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Global Hollow-Bore Encoders for Robot Joints Market Growth 2026-2032

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Abstracts

The global Hollow-Bore Encoders for Robot Joints market size is predicted to grow from US$ 186 million in 2025 to US$ 798 million in 2032; it is expected to grow at a CAGR of 18.2% from 2026 to 2032.

Hollow-Bore Encoders for Robot Joints are rotary position feedback devices designed for integration into robot joints, joint actuators, frameless motors and reducer output stages where a central through-hole is required for cables, shafts, pneumatic lines or other joint components. These products typically use magnetic, inductive, optical or capacitive sensing principles and are available in bearingless, ring-type, kit-type and other compact hollow-bore configurations. Key technical parameters include hollow-bore diameter, angular resolution, absolute-position capability, accuracy, repeatability, communication interface, mechanical thickness and resistance to shock, vibration and electromagnetic interference. The research focuses on complete encoder products capable of independently providing joint angular-position feedback, including single-position and dual-position architectures. Major applications cover industrial articulated robots, collaborative robots, humanoid robots, quadruped robots, surgical robots, exoskeleton robots and other high-integration robotic systems requiring compact, high-precision and reliable joint position sensing.

Key Findings

Global sales volume is estimated at approximately 1.15 million units in 2025 and approximately 2.10 million units in 2026

The weighted average selling price is estimated to decline from about US$165 per unit in 2025 to about US$143 per unit in 2026

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Humanoid robots are becoming the largest incremental demand source as multi-joint platforms move from pilot production toward scaled deployment

Magnetic and inductive technologies are gaining importance in compact hollow-joint architectures because of their integration flexibility and contamination tolerance

The competitive landscape combines large global encoder groups with specialized European and Asian robot-joint encoder manufacturers

Market Trends

Hollow-Bore Encoders for Robot Joints are evolving toward thinner profiles, larger through-hole diameters, higher absolute resolution and deeper integration with frameless motors and compact reducers. Robot manufacturers increasingly require the encoder to fit inside highly constrained actuator envelopes while maintaining a central passage for power cables, communication lines and structural components. This favors bearingless ring encoders, inductive printed structures and compact magnetic sensing solutions over traditional shaft-mounted feedback devices in many new joint architectures. Dual-position feedback is also becoming more important, particularly in high-performance humanoid and collaborative robot joints, because simultaneous measurement at the motor side and reducer output side can improve control accuracy, compensate for transmission error and provide additional functional-safety information. At the same time, product design is shifting from low-volume precision components toward manufacturable platform products suitable for automated calibration and higher-volume robotic applications, especially in China. As production scales, the market is likely to show continued performance improvement alongside gradual ASP compression.

Market Dynamics

Drivers

The principal growth driver is the rising number of high-integration robot joints requiring direct and accurate angular feedback. Collaborative robots, humanoid robots, surgical robots and compact industrial manipulators increasingly use hollow joint modules built around frameless torque motors and precision reducers, creating structural demand for encoders that preserve the central through-hole. The transition of humanoid robots from prototype programs to batch production is particularly significant because a single

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platform can contain several dozen rotary joints and feedback positions. At the same time, tighter motion-control requirements are increasing demand for higher resolution, better repeatability and direct output-side measurement. Expansion of domestic robot supply chains in China is also accelerating adoption by lowering encoder cost and shortening lead times for customized joint designs.

Restraints

Market expansion is constrained by the technical difficulty of achieving high angular accuracy in thin, large-bore and bearingless structures. Installation eccentricity, rotor-stator alignment, temperature drift, magnetic interference, contamination and mechanical tolerance can all degrade accuracy once the encoder is integrated into a compact joint. High-end optical and inductive systems can also carry relatively high component, calibration and manufacturing costs, particularly in low-volume applications. In addition, some traditional industrial robot architectures continue to rely on motor-integrated encoders or resolvers, limiting the penetration of independent hollow-bore solutions in established robot platforms. Price pressure is increasing as Chinese suppliers expand capacity and robot OEMs demand lower joint BOM costs.

Opportunities

The strongest opportunity lies in humanoid and legged robotics, where central cable routing, compact actuator dimensions and multi-axis feedback requirements strongly favor hollow-bore encoder architectures. Output-side encoders and dual-position encoders also offer additional opportunities as robot manufacturers seek higher joint stiffness estimation, transmission-error compensation and functional-safety capability. Medical and surgical robotics represent another attractive segment because precision, repeatability and compact mechanical integration are valued more highly than lowest-cost sourcing. Large-bore inductive and magnetic encoders may also gain share in direct-drive joints, lightweight collaborative systems and modular robot actuators. The rapid expansion of automated encoder manufacturing and calibration in China creates further opportunities for domestic suppliers to enter applications previously dominated by imported precision feedback components.

Challenges

The industry faces persistent challenges in product validation, standardization and qualification. Robot-joint encoder requirements differ materially by motor diameter, reducer architecture, communication protocol, safety level, bore size and mechanical stack-up, making universal product platforms difficult to develop. Long qualification

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cycles can slow customer conversion even when a supplier achieves competitive technical specifications. As more vendors enter humanoid robotics, intense price competition may compress margins before shipment volumes fully mature. Suppliers must also balance higher resolution and accuracy against manufacturability, calibration time and reliability under real joint operating conditions. Another long-term challenge is the coexistence of optical, magnetic, inductive and capacitive technologies, as no single sensing principle currently offers the optimal combination of cost, accuracy, size, environmental robustness and production scalability for every robot-joint architecture.

Industry Chain Analysis

The upstream portion of the Hollow-Bore Encoders for Robot Joints industry includes sensing chips, optical and magnetic materials, inductive or capacitive sensing structures, precision PCBs, magnetic rings, code discs, signal-processing ASICs, connectors, housings and related precision-machined components. The value of upstream components varies substantially by sensing principle. Optical products rely more heavily on precision optical elements and high-quality code structures, while magnetic and inductive products increasingly benefit from semiconductor integration, PCB-based sensing and automated calibration. Mechanical flatness, concentricity and temperature stability remain important cost and quality determinants across all technologies.

The midstream consists of encoder manufacturers responsible for sensing architecture design, electronics, mechanical integration, calibration, testing and complete product qualification. Value creation is concentrated in algorithm design, error compensation, absolute-position decoding, signal integrity, high-precision calibration and reliable high-volume manufacturing. Downstream customers include robot OEMs, joint actuator manufacturers, frameless motor suppliers and integrated motion-control system suppliers. As robot joints become more modular, encoder manufacturers are increasingly involved at the actuator design stage rather than serving only as standardized component vendors, making application engineering and joint-level integration capability more important to commercial competitiveness.

