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8. Anexos

I. Desenhos Técnicos das Peças do Manipulador.
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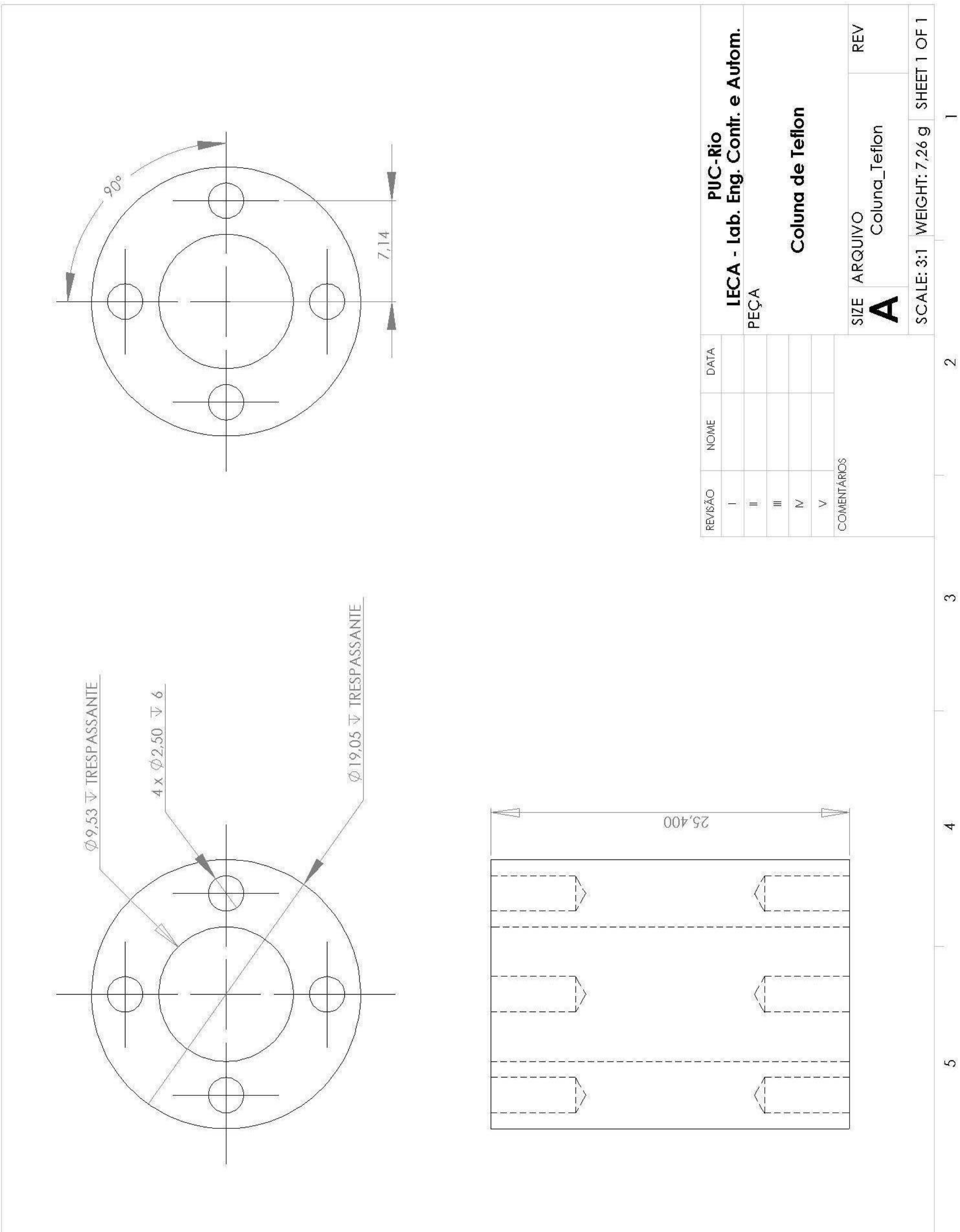
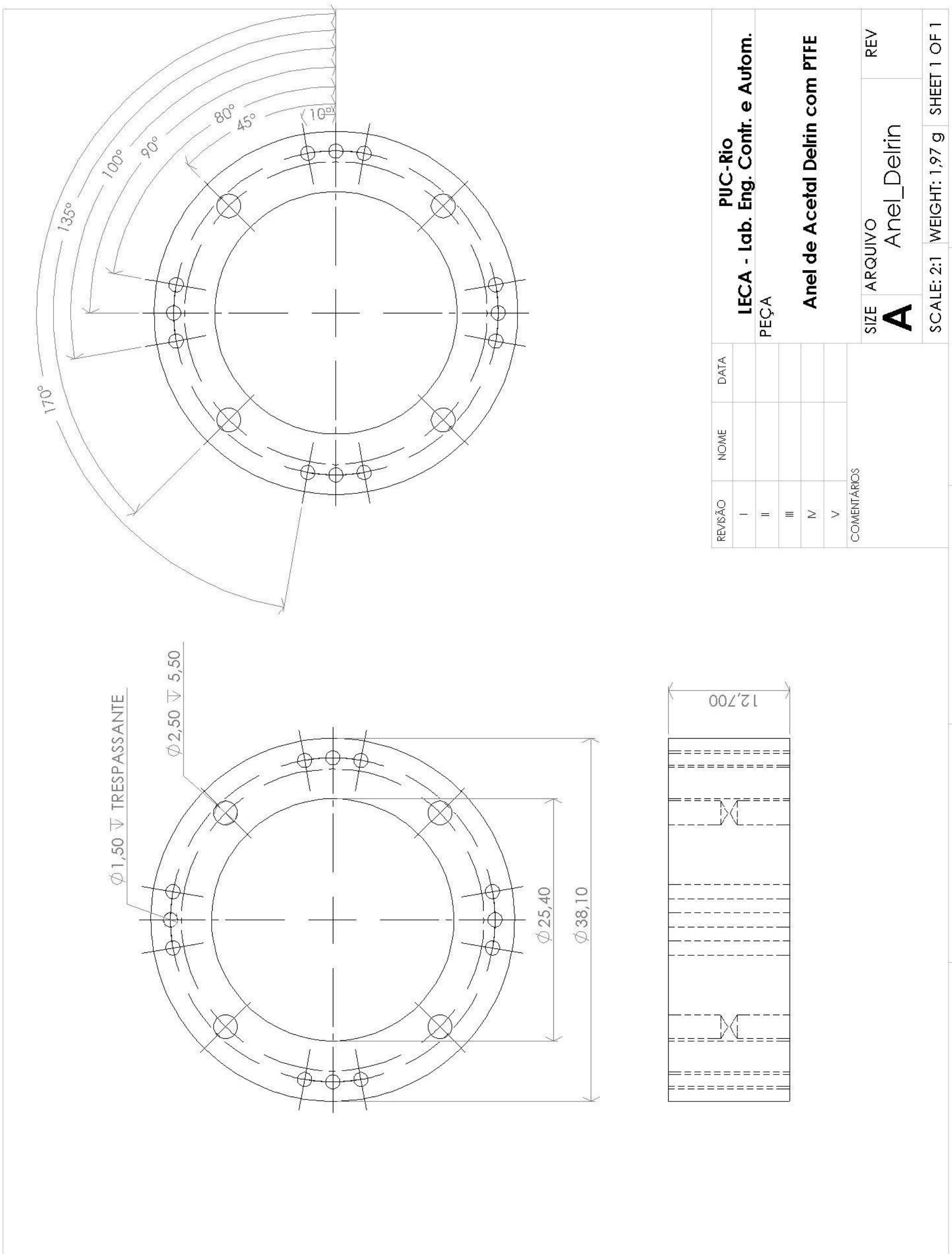
Anexo I

