

中国有色金属 China Non-ferrous Metals

机器人专题系列（七）-机器人三大核心零部件之减速器

Special Theme on Humanoid Robots (VII) - Reducer Driver-one of the 3 Core Parts of Robots

观点聚焦 Investment Focus

(Please see APPENDIX 1 for English summary)

股票名称	评级	股票名称	评级
紫金矿业	Outperform	锡业股份	Outperform
赣锋锂业	Outperform	驰宏锌锗	Outperform
天齐锂业	Outperform	赤峰黄金	Outperform
华友钴业	Outperform	银泰黄金	Outperform
洛阳钼业	Outperform	盛屯矿业	Outperform
山东黄金	Outperform	立中集团	Outperform
天华超净	Outperform	博威合金	Outperform
格林美	Outperform	安宁股份	Outperform
石英股份	Outperform	万丰奥威	Outperform
南山铝业	Outperform	宁波韵升	Outperform
横店东磁	Outperform	甬金股份	Outperform
中矿资源	Outperform	贵研铂业	Outperform
铜陵有色	Outperform	鑫铂股份	Outperform
川能动力	Outperform	盛达资源	Outperform
神火股份	Outperform	盛达资源	Outperform
金力永磁	Outperform		

资料来源: Factset, HTI

本专题系列报告聚焦于机器人领域，旨在介绍当前机器人核心零部件——减速器的特征及功能，探索其未来的产业前景与市场空间。

减速器是一种动力传达机构，在机器人动力系统中，主要用于传导伺服电机的动力，调整速度和扭矩，以精确控制机器人动作。减速器与伺服电机、控制器并称为机器人三大核心零部件。减速器在工业领域有着广泛的运用，在机器人行业中，应用最为广泛的为RV减速器与谐波减速器。RV减速器凭借其高负载能力和高刚度的优势，一般应用于多关节机器人中机座、大臂、肩部等重负载的位置。谐波减速器凭借其体积小、传动比高、精密度高的特点在机器人小臂、腕部或手部等高精密操作要求的部位有着广泛运用。

减速器生产对技术要求严格，目前日本企业占据大于80%的世界市场份额。我国减速器起步较晚，严重依赖进口。我国谐波减速器市场中，日本哈默纳科占据30%以上份额，绿的谐波紧跟其后。我国RV减速器市场中，日本企业纳博特斯克占据53%的市场份额。随着国产替代的趋势与国产减速器企业的发展，国产减速器仍有巨大的潜在市场空间。随着机器人产业的进步、人形机器人的发展，自由度增加与轻量化的趋势创造了减速器更大的需求空间。

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1. 减速器总述

减速器又称减速机，是一种动力传达机构，利用齿轮速度转换器，将马达的回转数减速至所需，增加扭矩，在原动机和工作机之间起着匹配转速和传递扭矩的作用。减速器与伺服电机、控制器并称为机器人三大核心零部件，在机器人动力系统中，主要用于传导伺服电机的动力，调整速度和扭矩，以精确控制机器人动作。整体来看，减速器在工业机器人总价值量中占比最大，达到总成本的 30%。随着机器人产业的进步、人形机器人的发展，自由度增加与轻量化的趋势创造了未来减速器更大的需求空间。

减速器的种类繁多，可按照齿轮形状、传动类型、传动级数、传动的布置形式、控制精度等依据进行分类。其中，在机器人领域应用最多的减速器为 RV 减速器与谐波减速器。

表 1 减速器分类

分类依据	减速器种类
齿轮形状	圆柱齿轮减速器
	圆锥齿轮减速器
	圆锥-圆柱齿轮减速器
传动类型	齿轮减速器
	蜗杆减速器
	行星齿轮减速器
传动级数	单级减速器
	多级减速器
传动的布置形式	展开式
	分流式
	同轴式减速器
控制精度	传动减速器
	精密减速器