Segment Insights

By sensing principle, magnetic, inductive, optical and capacitive encoders form the most stable product segmentation. Magnetic encoders benefit from compact structures, contamination resistance and relatively favorable cost scalability, making them increasingly competitive in humanoid and collaborative robot joints. Inductive encoders

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are particularly suitable for thin bearingless layouts and applications requiring robust absolute-position feedback without relying on optical cleanliness, while optical encoders retain advantages in applications requiring very high angular accuracy. Capacitive solutions remain a differentiated segment in ultra-thin, large-bore and lightweight configurations. The product mix is therefore becoming more diversified rather than converging toward a single dominant technology.

By measurement architecture, single-position encoders remain the broader installed base, while dual-position encoders represent a faster-developing high-value direction. Dual-position products can simultaneously measure motor-side and reducer-output-side position, supporting transmission-error compensation, more accurate joint control and functional monitoring. By hollow-bore diameter, products from below 20 mm to above 80 mm are commercially available, but the fastest product development is occurring in medium and large bore sizes as humanoid joints, direct-drive modules and integrated cable-routing designs place greater emphasis on usable central space.

Downstream Market Opportunities

Industrial articulated robots remain an important underlying demand base, but the highest incremental opportunities are shifting toward collaborative robots, humanoid robots and other compact high-degree-of-freedom platforms. Humanoid robots are particularly important because one unit can require multiple hollow-bore position feedback devices across shoulder, elbow, wrist, hip and knee joints, creating significantly higher encoder content per robot than many conventional industrial systems. Surgical robots provide a smaller but higher-value opportunity where compact packaging, low backlash, high repeatability and absolute-position reliability are critical. Quadruped and exoskeleton robots are also attractive emerging applications because leg and wearable joints require central routing, low weight and robust feedback under repeated dynamic loading. These applications are expanding the addressable market beyond traditional factory automation.

Regional Insights

Asia-Pacific is the central growth region for Hollow-Bore Encoders for Robot Joints, supported by the concentration of robot manufacturing, joint-module production and emerging humanoid robot supply chains in China, Japan and South Korea. China is increasingly important not only as a downstream robot market but also as a manufacturing base for magnetic and inductive robot-joint encoders. Rapid capacity expansion, automated calibration and closer cooperation with domestic actuator

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suppliers are strengthening local suppliers in cost-sensitive, high-volume applications. Japan retains strong capabilities in high-precision optical and absolute-position encoder technologies, while South Korea is developing a smaller but increasingly specialized local encoder supply base.

Europe remains a major technology and premium-product center, particularly in Germany, the United Kingdom, Slovenia and Italy, where established companies maintain strong positions in high-accuracy measurement, inductive sensing, magnetic ring encoders and robot-specific feedback systems. The United States participates primarily through motion-control and precision automation groups with global manufacturing networks, while Israel has established a distinctive position in ultra-thin capacitive encoder technology. Regional competition is therefore characterized by European and Japanese precision-technology strengths, U.S. motion-control platforms and rapidly expanding Chinese scale manufacturing.

Competitive Landscape Analysis

The competitive landscape of Hollow-Bore Encoders for Robot Joints is fragmented across several technology platforms and company types. Large global groups such as DR. JOHANNES HEIDENHAIN GmbH, NIKON CORPORATION, SICK AG, Novanta Inc., Renishaw plc and Ralliant Corporation benefit from broad engineering capabilities, established quality systems, international customer relationships and mature precision-manufacturing infrastructure. Specialized European manufacturers including FRABA B.V., RLS Merilna tehnika d.o.o., SIKO GmbH, Lika Electronic Srl and Netzer Precision Position Sensors A.C.S. Ltd. compete through focused sensing technologies, large-bore or bearingless architectures and robot-specific application expertise. Chinese manufacturers such as Zhejiang Reagle Sensing Technology Incorporated, Beijing KingKong Technology Co., Ltd., Shanghai Gongwang Electronic Technology Co., Ltd., Shenzhen Mosrac Motor Co., Ltd., ZeroErr Inc., Shanghai Shengnai Technology Co., Ltd., Weihai Idencoder Electronic Technology Co., Ltd. and Shanghai Hengxiang Optical Electronics Co., Ltd. are strengthening their positions through localized joint development, shorter customization cycles and increasing manufacturing automation. NRT Co., Ltd. represents an emerging Korean specialist. Competition is increasingly determined by the ability to combine accuracy, hollow-bore flexibility, thin mechanical profiles, calibration efficiency and scalable manufacturing rather than by nominal resolution alone.

Report Scope

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LP Information, Inc. (LPI) ' newest research report, the “Hollow-Bore Encoders for Robot Joints Industry Forecast” looks at past sales and reviews total world Hollow-Bore Encoders for Robot Joints sales in 2025, providing a comprehensive analysis by region and market sector of projected Hollow-Bore Encoders for Robot Joints sales for 2026 through 2032. With Hollow-Bore Encoders for Robot Joints sales broken down by region, market sector and sub-sector, this report provides a detailed analysis in US$ millions of the world Hollow-Bore Encoders for Robot Joints industry.

This Insight Report provides a comprehensive analysis of the global Hollow-Bore Encoders for Robot Joints landscape and highlights key trends related to product segmentation, company formation, revenue, and market share, latest development, and M&A activity. This report also analyzes the strategies of leading global companies with a focus on Hollow-Bore Encoders for Robot Joints portfolios and capabilities, market entry strategies, market positions, and geographic footprints, to better understand these firms’ unique position in an accelerating global Hollow-Bore Encoders for Robot Joints market.

This Insight Report evaluates the key market trends, drivers, and affecting factors shaping the global outlook for Hollow-Bore Encoders for Robot Joints and breaks down the forecast by Type, by Application, geography, and market size to highlight emerging pockets of opportunity. With a transparent methodology based on hundreds of bottom-up qualitative and quantitative market inputs, this study forecast offers a highly nuanced view of the current state and future trajectory in the global Hollow-Bore Encoders for Robot Joints.

This report presents a comprehensive overview, market shares, and growth opportunities of Hollow-Bore Encoders for Robot Joints market by product type, application, key manufacturers and key regions and countries.

Market Segmentation

Segmentation by Type:

Magnetic Encoders

Inductive Encoders

Optical Encoders

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Capacitive Encoders

Other

Segmentation by Hollow Bore Diameter:

Up to 20 mm

Above 20 mm to 40 mm

Above 40 mm to 80 mm

Above 80 mm

Other

Segmentation by Application:

Industrial Articulated Robots

Collaborative Robots

Humanoid Robots

Quadruped Robots

Surgical Robots

Exoskeleton Robots

Other

This report also splits the market by region:

Americas

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United States

Canada

Mexico

Brazil

APAC

China

Japan

Korea

Southeast Asia

India

Australia

Europe

Germany

France

UK

Italy

Russia

Middle East & Africa

Egypt

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South Africa

Israel

Turkey

GCC Countries

The below companies that are profiled have been selected based on inputs gathered from primary experts and analysing the company's coverage, product portfolio, its market penetration.

DR. JOHANNES HEIDENHAIN GmbH

NIKON CORPORATION

SICK AG

Novanta Inc.

Renishaw plc

Ralliant Corporation

FRABA B.V.

