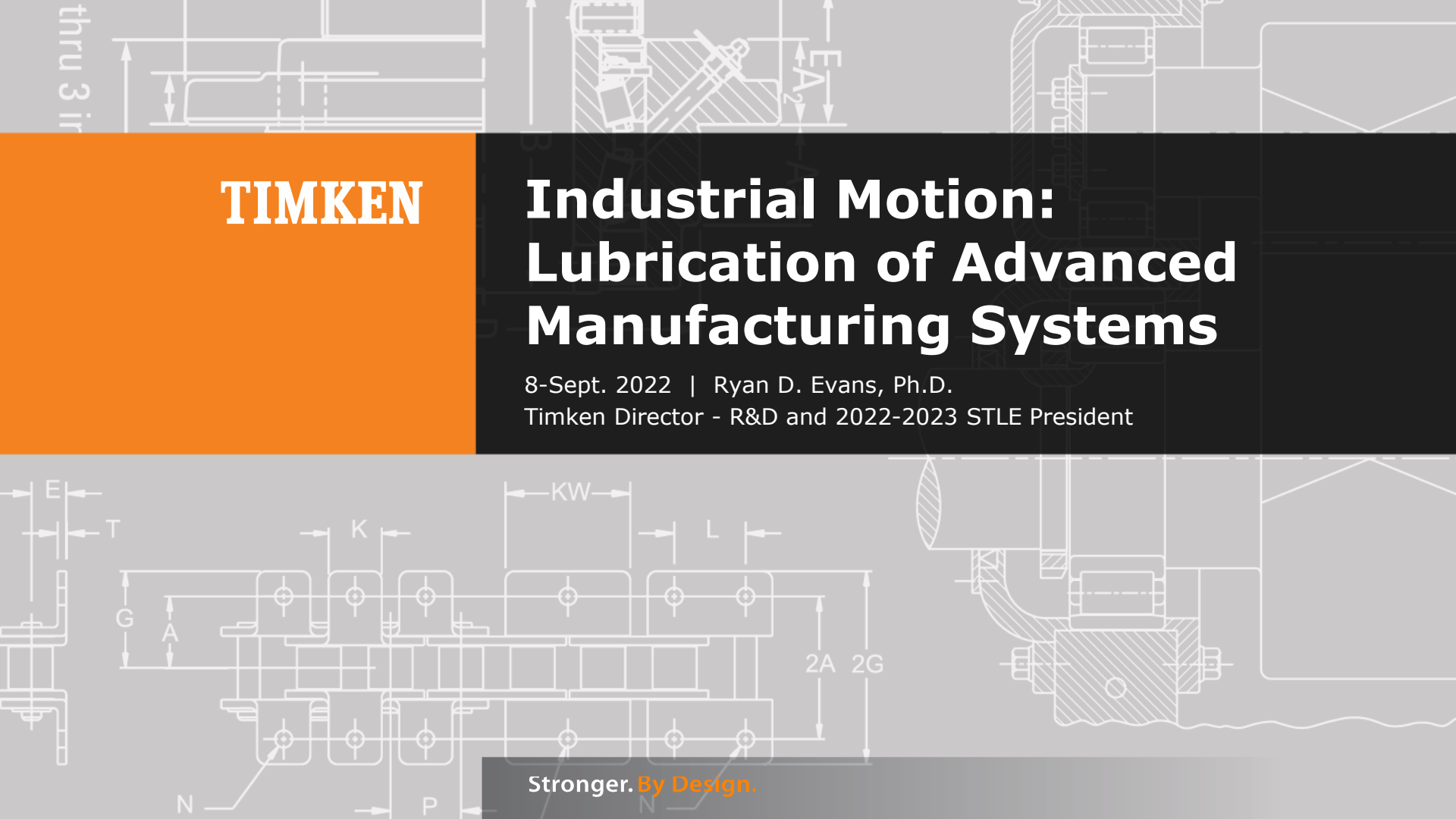




TIMKEN

Industrial Motion: Lubrication of Advanced Manufacturing Systems

8-Sept. 2022 | Ryan D. Evans, Ph.D.

