PR4: Robotics

L2 – Industrial Robots

L2 - Industrial robots

2.1 Units and components of robots

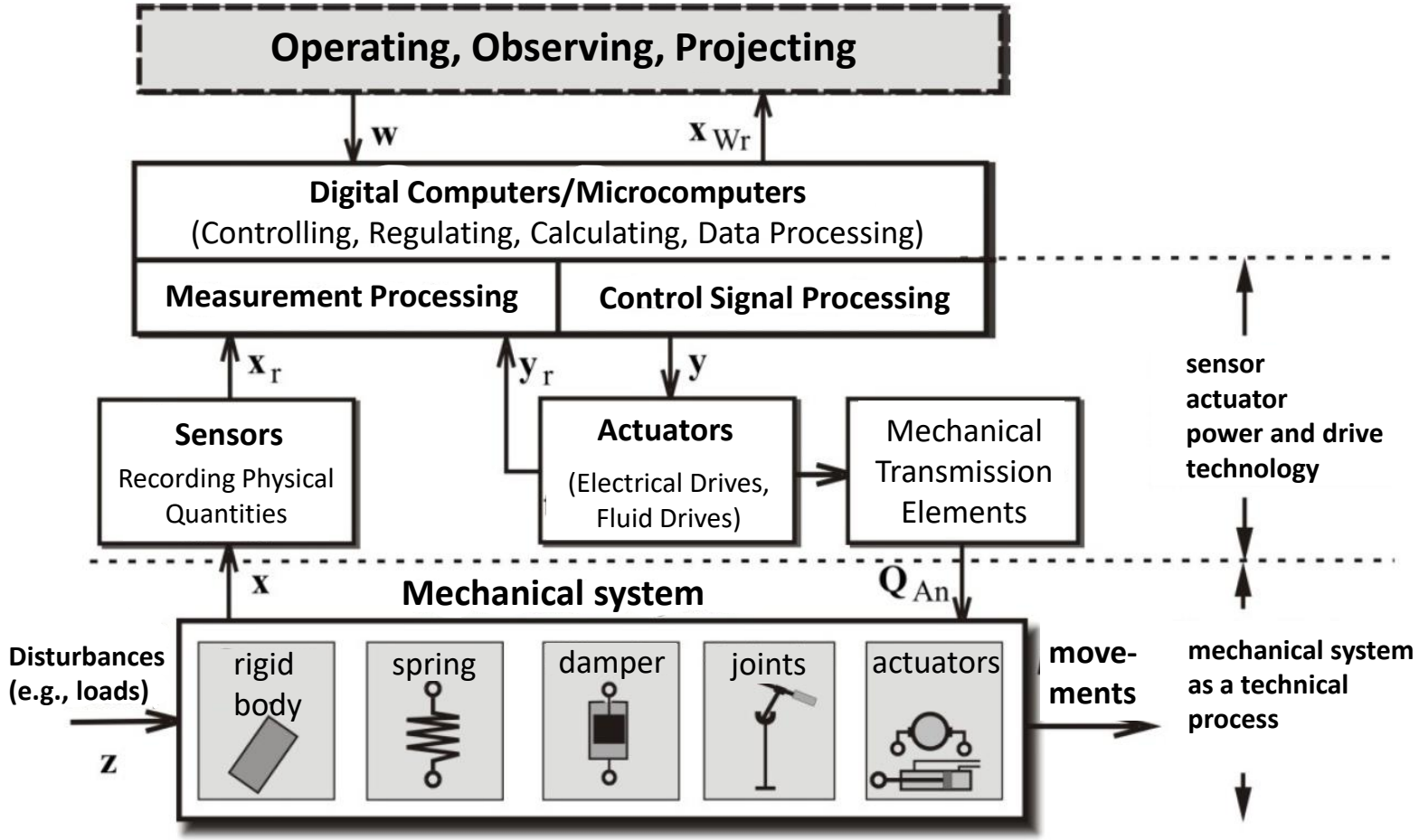
2.2 Degrees of freedom and types of transmission

2.3 Classification of Robots

2.4 Electrical hardware construction

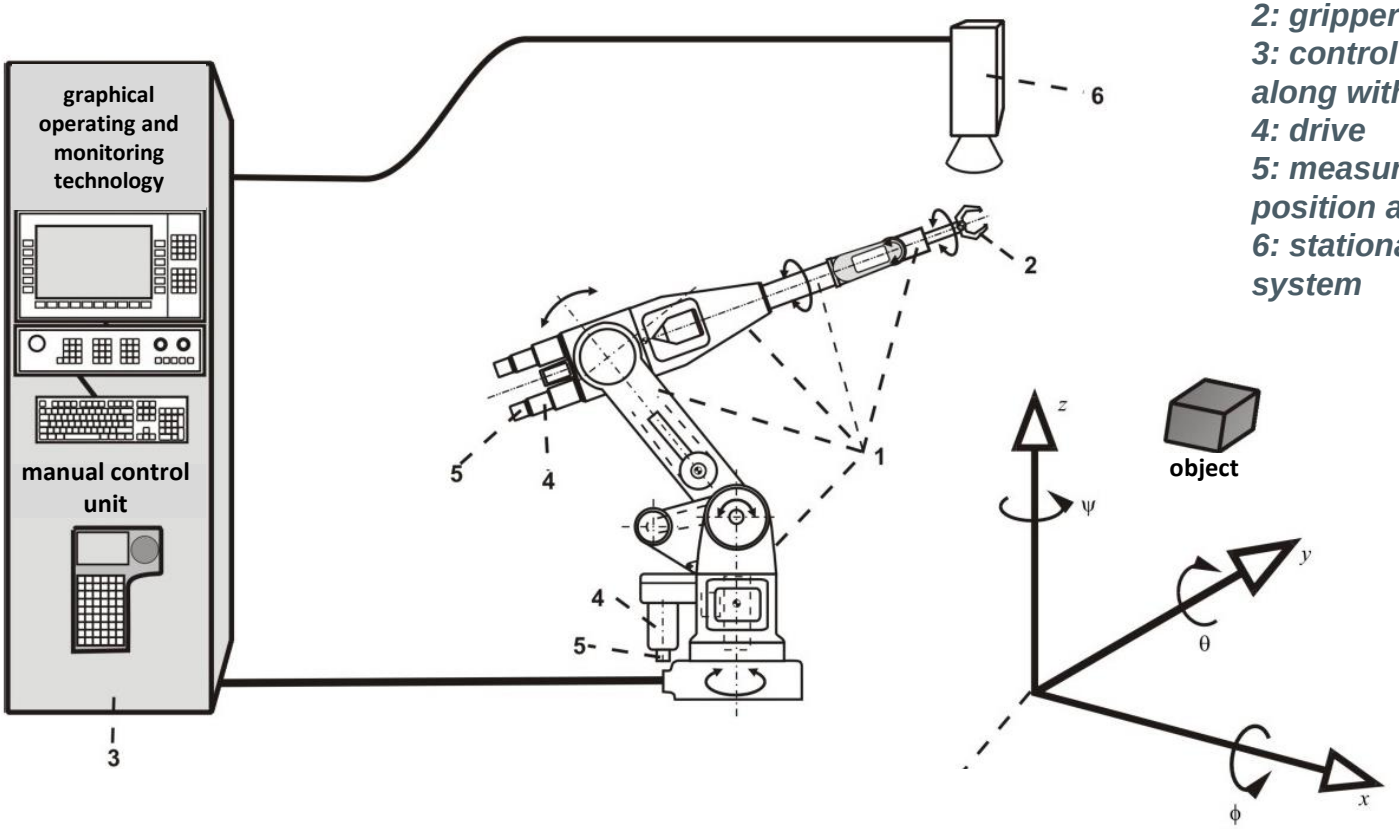
2.1 Units and components of robots

Typical internal structure of a mechatronic system



[Björnsson]

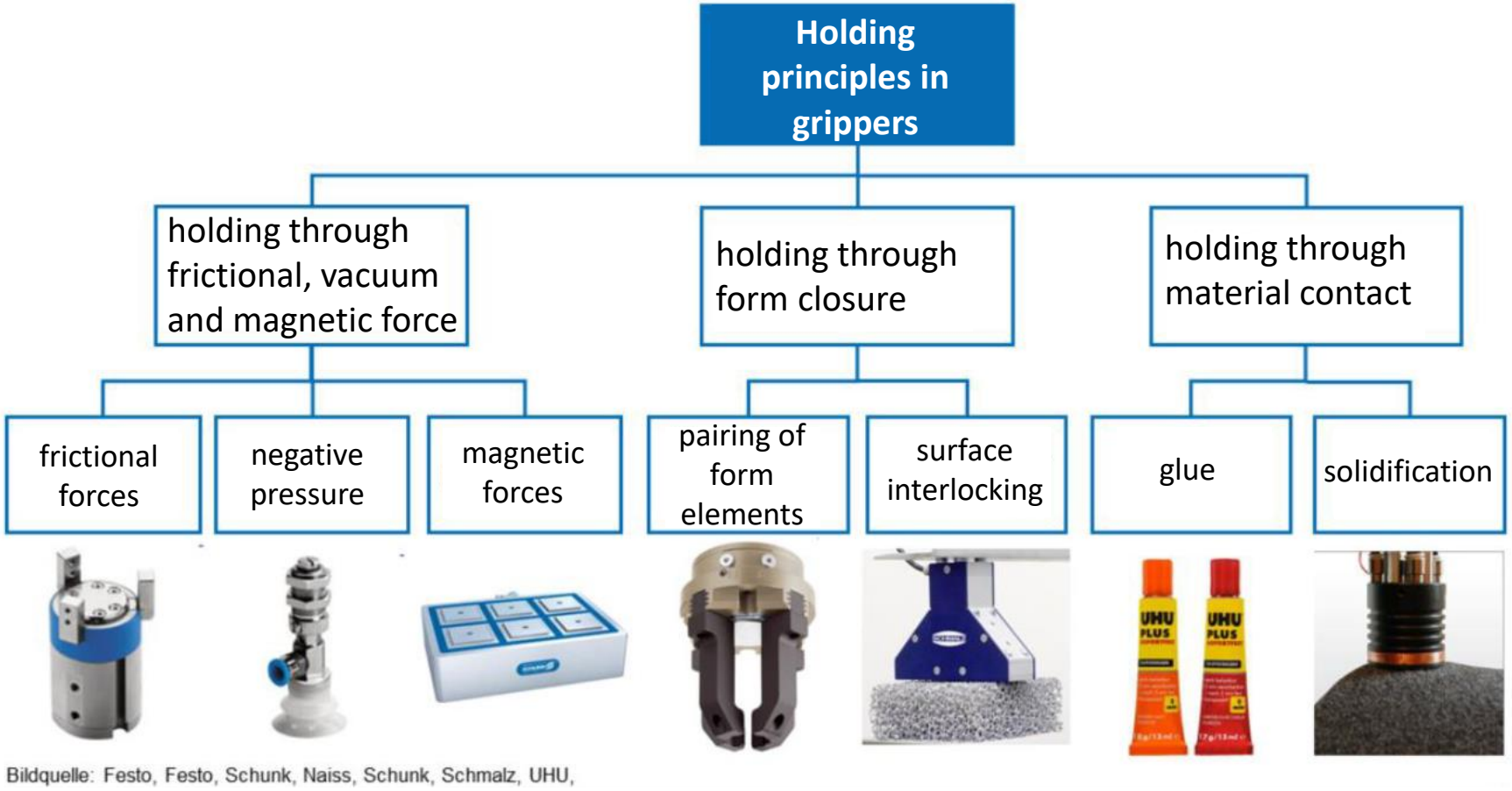
Units and components of robots



1: moving joint bodies of robots
2: gripper with Tool Center Point
3: control and regulation of robots along with operation
4: drive
5: measurement system for position and speed
6: stationary reference coordinate system

[Björnsson]