RLS Merilna tehnika d.o.o.

SIKO GmbH

Lika Electronic Srl

Netzer Precision Position Sensors A.C.S. Ltd.

Zhejiang Reagle Sensing Technology Incorporated

Beijing KingKong Technology Co., Ltd.

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Shanghai Gongwang Electronic Technology Co., Ltd.

Shenzhen Mosrac Motor Co., Ltd.

NRT Co., Ltd.

ZeroErr Inc.

Shanghai Shengnai Technology Co., Ltd.

Weihai Idencoder Electronic Technology Co., Ltd.

Shanghai Hengxiang Optical Electronics Co., Ltd.

Key Questions Addressed in this Report

What is the 10-year outlook for the global Hollow-Bore Encoders for Robot Joints market?

What factors are driving Hollow-Bore Encoders for Robot Joints market growth, globally and by region?

Which technologies are poised for the fastest growth by market and region?

How do Hollow-Bore Encoders for Robot Joints market opportunities vary by end market size?

How does Hollow-Bore Encoders for Robot Joints break out by Type, by Application?

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Contents

1 SCOPE OF THE REPORT

1.1 Market Introduction
1.2 Years Considered
1.3 Research Objectives
1.4 Market Research Methodology
1.5 Research Process and Data Source
1.6 Economic Indicators
1.7 Currency Considered
1.8 Market Estimation Caveats

2 EXECUTIVE SUMMARY

2.1 World Market Overview
  2.1.1 Global Hollow-Bore Encoders for Robot Joints Annual Sales 2021-2032
  2.1.2 World Current & Future Analysis for Hollow-Bore Encoders for Robot Joints by Geographic Region, 2021, 2025 & 2032
  2.1.3 World Current & Future Analysis for Hollow-Bore Encoders for Robot Joints by Country/Region, 2021, 2025 & 2032
2.2 Hollow-Bore Encoders for Robot Joints Segment by Type
  2.2.1 Magnetic Encoders
  2.2.2 Inductive Encoders
  2.2.3 Optical Encoders
  2.2.4 Capacitive Encoders
  2.2.5 Other
  2.2.6 Hollow-Bore Encoders for Robot Joints Sales by Type
    2.2.6.1 Global Hollow-Bore Encoders for Robot Joints Sales Market Share by Type (2021-2026)
    2.2.6.2 Global Hollow-Bore Encoders for Robot Joints Revenue and Market Share by Type (2021-2026)
    2.2.6.3 Global Hollow-Bore Encoders for Robot Joints Sale Price by Type (2021-2026)
2.3 Hollow-Bore Encoders for Robot Joints Segment by Hollow Bore Diameter
  2.3.1 Up to 20 mm
  2.3.2 Above 20 mm to 40 mm
  2.3.3 Above 40 mm to 80 mm
  2.3.4 Above 80 mm

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2.3.5 Other
2.3.6 Hollow-Bore Encoders for Robot Joints Sales by Hollow Bore Diameter
2.3.6.1 Global Hollow-Bore Encoders for Robot Joints Sales Market Share by Hollow Bore Diameter (2021-2026)
2.3.6.2 Global Hollow-Bore Encoders for Robot Joints Revenue and Market Share by Hollow Bore Diameter (2021-2026)
2.3.6.3 Global Hollow-Bore Encoders for Robot Joints Sale Price by Hollow Bore Diameter (2021-2026)
2.4 Hollow-Bore Encoders for Robot Joints Segment by Application
2.4.1 Industrial Articulated Robots
2.4.2 Collaborative Robots
2.4.3 Humanoid Robots
2.4.4 Quadruped Robots
2.4.5 Surgical Robots
2.4.6 Exoskeleton Robots
2.4.7 Other
2.4.8 Hollow-Bore Encoders for Robot Joints Sales by Application
2.4.8.1 Global Hollow-Bore Encoders for Robot Joints Sale Market Share by Application (2021-2026)
2.4.8.2 Global Hollow-Bore Encoders for Robot Joints Revenue and Market Share by Application (2021-2026)
2.4.8.3 Global Hollow-Bore Encoders for Robot Joints Sale Price by Application (2021-2026)

3 GLOBAL BY COMPANY

3.1 Global Hollow-Bore Encoders for Robot Joints Breakdown Data by Company
3.1.1 Global Hollow-Bore Encoders for Robot Joints Annual Sales by Company (2021-2026)
3.1.2 Global Hollow-Bore Encoders for Robot Joints Sales Market Share by Company (2021-2026)
3.2 Global Hollow-Bore Encoders for Robot Joints Annual Revenue by Company (2021-2026)
3.2.1 Global Hollow-Bore Encoders for Robot Joints Revenue by Company (2021-2026)
3.2.2 Global Hollow-Bore Encoders for Robot Joints Revenue Market Share by Company (2021-2026)
3.3 Global Hollow-Bore Encoders for Robot Joints Sale Price by Company
3.4 Key Manufacturers Hollow-Bore Encoders for Robot Joints Producing Area

+357 96 030922
info@marketpublishers.com

Distribution, Sales Area, Product Type
3.4.1 Key Manufacturers Hollow-Bore Encoders for Robot Joints Product Location Distribution
3.4.2 Players Hollow-Bore Encoders for Robot Joints Products Offered
3.5 Market Concentration Rate Analysis
3.5.1 Competition Landscape Analysis
3.5.2 Concentration Ratio (CR3, CR5 and CR10) & (2024-2026)
3.6 New Products and Potential Entrants
3.7 Market M&A Activity & Strategy

4 WORLD HISTORIC REVIEW FOR HOLLOW-BORE ENCODERS FOR ROBOT JOINTS BY GEOGRAPHIC REGION

4.1 World Historic Hollow-Bore Encoders for Robot Joints Market Size by Geographic Region (2021-2026)
4.1.1 Global Hollow-Bore Encoders for Robot Joints Annual Sales by Geographic Region (2021-2026)
4.1.2 Global Hollow-Bore Encoders for Robot Joints Annual Revenue by Geographic Region (2021-2026)
4.2 World Historic Hollow-Bore Encoders for Robot Joints Market Size by Country/Region (2021-2026)
4.2.1 Global Hollow-Bore Encoders for Robot Joints Annual Sales by Country/Region (2021-2026)
4.2.2 Global Hollow-Bore Encoders for Robot Joints Annual Revenue by Country/Region (2021-2026)
4.3 Americas Hollow-Bore Encoders for Robot Joints Sales Growth
4.4 APAC Hollow-Bore Encoders for Robot Joints Sales Growth
4.5 Europe Hollow-Bore Encoders for Robot Joints Sales Growth
4.6 Middle East & Africa Hollow-Bore Encoders for Robot Joints Sales Growth

