

Revision #: 8

Engr. Spec. #	Importance	Source	Specification (description)	Unit of Measure	Marginal Value	Ideal Value
ES1	1	CN7	Arm is capable of incorporating the hand	boolean		TRUE
ES2	3	CN12	Human interface can be understood quickly	minutes	20	5
ES3	1	CN1	Wrist has same number of degrees of freedom as the human hand	degrees of freedom	2	2
ES4	1	CN2	Forearm has same number of degrees of freedom as the human hand	degrees of freedom	1	1
ES5	1	CN3	Elbow has same number of degrees of freedom as the human hand	degrees of freedom	1	1
ES6	2	CN7	Provides enough power to be able to manuver previous hand	lbf	(arm's own weight)	(weight of arm and hand)
ES7	1	CN8,CN9,CN10	SolidWorks CAD model of every part	boolean		TRUE
ES8	3	CN4,CN5,CN6	Length of a arm, shoulder to fingertips ¹	inches	20-40	30
ES9	3	CN4	Hand length, wrist to fingertips ¹	inches	5-15	7
ES10	3	CN6	Bicep length ¹	inches	10-15	12
ES11	3	CN5	Forearm length ¹	inches	9-17	12
ES12	2	CN7	Maximum Manageable Weight	lbs	10	20
ES13	2	CN4	Wrist Sagittal Flexion replicates human motion (Wrist Down)	degrees	60	80
ES14	3		Position Tolerance	degrees	±8	±1
ES15	2	CN4	Wrist Sagittal Extension replicates human motion (Wrist Up)	degrees	55	70
ES16	3		Position Tolerance	degrees	±7	±1
ES17	2	CN4	Wrist Radial Deviation replicates human motion (Wrist Left)	degrees	15	20
ES18	3		Position Tolerance	degrees	±2	±1
ES19	2	CN4	Wrist Ulnar Deviation replicates human motion (Wrist Right)	degrees	20	30
ES20	3		Position Tolerance	degrees	±2	±1.5
ES21	2	CN5	Forearm Pronation (thumb in) resembles human motion (Rotate CCW)	degrees	60	80
ES22	3		Position Tolerance	degrees	±8	±1
ES23	2	CN5	Forearm Supination (thumb out) resembles human motion (Rotate CW)	degrees	60	80
ES24	3		Position Tolerance	degrees	±8	±1
ES25	2	CN6	Elbow Flexion resembles human motion (Elbow)	degrees	135	150
ES26	3		Position Tolerance	degrees	±15	±1
ES27	2	CN4	Wrist Movement speed (median)	deg/s	60	180
ES28	2	CN5	Forearm Movement speed (median)	deg/s	90	210
ES29	2	CN6	Elbow Movement speed (median)	deg/s	180	215

Engr. Spec. #: enables cross-referencing (traceability) and allows mapping to lower level specs within separate documents

Source: Customer need #, regulatory standard (eg. EN 60601), and/or "implied" (must exist but doesn't have an associated customer need)

Description: quantitative, measureable, testable details

¹ <http://www.jneuhaus.com/human.html>