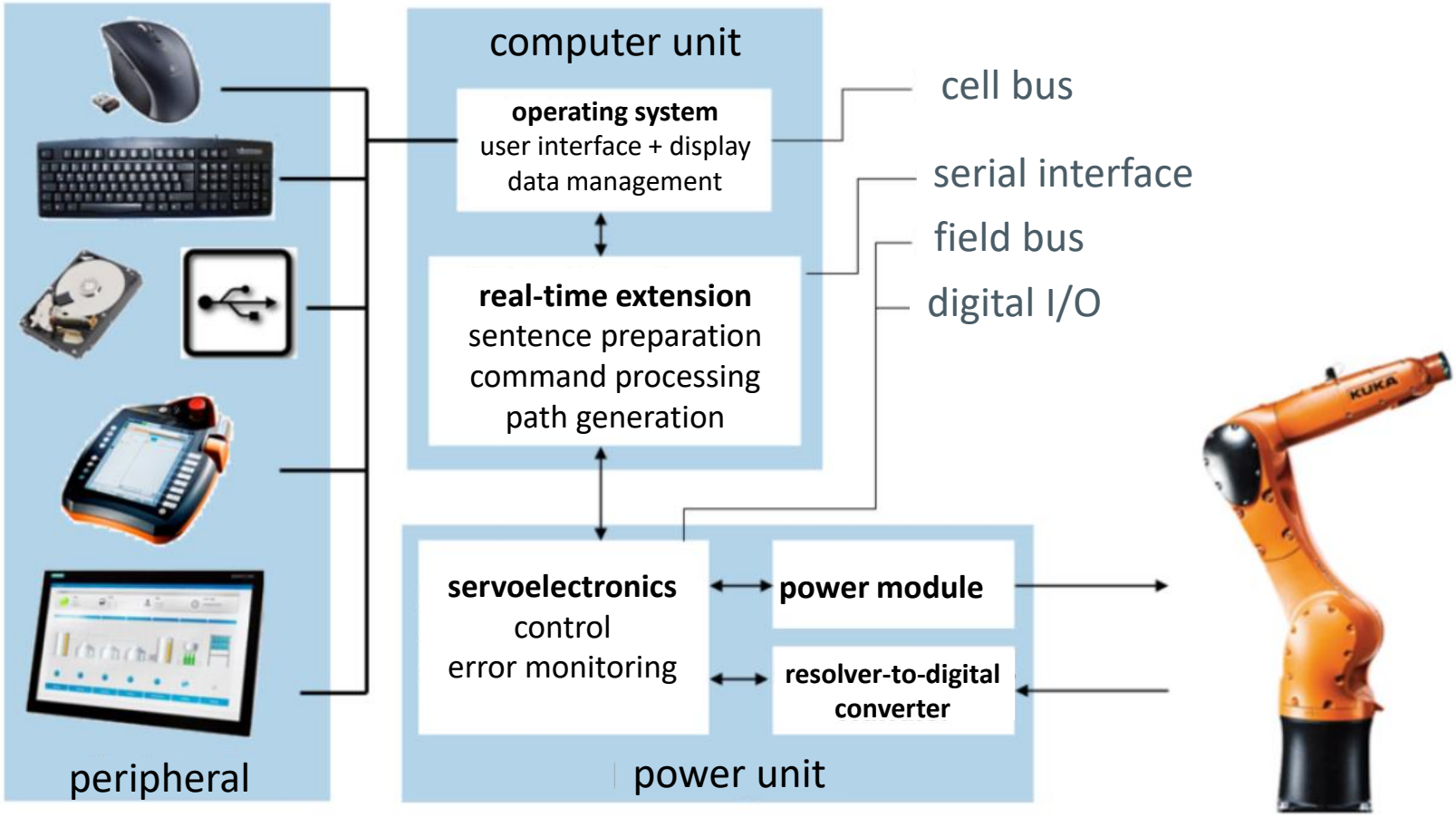
Clasification of grippers



Bildquelle: Festo, Festo, Schunk, Naiss, Schunk, Schmalz, UHU,

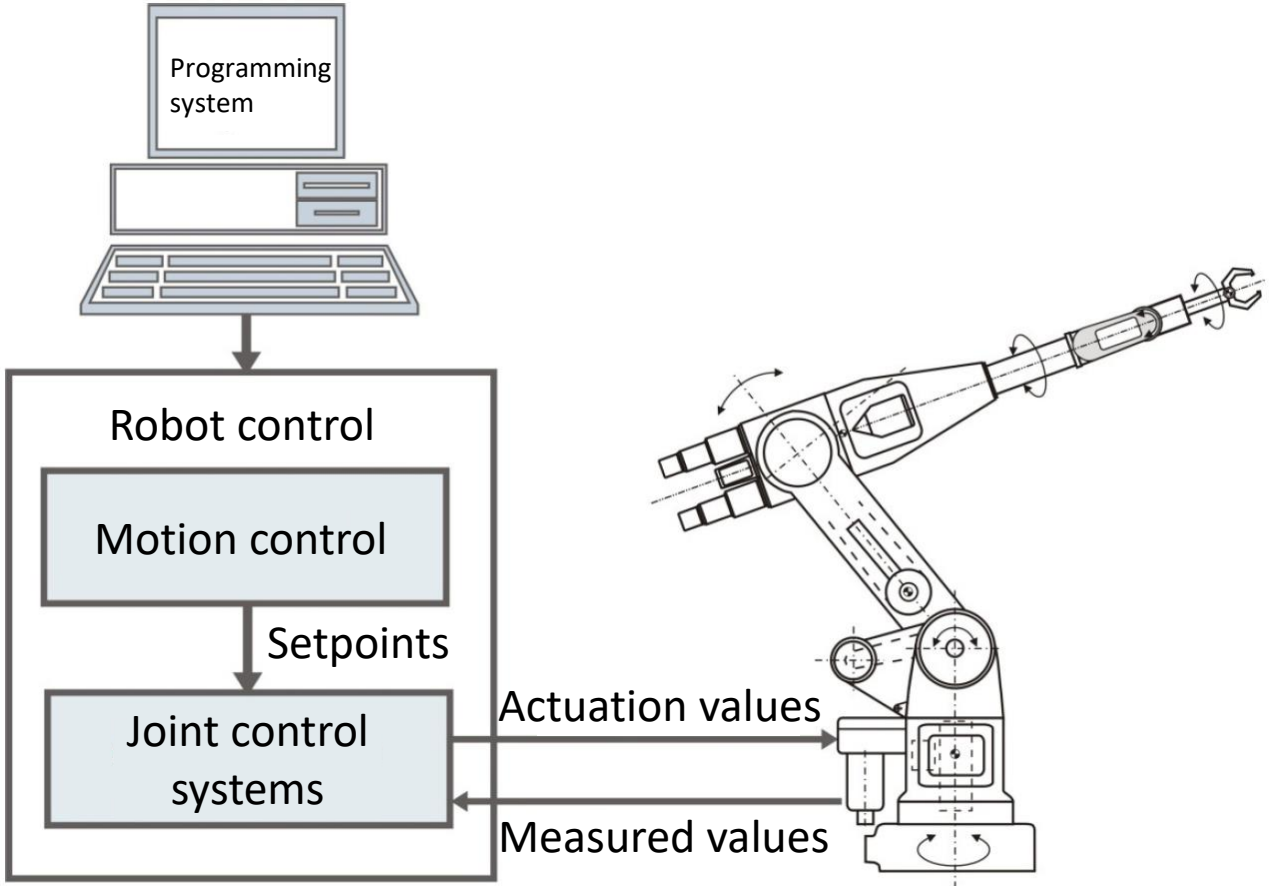
[Vette-Steinkamp]

Components of robot control



[Vette-Steinkamp]

Hierarchical structure of the control and regulation technology of an industrial robot



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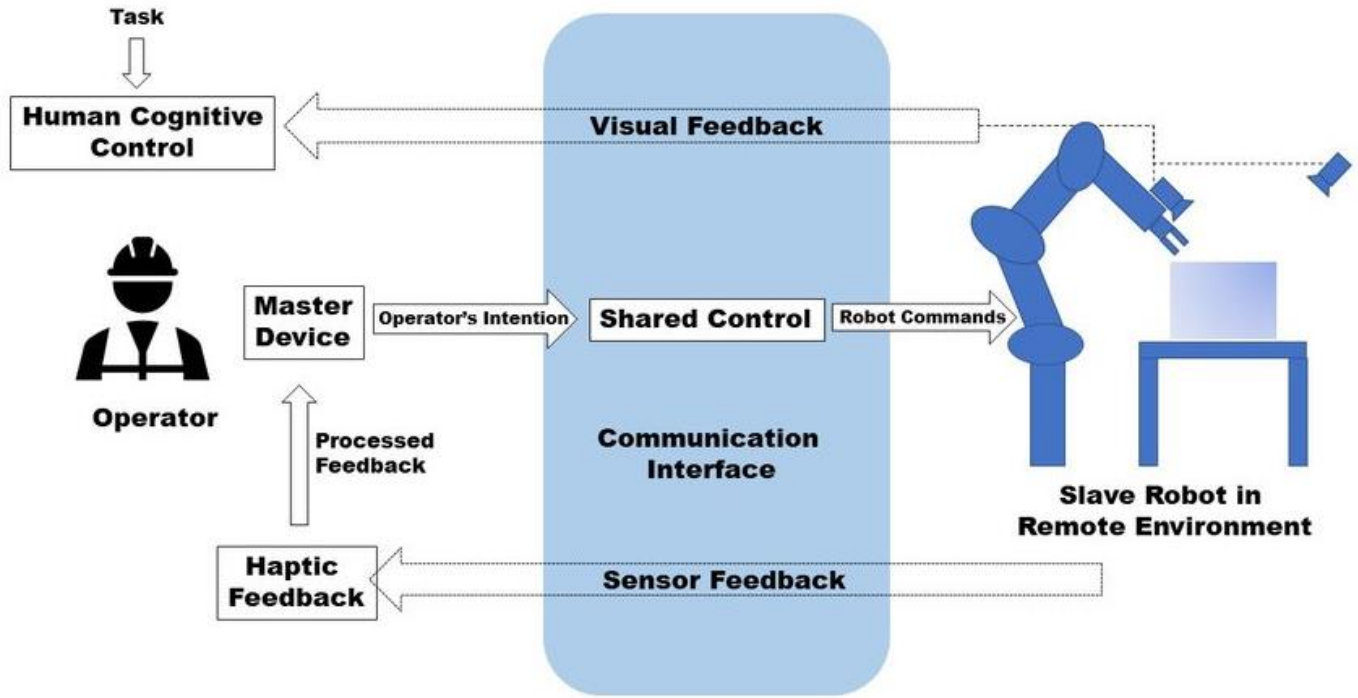
Graphical representation of remote shared control setup



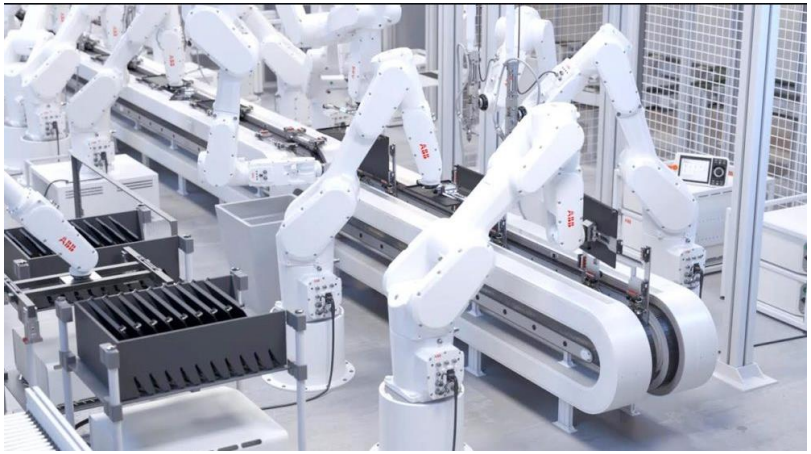
[https://www.researchgate.net/figure/Graphical-representation-of-a-remote-shared-control-setup-The-operator-receives-a-visual_fig3_333916024]

Most recognized brands of industrial robots

Fanuc biggest Robot
M-2000iA/1700 Robot lifts

Basic features:
Payloads **1700kg**
Reach **4.683 mm**
Axes **6**
Major destiny:
Lifting and positioning an entire car body within its generous work envelope

ABB
IRB 1300



Basic features:
Payloads **12kg**
Reach **4.683 mm**
Axes **6**
Major destiny:
High load applications in electronic, general industry, food and beverage, Logistics. It applies tending, polishing, assembly and testing applikation

Most recognized brands of industrial robots

KUKA
Mobile Robotics LBR iiwa 14 R820

Basic features:
Payloads **14kg**
Reach **4.683 mm**
Axes **7**
Major destiny:
The combination of mobile platform and intelligent, sensitive work assistant opens up a wide range of potential applications

Staubli
TS2-60 STERICLEAN robot

Basic features:
Payloads **8.4 kg**
Reach **620 mm**
Axes **4**
Major destiny:
It can operate in a Grade A environment for various applications in laboratory, batch testing or pharmaceutical production.

Most recognized brands of industrial robots

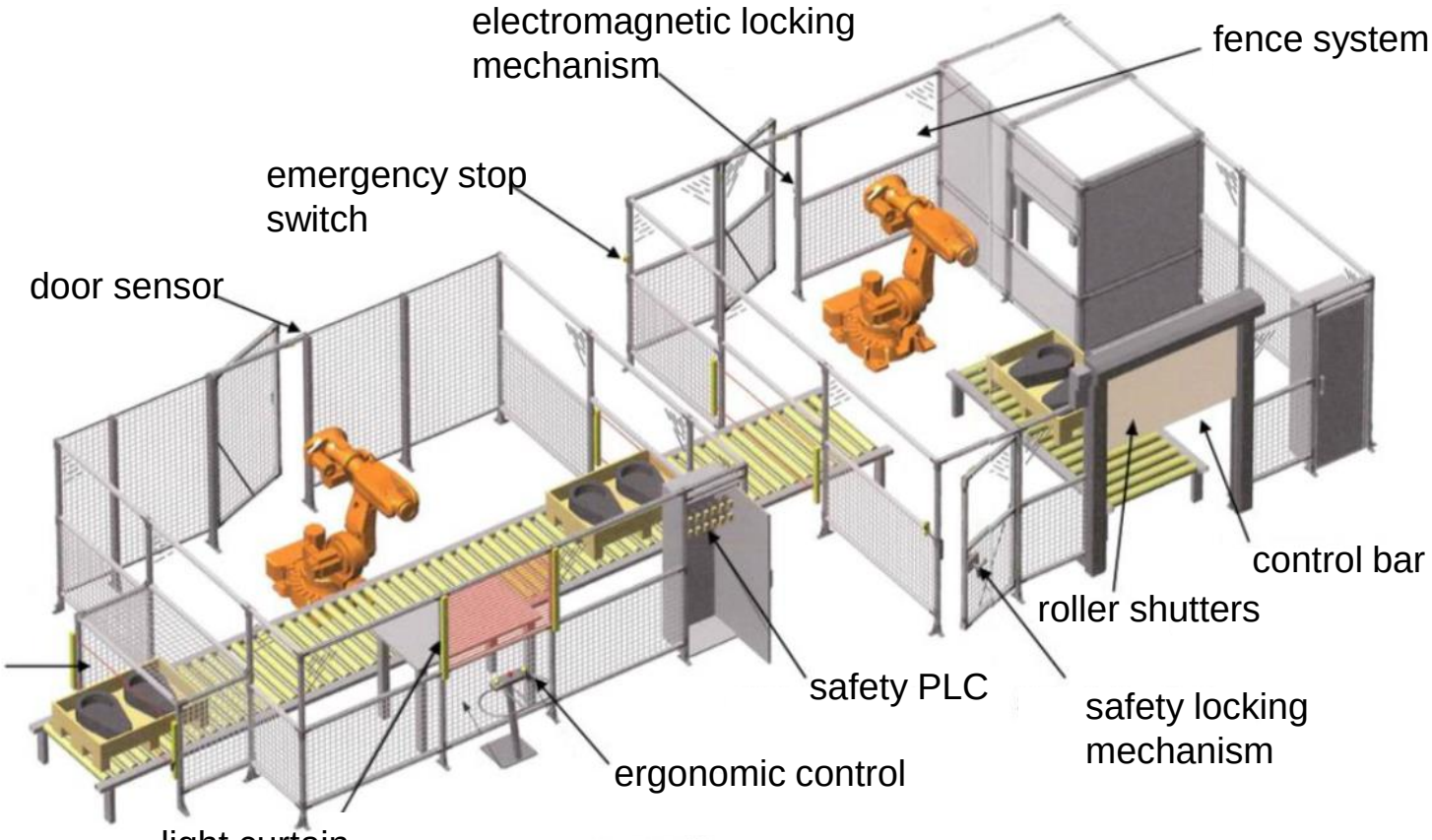
Mitsubishi
Industrial Cobot Melfa Assista (RV-5AS-D)

Basic features:
Payloads **5kg**
Reach **910 mm**
Axes **7**
Major destiny:
Cobots can share workspace with humans.