5 AMERICAS

5.1 Americas Hollow-Bore Encoders for Robot Joints Sales by Country
5.1.1 Americas Hollow-Bore Encoders for Robot Joints Sales by Country (2021-2026)
5.1.2 Americas Hollow-Bore Encoders for Robot Joints Revenue by Country (2021-2026)
5.2 Americas Hollow-Bore Encoders for Robot Joints Sales by Type (2021-2026)
5.3 Americas Hollow-Bore Encoders for Robot Joints Sales by Application (2021-2026)
5.4 United States

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info@marketpublishers.com

5.5 Canada
5.6 Mexico
5.7 Brazil

6 APAC

6.1 APAC Hollow-Bore Encoders for Robot Joints Sales by Region
  6.1.1 APAC Hollow-Bore Encoders for Robot Joints Sales by Region (2021-2026)
  6.1.2 APAC Hollow-Bore Encoders for Robot Joints Revenue by Region (2021-2026)
6.2 APAC Hollow-Bore Encoders for Robot Joints Sales by Type (2021-2026)
6.3 APAC Hollow-Bore Encoders for Robot Joints Sales by Application (2021-2026)
6.4 China
6.5 Japan
6.6 South Korea
6.7 Southeast Asia
6.8 India
6.9 Australia
6.10 China Taiwan

7 EUROPE

7.1 Europe Hollow-Bore Encoders for Robot Joints by Country
  7.1.1 Europe Hollow-Bore Encoders for Robot Joints Sales by Country (2021-2026)
  7.1.2 Europe Hollow-Bore Encoders for Robot Joints Revenue by Country (2021-2026)
7.2 Europe Hollow-Bore Encoders for Robot Joints Sales by Type (2021-2026)
7.3 Europe Hollow-Bore Encoders for Robot Joints Sales by Application (2021-2026)
7.4 Germany
7.5 France
7.6 UK
7.7 Italy
7.8 Russia

8 MIDDLE EAST & AFRICA

8.1 Middle East & Africa Hollow-Bore Encoders for Robot Joints by Country
  8.1.1 Middle East & Africa Hollow-Bore Encoders for Robot Joints Sales by Country (2021-2026)
  8.1.2 Middle East & Africa Hollow-Bore Encoders for Robot Joints Revenue by Country (2021-2026)

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8.2 Middle East & Africa Hollow-Bore Encoders for Robot Joints Sales by Type (2021-2026)
8.3 Middle East & Africa Hollow-Bore Encoders for Robot Joints Sales by Application (2021-2026)
8.4 Egypt
8.5 South Africa
8.6 Israel
8.7 Turkey
8.8 GCC Countries

9 MARKET DRIVERS, CHALLENGES AND TRENDS

9.1 Market Drivers & Growth Opportunities
9.2 Market Challenges & Risks
9.3 Industry Trends

10 MANUFACTURING COST STRUCTURE ANALYSIS

10.1 Raw Material and Suppliers
10.2 Manufacturing Cost Structure Analysis of Hollow-Bore Encoders for Robot Joints
10.3 Manufacturing Process Analysis of Hollow-Bore Encoders for Robot Joints
10.4 Industry Chain Structure of Hollow-Bore Encoders for Robot Joints

11 MARKETING, DISTRIBUTORS AND CUSTOMER

11.1 Sales Channel
  11.1.1 Direct Channels
  11.1.2 Indirect Channels
11.2 Hollow-Bore Encoders for Robot Joints Distributors
11.3 Hollow-Bore Encoders for Robot Joints Customer

12 WORLD FORECAST REVIEW FOR HOLLOW-BORE ENCODERS FOR ROBOT JOINTS BY GEOGRAPHIC REGION

12.1 Global Hollow-Bore Encoders for Robot Joints Market Size Forecast by Region
  12.1.1 Global Hollow-Bore Encoders for Robot Joints Forecast by Region (2027-2032)
  12.1.2 Global Hollow-Bore Encoders for Robot Joints Annual Revenue Forecast by Region (2027-2032)
12.2 Americas Forecast by Country (2027-2032)

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info@marketpublishers.com

12.3 APAC Forecast by Region (2027-2032)
12.4 Europe Forecast by Country (2027-2032)
12.5 Middle East & Africa Forecast by Country (2027-2032)
12.6 Global Hollow-Bore Encoders for Robot Joints Forecast by Type (2027-2032)
12.7 Global Hollow-Bore Encoders for Robot Joints Forecast by Application (2027-2032)

13 KEY PLAYERS ANALYSIS

13.1 DR. JOHANNES HEIDENHAIN GmbH
13.1.1 DR. JOHANNES HEIDENHAIN GmbH Company Information
13.1.2 DR. JOHANNES HEIDENHAIN GmbH Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.1.3 DR. JOHANNES HEIDENHAIN GmbH Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.1.4 DR. JOHANNES HEIDENHAIN GmbH Main Business Overview
13.1.5 DR. JOHANNES HEIDENHAIN GmbH Latest Developments
13.2 NIKON CORPORATION
13.2.1 NIKON CORPORATION Company Information
13.2.2 NIKON CORPORATION Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.2.3 NIKON CORPORATION Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.2.4 NIKON CORPORATION Main Business Overview
13.2.5 NIKON CORPORATION Latest Developments
13.3 SICK AG
13.3.1 SICK AG Company Information
13.3.2 SICK AG Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.3.3 SICK AG Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.3.4 SICK AG Main Business Overview
13.3.5 SICK AG Latest Developments
13.4 Novanta Inc.
13.4.1 Novanta Inc. Company Information
13.4.2 Novanta Inc. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.4.3 Novanta Inc. Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)

+357 96 030922
info@marketpublishers.com

13.4.4 Novanta Inc. Main Business Overview
13.4.5 Novanta Inc. Latest Developments
13.5 Renishaw plc
13.5.1 Renishaw plc Company Information
13.5.2 Renishaw plc Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.5.3 Renishaw plc Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.5.4 Renishaw plc Main Business Overview
13.5.5 Renishaw plc Latest Developments
13.6 Ralliant Corporation
13.6.1 Ralliant Corporation Company Information
13.6.2 Ralliant Corporation Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.6.3 Ralliant Corporation Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.6.4 Ralliant Corporation Main Business Overview
13.6.5 Ralliant Corporation Latest Developments
13.7 FRABA B.V.
13.7.1 FRABA B.V. Company Information
13.7.2 FRABA B.V. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.7.3 FRABA B.V. Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.7.4 FRABA B.V. Main Business Overview
13.7.5 FRABA B.V. Latest Developments
13.8 RLS Merilna tehnika d.o.o.
13.8.1 RLS Merilna tehnika d.o.o. Company Information
13.8.2 RLS Merilna tehnika d.o.o. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.8.3 RLS Merilna tehnika d.o.o. Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.8.4 RLS Merilna tehnika d.o.o. Main Business Overview
13.8.5 RLS Merilna tehnika d.o.o. Latest Developments
13.9 SIKO GmbH
13.9.1 SIKO GmbH Company Information
13.9.2 SIKO GmbH Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.9.3 SIKO GmbH Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and

