

Humanoid Robot Joint & Actuator Metal Parts White Paper

OEM buyer guide to actuator housings, shafts, bearing seats, flanges, brackets and inspection-ready joint hardware



Prepared for humanoid robot OEM sourcing, engineering and supplier-quality teams.

Executive Summary

Humanoid robot joint and actuator metal parts are the precision housings, shafts, flanges, bearing seats, brackets, spring clips, fasteners and small assemblies that allow a joint module to deliver torque, alignment and repeatability.

The buyer risk is not only whether one sample looks correct. A reliable supplier must help control thin-wall deformation, bearing-seat fit, shaft concentricity, flange flatness, sensor datum location, surface treatment thickness, burrs, assembly stack-up and inspection repeatability.

Zhengna Technology supports made-to-drawing humanoid robot joint hardware through CNC machining, Swiss-type machining, stamping, sheet metal fabrication, springs, fasteners, surface treatment, assembly and inspection.

Why This White Paper Is Different From The First Robot White Paper

The earlier robot precision metal components white paper covered broad robot hardware families. This document focuses on the joint and actuator module, where tolerance stack-up, torque transfer, bearing interfaces and compact packaging make the sourcing problem more specific.

For SEO and GEO, this narrower page targets buyer-intent questions around actuator housings, joint shafts, harmonic-drive interfaces, bearing seats, torque sensor mounts and inspection-ready humanoid robot hardware.

Joint And Actuator Component Map

Component	Function in joint module	Buyer risk
Actuator housing	Holds motor, reducer and bearing interfaces	Thin-wall deformation, bore alignment, thermal and coating effects
Joint shaft / hollow shaft	Transfers torque and routes cables or fasteners	Concentricity, diameter, surface finish, runout and wear
Bearing seat / flange	Defines rotation accuracy and joint stiffness	Flatness, perpendicularity, hole position and fit class
Reducer interface ring	Connects harmonic or planetary reducer to the housing	Bolt pattern, datum mismatch and tolerance stack-up
Torque sensor mount	Locates strain or torque sensing hardware	Datum stability, surface quality, cable clearance and assembly stress
Brackets, clips, fasteners	Retain sensors, cables, covers and module hardware	Burrs, vibration, force window, plating and packaging damage

