YASKAWA

Robot Terminology 101

An Introductory Guide to Robot Types, Anatomy, and Specifications

motoman.com

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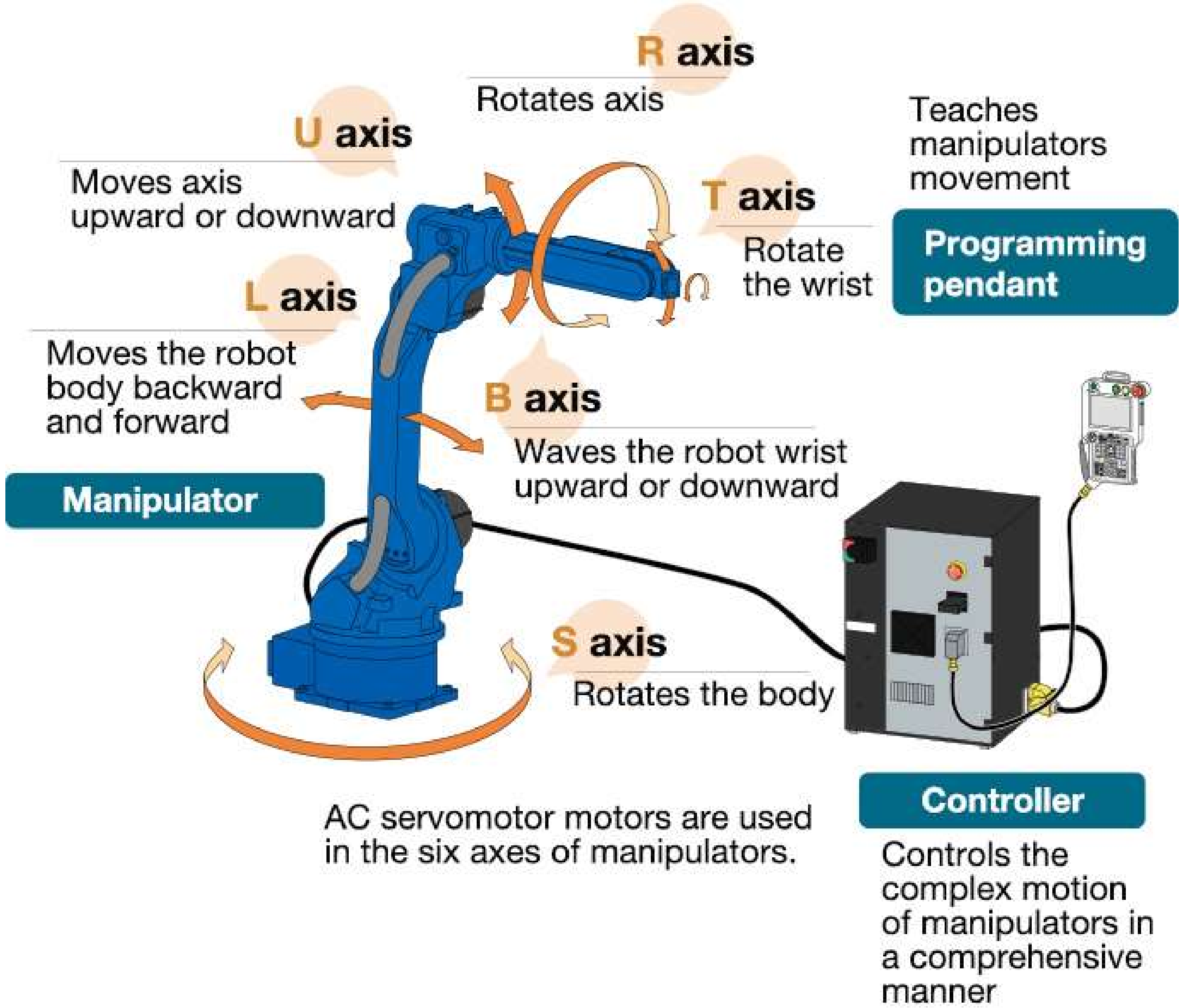
What Is A Robot?



- Start with this Yaskawa article to get a great initial understanding of what is an industrial robot: https://www.yaskawa-global.com/product/robotics/about
- In the article, the graphic to the left is used to explain the various definition of the main robot equipment and axes of rotation.

Robot Types

- Yaskawa offers many types of industrial robots that can be used for many different applications. A robot is named based on its application and a rating that is important to that application. For example:
  - GP50 is a General Purpose handling robot with a 50 kg payload
  - AR1440 is an Arc-Welding robot with a 1440 mm maximum horizontal reach