Desenhos Técnicos das Peças do Manipulador.

Desenho Técnico da Coluna



Desenho Técnico do Anel



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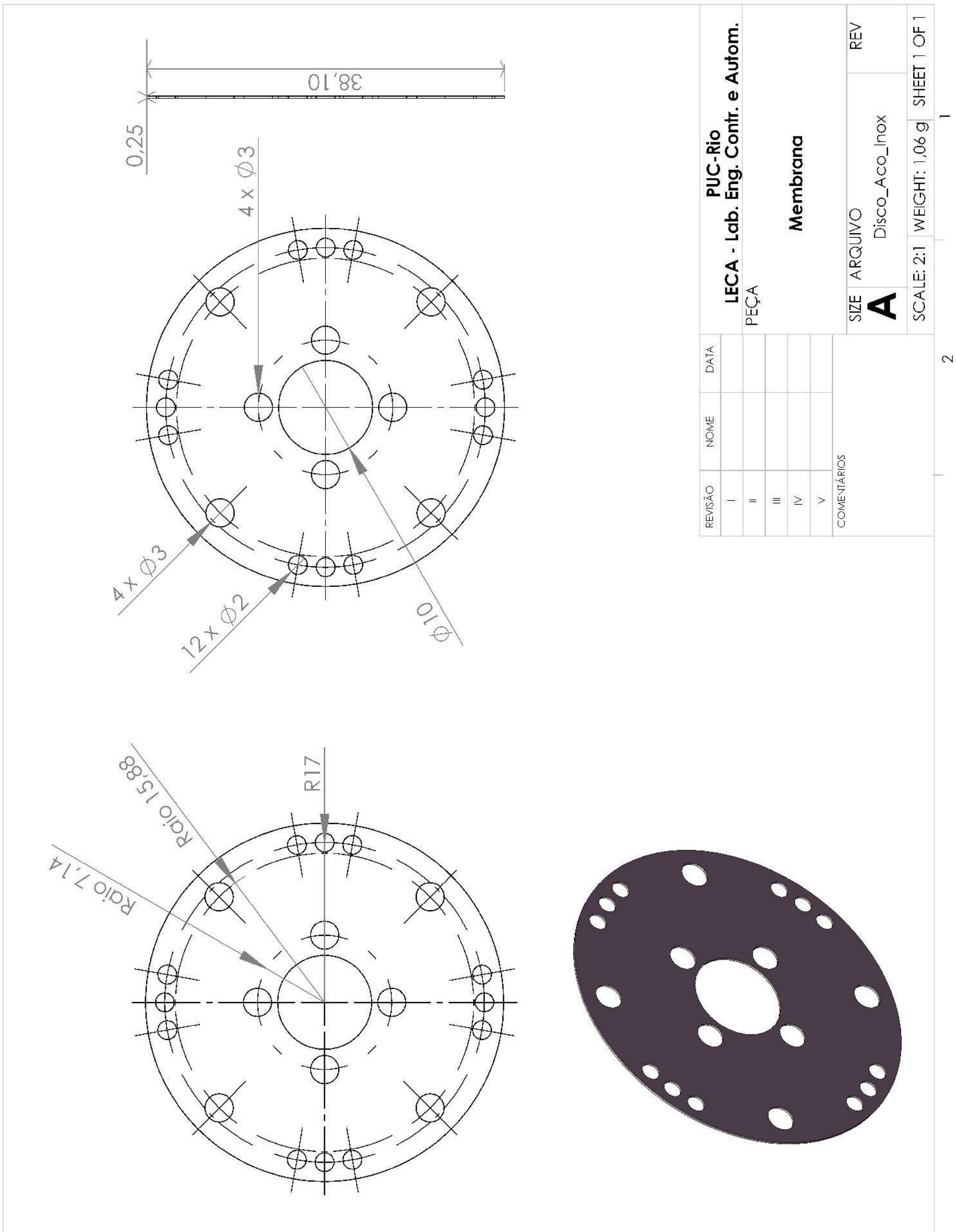
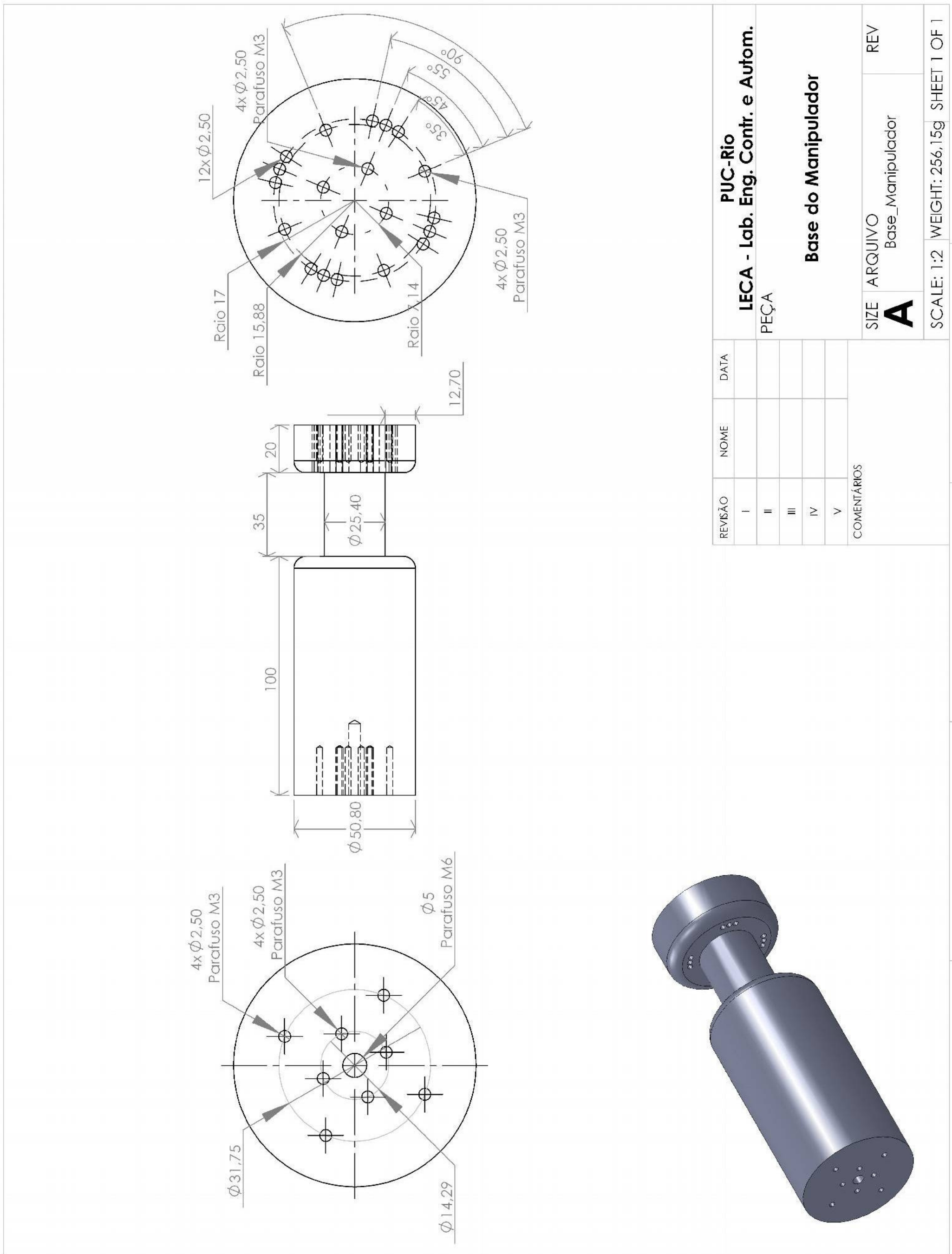
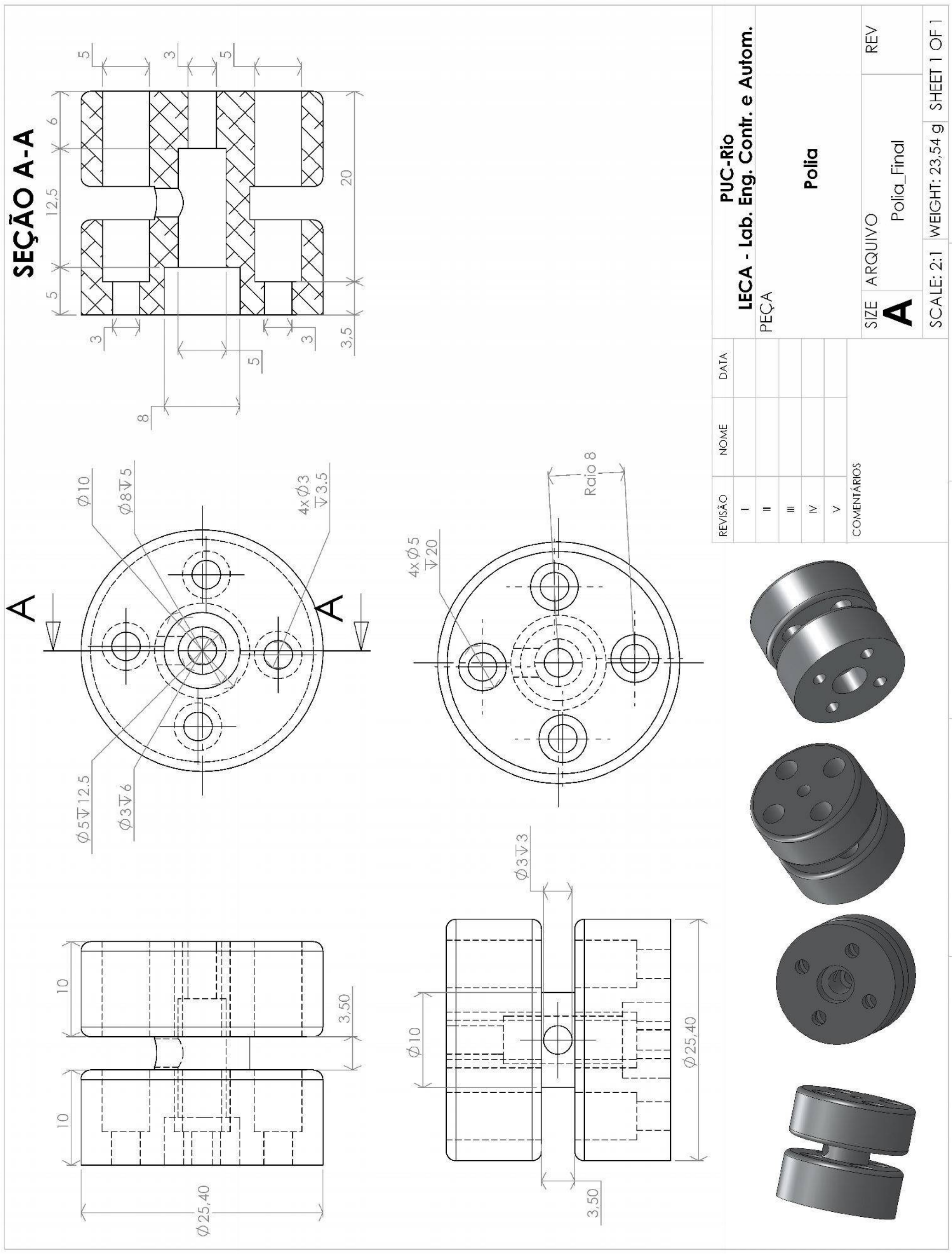