Omron
Parrel Delta Robot Quattro 650

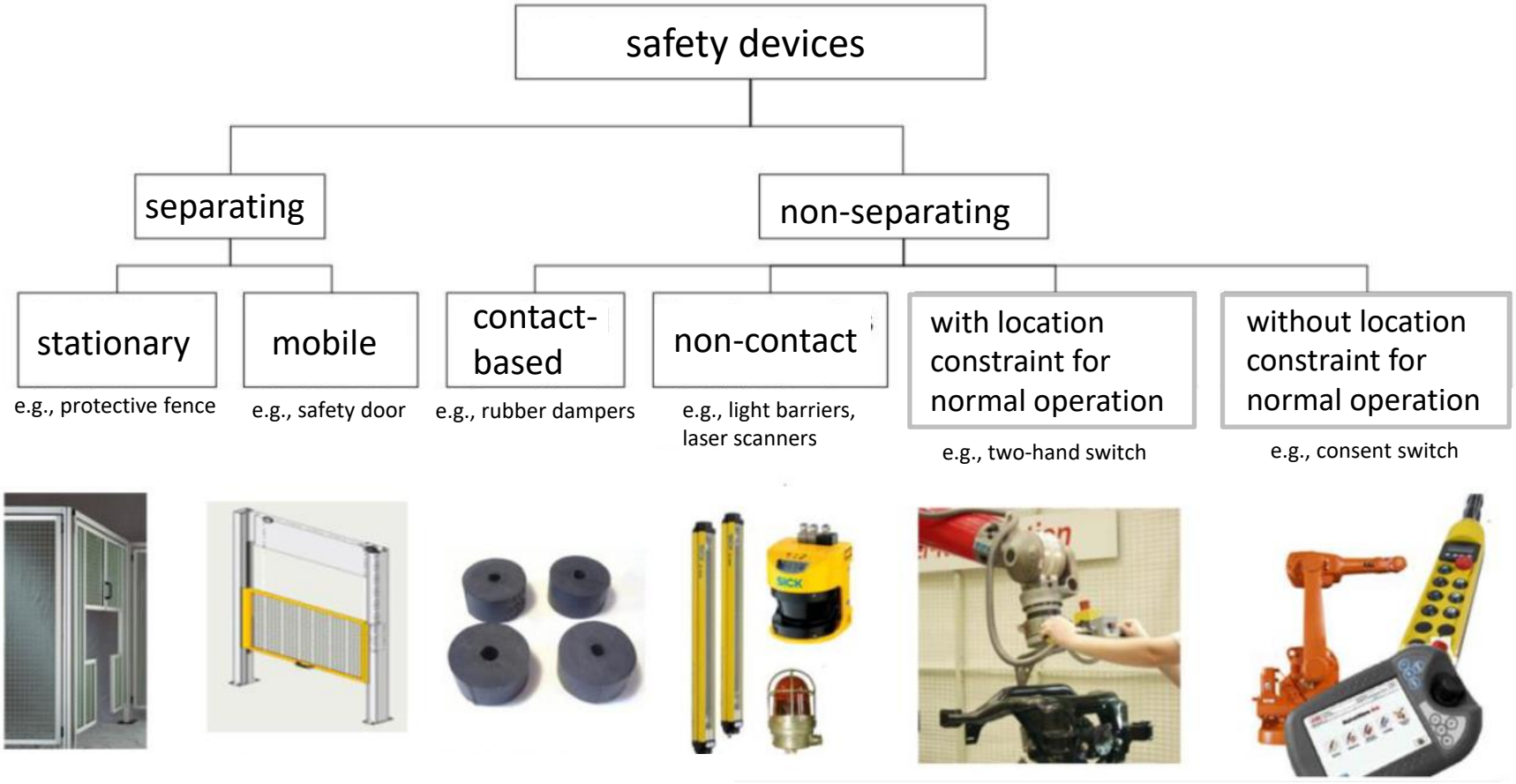
Basic features:
Payloads **6 kg**
Reach **650 mm**
Axes **4**
Major destiny:
Packing in Food & Beverage industry
Mesuring, inspection , testing in Automotive

Safety features on an assembly system



[Vette-Steinkamp]

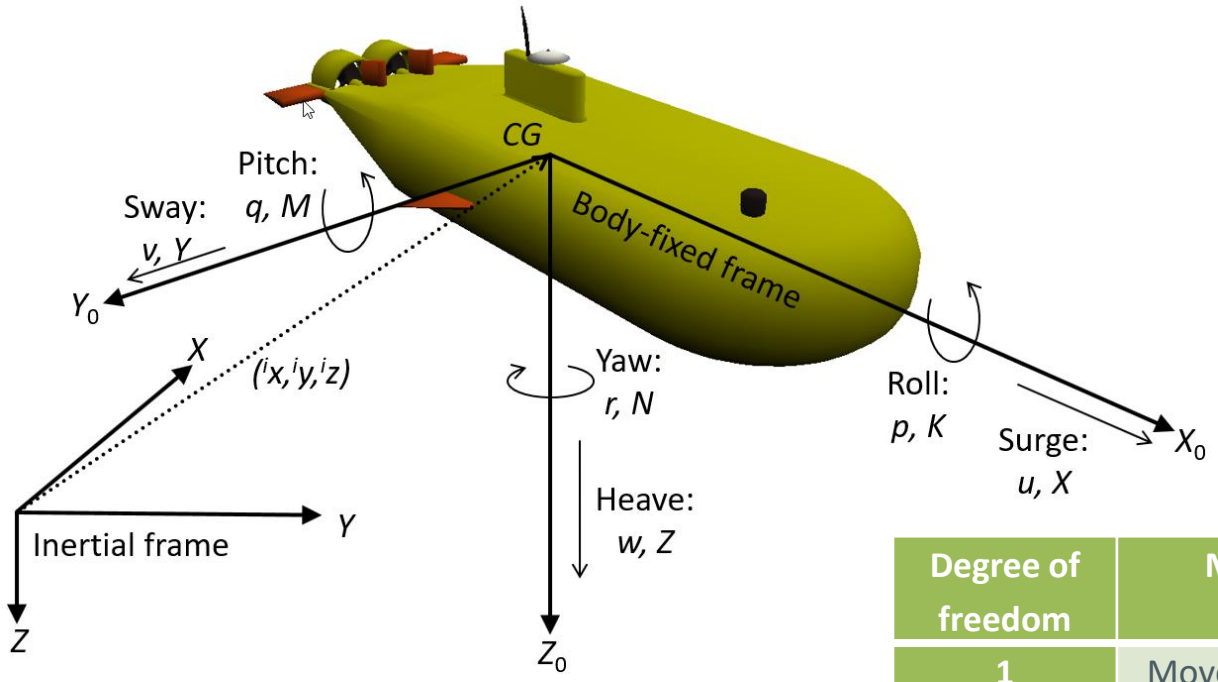
Classification of supplementary safety devices



[Vette-Steinkamp]

2.2 Degrees of freedom and types of transmission

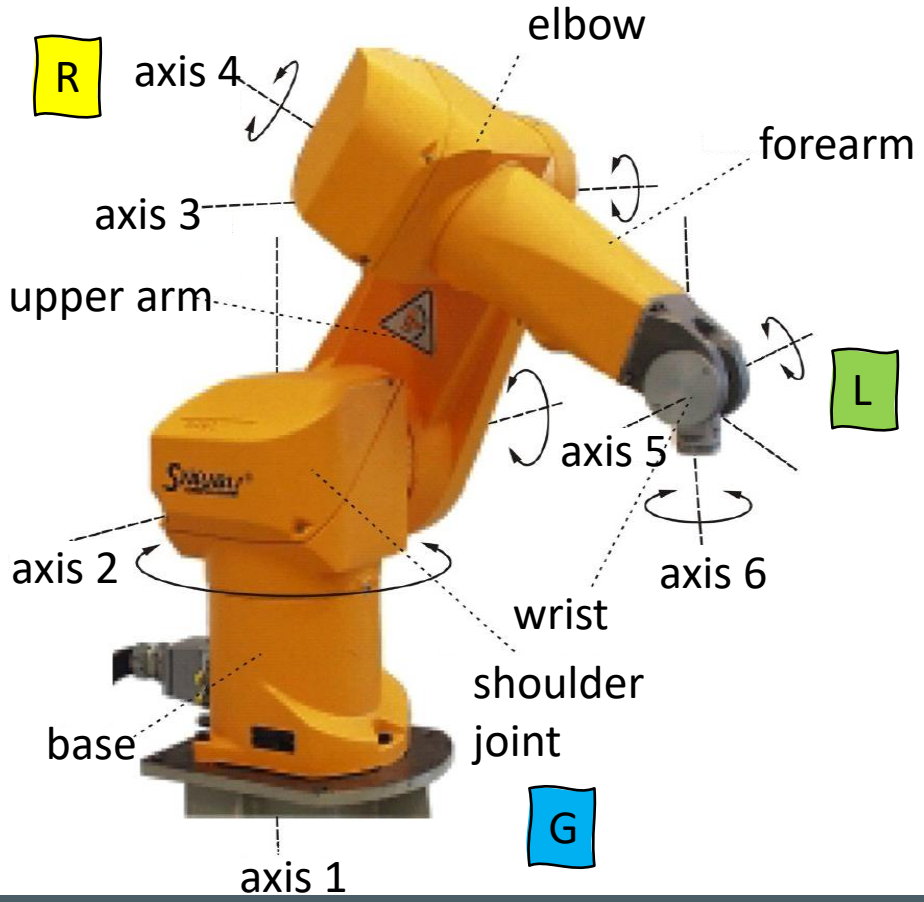
The six degrees of freedom of a body in three dimensions



Degree of freedom	Movement direction	label
1	Movement in the x-direction	surge
2	Movement in the y-direction	sway
3	Movement in the z-direction	heave
4	Rotation around the x-axis	roll
5	Rotation around the y-axis	pitch
6	Rotation around the z-axis	yaw

Typical articulated robot with 6 degrees of freedom

Adaptation of the robotic mechanics of a 6 DoF articulated robot to the human arm, illustrated using the example of the Stäubli RX60B robot.



Manipulator kinematic chain

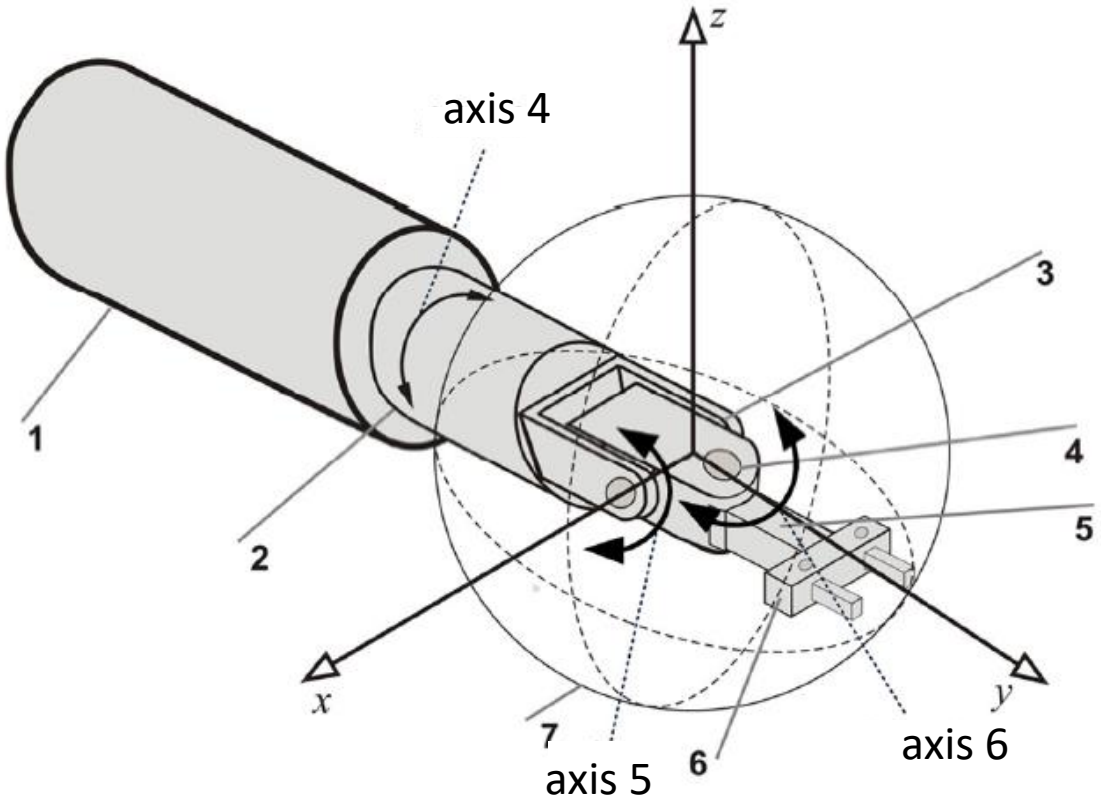
Local section (L)
The local section carries out tasks orinting and grasping a manipulated object.