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Robot Types

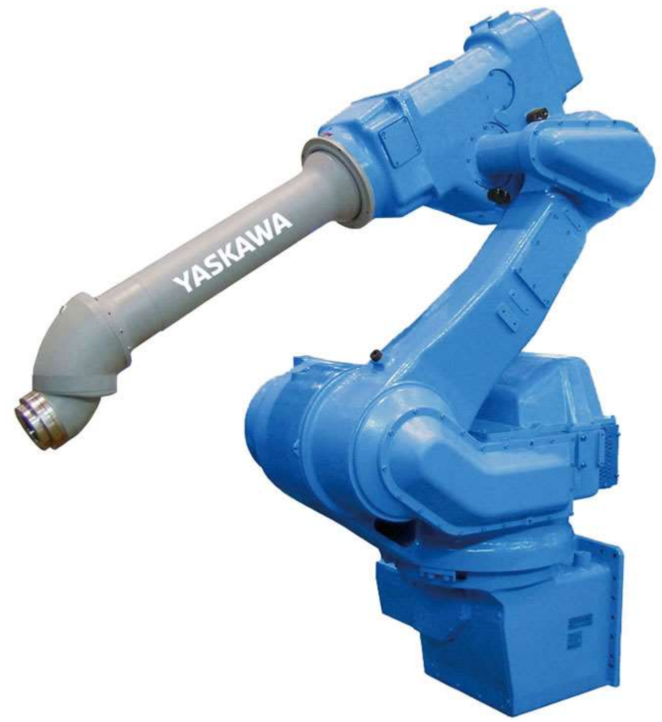
- Handling
  - Typically used for general part movement or assembly

- Palletizing
  - Typically used for stacking parts on a pallet or packaging parts and usually have less than 6 axis

Robot Types

- Welding
  - Typically used for arc or spot welding parts and usually are variants of standard handling robots

- Painting
  - Typically used for painting parts with spray guns and usually have higher IP ratings and/or explosion proof ratings



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Robot Types

- Collaborative
  - Typically used to operate in workspaces with humans and can be hand guided and/or are programmed with easy-to-use smart pendants

- Education
  - Robots that are smaller in size and typically come in a preconfigured cell for use in classrooms and are intended for newer users

Robot Anatomy

Axis Naming Conventions

- A standard Yaskawa industrial robot has 6 axis or rotation in the following order
  - S (swing)
  - L (lower)
  - U (upper)
  - R (rotation)
  - B (bend)
  - T (turn)
- The common acronym is SLURBT and is similar to other robot manufacturer's axis 1-6
- The best way to think of how these axis move is to imagine your own arm as a robot.