Desenho Técnico da Base do Manipulador



Desenho Técnico da Polia



Anexo II

Propriedades Mecânicas das Peças Utilizadas no Manipulador.

304 Stainless Steel

Categories: Metal; Ferrous Metal; Heat Resisting; Stainless Steel; T 300 Series Stainless Steel

Material Notes: Austenitic Cr-Ni stainless steel. Better corrosion resistance than Type 302. High ductility, excellent drawing, forming, and spinning properties. Essentially non-magnetic, becomes slightly magnetic when cold worked. Low carbon content means less carbide precipitation in the heat-affected zone during welding and a lower susceptibility to intergranular corrosion.

Applications: beer kegs, bellows, chemical equipment, coal hopper linings, cooking equipment, cooling coils, cryogenic vessels, dairy equipment, evaporators, flatware utensils, feedwater tubing, flexible metal hose, food processing equipment, hospital surgical equipment, hypodermic needles, kitchen sinks, marine equipment and fasteners, nuclear vessels, oil well filter screens, refrigeration equipment, paper industry, pots and pans, pressure vessels, sanitary fittings, valves, shipping drums, spinning, still tubes, textile dyeing equipment, tubing.

Corrosion Resistance: resists most oxidizing acids and salt spray.

UNS S30400; AMS 5501, 5513, 5560, 5565; ASME SA182, SA194 (8), SA213, SA240; ASTM A167, A182, A193, A194

Key Words: aisi304, aisi 304, T304, T 304, SUS304, SS304, 304SS, 304 SS, UNS S30400, AMS 5501, AMS 5513, AMS 5560, AMS 5565, AMS 5566, AMS 5567, AMS 5639, AMS 5697, ASME SA182, ASME SA194 (8), ASME SA213, ASME SA240, ASME SA249, ASME SA312, ASME SA320 (B8), ASME SA358, ASME SA376, ASME SA403, ASME SA409, ASME SA430, ASME SA479, ASME SA688, ASTM A167, ASTM A182, ASTM A193, ASTM A194, ASTM A666, FED QQ-S-763, MILSPEC MIL-S-5059, SAE 30304, DIN 1.4301, X5CrNi189, B.S. 304 S 15, EN 58E, PN 86020 (Poland), OH18N9, ISO 4954 X5CrNi189E, ISO 683/13 11, 18-8

Vendors: **Click here to view all available suppliers for this material.**

Please click here if you are a supplier and would like information on how to add your listing to this material.