+357 96 030922
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Gross Margin (2021-2026)
13.9.4 SIKO GmbH Main Business Overview
13.9.5 SIKO GmbH Latest Developments
13.10 Lika Electronic Srl
13.10.1 Lika Electronic Srl Company Information
13.10.2 Lika Electronic Srl Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.10.3 Lika Electronic Srl Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.10.4 Lika Electronic Srl Main Business Overview
13.10.5 Lika Electronic Srl Latest Developments
13.11 Netzer Precision Position Sensors A.C.S. Ltd.
13.11.1 Netzer Precision Position Sensors A.C.S. Ltd. Company Information
13.11.2 Netzer Precision Position Sensors A.C.S. Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.11.3 Netzer Precision Position Sensors A.C.S. Ltd. Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.11.4 Netzer Precision Position Sensors A.C.S. Ltd. Main Business Overview
13.11.5 Netzer Precision Position Sensors A.C.S. Ltd. Latest Developments
13.12 Zhejiang Reagle Sensing Technology Incorporated
13.12.1 Zhejiang Reagle Sensing Technology Incorporated Company Information
13.12.2 Zhejiang Reagle Sensing Technology Incorporated Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.12.3 Zhejiang Reagle Sensing Technology Incorporated Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.12.4 Zhejiang Reagle Sensing Technology Incorporated Main Business Overview
13.12.5 Zhejiang Reagle Sensing Technology Incorporated Latest Developments
13.13 Beijing KingKong Technology Co., Ltd.
13.13.1 Beijing KingKong Technology Co., Ltd. Company Information
13.13.2 Beijing KingKong Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.13.3 Beijing KingKong Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.13.4 Beijing KingKong Technology Co., Ltd. Main Business Overview
13.13.5 Beijing KingKong Technology Co., Ltd. Latest Developments
13.14 Shanghai Gongwang Electronic Technology Co., Ltd.
13.14.1 Shanghai Gongwang Electronic Technology Co., Ltd. Company Information
13.14.2 Shanghai Gongwang Electronic Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications

+357 96 030922
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13.14.3 Shanghai Gongwang Electronic Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.14.4 Shanghai Gongwang Electronic Technology Co., Ltd. Main Business Overview
13.14.5 Shanghai Gongwang Electronic Technology Co., Ltd. Latest Developments
13.15 Shenzhen Mosrac Motor Co., Ltd.
13.15.1 Shenzhen Mosrac Motor Co., Ltd. Company Information
13.15.2 Shenzhen Mosrac Motor Co., Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.15.3 Shenzhen Mosrac Motor Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.15.4 Shenzhen Mosrac Motor Co., Ltd. Main Business Overview
13.15.5 Shenzhen Mosrac Motor Co., Ltd. Latest Developments
13.16 NRT Co., Ltd.
13.16.1 NRT Co., Ltd. Company Information
13.16.2 NRT Co., Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.16.3 NRT Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.16.4 NRT Co., Ltd. Main Business Overview
13.16.5 NRT Co., Ltd. Latest Developments
13.17 ZeroErr Inc.
13.17.1 ZeroErr Inc. Company Information
13.17.2 ZeroErr Inc. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.17.3 ZeroErr Inc. Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.17.4 ZeroErr Inc. Main Business Overview
13.17.5 ZeroErr Inc. Latest Developments
13.18 Shanghai Shengnai Technology Co., Ltd.
13.18.1 Shanghai Shengnai Technology Co., Ltd. Company Information
13.18.2 Shanghai Shengnai Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.18.3 Shanghai Shengnai Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.18.4 Shanghai Shengnai Technology Co., Ltd. Main Business Overview
13.18.5 Shanghai Shengnai Technology Co., Ltd. Latest Developments
13.19 Weihai Idencoder Electronic Technology Co., Ltd.
13.19.1 Weihai Idencoder Electronic Technology Co., Ltd. Company Information
13.19.2 Weihai Idencoder Electronic Technology Co., Ltd. Hollow-Bore Encoders for

+357 96 030922
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Robot Joints Product Portfolios and Specifications
13.19.3 Weihai Idencoder Electronic Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.19.4 Weihai Idencoder Electronic Technology Co., Ltd. Main Business Overview
13.19.5 Weihai Idencoder Electronic Technology Co., Ltd. Latest Developments
13.20 Shanghai Hengxiang Optical Electronics Co., Ltd.
13.20.1 Shanghai Hengxiang Optical Electronics Co., Ltd. Company Information
13.20.2 Shanghai Hengxiang Optical Electronics Co., Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
13.20.3 Shanghai Hengxiang Optical Electronics Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales, Revenue, Price and Gross Margin (2021-2026)
13.20.4 Shanghai Hengxiang Optical Electronics Co., Ltd. Main Business Overview
13.20.5 Shanghai Hengxiang Optical Electronics Co., Ltd. Latest Developments

14 RESEARCH FINDINGS AND CONCLUSION

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List Of Tables

LIST OF TABLES

Table 1. Hollow-Bore Encoders for Robot Joints Annual Sales CAGR by Geographic Region (2021, 2025 & 2032) & ($ millions)
Table 2. Hollow-Bore Encoders for Robot Joints Annual Sales CAGR by Country/Region (2021, 2025 & 2032) & ($ millions)
Table 3. Major Players of Magnetic Encoders
Table 4. Major Players of Inductive Encoders
Table 5. Major Players of Optical Encoders
Table 6. Major Players of Capacitive Encoders
Table 7. Major Players of Other
Table 8. Global Hollow-Bore Encoders for Robot Joints Sales by Type (2021-2026) & (K Units)
Table 9. Global Hollow-Bore Encoders for Robot Joints Sales Market Share by Type (2021-2026)
Table 10. Global Hollow-Bore Encoders for Robot Joints Revenue by Type (2021-2026) & ($ million)
Table 11. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share by Type (2021-2026)
Table 12. Global Hollow-Bore Encoders for Robot Joints Sale Price by Type (2021-2026) & (US$/Unit)
Table 13. Major Players of Up to 20 mm
Table 14. Major Players of Above 20 mm to 40 mm
Table 15. Major Players of Above 40 mm to 80 mm
Table 16. Major Players of Above 80 mm
Table 17. Major Players of Other
Table 18. Global Hollow-Bore Encoders for Robot Joints Sales by Hollow Bore Diameter (2021-2026) & (K Units)
Table 19. Global Hollow-Bore Encoders for Robot Joints Sales Market Share by Hollow Bore Diameter (2021-2026)
Table 20. Global Hollow-Bore Encoders for Robot Joints Revenue by Hollow Bore Diameter (2021-2026) & ($ million)
Table 21. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share by Hollow Bore Diameter (2021-2026)
Table 22. Global Hollow-Bore Encoders for Robot Joints Sale Price by Hollow Bore Diameter (2021-2026) & (US$/Unit)
Table 23. Global Hollow-Bore Encoders for Robot Joints Sale by Application