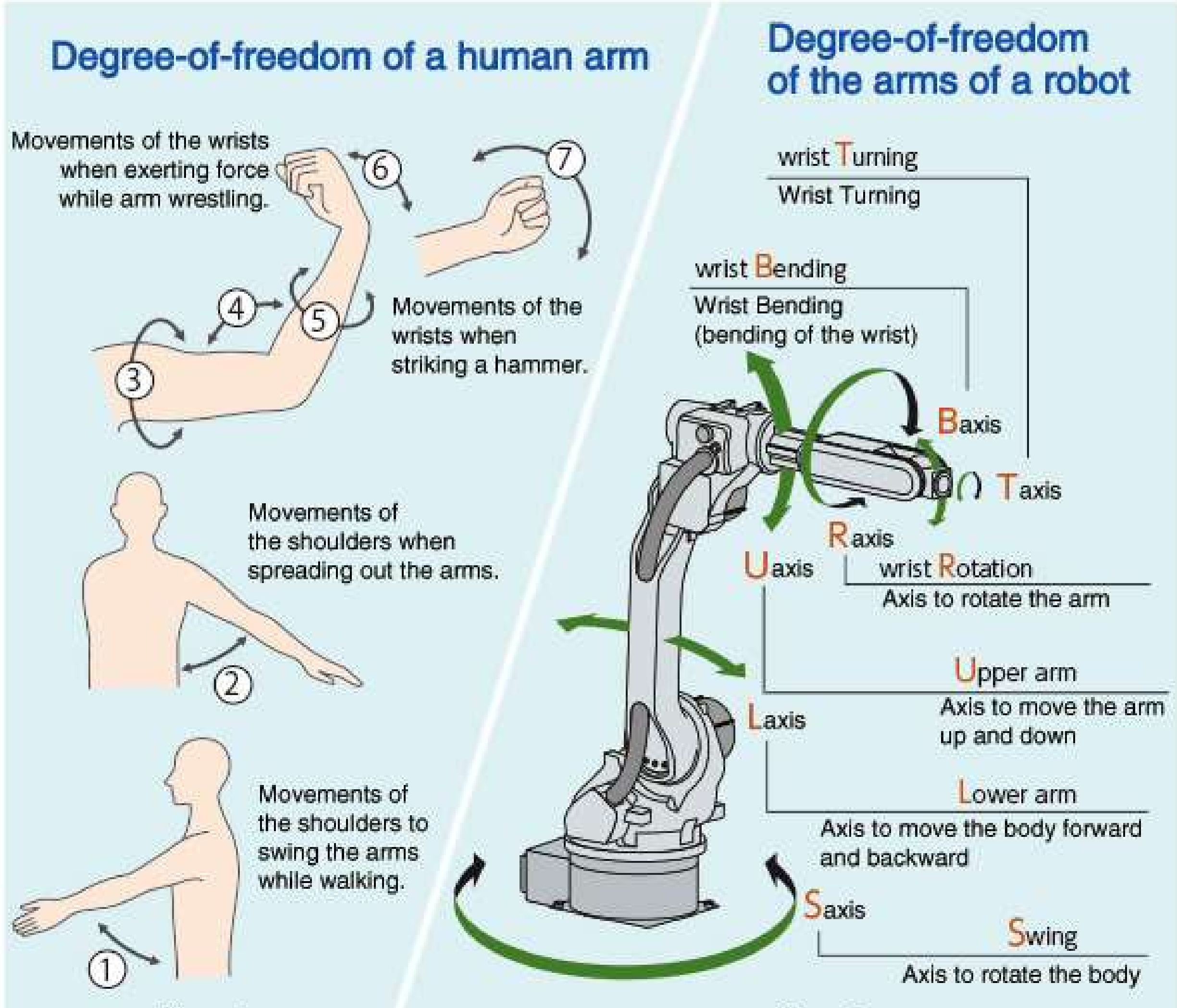

Figure 1
Figure 2

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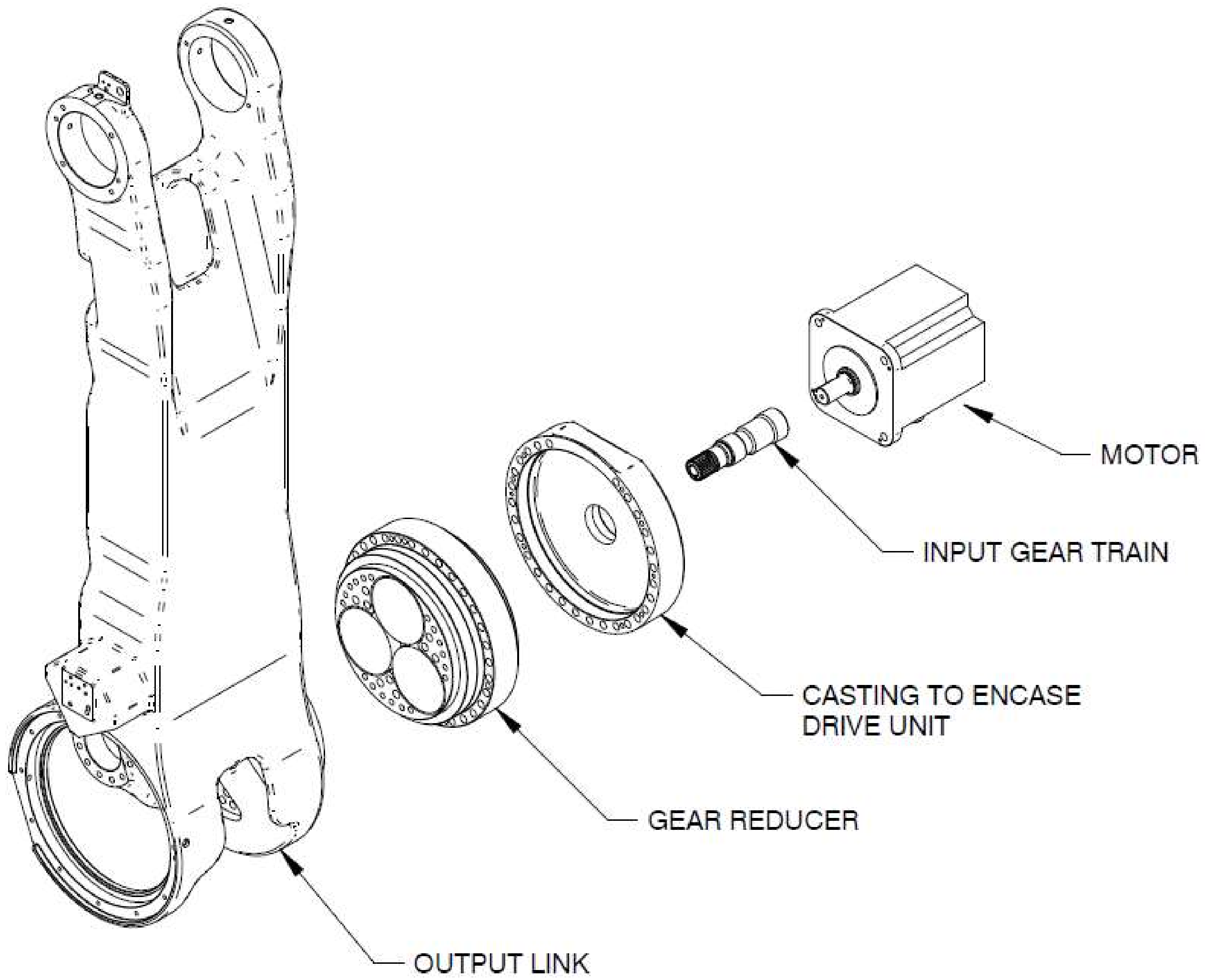
Robot Anatomy