Physical Properties	Metric	English	Comments
Density	8.00 g/cc	0.289 lb/in³	

Mechanical Properties	Metric	English	Comments
Hardness, Brinell	123	123	Converted from Rockwell B hardness.
Hardness, Knoop	138	138	Converted from Rockwell B hardness.
Hardness, Rockwell B	70	70	
Hardness, Vickers	129	129	Converted from Rockwell B hardness.
Tensile Strength, Ultimate	505 MPa	73200 psi	
Tensile Strength, Yield	215 MPa	31200 psi	at 0.2% offset
Elongation at Break	70.0 %	70.0 %	in 50 mm
Modulus of Elasticity	193 - 200 GPa	28000 - 29000 ksi	
Poissons Ratio	0.290	0.290	
Charpy Impact	325 J	240 ft-lb	
Shear Modulus	86.0 GPa	12500 ksi	

Electrical Properties	Metric	English	Comments
Electrical Resistivity	0.0000720 ohm-cm @Temperature 20.0 °C	0.0000720 ohm-cm @Temperature 68.0 °F	
	0.000116 ohm-cm @Temperature 650 °C	0.000116 ohm-cm @Temperature 1200 °F	
Magnetic Permeability	1.008	1.008	at RT

Thermal Properties	Metric	English	Comments
CTE, linear	17.3 µm/m-°C @Temperature 0.000 - 100 °C	9.61 µin/in-°F @Temperature 32.0 - 212 °F	
	17.8 µm/m-°C @Temperature 0.000 - 315 °C	9.89 µin/in-°F @Temperature 32.0 - 599 °F	
	18.7 µm/m-°C @Temperature 0.000 - 650 °C	10.4 µin/in-°F @Temperature 32.0 - 1200 °F	
Specific Heat Capacity	0.500 J/g-°C @Temperature 0.000 - 100 °C	0.120 BTU/lb-°F @Temperature 32.0 - 212 °F	
Thermal Conductivity	16.2 W/m-K @Temperature 0.000 - 100 °C	112 BTU-in/hr-ft²-°F @Temperature 32.0 - 212 °F	
	21.5 W/m-K @Temperature 500 °C	149 BTU-in/hr-ft²-°F @Temperature 932 °F	
Melting Point	1400 - 1455 °C	2550 - 2651 °F	
Solidus	1400 °C	2550 °F	
Liquidus	1455 °C	2651 °F	

Component Elements Properties	Metric	English	Comments
Carbon, C	<= 0.080 %	<= 0.080 %	
Chromium, Cr	18.0 - 20.0 %	18.0 - 20.0 %	
Iron, Fe	66.345 - 74.0 %	66.345 - 74.0 %	
Manganese, Mn	<= 2.0 %	<= 2.0 %	
Nickel, Ni	8.0 - 10.5 %	8.0 - 10.5 %	
Phosphorous, P	<= 0.045 %	<= 0.045 %	
Silicon, Si	<= 1.0 %	<= 1.0 %	
Sulfur, S	<= 0.030 %	<= 0.030 %	

Overview of materials for Nylon 6, Heat Stabilized

Categories: Polymer; Thermoplastic; Nylon; Nylon 6; Nylon 6, Heat Stabilized

Material Notes: This property data is a summary of similar materials in the MatWeb database for the category "Nylon 6, Heat Stabilized". Each property range of values reported is minimum and maximum values of appropriate MatWeb entries. The comments report the average value, and number of data points used to calculate the average. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

Vendors: **Click here to view all available suppliers for this material.**

Please click here if you are a supplier and would like information on how to add your listing to this material.

Physical Properties	Metric	English	Comments
Bulk Density	0.700 g/cc	0.0253 lb/in^3	Average value: 0.700 g/cc Grade Count:4
Density	1.06 - 1.58 g/cc	0.0383 - 0.0571 lb/in^3	Average value: 1.19 g/cc Grade Count:96
Filler Content	13.0 - 40.0 %	13.0 - 40.0 %	Average value: 27.2 % Grade Count:10
Water Absorption	0.450 - 10.0 %	0.450 - 10.0 %	Average value: 2.22 % Grade Count:47
Moisture Absorption at Equilibrium	0.250 - 3.00 %	0.250 - 3.00 %	Average value: 2.40 % Grade Count:21
Water Absorption at Saturation	6.00 - 9.50 %	6.00 - 9.50 %	Average value: 7.74 % Grade Count:17
Viscosity Measurement	2.60 - 200	2.60 - 200	Average value: 60.0 Grade Count:7
Viscosity Test	142 - 220 cm^3/g	142 - 220 cm^3/g	Average value: 194 cm^3/g Grade Count:3
Linear Mold Shrinkage	0.00200 - 0.0200 cm/cm	0.00200 - 0.0200 in/in	Average value: 0.00964 cm/cm Grade Count:60
	0.00500 - 0.00960 cm/cm @Temperature 280 - 290 °C	0.00500 - 0.00960 in/in @Temperature 536 - 554 °F	Average value: 0.00777 cm/cm Grade Count:4
	0.00500 - 0.00960 cm/cm @Pressure 50.0 - 60.0 MPa	0.00500 - 0.00960 in/in @Pressure 7250 - 8700 psi	Average value: 0.00777 cm/cm Grade Count:4
Linear Mold Shrinkage, Transverse	0.00500 - 0.0160 cm/cm	0.00500 - 0.0160 in/in	Average value: 0.0116 cm/cm Grade Count:9
	0.00500 - 0.00960 cm/cm @Temperature 280 - 290 °C	0.00500 - 0.00960 in/in @Temperature 536 - 554 °F	Average value: 0.00673 cm/cm Grade Count:4
	0.00500 - 0.00960 cm/cm @Pressure 50.0 - 60.0 MPa	0.00500 - 0.00960 in/in @Pressure 7250 - 8700 psi	Average value: 0.00673 cm/cm Grade Count:4
Melt Flow	3.60 - 30.0 g/10 min	3.60 - 30.0 g/10 min	Average value: 16.8 g/10 min Grade Count:4