Regional section (R)
The regional section carries out basic activities manipulative.

Global section (G)
The global section implements activities locomotion robot.

[Björnsson]

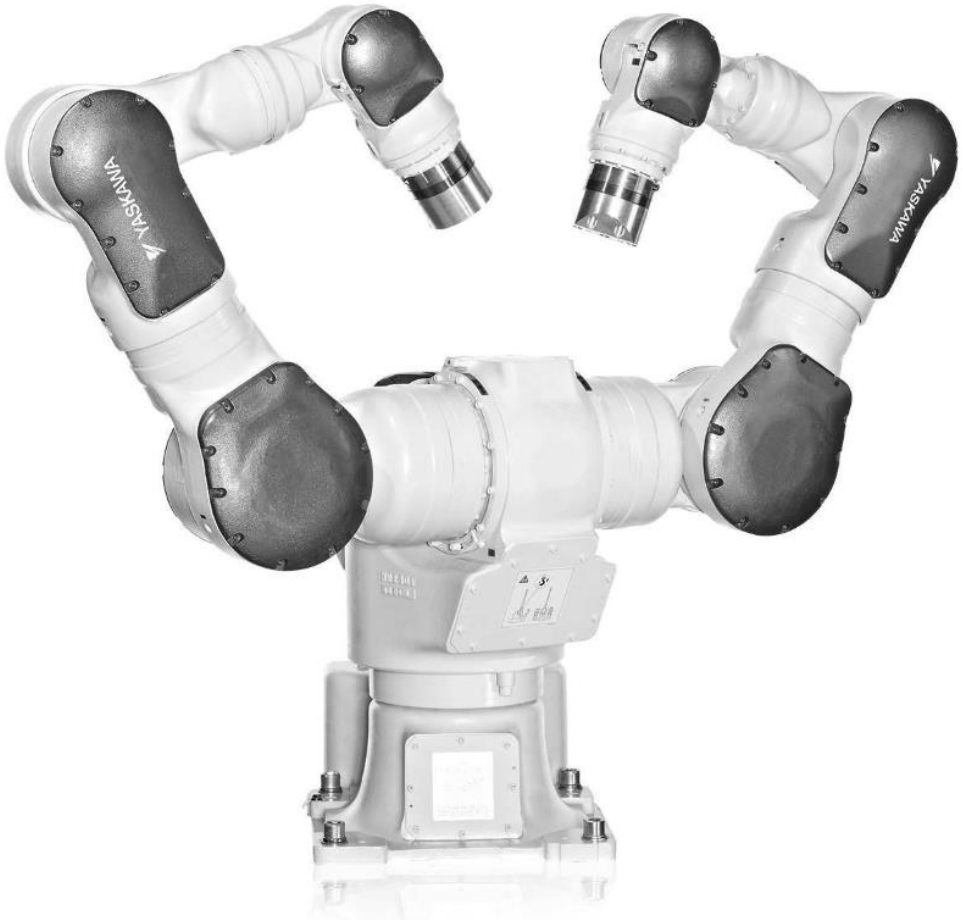
Typical arrangement of the hand axes



1: robot arm
2: hand rotation axis (axis 4)
3: bearing (axis 5)
4: rotating bearing for gripper (axis 6)
5: connection flange
6: gripper
7: auxiliary workspace boundary

[Björnsson]

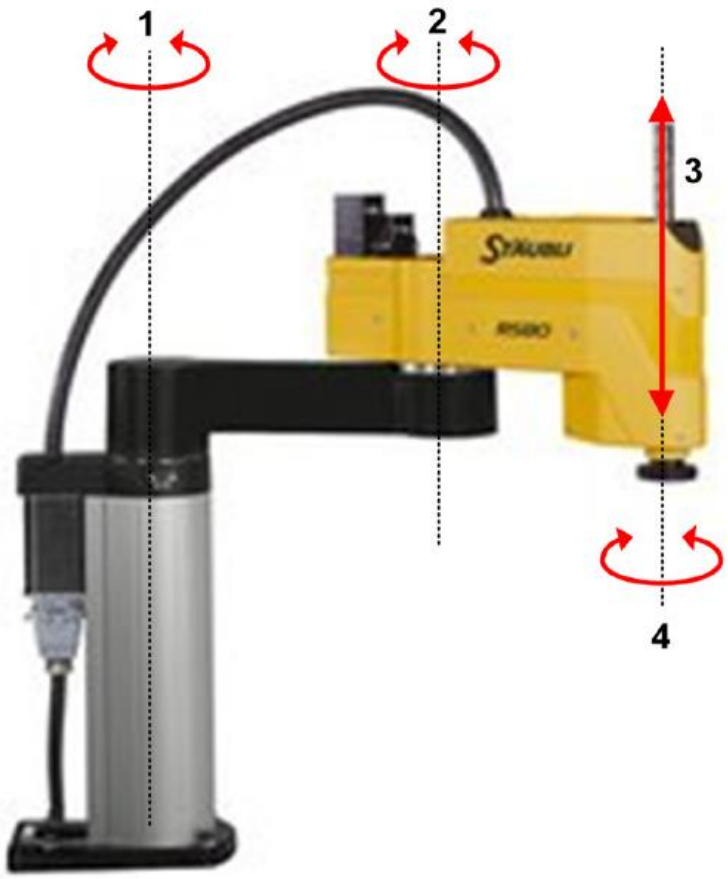
Example of a redundant kinematics: SDA200 by YASKAWA Europe



Seven degrees of freedom per arm plus one rotation around the vertical axis: 15 degrees of freedom

[Weber, W.: Industrieroboter, Methoden der Steuerung und Regelung, Hanser]

Example of a kinematics with fewer than 6 degrees of freedom



Assembly robot of the SCARA type with four degrees of freedom, illustrated using the example of the SCARA robot Stäubli RS800.

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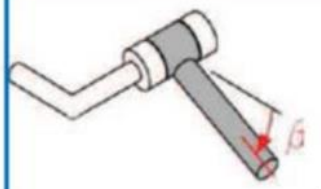
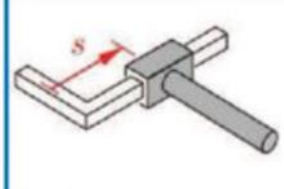
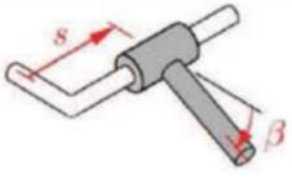
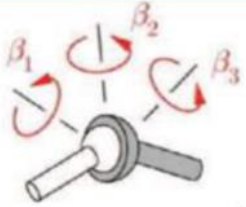
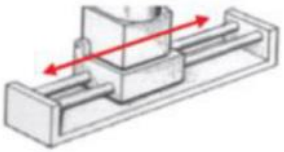
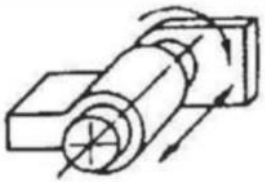
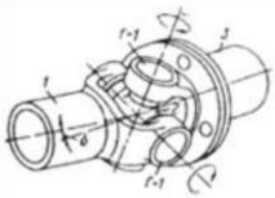
Degrees of Freedom of a ROBOT

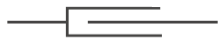
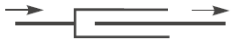
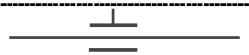
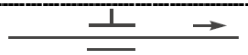
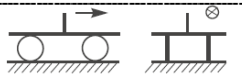
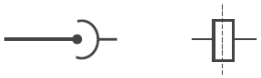
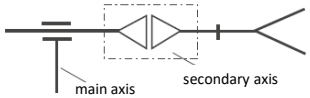
Different types of joints in industrial robots

rotational joint	prismatic joint	rotary-prismatic joint	universal (cardan) joint	ball joint
 f=1 R	 f=1 P	 f=2 RP	 f=2 D_2	 f=3 D_3
				

Source: THM: Grundlagen der Robotik, iam, Uni Rostock, VDI 2156

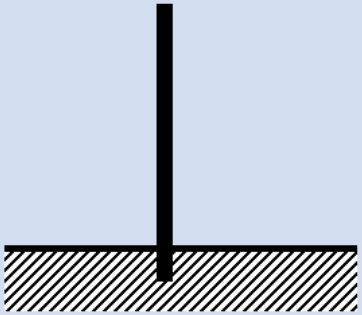
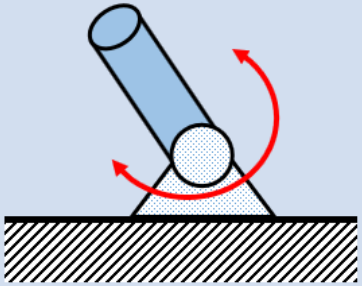
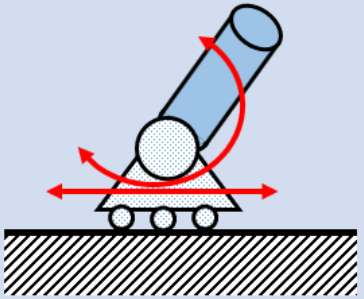
[Vette-Steinkamp]

Symbols for the kinematic description of robots (according to VDI 2861).

components	symbol	Explanation or symbol with indication of movement capability
Translational axis, aligned, telescopic axis		
Translational axis, non-aligned		
Translational Axis, Travel Axis		
Rotational axis, aligned		
Rotational axis, non-aligned		
Tools		Spray gun, welding pliers
Gripper		Pincer gripper
Marking of system boundaries		Short separation line, real interface, e.g., interchangeable tools
Separation between main and secondary axes.		

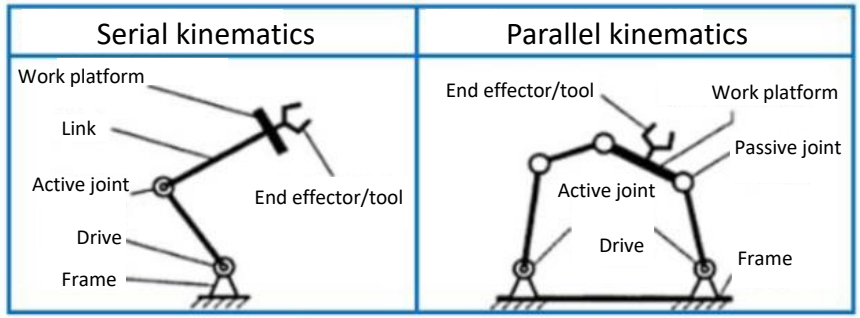
[Björnsson]

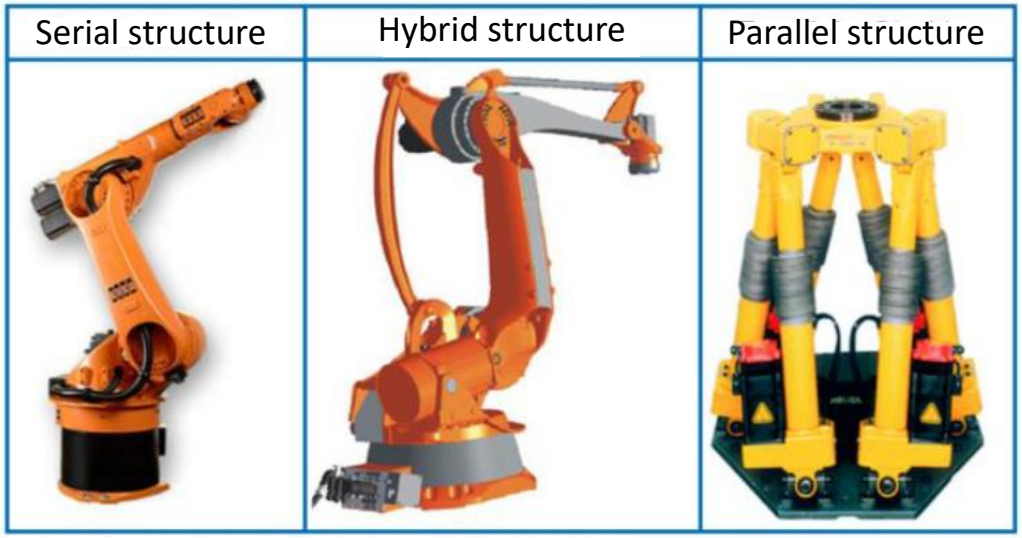
Symbolic representation of the anchoring of the robot