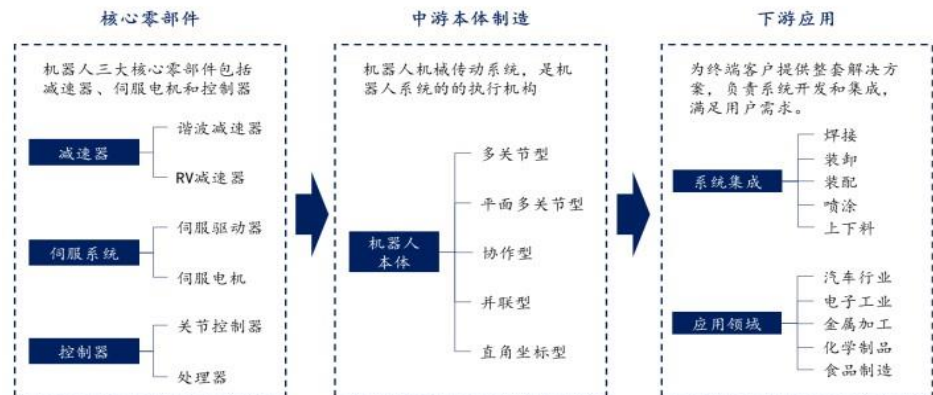
来源：前瞻产业研究院，亿欧智库，海通国际

减速器生产对技术要求严格，严重依赖进口。减速器为纯机械精密部件，对于材料、热处理工艺和高精度加工机床要求严格。而我国的减速器起步较晚，技术较为落后，严重依赖日本进口。截至 2021 年，日本企业在中国减速器市场中仍处于垄断地位：谐波减速器市场中，日本哈默纳科占据 30% 以上份额，其次绿的谐波，日本新宝、来福谐波、同川科技、中技克美等也占有一定市场份额；我国 RV 减速器市场中，日本企业纳博特斯克占据 53% 的市场份额，其次双环，市场份额为 14%。

2. 精密减速器市场分析

减速器是机器人的关键零部件，位于机器人产业链的上游。同时，减速器具体下游应用产业有工业机器人、服务机器人、数控机床、航空航天、光伏设备、医疗设备。

图 1 机器人产业链



资料来源：绿的谐波招股说明书，海通国际

工业 4.0 的大背景下，以美国、日本、德国为代表的世界国家和地区大力推动机器人产业的发展。近年来，全球工业机器人行业保持快速发展。据国家统计局数据，2021 年中国工业机器人产量达 36.6 万台，同比增长 54.4%；销量为 25.6 万台，同增 48.8%，受此带动，作为工业机器人的核心零部件，精密减速器市场迎来高速发展。

全球范围内，日本精密减速器产业发展领先，哈默纳科与纳博特斯克分别在谐波减速器和 RV 减速器领域取得了市场主导地位。我国精密减速器发展较晚，GGII 数据显示，2018 年国产减速器出货量市场份额不足 30%，且产品售价较高、交货周期较长，成为制约我国工业机器人产业发展的重要瓶颈之一，国产替代的需求也日益强烈。

目前我国正处在转型升级和新旧动能转换的关键阶段，新技术、新产业、新业态、新模式、新产品、新动能加快孕育，智能制造、数字化生产成为近年来推动经济结构优化、动力转换和质量提升的重要力量。近年来，国内谐波减速器产业也在国家政策支持下不断发展，《中国制造 2025》与《机器人产业“十三五”发展规划》的制定将进一步带动机器人及相关产业的发展，受益于政策和主要下游行业的驱动，国产减速器将迎来快速发展时期。

表 2 减速器行业主要企业

减速器类别	企业名称	企业概况
谐波减速器	哈默纳科	成立于 1970 年，位于日本东京，是日本东京证券交易所上市公司（6324.T），主要从事谐波减速器、机电一体化产品、精密行星减速器等生产和销售，是整体运动控制的领军企业，其生产的谐波减速器被广泛应用于各种传动系统中，在全球工业机器人领域中有着较高的市占率。2021 年实现营收 570.87 亿日元（合人民币 29.67 亿元），同增 54.1%；归母净利 66.43 亿日元（合人民币 3.45 亿元），同增 902.9%。
	日本新宝	成立于 1952 年，总部位于日本京都，是日本电产公司（6549.T）旗下子公司，主要从事精密减速机、变速机的开发、生产和销售。2021 年实现营收 1172.14 亿日元（合 60.91 亿人民币），同增 5.9%；归母净利润 193.59 亿日元（合 10.06 亿人民币），同增 10.5%。
	中技克美	成立于 1994 年，注册资本 4,000 万元，位于北京市，在 2017 年于全国中小企业股份转让系统挂牌（871601.OC），主营业务包括谐波传动产品、谐波传动机电产品的制造和研发。2021 年实现营收 2788.29 万元，同增 14.04%；归母净利 2006.48 万元，同增 52.54%。
	绿的谐波	成立于 2011 年，从事精密传动装置研发、设计和生产，主要产品包括谐波减速器、机电一体化执行器及金属部件。公司产品主要广泛应用于工业机器人、数控机床、航空航天、医疗器械、半导体设备、新能源等领域。公司产品在中国自主品牌机器人市场占有率已经超过 60%，排名第一。2021 年实现营收 4.43 亿元，同增 104.77%；归母净利 1.89 亿元，同增 130.56%。
RV 减速器	纳博特斯克	成立于 2003 年，总部位于日本，主营业务为精密减速器制造，产品在 RV 减速器领域全球市占率超过 80%，公司的精密减速器客户主要包括工业机器人和机床，其中工业机器人客户覆盖全球四大家族机器人企业以及各知名机器人厂商。2021 年实现营收 2998.02 亿日元（合 166.14 亿人民币），同增 7.3%；归母净利 648.18 亿日元（合 35.92 亿人民币），同增 216.1%。
	住友	总部位于日本，是住友集团旗下的建设机械厂家，日本东京证券交易所上市公司（6302.T）。1982 年进入工业机器人减速机领域，为焊接、搬运、喷涂、装配等机器人应用领域提供全面减速机产品方案。
	南通振康	成立于 1993 年，位于江苏省海门市，主营业务包为精密机械产品研发、生产，于 2015 年实现镇康 RV 减速器的首批生产，是国内较早涉足机器人用 RV 减速器的厂商。
	中大力德	成立于 2006 年 8 月，注册资本 8,000 万元，位于浙江省宁波市，2017 年于深交所主板上市（002896.SZ），主营业务为机械传动与控制应用领域关键零部件的研发、生产、销售和服务，产品包括精密减速器、传动行星减速器、各类小型及微型减速电机等。2021 年实现营收 9.53 亿元，同增 25.3%；归母净利 0.81 亿元，同增 15.85%。