Mechanical Properties	Metric	English	Comments
Hardness, Rockwell R	78.0 - 121	78.0 - 121	Average value: 109 Grade Count:20
Ball Indentation Hardness	60.0 - 230 MPa	8700 - 33400 psi	Average value: 146 MPa Grade Count:14
Tensile Strength, Ultimate	37.9 - 107 MPa	5500 - 15500 psi	Average value: 71.2 MPa Grade Count:25
	21.0 - 60.0 MPa @Temperature 60.0 - 120 °C	3050 - 8700 psi @Temperature 140 - 248 °F	Average value: 40.2 MPa Grade Count:2
Tensile Strength, Yield	29.0 - 221 MPa	4200 - 32000 psi	Average value: 85.6 MPa Grade Count:79
Elongation at Break	1.50 - 300 %	1.50 - 300 %	Average value: 65.4 % Grade Count:66
Elongation at Yield	3.00 - 25.0 %	3.00 - 25.0 %	Average value: 6.53 % Grade Count:25
Creep Strength	4.00 - 20.0 MPa	580 - 2900 psi	Average value: 11.9 MPa Grade Count:10
Modulus of Elasticity	0.600 - 8.50 GPa	87.0 - 1230 ksi	Average value: 3.15 GPa Grade Count:26
Flexural Modulus	0.614 - 13.1 GPa	89.0 - 1900 ksi	Average value: 3.65 GPa Grade Count:86
	0.450 - 3.70 GPa @Temperature 60.0 - 120 °C	65.3 - 537 ksi @Temperature 140 - 248 °F	Average value: 1.54 GPa Grade Count:2
Flexural Yield Strength	28.0 - 317 MPa	4060 - 46000 psi	Average value: 115 MPa Grade Count:80
Compressive Yield Strength	29.0 - 147 MPa	4210 - 21300 psi	Average value: 66.6 MPa Grade Count:12
Poissons Ratio	0.350	0.350	Average value: 0.350 Grade Count:4
Izod Impact, Unnotched (ISO)	35.0 - 90.0 kJ/m^2	16.7 - 42.8 ft-lb/in^2	Average value: 53.8 kJ/m^2 Grade Count:4
	60.0 - 60.0 kJ/m^2 @Temperature -30.0 - -30.0 °C	28.6 - 28.6 ft-lb/in^2 @Temperature -22.0 - -22.0 °F	Average value: 60.0 kJ/m^2 Grade Count:2
Charpy Impact Unnotched	2.10 J/cm^2 - NB	9.99 ft-lb/in^2 - NB	Average value: 6.77 J/cm^2 Grade Count:13
	1.70 J/cm^2 - NB @Temperature -40.0 - -20.0 °C	8.09 ft-lb/in^2 - NB @Temperature -40.0 - -4.00 °F	Average value: 5.10 J/cm^2 Grade Count:7
Charpy Impact, Notched	0.430 J/cm^2 - NB	2.05 ft-lb/in^2 - NB	Average value: 2.38 J/cm^2 Grade Count:10
	0.380 - 1.00 J/cm^2 @Temperature -30.0 - -30.0 °C	1.81 - 4.76 ft-lb/in^2 @Temperature -22.0 - -22.0 °F	Average value: 0.603 J/cm^2 Grade Count:7
Coefficient of Friction	0.0400 - 0.390	0.0400 - 0.390	Average value: 0.200 Grade Count:13
Tear Strength Test	0.150 - 0.250	0.150 - 0.250	Average value: 0.190 Grade Count:10
K Factor (Wear Factor)	9.00e-11 - 0.440	9.00e-11 - 0.440	Average value: 0.0400 Grade Count:11
Izod Impact, Notched	0.300 - 5340 J/cm	0.562 - 10000 ft-lb/in	Average value: 1.39 J/cm Grade Count:66
Izod Impact, Notched (ISO)	2.50 - 100000 kJ/m^2	1.19 - 47600 ft-lb/in^2	Average value: 9.41 kJ/m^2 Grade Count:17
	7.00 - 8.00 kJ/m^2 @Temperature -30.0 - -30.0 °C	3.33 - 3.81 ft-lb/in^2 @Temperature -22.0 - -22.0 °F	Average value: 7.50 kJ/m^2 Grade Count:2

Electrical Properties	Metric	English	Comments
Electrical Resistivity	1.00e+11 - 1.00e+15 ohm-cm	1.00e+11 - 1.00e+15 ohm-cm	Average value: 2.86e+14 ohm-cm Grade Count:26
Surface Resistance	1.00e+10 - 1.00e+15 ohm	1.00e+10 - 1.00e+15 ohm	Average value: 6.11e+13 ohm Grade Count:17
Dielectric Constant	2.00 - 7.00	2.00 - 7.00	Average value: 3.60 Grade Count:17
Dielectric Strength	16.5 - 80.0 kV/mm	420 - 2030 kV/in	Average value: 30.2 kV/mm Grade Count:27
Dielectric Loss Index	0.0300	0.0300	Average value: 0.0300 Grade Count:10
Comparative Tracking Index	375 - 600 V	375 - 600 V	Average value: 542 V Grade Count:12