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(2021-2026) & (K Units)
Table 24. Global Hollow-Bore Encoders for Robot Joints Sale Market Share by Application (2021-2026)
Table 25. Global Hollow-Bore Encoders for Robot Joints Revenue by Application (2021-2026) & ($ million)
Table 26. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share by Application (2021-2026)
Table 27. Global Hollow-Bore Encoders for Robot Joints Sale Price by Application (2021-2026) & (US$/Unit)
Table 28. Global Hollow-Bore Encoders for Robot Joints Sales by Company (2021-2026) & (K Units)
Table 29. Global Hollow-Bore Encoders for Robot Joints Sales Market Share by Company (2021-2026)
Table 30. Global Hollow-Bore Encoders for Robot Joints Revenue by Company (2021-2026) & ($ millions)
Table 31. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share by Company (2021-2026)
Table 32. Global Hollow-Bore Encoders for Robot Joints Sale Price by Company (2021-2026) & (US$/Unit)
Table 33. Key Manufacturers Hollow-Bore Encoders for Robot Joints Producing Area Distribution and Sales Area
Table 34. Players Hollow-Bore Encoders for Robot Joints Products Offered
Table 35. Hollow-Bore Encoders for Robot Joints Concentration Ratio (CR3, CR5 and CR10) & (2024-2026)
Table 36. New Products and Potential Entrants
Table 37. Market M&A Activity & Strategy
Table 38. Global Hollow-Bore Encoders for Robot Joints Sales by Geographic Region (2021-2026) & (K Units)
Table 39. Global Hollow-Bore Encoders for Robot Joints Sales Market Share Geographic Region (2021-2026)
Table 40. Global Hollow-Bore Encoders for Robot Joints Revenue by Geographic Region (2021-2026) & ($ millions)
Table 41. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share by Geographic Region (2021-2026)
Table 42. Global Hollow-Bore Encoders for Robot Joints Sales by Country/Region (2021-2026) & (K Units)
Table 43. Global Hollow-Bore Encoders for Robot Joints Sales Market Share by Country/Region (2021-2026)
Table 44. Global Hollow-Bore Encoders for Robot Joints Revenue by Country/Region

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(2021-2026) & ($ millions)
Table 45. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share by Country/Region (2021-2026)
Table 46. Americas Hollow-Bore Encoders for Robot Joints Sales by Country (2021-2026) & (K Units)
Table 47. Americas Hollow-Bore Encoders for Robot Joints Sales Market Share by Country (2021-2026)
Table 48. Americas Hollow-Bore Encoders for Robot Joints Revenue by Country (2021-2026) & ($ millions)
Table 49. Americas Hollow-Bore Encoders for Robot Joints Sales by Type (2021-2026) & (K Units)
Table 50. Americas Hollow-Bore Encoders for Robot Joints Sales by Application (2021-2026) & (K Units)
Table 51. APAC Hollow-Bore Encoders for Robot Joints Sales by Region (2021-2026) & (K Units)
Table 52. APAC Hollow-Bore Encoders for Robot Joints Sales Market Share by Region (2021-2026)
Table 53. APAC Hollow-Bore Encoders for Robot Joints Revenue by Region (2021-2026) & ($ millions)
Table 54. APAC Hollow-Bore Encoders for Robot Joints Sales by Type (2021-2026) & (K Units)
Table 55. APAC Hollow-Bore Encoders for Robot Joints Sales by Application (2021-2026) & (K Units)
Table 56. Europe Hollow-Bore Encoders for Robot Joints Sales by Country (2021-2026) & (K Units)
Table 57. Europe Hollow-Bore Encoders for Robot Joints Revenue by Country (2021-2026) & ($ millions)
Table 58. Europe Hollow-Bore Encoders for Robot Joints Sales by Type (2021-2026) & (K Units)
Table 59. Europe Hollow-Bore Encoders for Robot Joints Sales by Application (2021-2026) & (K Units)
Table 60. Middle East & Africa Hollow-Bore Encoders for Robot Joints Sales by Country (2021-2026) & (K Units)
Table 61. Middle East & Africa Hollow-Bore Encoders for Robot Joints Revenue Market Share by Country (2021-2026)
Table 62. Middle East & Africa Hollow-Bore Encoders for Robot Joints Sales by Type (2021-2026) & (K Units)
Table 63. Middle East & Africa Hollow-Bore Encoders for Robot Joints Sales by Application (2021-2026) & (K Units)

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Table 64. Key Market Drivers & Growth Opportunities of Hollow-Bore Encoders for Robot Joints
Table 65. Key Market Challenges & Risks of Hollow-Bore Encoders for Robot Joints
Table 66. Key Industry Trends of Hollow-Bore Encoders for Robot Joints
Table 67. Hollow-Bore Encoders for Robot Joints Raw Material
Table 68. Key Suppliers of Raw Materials
Table 69. Hollow-Bore Encoders for Robot Joints Distributors List
Table 70. Hollow-Bore Encoders for Robot Joints Customer List
Table 71. Global Hollow-Bore Encoders for Robot Joints Sales Forecast by Region (2027-2032) & (K Units)
Table 72. Global Hollow-Bore Encoders for Robot Joints Revenue Forecast by Region (2027-2032) & ($ millions)
Table 73. Americas Hollow-Bore Encoders for Robot Joints Sales Forecast by Country (2027-2032) & (K Units)
Table 74. Americas Hollow-Bore Encoders for Robot Joints Annual Revenue Forecast by Country (2027-2032) & ($ millions)
Table 75. APAC Hollow-Bore Encoders for Robot Joints Sales Forecast by Region (2027-2032) & (K Units)
Table 76. APAC Hollow-Bore Encoders for Robot Joints Annual Revenue Forecast by Region (2027-2032) & ($ millions)
Table 77. Europe Hollow-Bore Encoders for Robot Joints Sales Forecast by Country (2027-2032) & (K Units)
Table 78. Europe Hollow-Bore Encoders for Robot Joints Revenue Forecast by Country (2027-2032) & ($ millions)
Table 79. Middle East & Africa Hollow-Bore Encoders for Robot Joints Sales Forecast by Country (2027-2032) & (K Units)
Table 80. Middle East & Africa Hollow-Bore Encoders for Robot Joints Revenue Forecast by Country (2027-2032) & ($ millions)
Table 81. Global Hollow-Bore Encoders for Robot Joints Sales Forecast by Type (2027-2032) & (K Units)
Table 82. Global Hollow-Bore Encoders for Robot Joints Revenue Forecast by Type (2027-2032) & ($ millions)
Table 83. Global Hollow-Bore Encoders for Robot Joints Sales Forecast by Application (2027-2032) & (K Units)
Table 84. Global Hollow-Bore Encoders for Robot Joints Revenue Forecast by Application (2027-2032) & ($ millions)
Table 85. DR. JOHANNES HEIDENHAIN GmbH Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 86. DR. JOHANNES HEIDENHAIN GmbH Hollow-Bore Encoders for Robot