来源：绿的谐波招股说明书，Wind,海通国际

3. RV 减速器与谐波减速器对比分析

RV 减速器与谐波减速器同属于精密减速器，在轻负载精密减速器领域内，谐波减速器有体积小、传动比高、精密度高等特点，在人形机器人中用于肩部、肘部、腿部、腕部、腰部、颈部等几个主要关节。RV 减速器的传动原理及结构特点，使其具有大体积、高负载能力和高刚度特性的特点，其在重负载精密减速器领域内也具有一定主导地位，在人形机器人中主要用于腰部、髋部。

表 3 RV 减速器与谐波减速器对比分析

	RV 减速器	谐波减速器
结构示意图		
技术特点	通过多级减速实现传动，一般由行星齿轮减速器的前级和摆线针轮减速器的后级组成，组成的零部件较多。	通过柔轮的弹性变形传递运动，主要由柔轮、刚轮、波发生器三个核心零部件组成。与 RV 及其他精密减速器相比，谐波减速器使用的材料、体积及重量大幅度下降。
主要优势	高负载能力和高刚度特性	体积小、传动比高、精密度高
缺点	体积较大，精度略低于谐波减速器	柔轮寿命有限，不耐冲击，输入转速不宜过高
应用场景	一般应用于多关节机器人中机座、大臂、肩部等重负载的位置。人形机器人中主要应用于腰部、髋部。	主要应用于机器人小臂、腕部或手部。由于谐波减速器在除机器人以外的精密传动领域亦可广泛适用，应用行业有不断拓宽的趋势
终端领域	汽车、运输、港口码头等行业中通常使用配有 RV 减速器的重负载机器人。	3C、半导体、食品、注塑、模具、医疗等行业中通常使用由谐波减速器组成的 30kg 负载以下的机器人。
价格区间	5000-8000 元/台	1000-5000 元/台
人形机器人单机配备量	2-4 个	9-14 个
单个人形机器人应用价值量	12000 元	20000 元

来源：绿的谐波，亿欧智库，OFweek 机器人网，海通国际

APPENDIX 1

Summary

This special series of reports focuses on the field of robotics and aims to introduce the characteristics and functions of the current core components of robots—reducers and explore its future industrial prospects and market space.

The reducer is a power transmission mechanism. The robot power system is mainly used to transmit the power of the servo motor and adjust the speed and torque to precisely control the robot's action. The reducer, the servo motor, and the controller are called the three core components of robots. Reducers are widely used in the industrial field. In the robot industry, the most widely used are RV reducers and harmonic reducers. With its advantages of high load capacity and high stiffness, RV reducers are generally used in positions with heavy loads such as machine bases, arms, and shoulders in multi-joint robots. Due to their small size, high transmission ratio, and high precision, harmonic reducers are widely used in parts that require high-precision operations such as robot forearms, wrists, or hands.

The production of reducers has strict technical requirements, and Japanese companies currently occupy more than 80% of the world's market share. The reducer industry in China starts late and relied heavily on imports. In the Chinese harmonic reducer market, Japan company- Hamernaco occupies more than 30% of market share, followed by green harmonics. In the Chinese RV reducer market, the Japanese company Nabtesco occupies 53% of the market share. With the trend of domestic substitution and the development of domestic reducer enterprises, there is still a vast potential market space for China's domestic reducer. With the progress of the robot industry and the development of humanoid robots, the trend of increasing degrees of freedom and light weight has created a larger demand space for reducers in the future.