Thermal Properties	Metric	English	Comments
CTE, linear	30.6 - 130 µm/m-°C	17.0 - 72.2 µin/in-°F	Average value: 70.6 µm/m-°C Grade Count:38
CTE, linear, Transverse to Flow	60.0 - 140 µm/m-°C	33.3 - 77.8 µin/in-°F	Average value: 110 µm/m-°C Grade Count:7
Specific Heat Capacity	1.67 J/g-°C	0.399 BTU/lb-°F	Average value: 1.67 J/g-°C Grade Count:10
Thermal Conductivity	0.250 W/m-K	1.74 BTU-in/hr-ft^2-°F	Average value: 0.250 W/m-K Grade Count:10
Melting Point	215 - 224 °C	419 - 434 °F	Average value: 220 °C Grade Count:45
Maximum Service Temperature, Air	80.0 - 190 °C	176 - 374 °F	Average value: 146 °C Grade Count:15
Deflection Temperature at 0.46 MPa (66 psi)	105 - 216 °C	221 - 420 °F	Average value: 187 °C Grade Count:50
Deflection Temperature at 1.8 MPa (264 psi)	45.0 - 221 °C	113 - 430 °F	Average value: 100 °C Grade Count:75
Vicat Softening Point	166 - 205 °C	331 - 401 °F	Average value: 186 °C Grade Count:5
	205 - 210 °C @Temperature 120 - 120 °C	401 - 410 °F @Temperature 248 - 248 °F	Average value: 208 °C Grade Count:1
	205 - 210 °C @Load 0.999 - 5.00 kg	401 - 410 °F @Load 2.20 - 11.0 lb	Average value: 208 °C Grade Count:1
Minimum Service Temperature, Air	-100 - -40.0 °C	-148 - -40.0 °F	Average value: -45.0 °C Grade Count:11
Flammability, UL94	HB - 5VB	HB - 5VB	Grade Count:31
Oxygen Index	26.0 - 30.0 %	26.0 - 30.0 %	Average value: 28.3 % Grade Count:3
Glow Wire Test	775 - 960 °C	1430 - 1760 °F	Average value: 905 °C Grade Count:3
Shrinkage	0.0500 - 0.250 % @Temperature 120 - 120 °C	0.0500 - 0.250 % @Temperature 248 - 248 °F	Average value: 0.112 % Grade Count:4
	0.0500 - 0.250 % @Time 4.00 - 4.00 hour	0.0500 - 0.250 % @Time 4.00 - 4.00 hour	Average value: 0.112 % Grade Count:4

Processing Properties	Metric	English	Comments
Processing Temperature	40.0 - 293 °C	104 - 560 °F	Average value: 251 °C Grade Count:66
Rear Barrel Temperature	138 - 282 °C	280 - 540 °F	Average value: 235 °C Grade Count:15
Middle Barrel Temperature	227 - 277 °C	440 - 530 °F	Average value: 244 °C Grade Count:15
Front Barrel Temperature	227 - 271 °C	440 - 520 °F	Average value: 251 °C Grade Count:15
Nozzle Temperature	227 - 293 °C	440 - 560 °F	Average value: 249 °C Grade Count:15
Head Temperature	230 - 250 °C	446 - 482 °F	Average value: 244 °C Grade Count:4
Mold Temperature	21.1 - 121 °C	70.0 - 250 °F	Average value: 80.0 °C Grade Count:53
Drying Temperature	73.9 - 100 °C	165 - 212 °F	Average value: 78.8 °C Grade Count:45
Dry Time	2.00 - 12.0 hour	2.00 - 12.0 hour	Average value: 3.69 hour Grade Count:33
	2.00 - 4.00 hour @Temperature 79.4 - 79.4 °C	2.00 - 4.00 hour @Temperature 175 - 175 °F	Average value: 3.00 hour Grade Count:11
Moisture Content	0.0500 - 0.200 %	0.0500 - 0.200 %	Average value: 0.174 % Grade Count:25
Injection Pressure	3.45 - 172 MPa	500 - 25000 psi	Average value: 17.5 MPa Grade Count:18
Back Pressure	0.000 - 1.72 MPa	0.000 - 250 psi	Average value: 0.450 MPa Grade Count:37
Shot Size	30.0 - 80.0 %	30.0 - 80.0 %	Average value: 55.0 % Grade Count:13
Screw Speed	20.0 - 120 rpm	20.0 - 120 rpm	Average value: 73.9 rpm Grade Count:37

DuPont™ Delrin® AF Blend, Acetal homopolymer, PTFE-filled, extruded

Categories: Polymer; Thermoplastic; Acetal; Acetal Homopolymer, PTFE-Filled; Filled/Reinforced Thermoplastic

Material Notes: Delrin® AF Blend acetal is a unique thermoplastic material for use in moving parts in which low friction and long wear are important. It is a combination of Teflon® fibers uniformly dispersed in Delrin acetal resin. This combination produces a material that has strength, toughness, dimensional stability and good machinability, plus improved wear characteristics over unfilled Delrin. Delrin AF Blend, most commonly supplied as a 2:1 blend of Delrin AF100 and Delrin 150 resins, has excellent sliding/friction properties. Bearings made of Delrin AF Blend sustain high loads when operating at high speeds and show reduced wear. These bearings are also essentially free of slip-stick behavior because the static and dynamic coefficient of friction are closer than with most plastics. Delrin AF Blend retains much of the strength that is inherent in unmodified Delrin acetal. Some properties are changed due to the addition of the softer Teflon fiber. The natural color of Delrin AF Blend is dark brown.

Data provided by Quadrant Engineering Plastic Products from tests on stock shapes and parts produced by Quadrant EPP.

Key Words: Quadrant Engineering Plastics Products; POM, Polyoxymethylene; Polyformaldehyde; Polyacetal

Vendors: **Click here to view all available suppliers for this material.**

Please click here if you are a supplier and would like information on how to add your listing to this material.