Timken Director - R&D and 2022-2023 STLE President

Stronger. **By Design.**

Timken at a Glance

TKR

Founded 1899
NYSE listed
since 1922

>18K

Timken
employees

42

Countries
worldwide

99+

Years
continuous
quarterly
dividends

13.9%

3-year
annualized
total
shareholder
return⁽¹⁾⁽²⁾

2021 Key Metrics

\$4.1B Revenue

\$718M Adjusted EBITDA

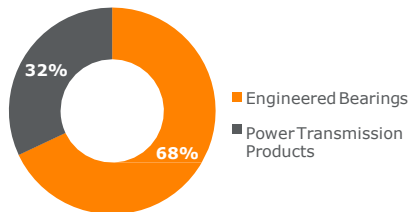
17.4% Adjusted EBITDA Margins

\$4.72 Adjusted EPS

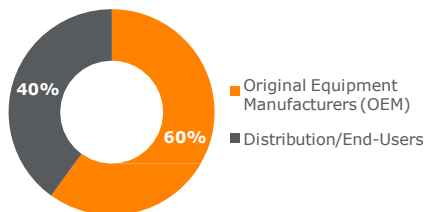
\$239M Free Cash Flow

2.0% Dividend Yield⁽¹⁾

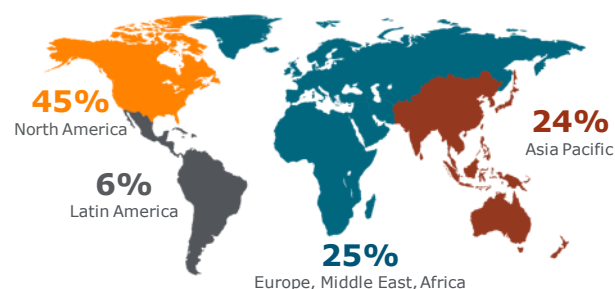
Product Offering Sales⁽³⁾



Sales by Channel⁽³⁾



Sales By Geography⁽³⁾



(1) Total shareholder return and dividend yield as of March 31, 2022.

(2) Total shareholder return for the Company was calculated on an annualized basis, assumes quarterly reinvestment of dividends

(3) Percentage of actual sales for 2021.

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Our Expertise

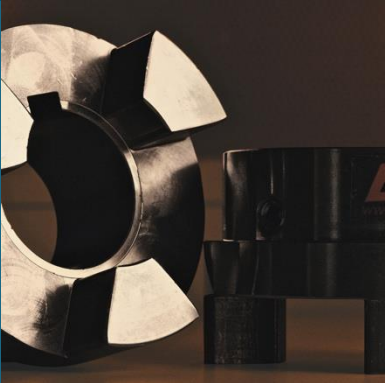
3



Timken **engineered bearings** offer a broad range of sizes, rolling elements and proprietary designs, delivering the strongest performance, consistency and reliability.



Timken **industrial motion** products and services provide a wide range of solutions and power system rebuild and repair services, improving the reliability of industrial equipment and machinery.



TIMKEN

Stronger. *By Design.*

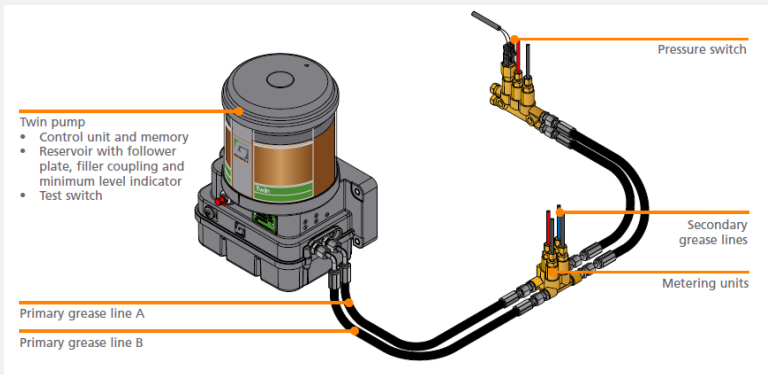
Advanced Manufacturing System Trends

- **Robotic material handling**
- **Lights-out or dim-lights manufacturing**
- **Lean flow processes**
- **Emphasis on improved material utilization and waste reduction**
- **Automated process control and feedback dashboarding**
- **On-machine and non-contact gauging and inspection**