Fixed support	Fixed bearing	Floating bearing
		
No degree of freedom	One degree of freedom (rotational)	Two degrees of freedom (1x rotational, 1x translational)

2.3 Classification of Robots

Classification based on serial and parallel kinematics



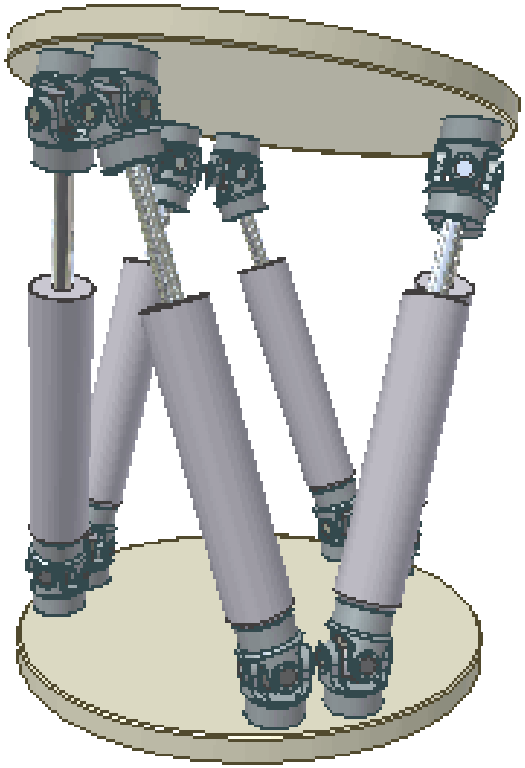


	Serial Robot	Parallel Robot
repeatability accuracy		+
rigidity		+
self-weight ratio		+
workspace (size, obstacle avoidance)	+	-
flexibility	+	

Reference: Helm, Penetrating Mechanisms for Parallel Robots
Images: KUKA, Spong, Fanuc

[Vette-Steinkamp]

Example of parallel kinematics: Hexapod



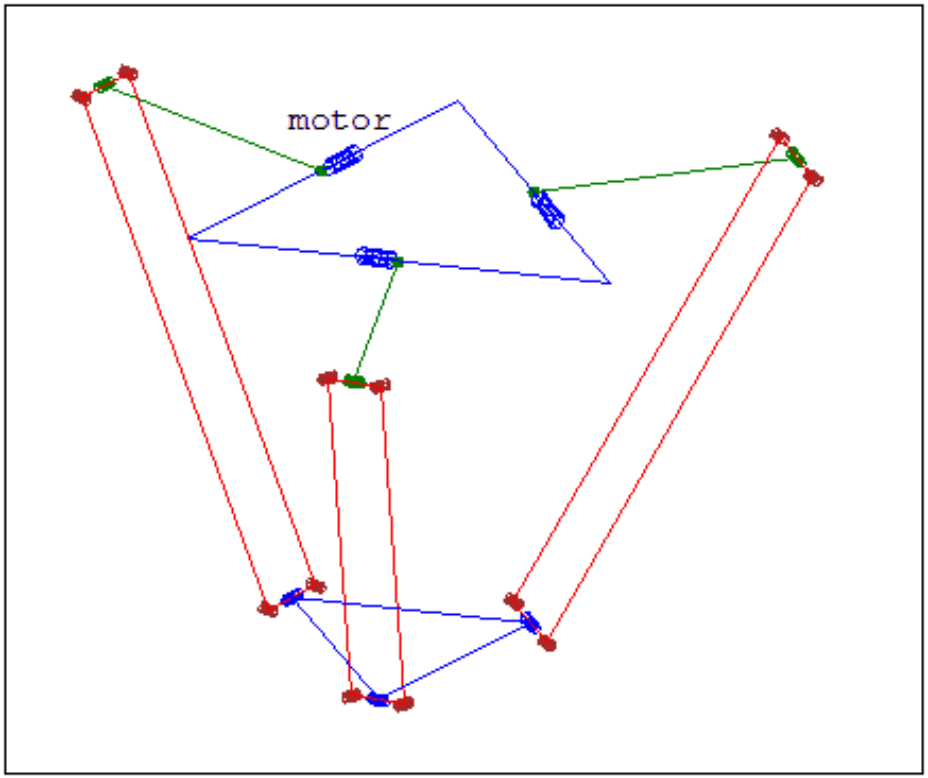
By UtzOnBike at German Wikipedia - Transferred from de.wikipedia to Commons. Originally uploaded at de:Bild:Hexapod allgemein Anim.gifOwn work. Created with Autodesk Inventor, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=214225

Von Ethan Arnold, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=8864535

Example of parallel kinematics: Hexapod

https://www.youtube.com/watch?v=ogxnEGET_-o

Example of parallel kinematics: Delta robot



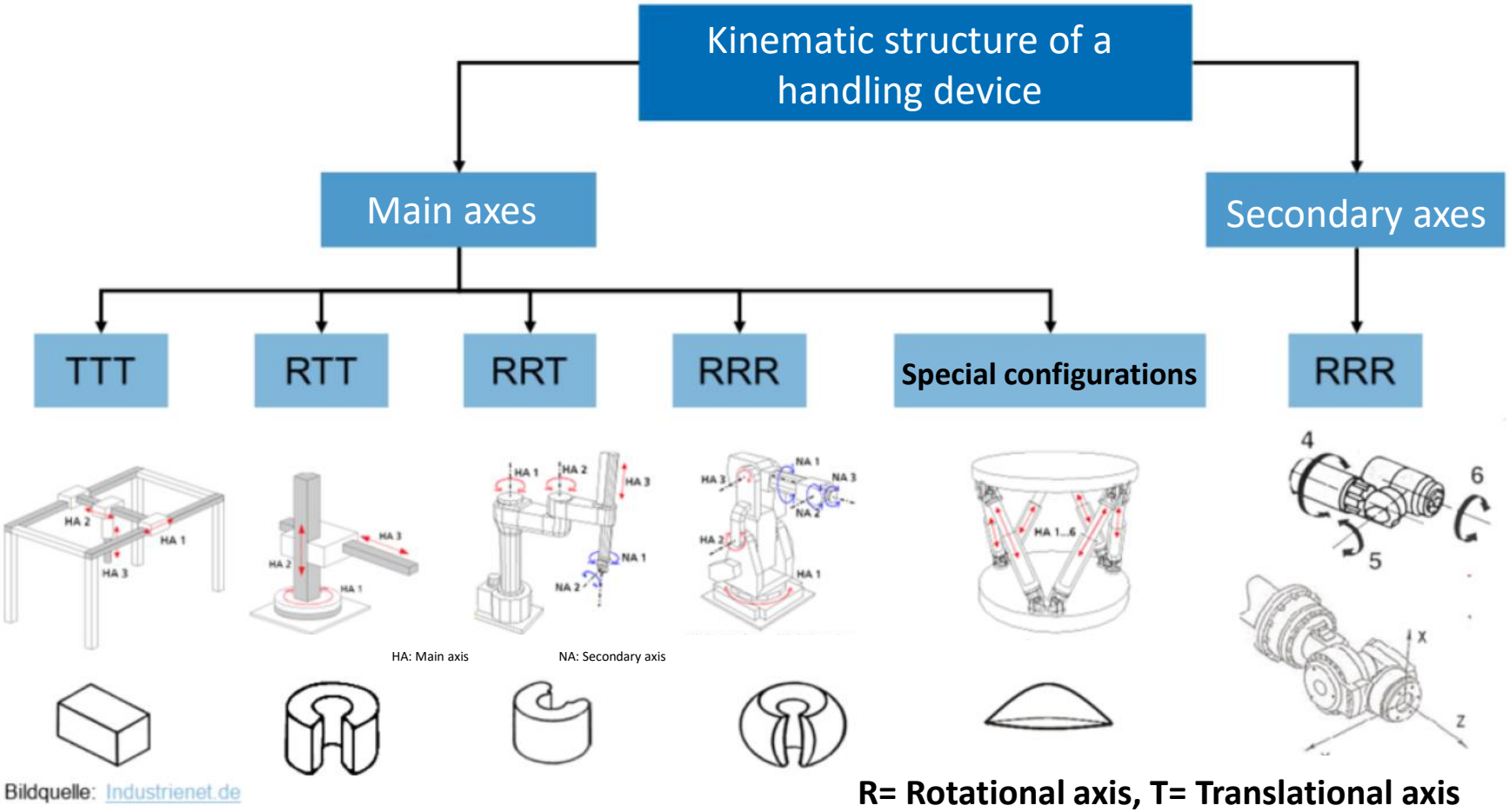
Von Ber7 - http://en.smath.info/forum/yaf_poststst2307_Method-A-B--Draghilev-and-animation-spatial-mechanisms.aspx, CC0, https://commons.wikimedia.org/w/index.php?curid=45150160

Fa. Autonox24, https://www.autonox24.de/

Example of parallel kinematics: Delta robot

https://www.youtube.com/watch?v=QFZMhsVn_CE

Classification of robots with serial kinematics

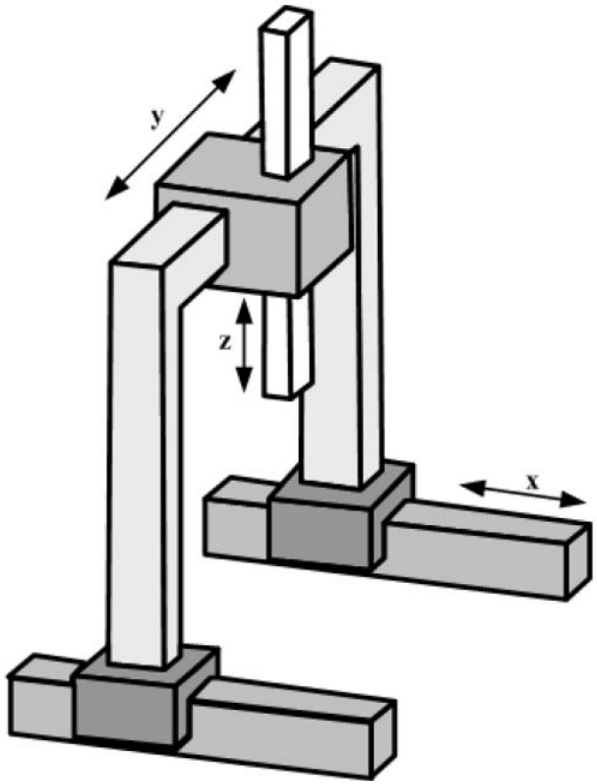


Bildquelle: Industrienet.de

R= Rotational axis, T= Translational axis

[Vette-Steinkamp]

TTT-Kinamatik, example gantry robot and crane



[Björnsson]

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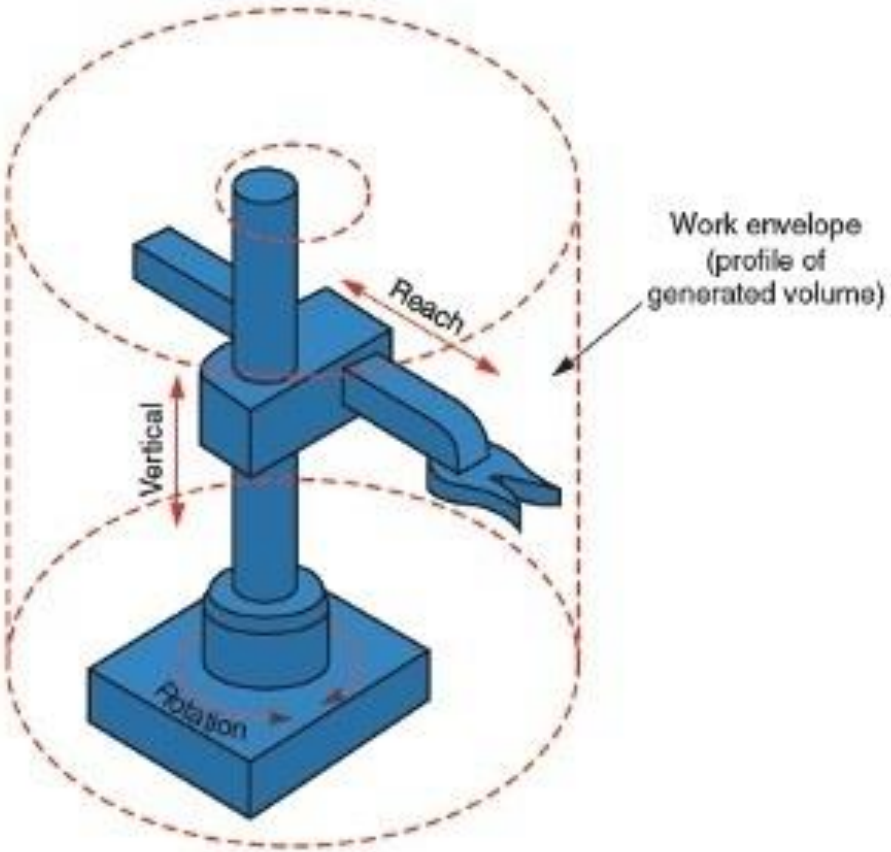
TTT-Kinamatik, example gantry robot

