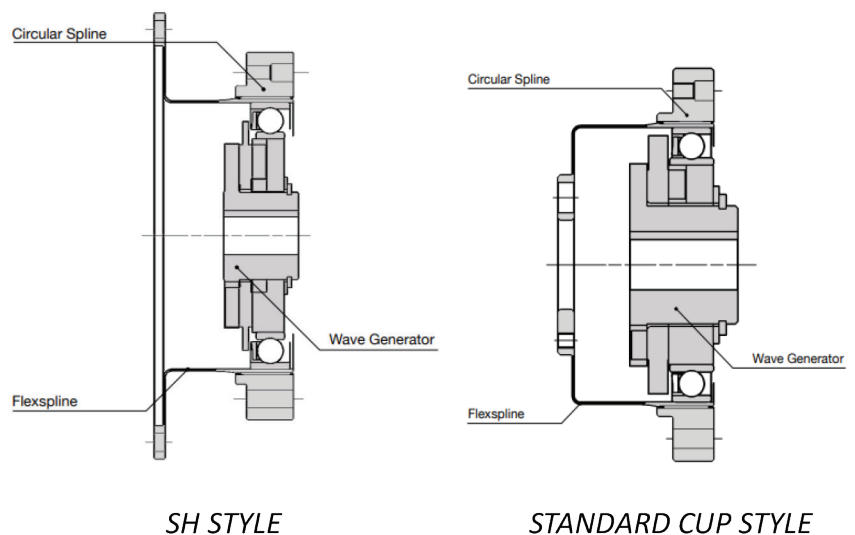
If the motor does not have a rotary oil seal, then one should be provided within the motor adapter plate to prevent leakage into the electronics.



*Lightweight versions of the UH are available, which are ideal as end-of-arm axes in a robot, for instance, where minimal weight is necessary.*

### ULTRA COMPACTNESS

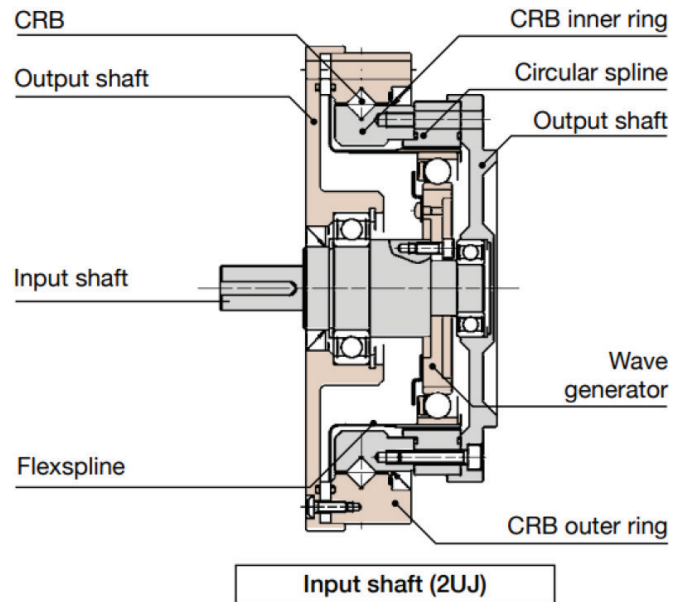
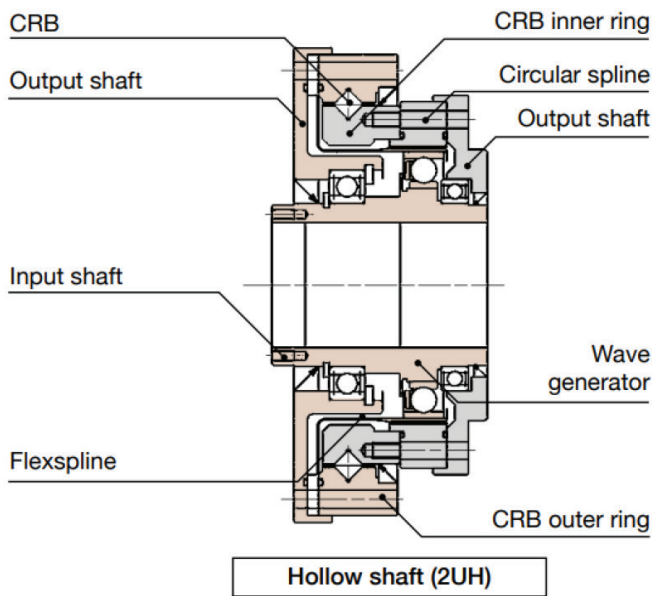
Some of the key advantages of strain wave gears over other types of speed reduction are compactness, adaptability to optimize design configurations, and high torque density.



SH STYLE

STANDARD CUP STYLE

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For ultimate axial compactness, strain wave gears incorporating the SH (silk hat) style Flexsplines can be considered.

The output flange of the SH Flexspline flares out from the center of the component set. This enables many design configurations that are offered in fully housed options.

2UH Style gear heads are fully enclosed, lubricated and sealed.

Output flanges are supported by heavy-duty precision cross roller bearings, and wave generators are located and fixed between preloaded support bearings.

The benefit of the SH (Silk Hat) style gears allows ancillary design features to be located inside the

available space within the Flexspline, allowing maximum axial compactness.

Large through bores can accommodate center posts, cables and ancillary devices, making this style ideal for azimuth drives or the base rotation for robots.

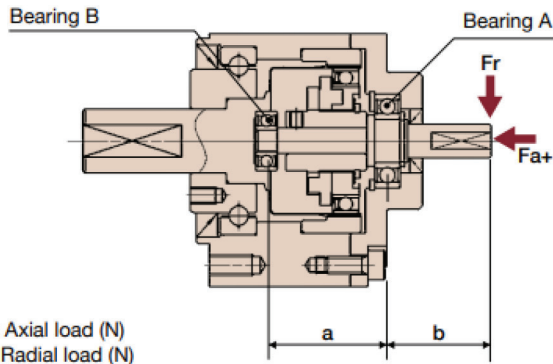
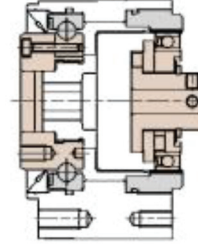
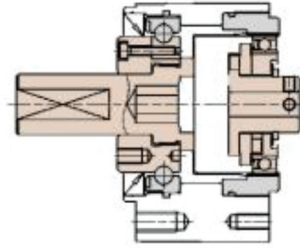
### MINIATURE GEAR HEADS

Many configurations of miniature housed units using strain wave gears are available.

The gears are assembled in fully contained and lubricated housings as small as 20.4mm square with options of flange or shaft output.

The open input side of the gearbox allows for simple motor adaptation. Alternatively bearing-supported input shaft configurations are offered.

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Miniature gearbox with strain wave gear.

X style angular contact output bearing.

Spaced input support bearings A and B able to support both axial radial and moments loads.

Fully contained lubricated and sealed.

### MINIATURE GEARHEAD OPTIONS

The versatility and adaptability of strain wave gearings allow so many design options that it is impossible to completely cover in one article.

Each style and option of gearbox offers the same backlash-free speed reduction, providing excellent dynamic response and positioning capability.

Consult your supplier for assistance with optimum selection for each application, support for your own design or specific custom design and manufacture.

Suppliers' engineers have the skills and years of experience to ensure your successful power transmission requirements.

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