Axis Drive Units

- Each axis of the robot has a drive unit typically made up of the following components:
  - Motor
  - Input gear train
  - Gear reducer
  - Output flange or link
- The drive will be encased with other robot parts that typically have sealing elements (i.e. oil seals, o-rings, or a glue-like surface adhesive)
- Once the drive unit is confirmed to be leak-proof, it is filled with grease to a value typically less than 90% of the drive's interior volume
- The robot arms/links are usually castings and are connected to each other with bearings and shafts for easy rotation



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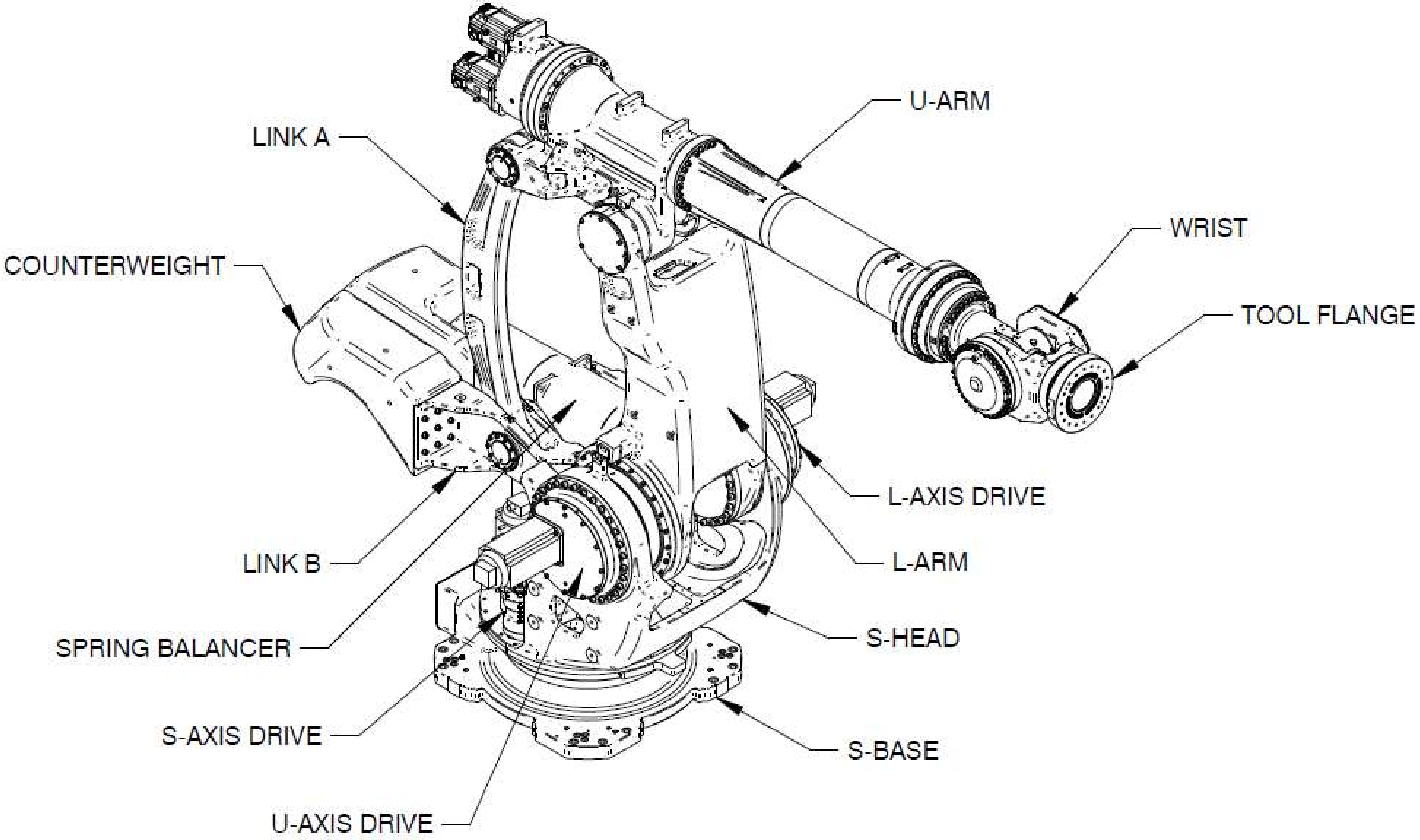
Robot Anatomy