+357 96 030922
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Joints Product Portfolios and Specifications
Table 87. DR. JOHANNES HEIDENHAIN GmbH Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 88. DR. JOHANNES HEIDENHAIN GmbH Main Business
Table 89. DR. JOHANNES HEIDENHAIN GmbH Latest Developments
Table 90. NIKON CORPORATION Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 91. NIKON CORPORATION Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 92. NIKON CORPORATION Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 93. NIKON CORPORATION Main Business
Table 94. NIKON CORPORATION Latest Developments
Table 95. SICK AG Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 96. SICK AG Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 97. SICK AG Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 98. SICK AG Main Business
Table 99. SICK AG Latest Developments
Table 100. Novanta Inc. Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 101. Novanta Inc. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 102. Novanta Inc. Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 103. Novanta Inc. Main Business
Table 104. Novanta Inc. Latest Developments
Table 105. Renishaw plc Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 106. Renishaw plc Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 107. Renishaw plc Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 108. Renishaw plc Main Business
Table 109. Renishaw plc Latest Developments
Table 110. Ralliant Corporation Basic Information, Hollow-Bore Encoders for Robot

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Joints Manufacturing Base, Sales Area and Its Competitors
Table 111. Ralliant Corporation Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 112. Ralliant Corporation Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 113. Ralliant Corporation Main Business
Table 114. Ralliant Corporation Latest Developments
Table 115. FRABA B.V. Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 116. FRABA B.V. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 117. FRABA B.V. Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 118. FRABA B.V. Main Business
Table 119. FRABA B.V. Latest Developments
Table 120. RLS Merilna tehnika d.o.o. Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 121. RLS Merilna tehnika d.o.o. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 122. RLS Merilna tehnika d.o.o. Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 123. RLS Merilna tehnika d.o.o. Main Business
Table 124. RLS Merilna tehnika d.o.o. Latest Developments
Table 125. SIKO GmbH Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 126. SIKO GmbH Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 127. SIKO GmbH Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 128. SIKO GmbH Main Business
Table 129. SIKO GmbH Latest Developments
Table 130. Lika Electronic Srl Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 131. Lika Electronic Srl Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 132. Lika Electronic Srl Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 133. Lika Electronic Srl Main Business
Table 134. Lika Electronic Srl Latest Developments

+357 96 030922
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Table 135. Netzer Precision Position Sensors A.C.S. Ltd. Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 136. Netzer Precision Position Sensors A.C.S. Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 137. Netzer Precision Position Sensors A.C.S. Ltd. Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 138. Netzer Precision Position Sensors A.C.S. Ltd. Main Business
Table 139. Netzer Precision Position Sensors A.C.S. Ltd. Latest Developments
Table 140. Zhejiang Reagle Sensing Technology Incorporated Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 141. Zhejiang Reagle Sensing Technology Incorporated Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 142. Zhejiang Reagle Sensing Technology Incorporated Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 143. Zhejiang Reagle Sensing Technology Incorporated Main Business
Table 144. Zhejiang Reagle Sensing Technology Incorporated Latest Developments
Table 145. Beijing KingKong Technology Co., Ltd. Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 146. Beijing KingKong Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 147. Beijing KingKong Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 148. Beijing KingKong Technology Co., Ltd. Main Business
Table 149. Beijing KingKong Technology Co., Ltd. Latest Developments
Table 150. Shanghai Gongwang Electronic Technology Co., Ltd. Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 151. Shanghai Gongwang Electronic Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 152. Shanghai Gongwang Electronic Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 153. Shanghai Gongwang Electronic Technology Co., Ltd. Main Business
Table 154. Shanghai Gongwang Electronic Technology Co., Ltd. Latest Developments
Table 155. Shenzhen Mosrac Motor Co., Ltd. Basic Information, Hollow-Bore Encoders

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for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 156. Shenzhen Mosrac Motor Co., Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 157. Shenzhen Mosrac Motor Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 158. Shenzhen Mosrac Motor Co., Ltd. Main Business
Table 159. Shenzhen Mosrac Motor Co., Ltd. Latest Developments
Table 160. NRT Co., Ltd. Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 161. NRT Co., Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 162. NRT Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 163. NRT Co., Ltd. Main Business
Table 164. NRT Co., Ltd. Latest Developments
Table 165. ZeroErr Inc. Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 166. ZeroErr Inc. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 167. ZeroErr Inc. Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 168. ZeroErr Inc. Main Business
Table 169. ZeroErr Inc. Latest Developments
Table 170. Shanghai Shengnai Technology Co., Ltd. Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 171. Shanghai Shengnai Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 172. Shanghai Shengnai Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 173. Shanghai Shengnai Technology Co., Ltd. Main Business
Table 174. Shanghai Shengnai Technology Co., Ltd. Latest Developments
Table 175. Weihai Idencoder Electronic Technology Co., Ltd. Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 176. Weihai Idencoder Electronic Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 177. Weihai Idencoder Electronic Technology Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)

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Table 178. Weihai Idencoder Electronic Technology Co., Ltd. Main Business
Table 179. Weihai Idencoder Electronic Technology Co., Ltd. Latest Developments
Table 180. Shanghai Hengxiang Optical Electronics Co., Ltd. Basic Information, Hollow-Bore Encoders for Robot Joints Manufacturing Base, Sales Area and Its Competitors
Table 181. Shanghai Hengxiang Optical Electronics Co., Ltd. Hollow-Bore Encoders for Robot Joints Product Portfolios and Specifications
Table 182. Shanghai Hengxiang Optical Electronics Co., Ltd. Hollow-Bore Encoders for Robot Joints Sales (K Units), Revenue ($ Million), Price (US$/Unit) and Gross Margin (2021-2026)
Table 183. Shanghai Hengxiang Optical Electronics Co., Ltd. Main Business
Table 184. Shanghai Hengxiang Optical Electronics Co., Ltd. Latest Developments

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List Of Figures

LIST OF FIGURES

Figure 1. Picture of Hollow-Bore Encoders for Robot Joints
Figure 2. Hollow-Bore Encoders for Robot Joints Report Years Considered
Figure 3. Research Objectives
Figure 4. Research Methodology
Figure 5. Research Process and Data Source
Figure 6. Global Hollow-Bore Encoders for Robot Joints Sales Growth Rate 2021-2032 (K Units)
Figure 7. Global Hollow-Bore Encoders for Robot Joints Revenue Growth Rate 2021-2032 ($ millions)
Figure 8. Hollow-Bore Encoders for Robot Joints Sales by Geographic Region (2021, 2025 & 2032) & ($ millions)
Figure 9. Hollow-Bore Encoders for Robot Joints Sales Market Share by Country/Region (2025)
Figure 10. Hollow-Bore Encoders for Robot Joints Sales Market Share by Country/Region (2021, 2025 & 2032)
Figure 11. Product Picture of Magnetic Encoders
Figure 12. Product Picture of Inductive Encoders
Figure 13. Product Picture of Optical Encoders
Figure 14. Product Picture of Capacitive Encoders
Figure 15. Product Picture of Other
Figure 16. Global Hollow-Bore Encoders for Robot Joints Sales Market Share by Type in 2026
Figure 17. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share by Type (2021-2026)
Figure 18. Product Picture of Up to 20 mm
Figure 19. Product Picture of Above 20 mm to 40 mm
Figure 20. Product Picture of Above 40 mm to 80 mm
Figure 21. Product Picture of Above 80 mm
Figure 22. Product Picture of Other
Figure 23. Global Hollow-Bore Encoders for Robot Joints Sales Market Share by Hollow Bore Diameter in 2026
Figure 24. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share by Hollow Bore Diameter (2021-2026)
Figure 25. Hollow-Bore Encoders for Robot Joints Consumed in Industrial Articulated Robots