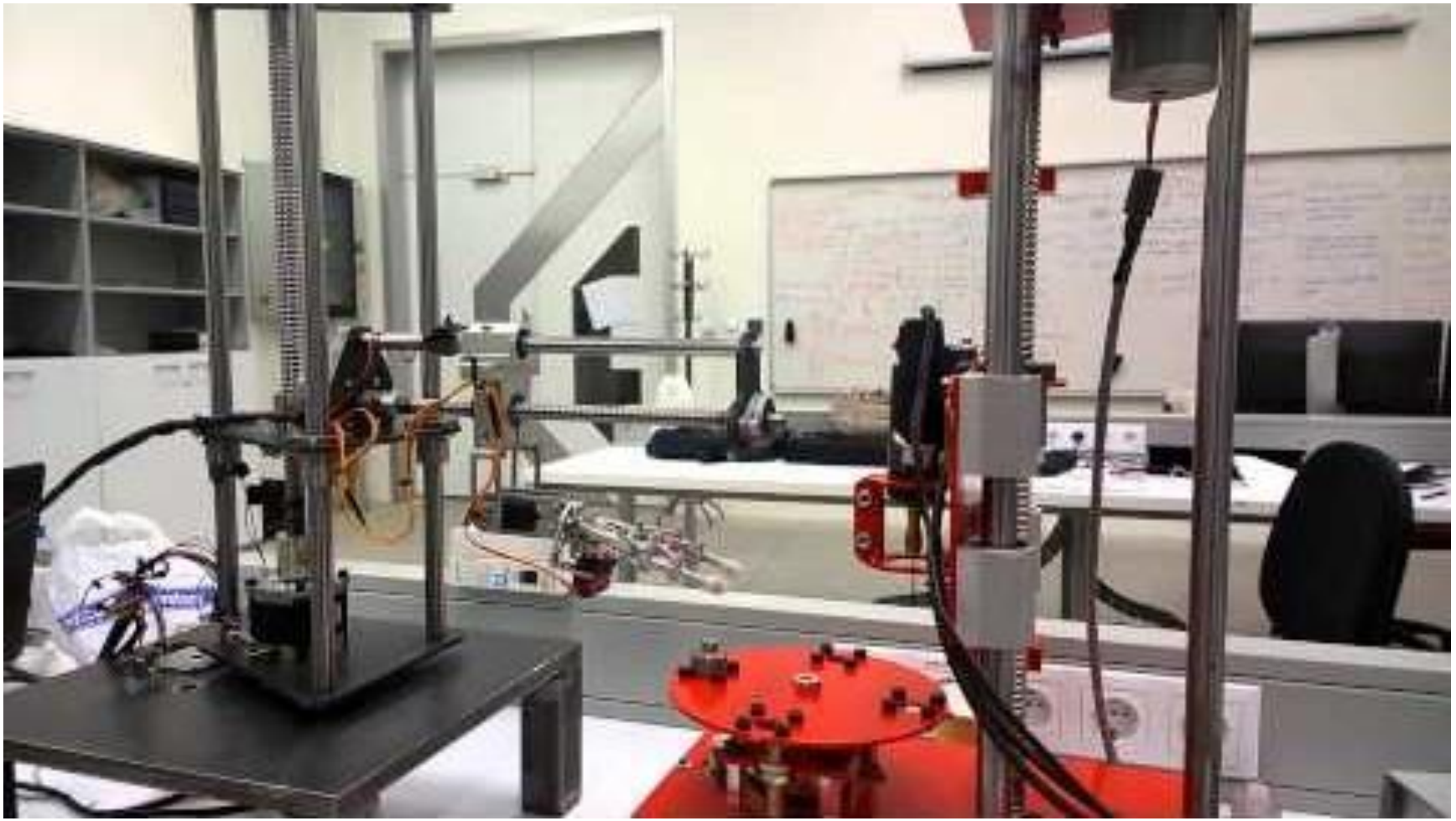
https://www.youtube.com/watch?v=AndcKJYV6qw

RTT-Kinematik, example cylindrical robot



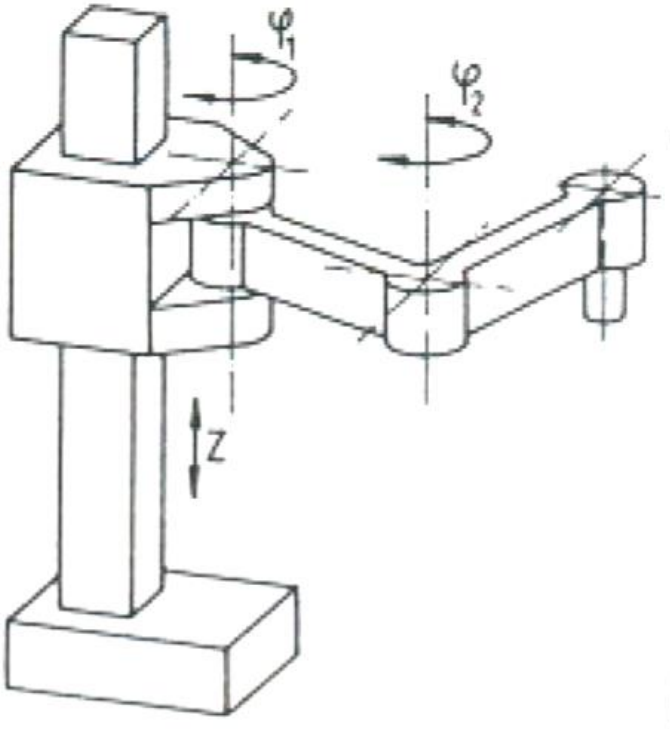
https://www.quora.com/What-should-I-learn-to-build-a-robotic-arm

RTT-Kinematik, example cylindrical robot



https://www.youtube.com/watch?v=EWSqus82wIY

RRT/TRR-Kinematik, example SCARA robot



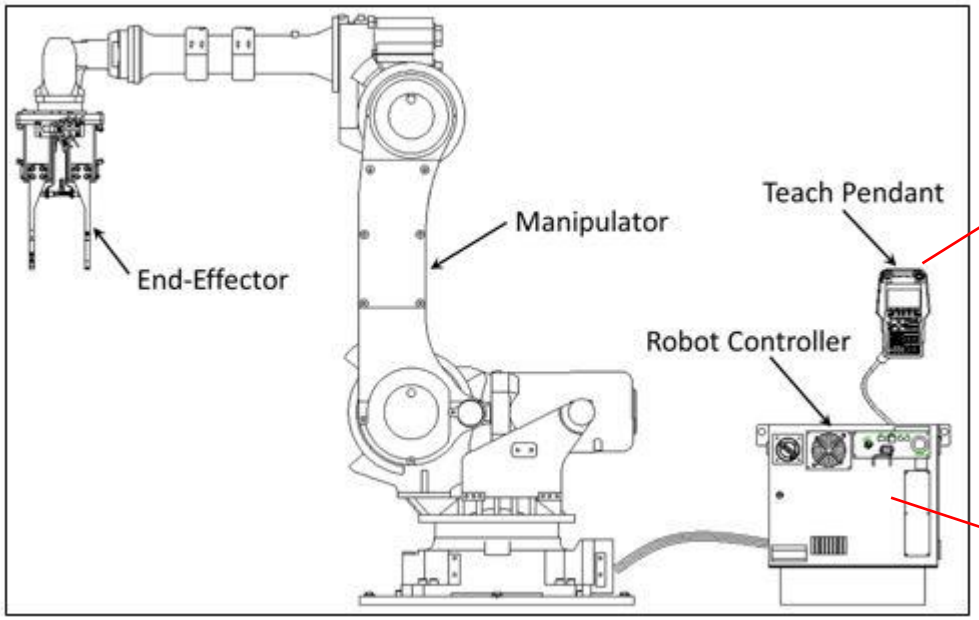
[Björnsson]

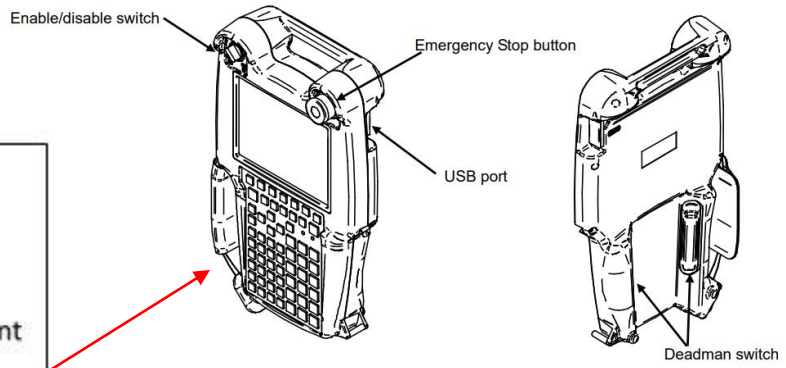
RRT/TRR-Kinematik, example SCARA robot

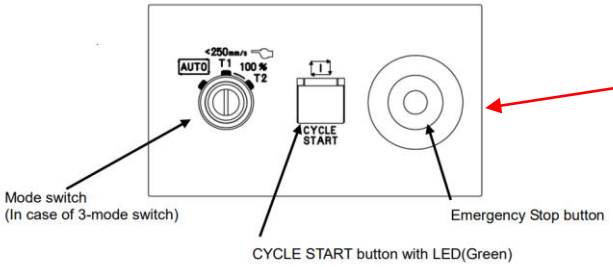
https://www.youtube.com/watch?v=QUhYcuDFH_A