Robot Part Names

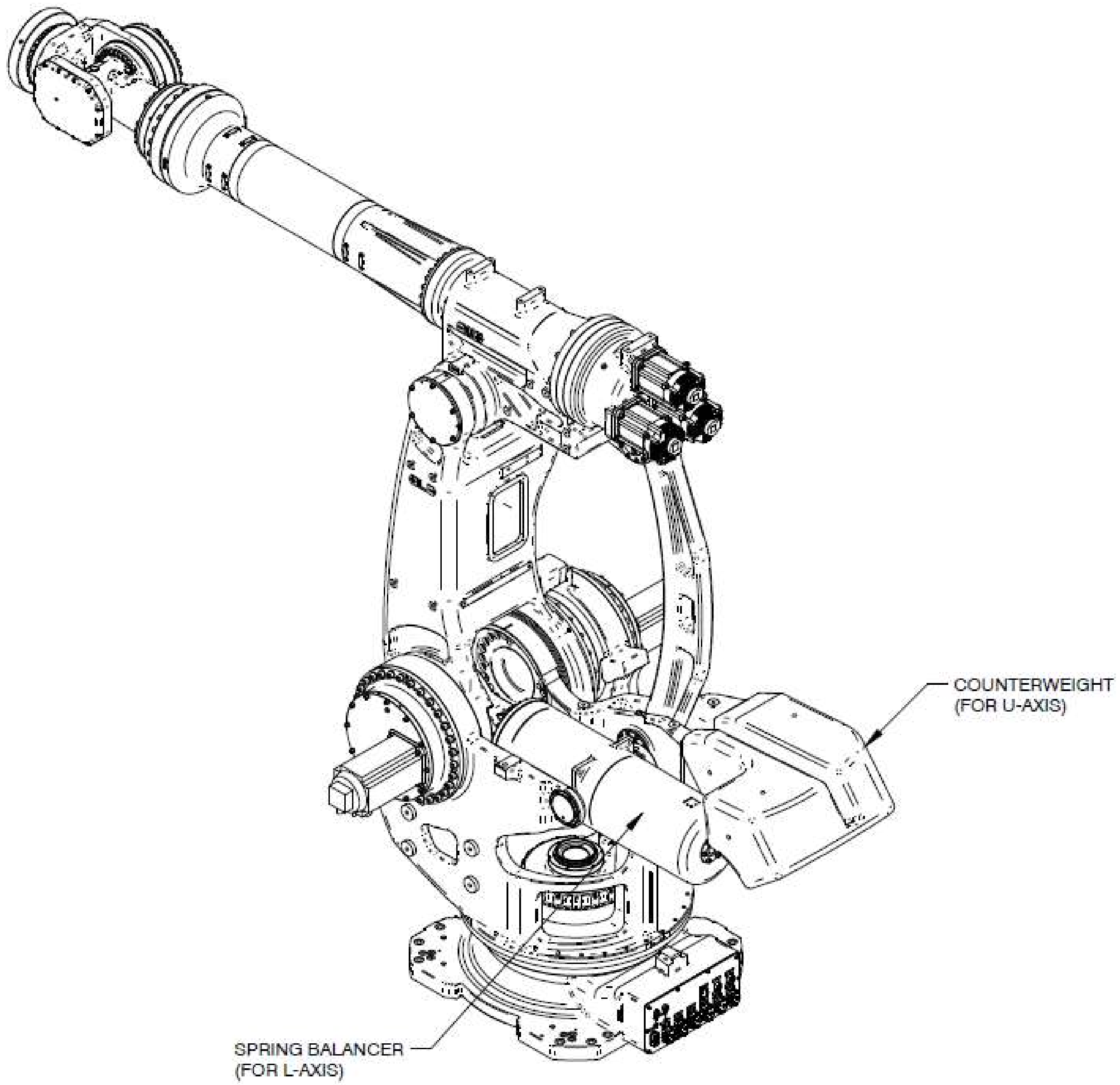


- The image on the left is for a handling robot with a parallel link. This has a majority of the most common robot elements.
- Other robots may have different configurations, but most of these part names and locations are universal.

Robot Anatomy

Counterweights and Spring Balancers

- Some robots may have a counterweight or a spring balancer.
- A counterweight is typically used to maintain the robot's center or gravity so there is never a risk of tipping. These are mainly used on robots with a parallel link structure.
- A spring balancer is typically used to assist the motor torque by adding a restorative torque. This torque always acts in a direction that moves the robot axis back to a neutral, low torque position.



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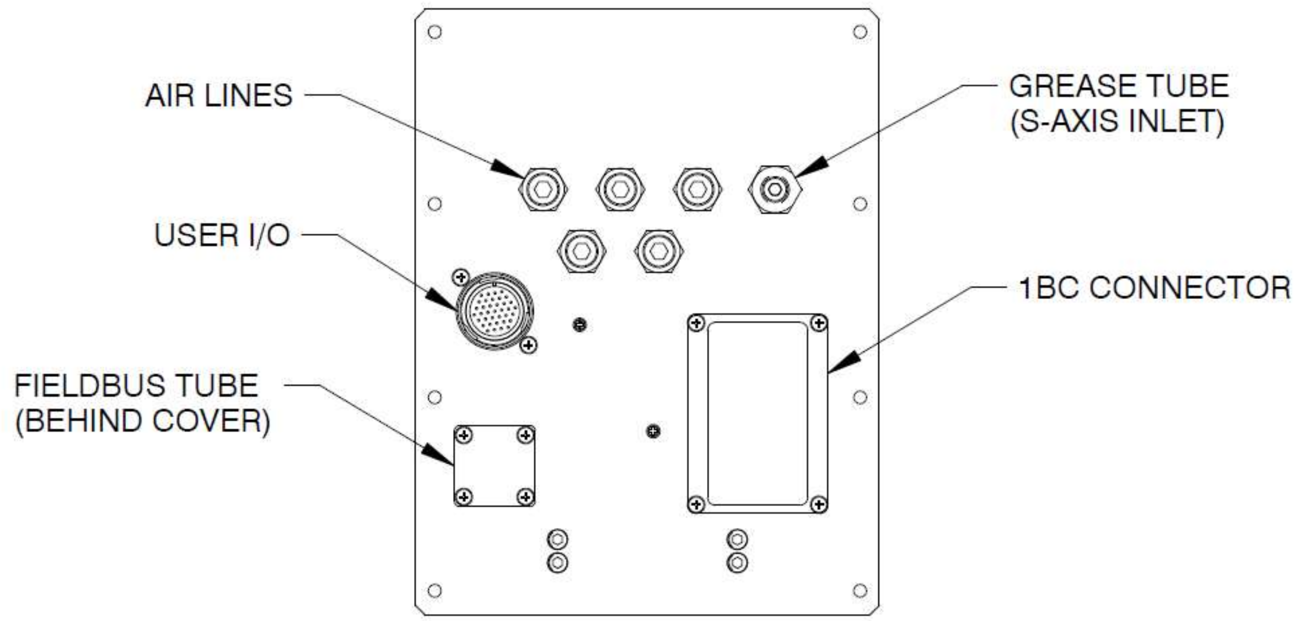
Robot Anatomy