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Figure 26. Global Hollow-Bore Encoders for Robot Joints Market: Industrial Articulated Robots (2021-2026) & (K Units)
Figure 27. Hollow-Bore Encoders for Robot Joints Consumed in Collaborative Robots
Figure 28. Global Hollow-Bore Encoders for Robot Joints Market: Collaborative Robots (2021-2026) & (K Units)
Figure 29. Hollow-Bore Encoders for Robot Joints Consumed in Humanoid Robots
Figure 30. Global Hollow-Bore Encoders for Robot Joints Market: Humanoid Robots (2021-2026) & (K Units)
Figure 31. Hollow-Bore Encoders for Robot Joints Consumed in Quadruped Robots
Figure 32. Global Hollow-Bore Encoders for Robot Joints Market: Quadruped Robots (2021-2026) & (K Units)
Figure 33. Hollow-Bore Encoders for Robot Joints Consumed in Surgical Robots
Figure 34. Global Hollow-Bore Encoders for Robot Joints Market: Surgical Robots (2021-2026) & (K Units)
Figure 35. Hollow-Bore Encoders for Robot Joints Consumed in Exoskeleton Robots
Figure 36. Global Hollow-Bore Encoders for Robot Joints Market: Exoskeleton Robots (2021-2026) & (K Units)
Figure 37. Hollow-Bore Encoders for Robot Joints Consumed in Other
Figure 38. Global Hollow-Bore Encoders for Robot Joints Market: Other (2021-2026) & (K Units)
Figure 39. Global Hollow-Bore Encoders for Robot Joints Sale Market Share by Application (2025)
Figure 40. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share by Application in 2025
Figure 41. Hollow-Bore Encoders for Robot Joints Sales by Company in 2025 (K Units)
Figure 42. Global Hollow-Bore Encoders for Robot Joints Sales Market Share by Company in 2025
Figure 43. Hollow-Bore Encoders for Robot Joints Revenue by Company in 2025 ($ millions)
Figure 44. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share by Company in 2025
Figure 45. Global Hollow-Bore Encoders for Robot Joints Sales Market Share by Geographic Region (2021-2026)
Figure 46. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share by Geographic Region in 2025
Figure 47. Americas Hollow-Bore Encoders for Robot Joints Sales 2021-2026 (K Units)
Figure 48. Americas Hollow-Bore Encoders for Robot Joints Revenue 2021-2026 ($ millions)
Figure 49. APAC Hollow-Bore Encoders for Robot Joints Sales 2021-2026 (K Units)

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Figure 50. APAC Hollow-Bore Encoders for Robot Joints Revenue 2021-2026 ($ millions)
Figure 51. Europe Hollow-Bore Encoders for Robot Joints Sales 2021-2026 (K Units)
Figure 52. Europe Hollow-Bore Encoders for Robot Joints Revenue 2021-2026 ($ millions)
Figure 53. Middle East & Africa Hollow-Bore Encoders for Robot Joints Sales 2021-2026 (K Units)
Figure 54. Middle East & Africa Hollow-Bore Encoders for Robot Joints Revenue 2021-2026 ($ millions)
Figure 55. Americas Hollow-Bore Encoders for Robot Joints Sales Market Share by Country in 2025
Figure 56. Americas Hollow-Bore Encoders for Robot Joints Revenue Market Share by Country (2021-2026)
Figure 57. Americas Hollow-Bore Encoders for Robot Joints Sales Market Share by Type (2021-2026)
Figure 58. Americas Hollow-Bore Encoders for Robot Joints Sales Market Share by Application (2021-2026)
Figure 59. United States Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 60. Canada Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 61. Mexico Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 62. Brazil Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 63. APAC Hollow-Bore Encoders for Robot Joints Sales Market Share by Region in 2025
Figure 64. APAC Hollow-Bore Encoders for Robot Joints Revenue Market Share by Region (2021-2026)
Figure 65. APAC Hollow-Bore Encoders for Robot Joints Sales Market Share by Type (2021-2026)
Figure 66. APAC Hollow-Bore Encoders for Robot Joints Sales Market Share by Application (2021-2026)
Figure 67. China Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 68. Japan Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 69. South Korea Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)

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Figure 70. Southeast Asia Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 71. India Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 72. Australia Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 73. China Taiwan Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 74. Europe Hollow-Bore Encoders for Robot Joints Sales Market Share by Country in 2025
Figure 75. Europe Hollow-Bore Encoders for Robot Joints Revenue Market Share by Country (2021-2026)
Figure 76. Europe Hollow-Bore Encoders for Robot Joints Sales Market Share by Type (2021-2026)
Figure 77. Europe Hollow-Bore Encoders for Robot Joints Sales Market Share by Application (2021-2026)
Figure 78. Germany Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 79. France Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 80. UK Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 81. Italy Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 82. Russia Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 83. Middle East & Africa Hollow-Bore Encoders for Robot Joints Sales Market Share by Country (2021-2026)
Figure 84. Middle East & Africa Hollow-Bore Encoders for Robot Joints Sales Market Share by Type (2021-2026)
Figure 85. Middle East & Africa Hollow-Bore Encoders for Robot Joints Sales Market Share by Application (2021-2026)
Figure 86. Egypt Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 87. South Africa Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 88. Israel Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 89. Turkey Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026

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($ millions)
Figure 90. GCC Countries Hollow-Bore Encoders for Robot Joints Revenue Growth 2021-2026 ($ millions)
Figure 91. Manufacturing Cost Structure Analysis of Hollow-Bore Encoders for Robot Joints in 2026
Figure 92. Manufacturing Process Analysis of Hollow-Bore Encoders for Robot Joints
Figure 93. Industry Chain Structure of Hollow-Bore Encoders for Robot Joints
Figure 94. Channels of Distribution
Figure 95. Global Hollow-Bore Encoders for Robot Joints Sales Market Forecast by Region (2027-2032)
Figure 96. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share Forecast by Region (2027-2032)
Figure 97. Global Hollow-Bore Encoders for Robot Joints Sales Market Share Forecast by Type (2027-2032)
Figure 98. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share Forecast by Type (2027-2032)
Figure 99. Global Hollow-Bore Encoders for Robot Joints Sales Market Share Forecast by Application (2027-2032)
Figure 100. Global Hollow-Bore Encoders for Robot Joints Revenue Market Share Forecast by Application (2027-2032)

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