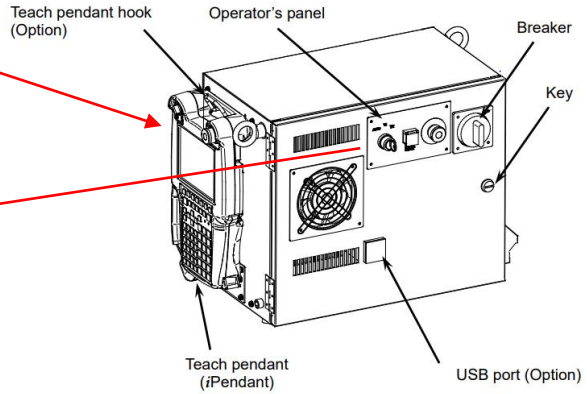
2.4 Electrical hardware construction

General Hardware configuration

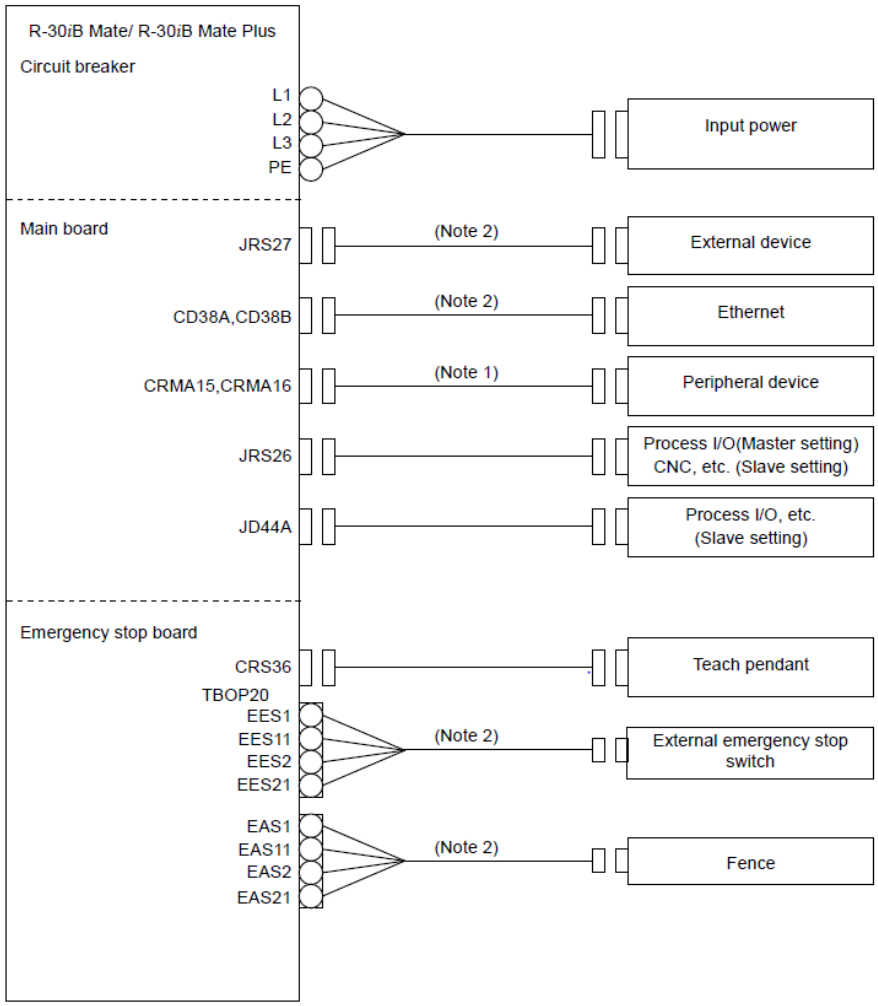




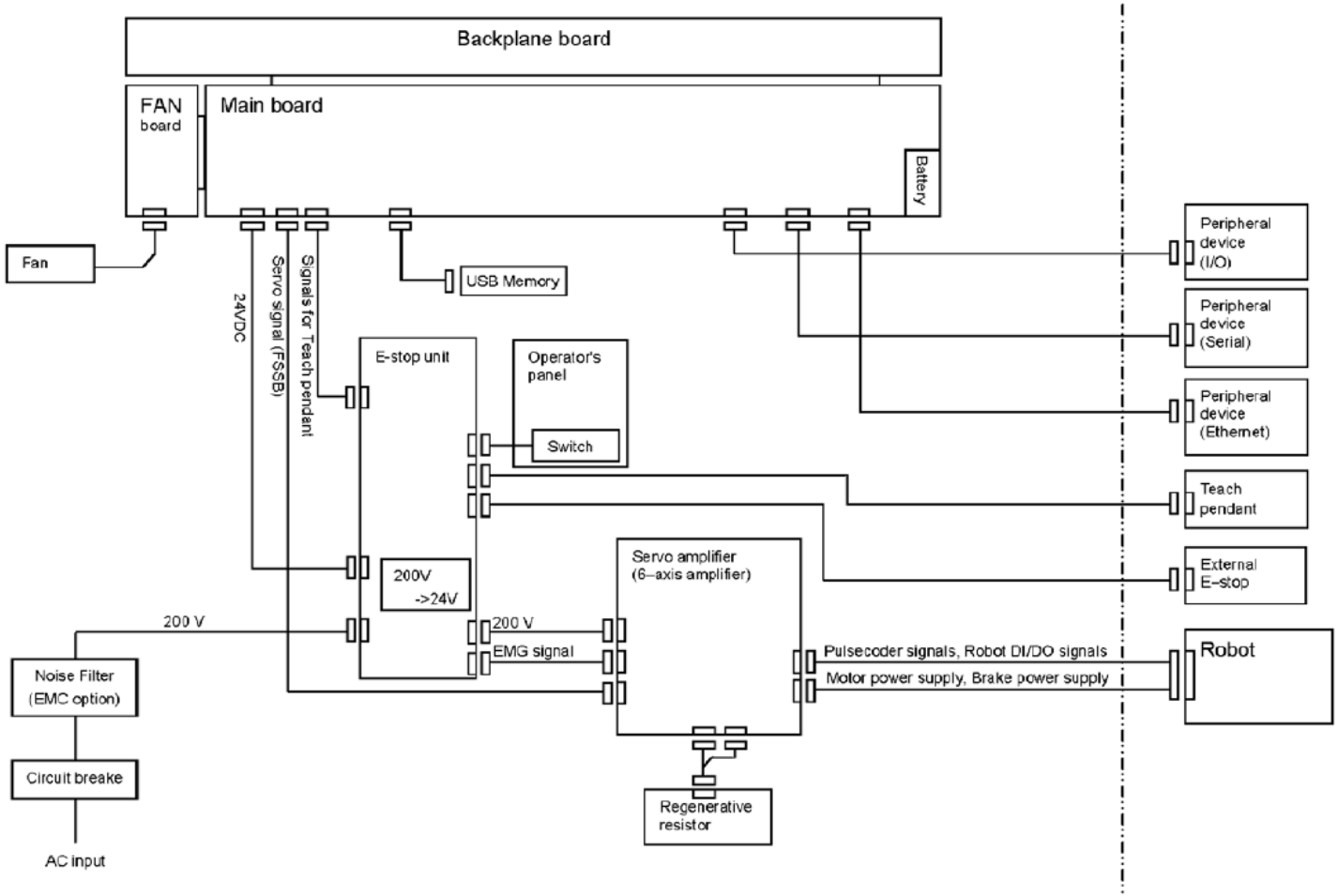




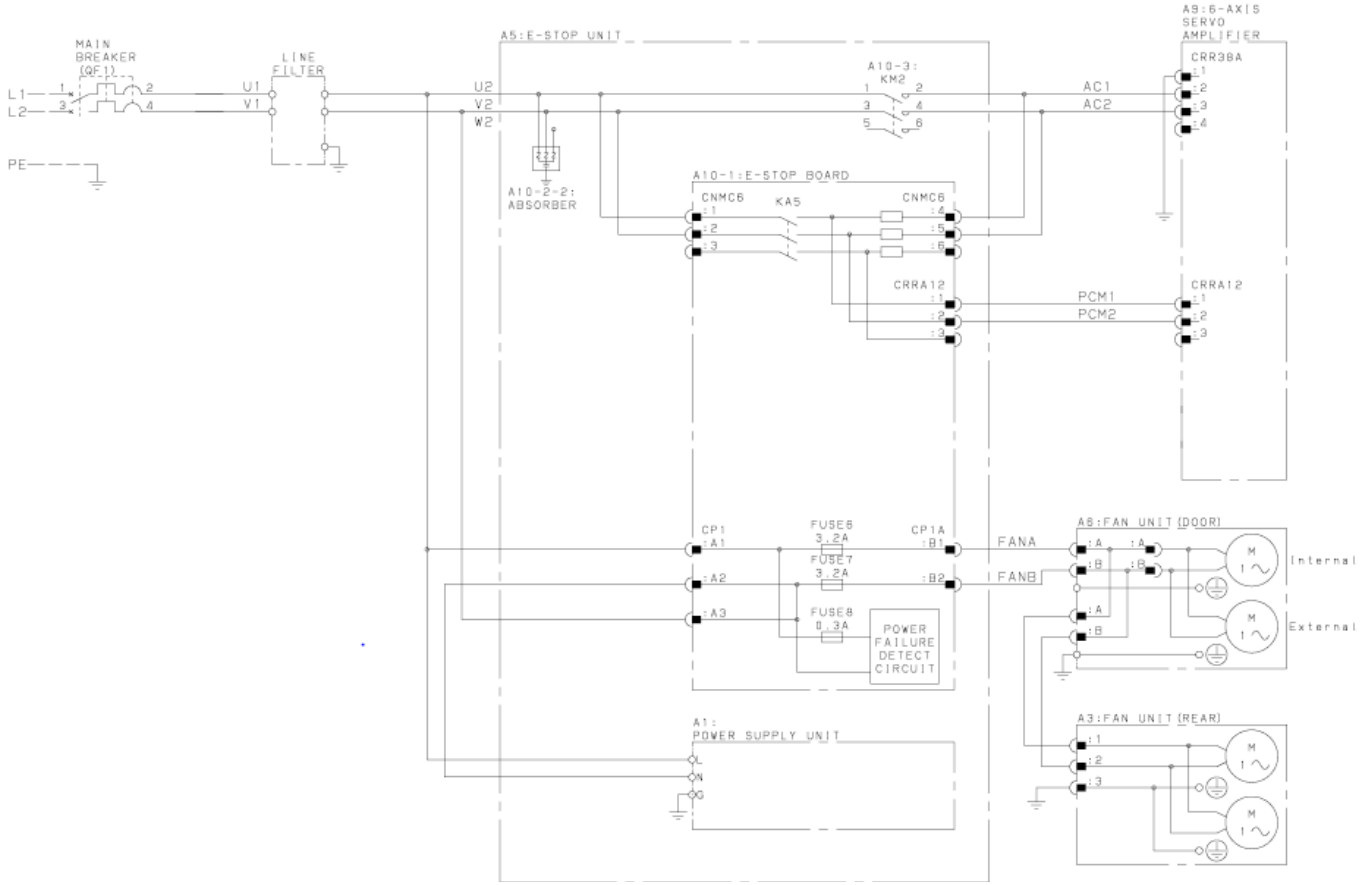
Connection diagram example of controler power and control wires



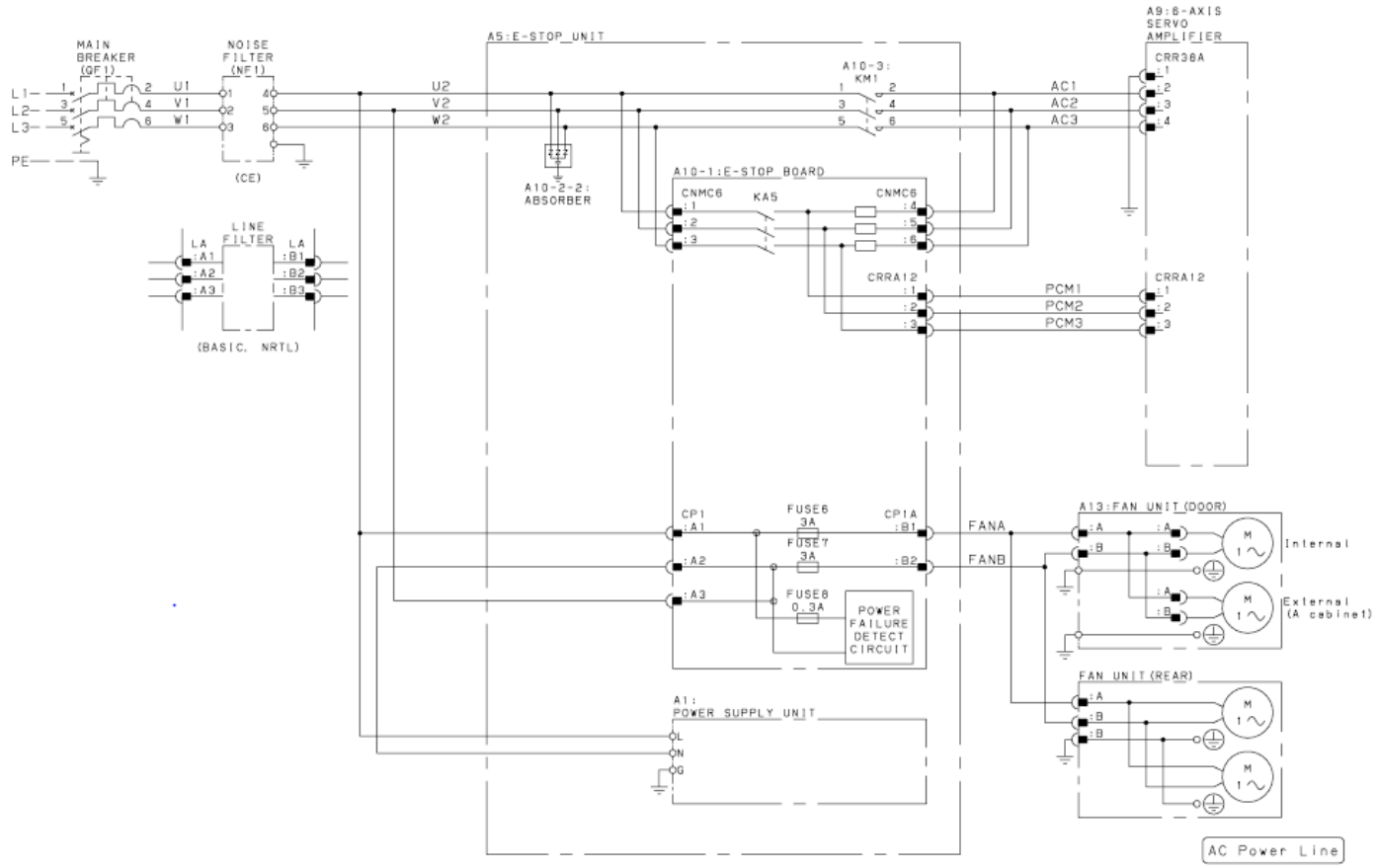
Block diagram of The Controller R-30iB Mate (FANUC)



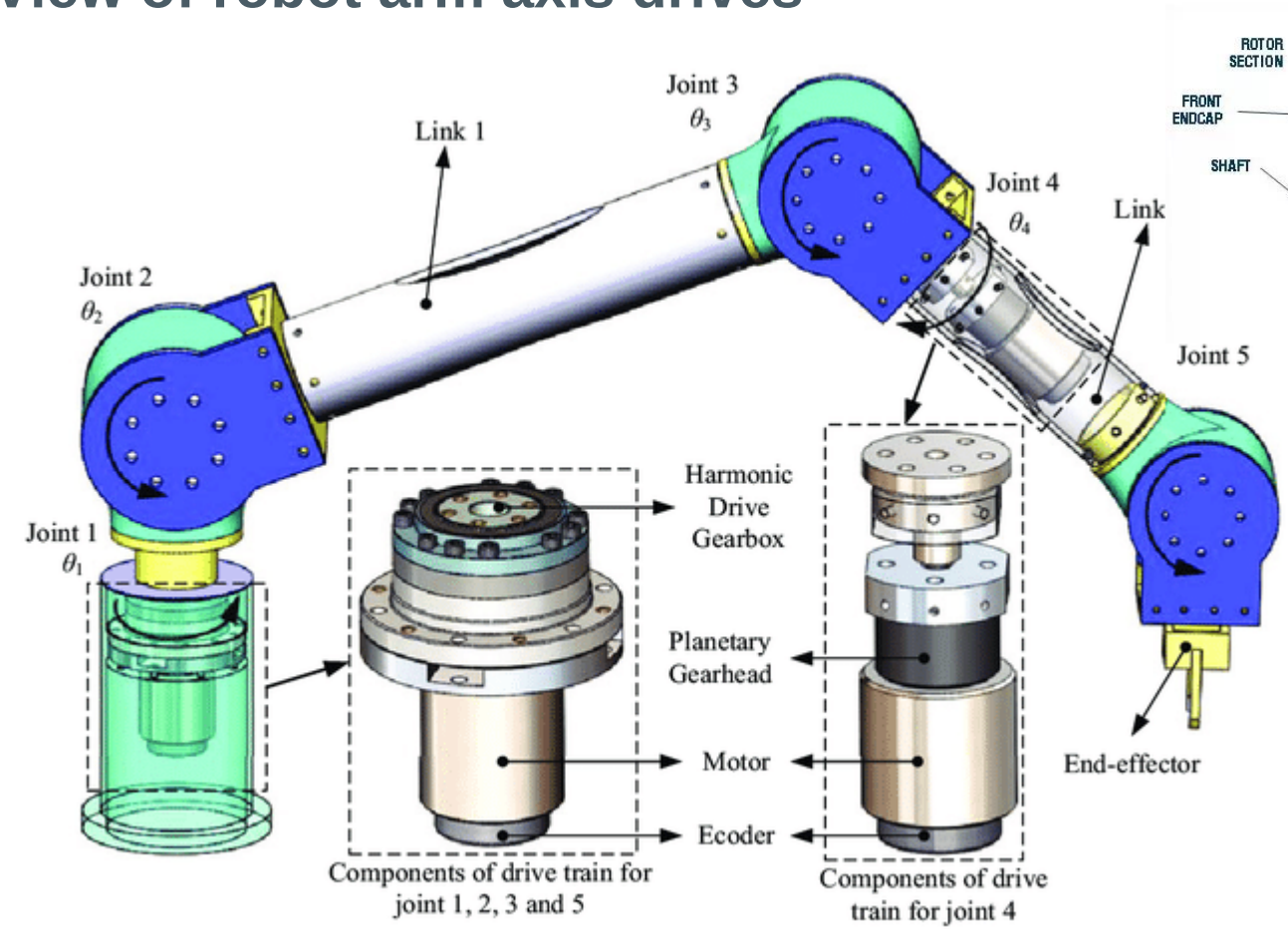
Power line connection examples – single phase power source