Cable Connections

- Each robot has a connector panel for it’s main cable connections. On the next slide, the typical connections shown below will be explained.



Robot Anatomy

Cable Connections

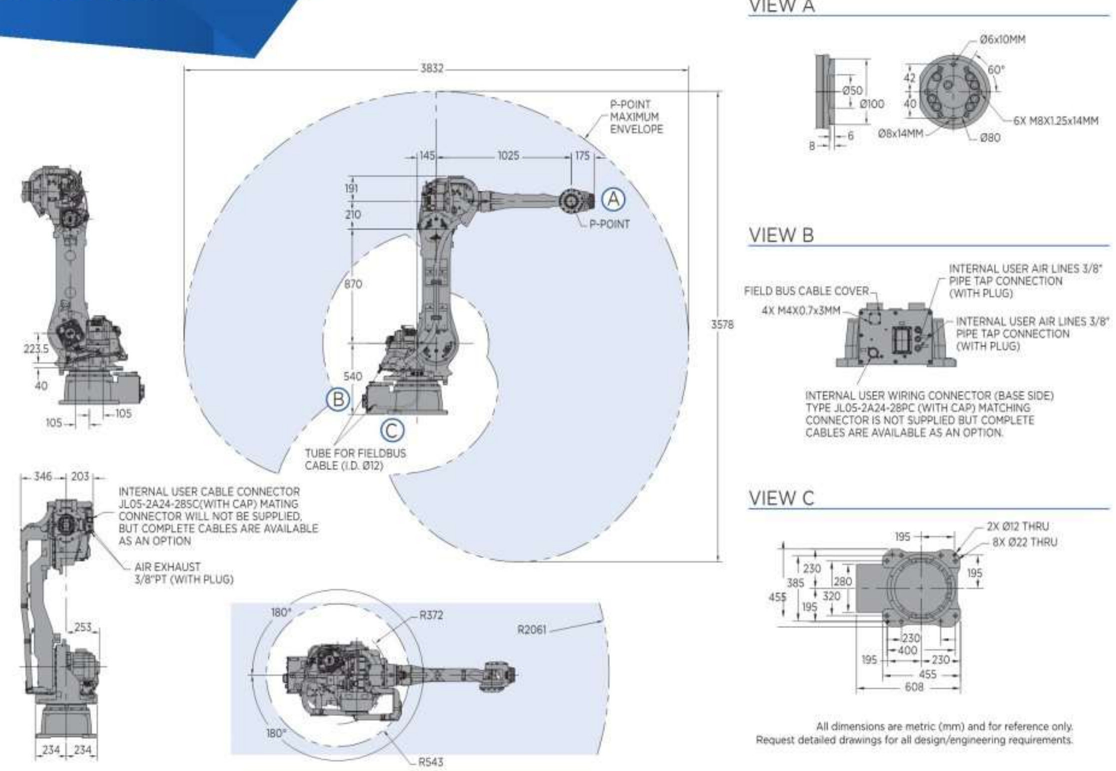
- 1BC
  - The main cable from the controller provides power to each axis' motor, brake, and encoder. This then splits in the robot's cable harness to reach each motor. On larger robots, there may be more BC cables, and sometimes the brake and encoders receive their own connector.
- User I/O
  - The I/O cable connection is for the customer so they can add controls to the robot's tooling. Typically this will output near the robot tooling or upper arm.
- Fieldbus
  - Behind the cover is a tube with a wire inside that allows a customer to pull their own custom cable through the robot's harness. An example might be a custom Ethernet control cable. This typically outputs near the User I/O.
- Airlines
  - These tubes are for air connections and vary in number. Typically they also output near the User I/O.
- Grease
  - This is the inlet for the S-Axis drive unit. Each drive unit or pivot location has both an inlet and outlet for grease.