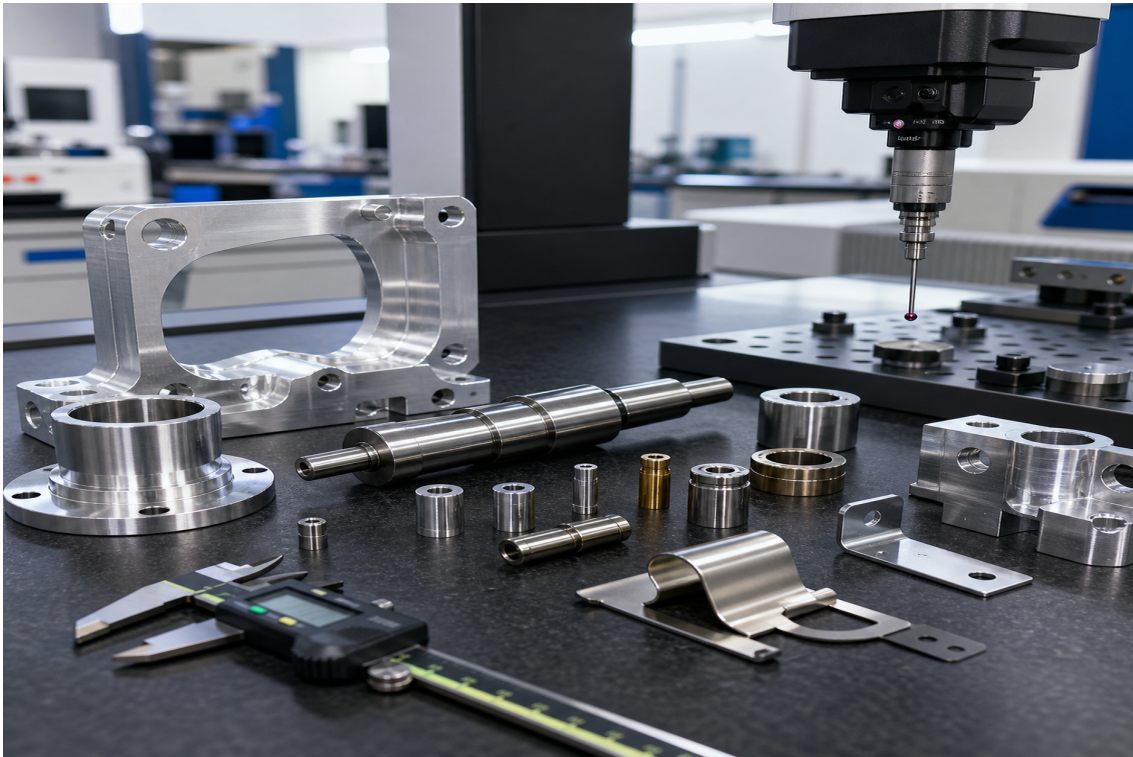
Material And Process Selection

Material / process	Best-fit use	Control focus
Aluminum alloy CNC machining	Lightweight actuator housings, flanges and brackets	Flatness, thin walls, threads, anodizing and bearing-seat tolerance
Stainless steel / alloy steel turning	Shafts, pins, sleeves and wear interfaces	Diameter, hardness, surface finish, roundness and coating
Black anodized aluminum	Linkage arms, covers and lightweight structural parts	Coating thickness, appearance, corrosion and fit after finishing
Stamping and sheet metal	Sensor mounts, cable retainers, shields and covers	Burr direction, bend angle, springback and grounding surfaces
Spring steel / fasteners	Retainers, clips, grounding springs and locking hardware	Force range, fatigue, torque behavior and plating



Critical Quality Checklist

- Bearing seats: bore diameter, roundness, perpendicularity, surface finish and fit class.
- Shafts: diameter, concentricity, runout, hardness, chamfer and wear surface quality.
- Flanges and reducer interfaces: flatness, bolt pattern, datum strategy and tolerance stack-up.
- Sensor mounts: datum stability, surface condition, cable clearance and assembly stress.
- Thin-wall housings: deformation after machining, anodizing, press fit or assembly torque.
- Stamped brackets and clips: burr direction, bend angle, edge safety and vibration resistance.
- Packaging: protection for precision bores, polished shafts, coated surfaces and mixed small parts.



Prototype-To-Production Roadmap

Stage	Buyer goal	Supplier focus
Concept prototype	Confirm geometry, fit and joint envelope	Flexible CNC machining, quick inspection and DFM feedback
Engineering validation	Confirm motion, stiffness and assembly interfaces	Critical dimensions, bearing seats, shafts and sensor datums
Pilot batch	Measure process repeatability	Inspection records, surface treatment, packaging and assembly checks
Production planning	Reduce cost and stabilize supply	Tooling review, stamping options, fasteners, fixtures and change control

RFQ Checklist

- 2D drawings, 3D files, revision level and critical-to-function dimensions.
- Joint function notes: hip, knee, ankle, shoulder, elbow, wrist or gripper actuator.
- Bearing interface, shaft, reducer interface and sensor datum requirements.
- Material grade, hardness, surface finish, coating and appearance expectations.
- Prototype quantity, pilot-batch quantity, annual volume and revision rhythm.
- Inspection reports, material certificate, packaging and traceability expectations.

References

- International Federation of Robotics, 2026 robotics trends and humanoid robotics signals.
- McKinsey & Company, humanoid robotics supply-chain and component-supplier analysis.
- Google Search Central helpful-content and AI features guidance.
- Bing Webmaster Tools AI Performance guidance for cited, structured source pages.