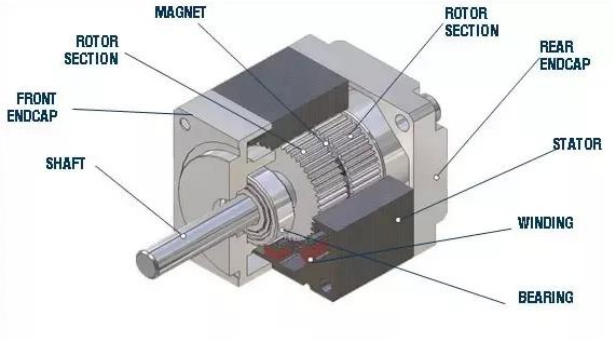


Power line connection examples – three phase power source



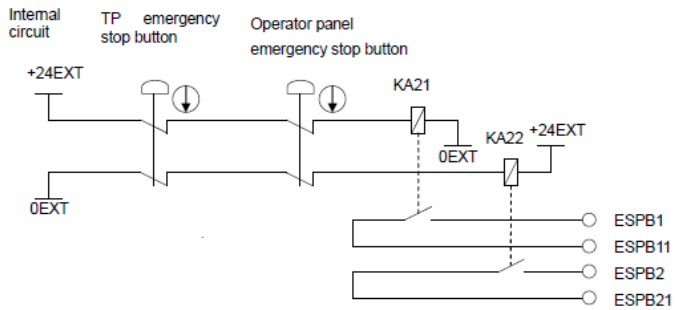
View of robot arm axis drives

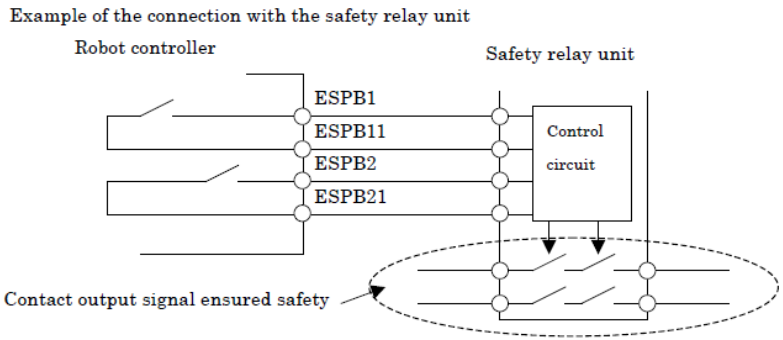




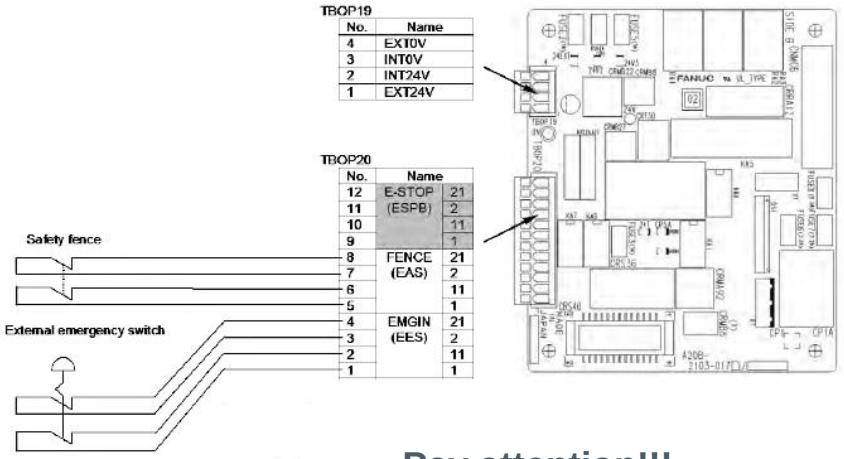
Emergency Stop circuits

Robots Touch Pendants and Operator Panels
Emergency wires connected to external safety unit

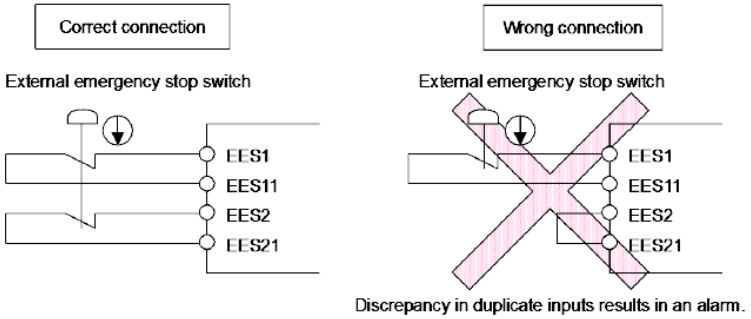




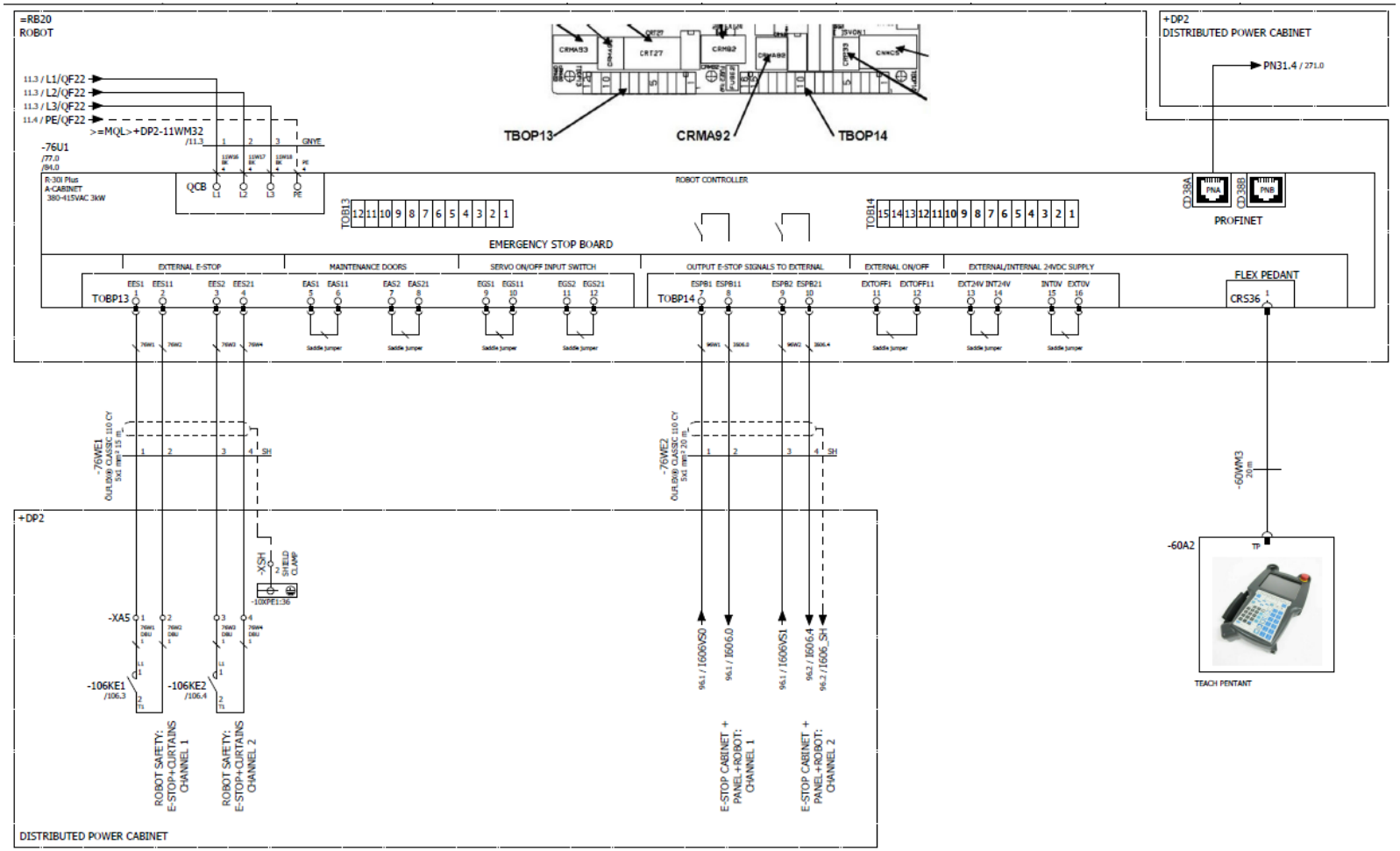
External emergency and safety fence connection



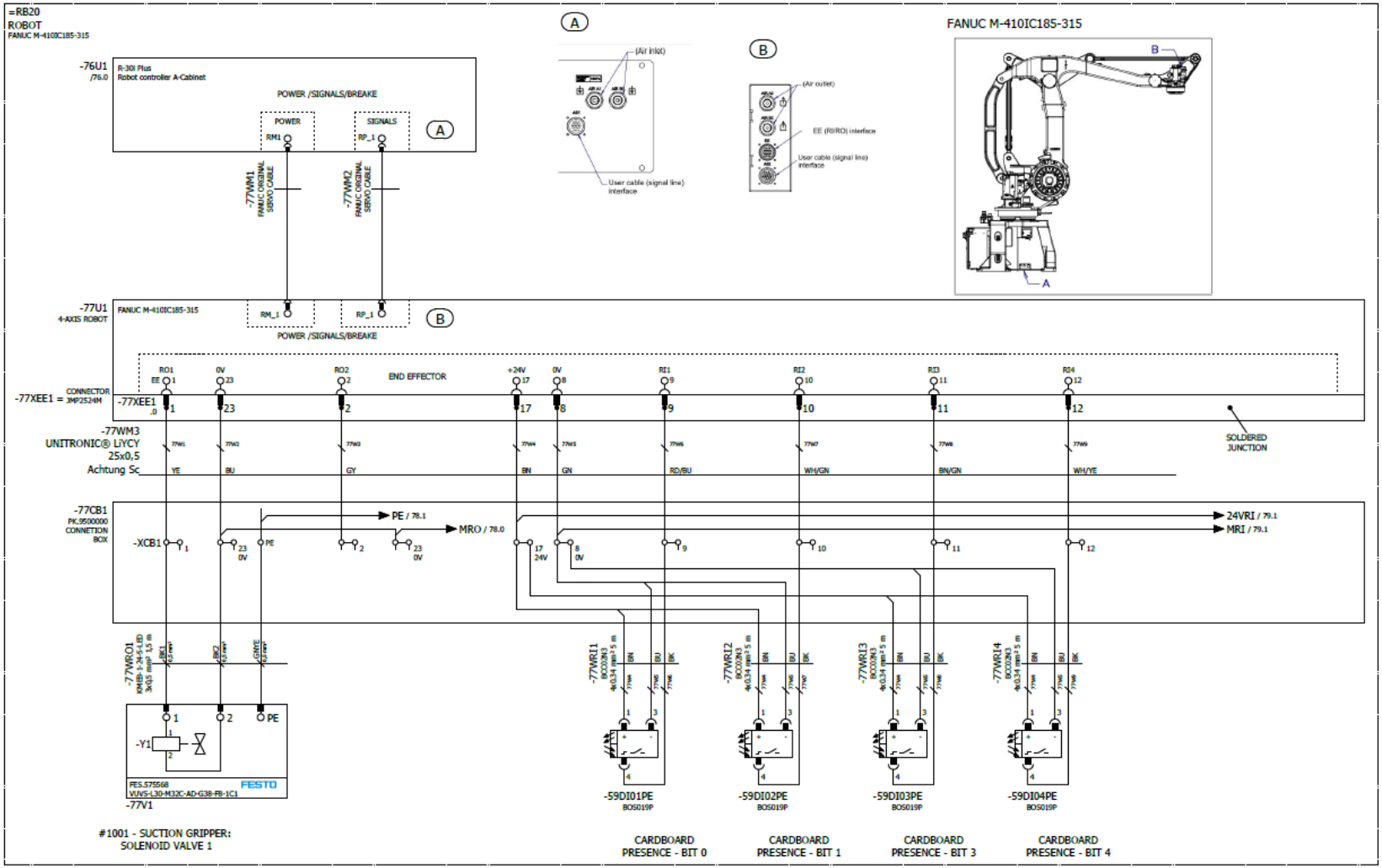
Pay attention!!!



Example diagrams in industrial aplication of assembly line



Example diagrams in industrial aplication of assembly line



Thank you very much for your attention!