Robot Specifications

Spec Sheet

- Each robot has a corresponding specifications sheet that provides all the main information about the robot. The image on the right is a typical example.
- The following is the typical information provided on the spec sheet:
  - Allowable payload, moment, and inertia of tool
  - Speed and range of each axis
  - Tooling envelope and robot reach limits
  - Mounting patterns for base and tool flange
  - Connector information and power requirements

GP50 Robot



All dimensions are metric (mm) and for reference only.
Request detailed drawings for all design/engineering requirements.

SPECIFICATIONS

Axes	Maximum motion range [°]	Maximum speed [°/sec.]	Allowable moment [N•m]	Allowable moment of inertia [kg•m²]
S	±180	180	-	-
L	+135/-90	178	-	-
U	+206/-80	178	-	-
R	±360	250	216	28
B	±125	250	216	28
T	±360	360	147	11

Specifications for GP50 with XP package may be different.

Mounting Options: Floor, Wall, Tilt or Ceiling

* The MLX300 software option is not available for use with arc or spot welding applications. MLX300 fieldbus cards, I/O cards and vision equipment must be purchased separately from the supplier. All peripherals are programmed using a PLC.

Item	GP50
Controlled axes	6
Maximum payload [kg]	50
Repeatability [mm]	±0.07
Horizontal reach [mm]	2,061
Vertical reach [mm]	3,578
Weight [kg]	570
Internal user I/O cable	24 conductors w/ ground
Internal user air line	(2) 3/8" connection
Power requirements	380-480 VAC
Power rating [kVA]	4.5

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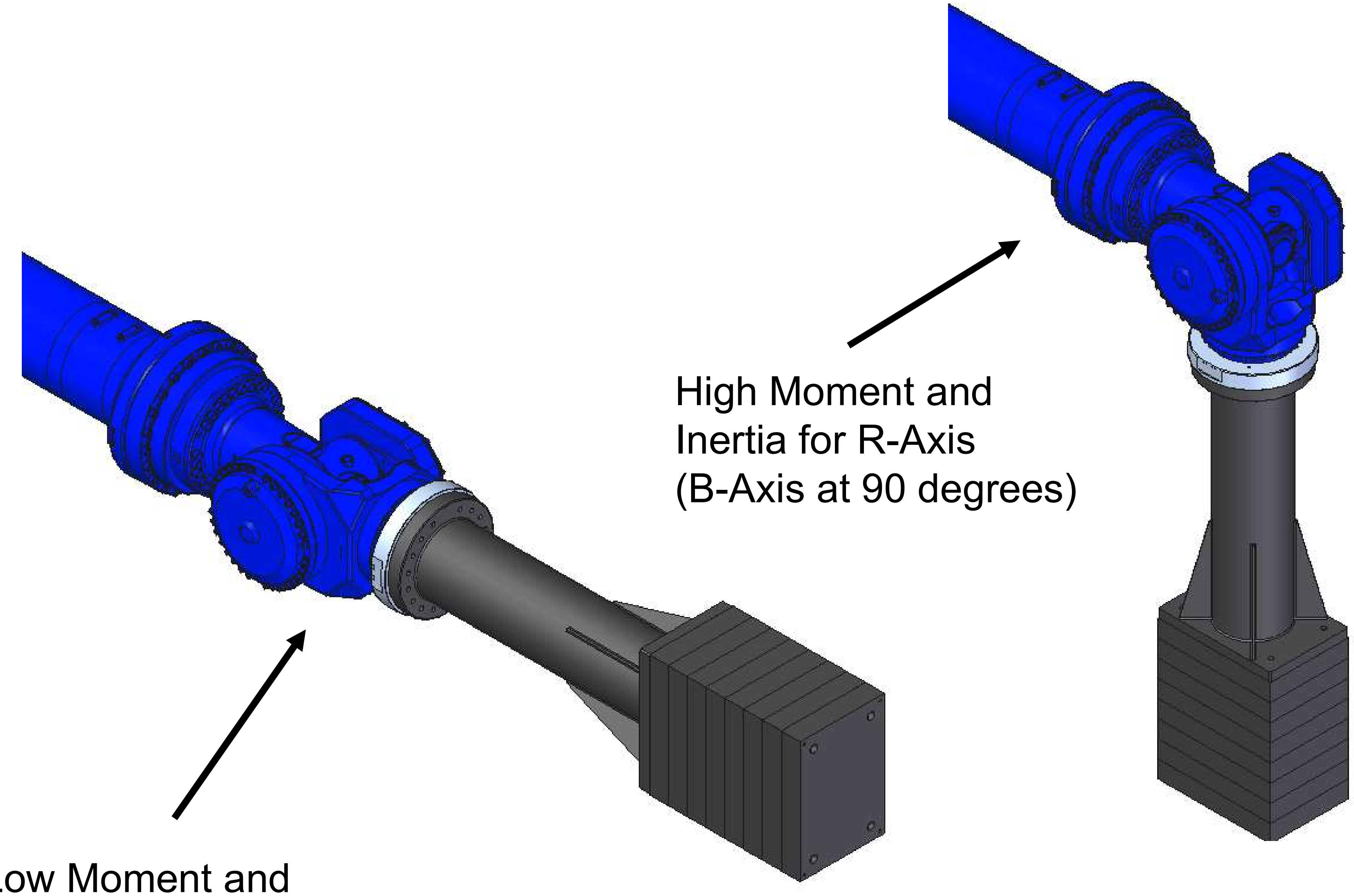
Robot Specifications