Focus Areas for Discussion

Automated Lubrication Systems for Manufacturing Equipment



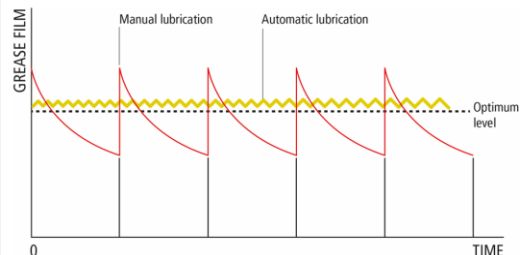
Robotic Motion Control Components and Lubrication Requirements

Automatic Lubrication Systems

6

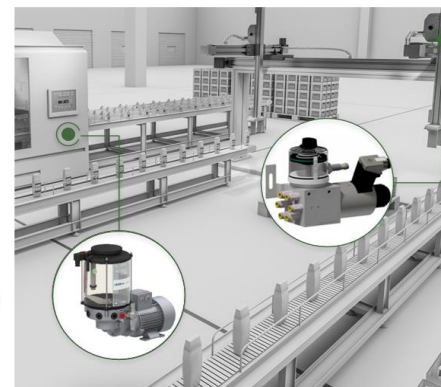
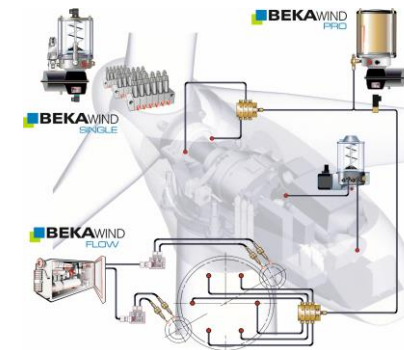
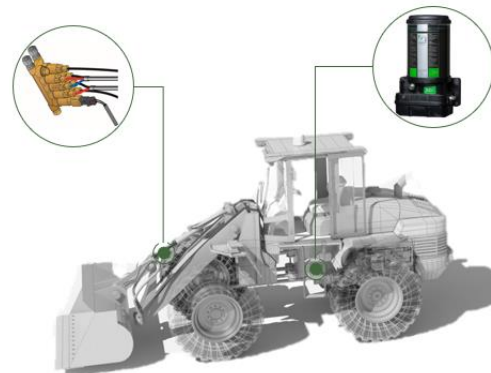
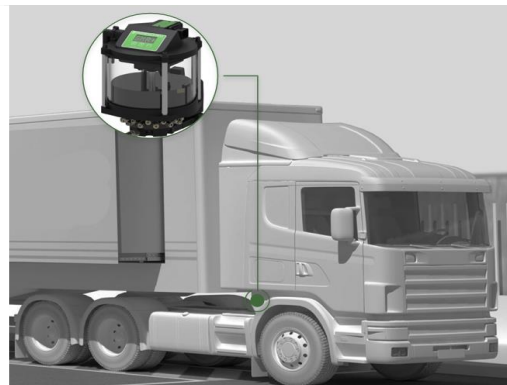
Pump **automatically** applies lubrication to equipment bearings

This **eliminates labor** and **improves reliability** versus manual lubrication



Improper lubrication accounts for 53% of all bearing failures.

Manufacturing applications in Metals, Mining, and Recycling, for example.



