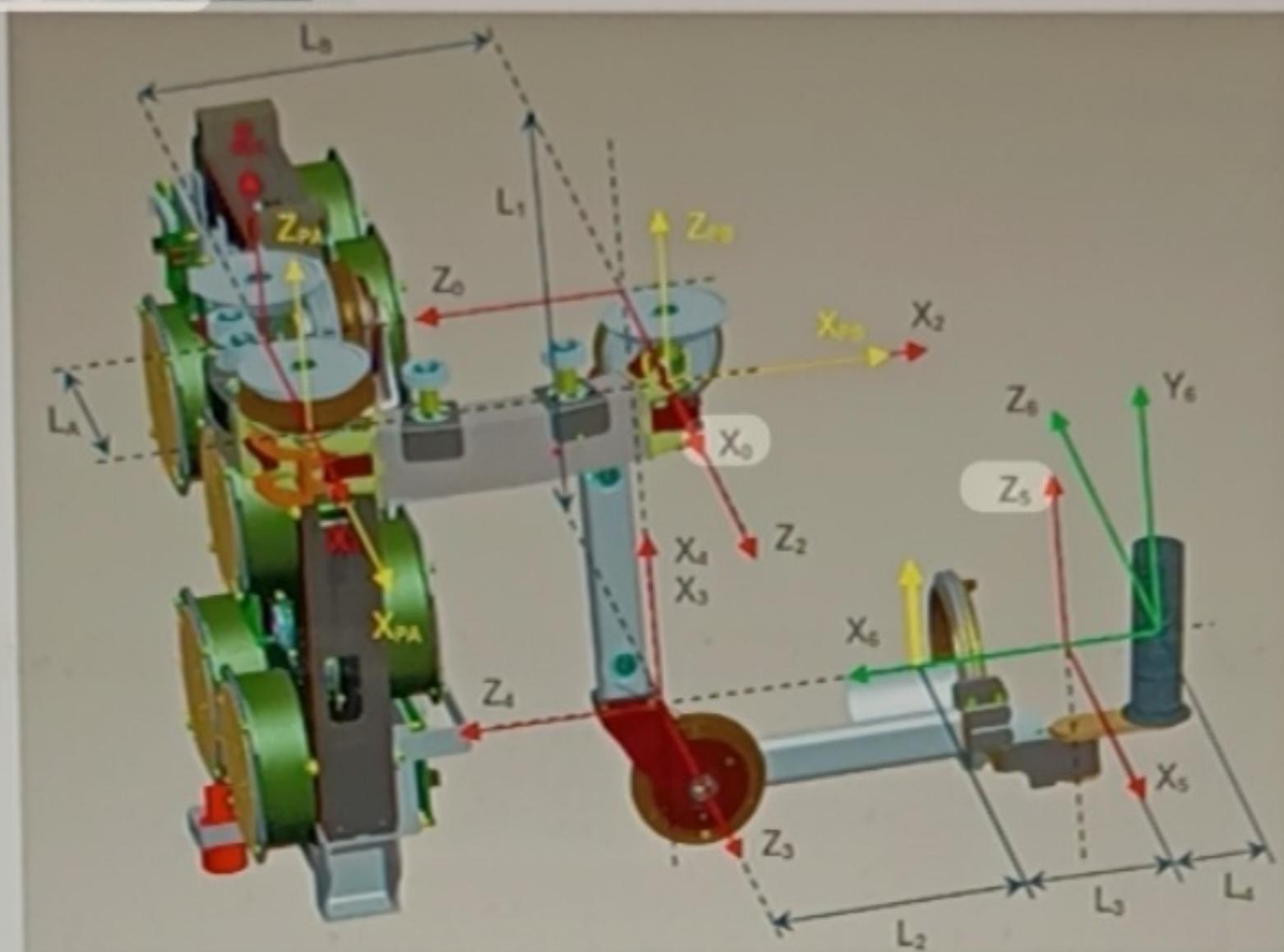## Label Connected/disconnected

The Connected/disconnected label on the GUI checks the communication frequency between the GUI and the Controlio. In practice, it becomes connected when the frequency, read by the Frequency() function in sharedMemory, is greater than 20.

Host Status Connected is a deprecated parameter.

Reference triads used

DH parameters

Link	D_i	ϑ_i	a_i	α_i
1	L_8 (300mm)	0	0	$-\pi/2$
A	0	0	The (170mm)	0
B	0	$\pi/2$	The	0
2	0	0	0	$\pi/2$
3	$-L_A$	$\pi/2$	$-L_1$ (278mm)	0
4	0	0	0	$-\pi/2$
5	$-(L_2+ L_3)$ (256mm)	$-\pi/2$	0	$-\pi/2$
6	0	$-\pi/2$	$-L_4$ (63mm)	$\pi/2$

Joint variable mapping

Regarding the joint variables, it should be noted that joint 2 contains the three rotations of the link that implement it: by construction, the three rotations are linked to each other (equal in magnitude, alternating signs). In conclusion, the joint variables reported in Joint Pos have the following meaning:

Position in Joint_Pos	Meaning	Note
1	Joint rotation 1	
2	PA rotation	Value and sign equal to joint rotation 2
3	PB rotation	Value equal to joint rotation 2, opposite sign
4	Joint rotation 2	
5	Joint rotation 3	
6	Rołazione joint 4	
7	Joint rotation 5	
8	Joint rotation 6	

Complete list of ControlPhases

Phase	Value	Meaning
PHASE_STARTING_UP	-100	The system just turned on, instantly switches to phase PHASE_DRIVER_OFF
PHASE_DRIVER_OFF	0	Current drivers disabled, arm ready to be turned on
PHASE_ACT_DRIVER	5	Arm activation procedure in progress: enabling motor current drivers
PHASE_ACT_CONTROL	6	Arm activation procedure in progress: motor current drivers enabled
PHASE_MOTOR_RESET	7	Arm activation procedure in progress: motor reset procedure in progress (encoders are reset via index signal and tests are performed on rotor phasing and correct encoder rotation signs)
PHASE_ENCODER_RESET	8	Arm activation procedure in progress: encoders reset in progress (the arm assumes a known posture and a correction offset determined using the positions measured by the sensors in the joints is applied to the position of the incremental encoders)
PHASE_WEARING	10	Arm activation procedure completed, the arm is ready to be worn
PHASE_PRE_REHAB	15	Activation of the rehabilitation phase: activation of friction compensations for maximum transparency, but no rehabilitation commands from the application
PHASE_REHAB	20	Rehabilitation phase: the controller receives the rehabilitation commands and applies them
PHASE_DEACT_CONTROL	2	Arm deactivation procedure in progress: progressive reduction of the weight compensation of the robotic arm, which slowly falls into the rest position
PHASE_DEACT_DRIVER	1	Arm deactivation procedure in conso: disabling the current drivers
PHASE_FAULT	100	The system has detected a fault condition and goes into a safe state (drivers disabled... very similar to the driver off phase)

Other stages are reached only during calibration and in service functionality

Rehab phase

When the controller in the Wearing phase receives the Rehab command, it immediately switches to the Pre_Rehab phase (15). The transition from the Pre_Rehab phase to the Rehab phase (20) occurs as soon as UDP command packets are received. If the command data communication is interrupted, the controller switches back to the Pre_Rehab phase.

Mirror mode

In Mirror mode there is no master arm and no slave arm... both are controlled in the same way: each of the two arms is positionally controlled and has the position of the other arm as a reference.

The bilateral factor parameter allows to reduce the position control gains, to obtain a more compliant mirror function.

The bilateral FunctionActivation is the function, present in sharedMemory, that activates the Mirror mode

ControlMode and ToolMode

ControlMode is set when the machine is turned off and specifies the operating mode the machine will have when turned on. In addition to the normal mode set for performing rehabilitation exercises, there are modes used to calibrate the machine.

ToolMode was used for research projects, now it is obsolete.

Control mode

The command packet can only be sent in its entirety. To activate one mode at a time, you must set values that nullify the effects of the modes you want to exclude.

The following table details the parameter values to be set to deactivate the control modes.

Mode	Structure field ALEX30_REHAB_Exos_DataOut	Value to deactivate the modality
Forza all'end-effector	EE_Force_des[3]	[0 0 0]
Torque at joints	Joint_Torque_des[4]	[0 0 0 0]
Impendenza all'end-effector	EE_Pos_des[3]	Any value
	EE_Vel_des[3]	Any value
	EE_Impedance.Pos.K[3]	[0 0 0]
	EE_Impedance.Pos.C_rel[3]	[0 0 0]
	EE_Impedance.Pos.C_ass[3]	[0 0 0]
	EE_Impedance.Pos.Speed[3]	[10000 10000 10000]
	EE_Impedance.Neg.K[3]	[0 0 0]
	EE_Impedance.Neg.C_rel[3]	[0 0 0]
	EE_Impedance.Neg.C_ass[3]	[0 0 0]
	EE_Impedance.Neg.Speed[3]	[10000 10000 10000]
	EE_Impedance.Revo[9]	Any array of rotation
	EE_Speed_max	Any value
	EE_Force_max	Any value
Joint impedance	Joint_Pos_des[4]	Any value
	Joint_Vel_des[4]	Any value
	Joint_Impedance1.K	0
	Joint_Impedance1.C_rel	0
	Joint_Impedance1.C_ass	0
	Joint_Impedance1.Speed	10000
	Joint_Impedance2.K	0

Joint_Impedance2.C_rel	0
Joint_Impedance2.C_ass	0
Joint_Impedance2.Speed	10000
Joint_Impedance3.K	0
Joint_Impedance3.C_rel	0
Joint_Impedance3.C_ass	0
Joint_Impedance3.Speed	10000
Joint_Impedance4.K	0
Joint_Impedance4.C_rel	0
Joint_Impedance4.C_ass	0
Joint_Impedance4.Speed	10000
Joint_Speed_max[4]	Any value
Joint_Torque_max[4]	Any value