Tooling Ratings

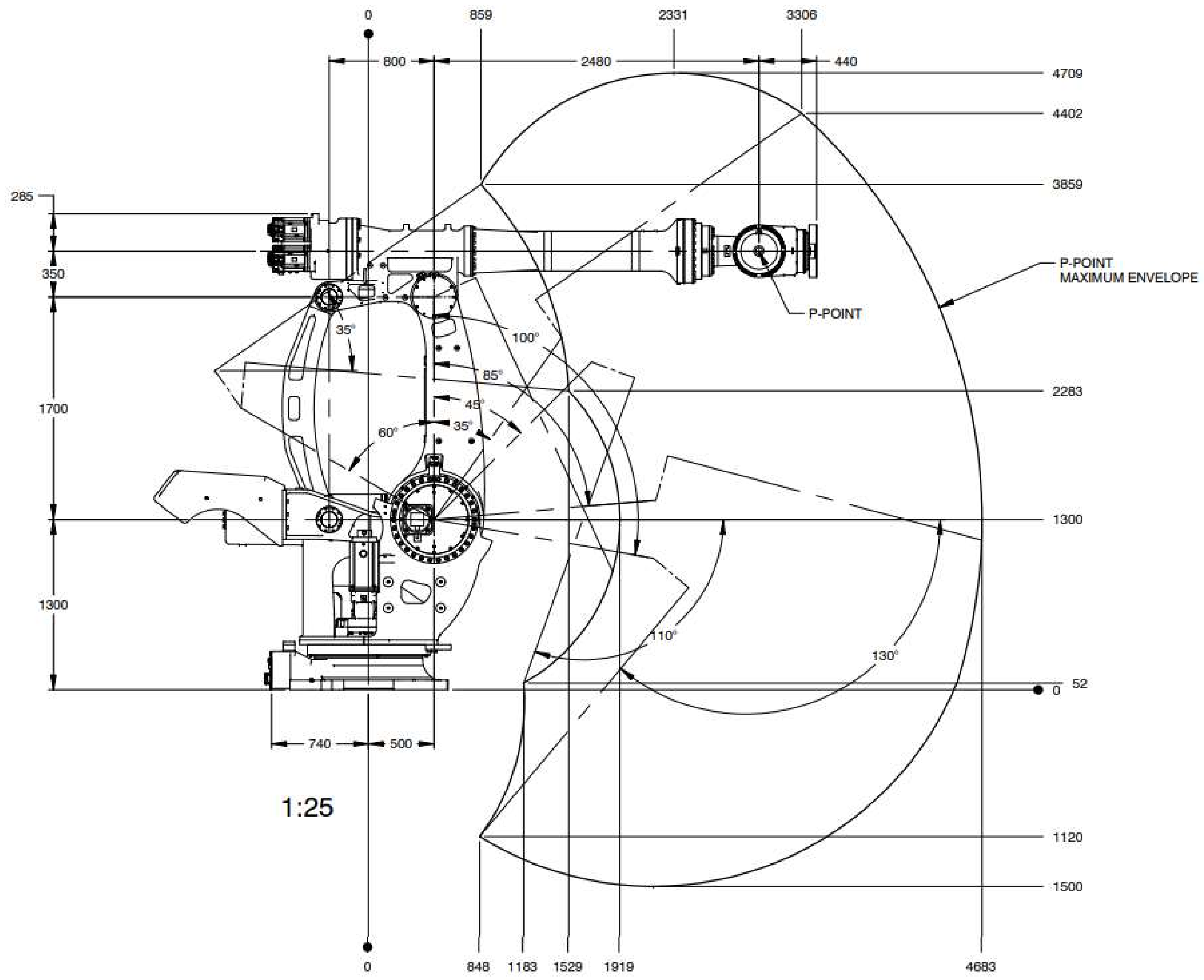
- The ratings of the moment and inertia for the wrist axis (usually RBT) are axis specific. Since the wrist can be in several different orientations, always try to consider the worst posture.
- For example, a tool might have low moment and inertia around the R-Axis when B-Axis is at 0 degrees, but high moment and inertia around the R-Axis when B-Axis is at 90 degrees.



Robot Specifications

Tooling Envelope

- Each robot has a “P-Point” which is usually the center rotation point of the wrist unit. This point is tracked by the controller through kinematics.
- Based on the allowable motion range for each axis, a tooling envelope is created that defines the allowable range for the P-Point.
- In the image to the right, you can see the phantom lines that show the robot at the various postures that are limited by the axis motion ranges. These form the “points” of the envelope.



Thank You for Your Attention