Automatic Lubrication Systems

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Increased **Efficiency**

- Reduced man-hours required to lubricate
- Reduced grease consumption
- Reduced lubricant spillage compared to manual

Higher Equipment **Productivity**

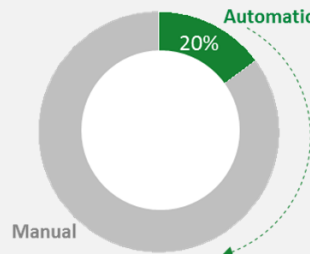
- Reduced equipment downtime
- Lube during machine operation / in motion

Decreased **Maintenance**

- Reduced replacement of wearing components by up to 50%

Improved **Safety**

80%
*of all greasing points in the world
are still greased manually*



Systems are Configurable to Application Needs

- NLGI 000 to 2
- -20°C to +70°C
- Various pressures and flowrates



Engineered Components for Industrial Robotics

8

Cone Drive

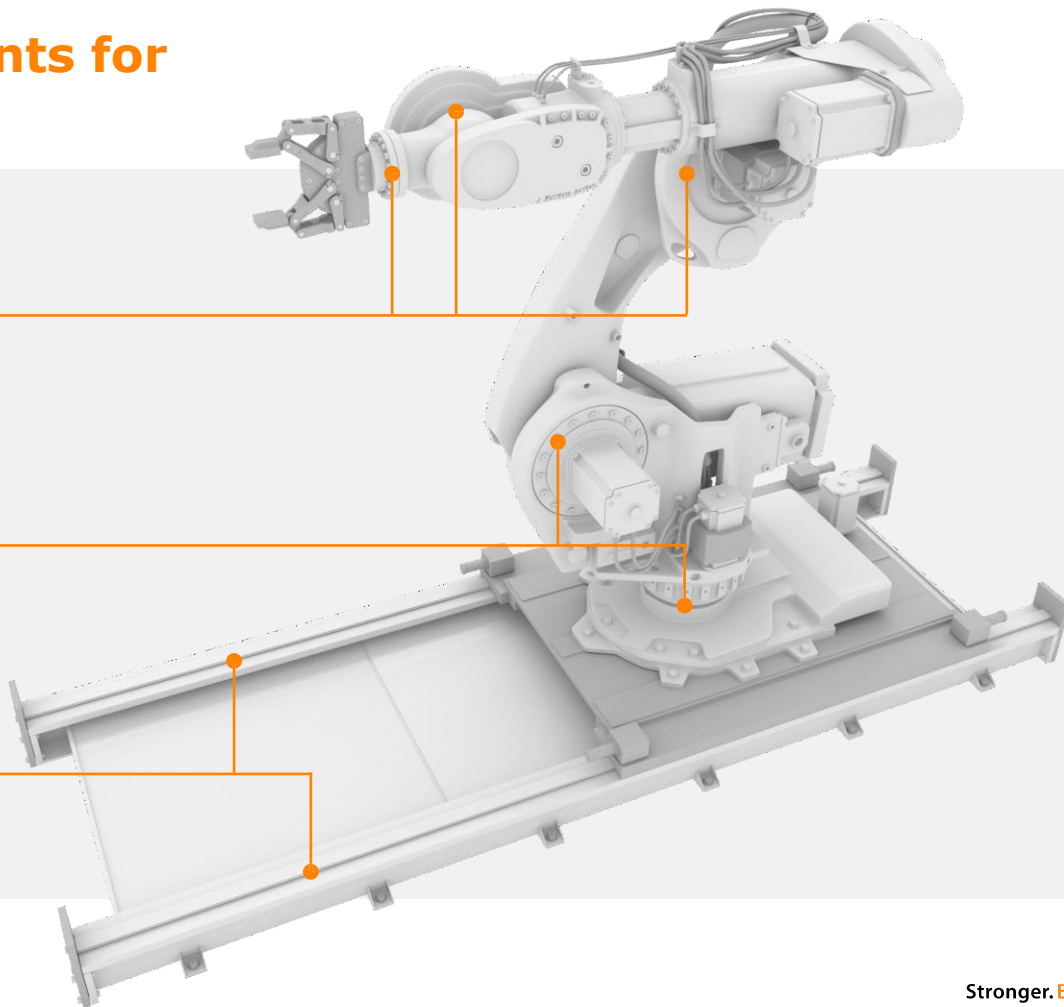
Strain Wave Gearing

Spinea

Cycloidal Reduction
Gearing

Rollon and iMS

Robotic Transfer Units
Linear Bearings



Strain Wave Gear Drives

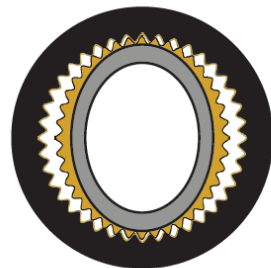
9

Compact, torque-dense gear drive module

High positional accuracy, high torsional stiffness, and zero backlash

High ratio reduction in a single stage makes it perfect for light-duty robotic and positioning joints

Variety of sizes, output torques, and output ratios available (e.g., 160:1)



KEY

ID Spline (circular spline)

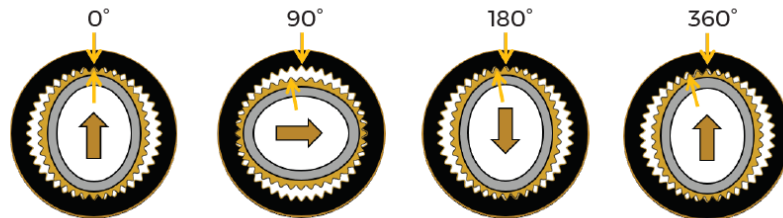
Rigid, circular ring with gear teeth on the inner diameter