附录 APPENDIX

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分析师股票评级

优于大市, 未来 12-18 个月内预期相对基准指数涨幅在 10%以上, 基准定义如下

中性, 未来 12-18 个月内预期相对基准指数变化不大, 基准定义如下。根据 FINRA/NYSE 的评级分布规则, 我们会将中性评级划入持有这一类别。

弱于大市, 未来 12-18 个月内预期相对基准指数跌幅在 10%以上, 基准定义如下

各地股票基准指数: 日本 – TOPIX, 韩国 – KOSPI, 台湾 – TAIEX, 印度 – Nifty100, 美国 – SP500; 其他所有中国概念股 – MSCI China.

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Analyst Stock Ratings

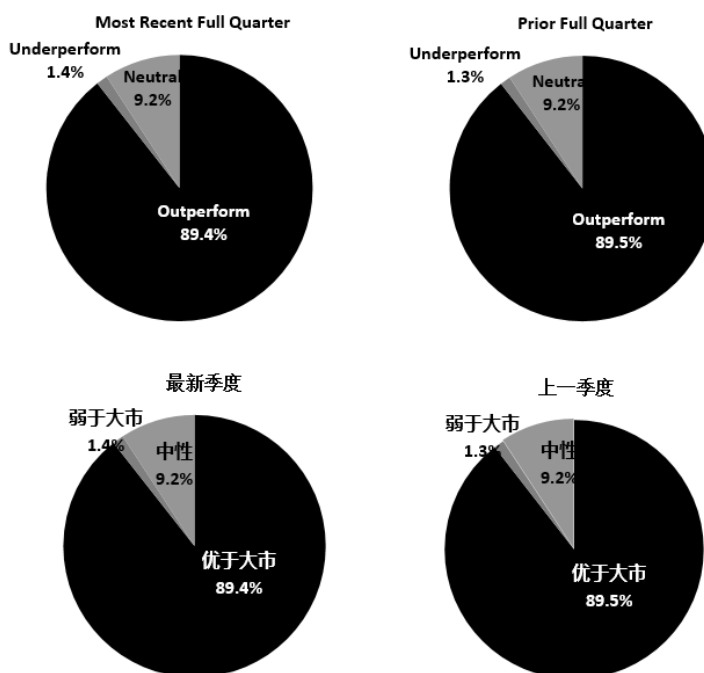
Outperform: The stock's total return over the next 12-18 months is expected to exceed the return of its relevant broad market benchmark, as indicated below.

Neutral: The stock's total return over the next 12-18 months is expected to be in line with the return of its relevant broad market benchmark, as indicated below. For purposes only of FINRA/NYSE ratings distribution rules, our Neutral rating falls into a hold rating category.

Underperform: The stock's total return over the next 12-18 months is expected to be below the return of its relevant broad market benchmark, as indicated below.

Benchmarks for each stock's listed region are as follows: Japan – TOPIX, Korea – KOSPI, Taiwan – TAIEX, India – Nifty100, US – SP500; for all other China-concept stocks – MSCI China.

评级分布 Rating Distribution



截至 2022 年 9 月 30 日海通国际股票研究评级分布

	优于大市	中性 (持有)	弱于大市
海通国际股票研究覆盖率	89.4%	9.2%	1.4%
投资银行客户*	5.5%	6.8%	4.5%

*在每个评级类别里投资银行客户所占的百分比。

上述分布中的买入, 中性和卖出分别对应我们当前优于大市, 中性和落后大市评级。

只有根据 FINRA/NYSE 的评级分布规则, 我们才将中性评级划入持有这一类别。请注意在上表中不包含非评级的股票。

此前的评级系统定义（直至 2020 年 6 月 30 日）：

买入，未来 12-18 个月内预期相对基准指数涨幅在 10%以上，基准定义如下

中性，未来 12-18 个月内预期相对基准指数变化不大，基准定义如下。根据 FINRA/NYSE 的评级分布规则，我们会将中性评级划入持有这一类别。

卖出，未来 12-18 个月内预期相对基准指数跌幅在 10%以上，基准定义如下

各地股票基准指数：日本 – TOPIX, 韩国 – KOSPI, 台湾 – TAIEX, 印度 – Nifty100; 其他所有中国概念股 – MSCI China.

Haitong International Equity Research Ratings Distribution, as of Sep 30, 2022

	Outperform	Neutral (hold)	Underperform
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IB clients*	5.5%	6.8%	4.5%

*Percentage of investment banking clients in each rating category.

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Previous rating system definitions (until 30 Jun 2020):

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NEUTRAL: The stock's total return over the next 12-18 months is expected to be in line with the return of its relevant broad market benchmark, as indicated below. For purposes only of FINRA/NYSE ratings distribution rules, our Neutral rating falls into a hold rating category.

SELL: The stock's total return over the next 12-18 months is expected to be below the return of its relevant broad market benchmark, as indicated below.

Benchmarks for each stock's listed region are as follows: Japan – TOPIX, Korea – KOSPI, Taiwan – TAIEX, India – Nifty100; for all other China-concept stocks – MSCI China.

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