OD Spline (flex spline)

Thin alloy steel designed for increased compliance in radial deflection

Wave Generator

Elliptical disc with an outer ball bearing



Strain Wave Gear Drives - Lubrication

Strain wave gear drives are assembled and lubricated in a class 8 clean room environment

Drive components are machined into matched sets – do not mix or match components

Most drives are grease lubricated – change after first 100 hrs and then every 2000 hours/12 months use thereafter

Follow recommended break-in procedures

Lubricate only with approved Cone Drive Harmonic Solutions® High Performance L1 Grease

- Apply to input bearings
- Apply to all spline teeth
- Apply to output bearings
- Ensure seals are not damaged

**CIRCULAR
SPLINE**

**FLEX
SPLINE**

**WAVE
GENERATOR**



Cycloidal Reduction Gearing

Eccentricity on a rotating shaft generates cycloidal movement that carries the needles in the case with pure rolling friction

High precision, zero backlash, compact design

High torsional and tilting stiffness

High overload capacity, wide range of torques

High gear ratios, from 33 to 191



More than 300 moving parts

Cycloidal Reduction Gearing - Lubrication

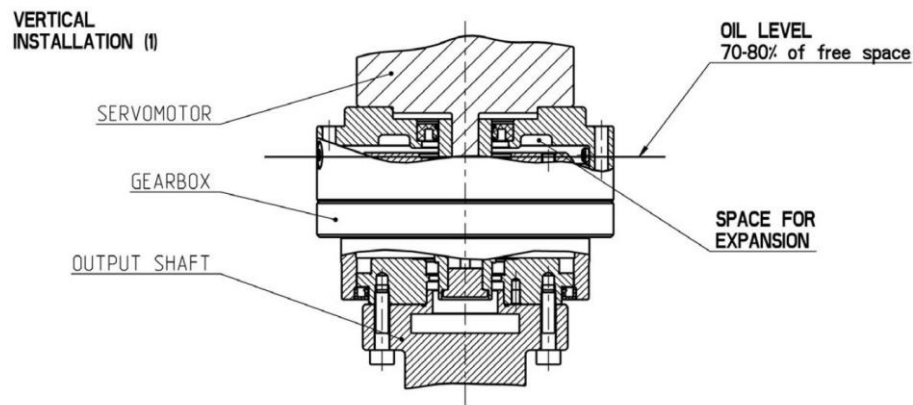
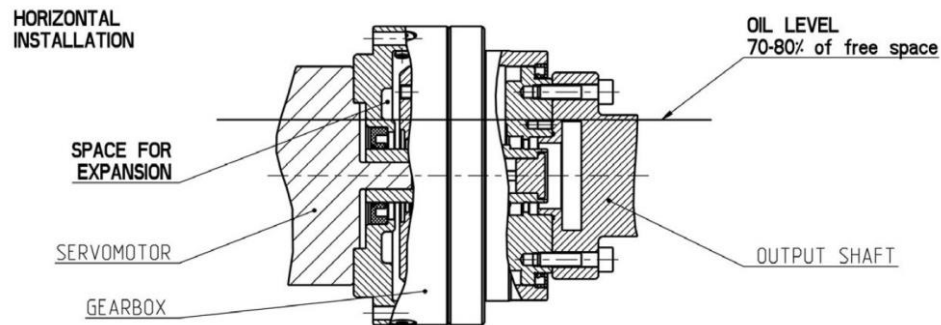
Cycloidal reduction gear drives are lubricated with either grease or oil to manufacturer's recommendations

Do not mix used lubricants with other lubricant types

Lubrication interval depends on use, but a guideline is every ~20k hours

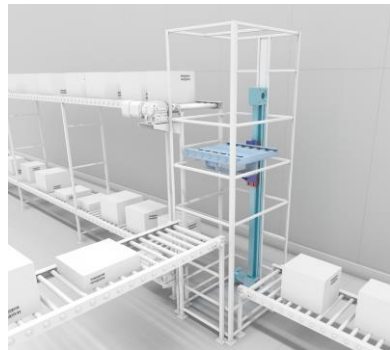
Manufacturer guidelines specify the amount of grease or oil needed per specific drive unit (~80% of free volume)

Operating temperatures typically -10C to +40C.



Linear Motion Bearings for Warehouse Automation

13



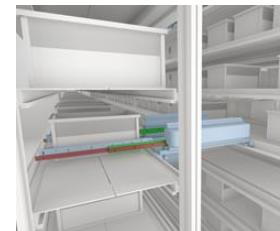
AGV

Vertical Storage

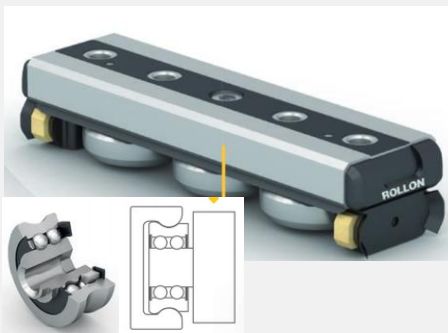
Stacker Crane

Vertical Conveyor

Shuttle Business



Linear Motion Bearings - Lubrication



Compact rollers guide with wiper heads

- High speed
- Low noise
- Long lubrication interval

Full synthetic oil lubricated



Balls cage guide and telescopic slide

- Low speed
- High load

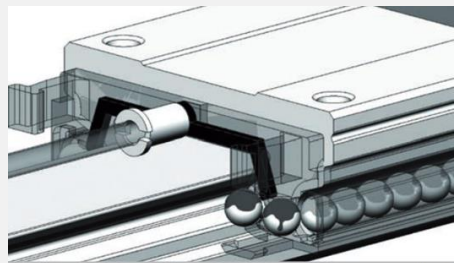
Lithium grease, NLGI 3, ISO VG-320



Rollers guide

- High speed
- Low noise

Lithium grease, NLGI 3, ISO VG-320



Recirculating balls guide

- Medium speed
- High load

Fluid grease for high pressure

Take-Aways

- **Advanced manufacturing systems often require the use of automatic lubrication systems.**
- **Compact drive units in robotics are highly precise and require manufacturer-specified lubricants and relubrication measures.**
- **Linear motion bearings require lubrication and maintenance too!**
- **Please read the manuals for lubrication instructions and contact the manufacturer as needed.**



The background of the image features technical drawings of mechanical components. At the top, there are cross-sectional views of shafts and bearings, with labels like 'thru 3 ir' on the left and 'EA2' on the right. At the bottom, there is a detailed side view of a multi-roller bearing assembly with various dimension lines and labels including E, T, K, KW, L, G, A, 2A, 2G, N, and P. The central part of the image is a solid orange band.

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