Physical Properties	Metric	English	Comments
Specific Gravity	1.50 g/cc	1.50 g/cc	ASTM D792
Water Absorption	0.200 %	0.200 %	Immersion, 24hr; ASTM D570(2)
Water Absorption at Saturation	1.00 %	1.00 %	Immersion; ASTM D570(2)

Mechanical Properties	Metric	English	Comments
Hardness, Rockwell M	85	85	ASTM D785
Hardness, Rockwell R	115	115	ASTM D785
Hardness, Shore D	83	83	ASTM D2240
Tensile Strength, Ultimate	55.2 MPa	8000 psi	ASTM D638
Elongation at Break	15.0 %	15.0 %	ASTM D638
Tensile Modulus	3.00 GPa	435 ksi	ASTM D638
Flexural Modulus	3.07 GPa	445 ksi	ASTM D790
Flexural Yield Strength	82.7 MPa	12000 psi	ASTM D790
Compressive Strength	110 MPa	16000 psi	10% Def.; ASTM D695
Compressive Modulus	2.41 GPa	350 ksi	ASTM D695
Shear Strength	52.4 MPa	7600 psi	ASTM D732
Coefficient of Friction	0.190	0.190	Dry vs. Steel; QTM55007
K (wear) Factor	121 x 10^{-8} mm^3/N-M	60.0 x 10^{-10} in^3-min/ft-lb-hr	QTM 55010
Limiting Pressure Velocity	0.291 MPa-m/sec	8300 psi-ft/min	4:1 safety factor; QTM 55007
Izod Impact, Notched	0.374 J/cm	0.700 ft-lb/in	ASTM D256 Type A

Electrical Properties	Metric	English	Comments
Surface Resistivity per Square	>= 1.00e+13 ohm	>= 1.00e+13 ohm	EOS/ESD S11.11
Dielectric Constant	3.10 @Frequency 1e+6 Hz	3.10 @Frequency 1e+6 Hz	ASTM D150
Dielectric Strength	15.7 kV/mm	400 kV/in	Short Term; ASTM D149
Dissipation Factor	0.0100 @Frequency 1e+6 Hz	0.0100 @Frequency 1e+6 Hz	ASTM D150

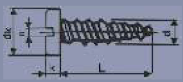
Thermal Properties	Metric	English	Comments
CTE, linear	90.0 µm/m-°C @Temperature -40.0 - 149 °C	50.0 µin/in-°F @Temperature -40.0 - 300 °F	ASTM E831
Melting Point	175 °C	347 °F	Crystalline, Peak; ASTM D3418
Maximum Service Temperature, Air	82.2 °C	180 °F	Long Term
Deflection Temperature at 1.8 MPa (264 psi)	118 °C	244 °F	ASTM D648
Flammability, UL94	HB	HB	1/8 inch (Estimated Rating)

Descriptive Properties			
Compliance - FDA		Not Compliant	
Machinability		1	1-10, 1=Easier to Machine
Service in Alcohols		Acceptable	
Service in Aliphatic Hydrocarbons		Acceptable	
Service in Aromatic Hydrocarbons		Acceptable	
Service in Chlorinated Solvents		Limited	
Service in Ethers		Acceptable	
Service in Ketones		Acceptable	
Service in Strong Acids		Unacceptable	
Service in Strong Alkalis		Unacceptable	
Service in Sunlight		Limited	
Service in Weak Acids		Limited	

Parafuso Auto-Atarraxante

Cabeça Panela com Fenda

Aço Baixo Carbono Cimentado



Acabamento - Zincado Branco
Dimensões - DIN 7971
Rosca - DIN 7970

Tabela de Dimensões								
(d) diâmetro	2,2	2,9	3,5	3,9	4,2	4,8	5,5	6,3
p (rosca/passo)	0,8	1,1	1,3	1,3	1,4	1,6	1,8	1,8
k (altura cabeça)	1,35	1,75	2,1	2,25	2,45	2,8	3,2	3,65
dk (diâmetro cabeça)	4,2	5,6	6,9	7,5	8,2	9,5	10,8	12,5
n (fenda)	0,6	0,8	1	1	1,2	1,2	1,6	1,6

DIÂMETRO / COMPRIMENTO	2,2	2,9	3,5	3,9	4,2	4,8	5,5	6,3
6,5	500 02294	500 02297	500 02302					
9,5	500 02295	500 02298	500 02303	500 02309	500 02316	500 02324		
13	500 02296	500 02299	500 02304	500 02310	500 02317	500 02325	500 02334	200 02343
16		500 02300	500 02305	500 02311	500 02318	500 02326	200 02335	200 02344
19		500 02301	500 02306	500 02312	500 02319	500 02327	200 02336	200 02345
22			500 02307	500 02313	500 02320	500 02328	200 02337	200 02346
25			500 02308	500 02314	500 02321	500 02329	200 02338	200 02347
32				500 02315	500 02322	500 02330	200 02339	200 02348
38					500 02323	500 02331	200 02340	200 02349
45						200 02332	200 02341	200 02350
50						200 02333	200 02342	200 02351

Anexo III

Datasheet muRata SV01.

R50E.pdf
05.9.9

Rotary Position Sensors

muRata

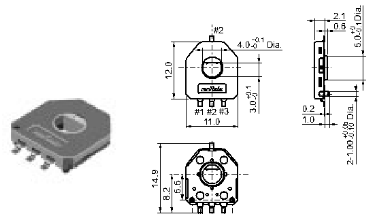
SMD/Lead Dust-proof Type 12mm Size SV01 Series

■ Features

1. Dust-proof construction protects the interior from dust, which maintains stable characteristics.
2. Compliant to high peak temperature lead free soldering.
3. Excellent resistance materials and high reliability wiper achieves 1M cycles.
4. D formation thru-hole rotor enables selection of any kind of gear shape.
5. Both D formation thru-hole rotor and T formation thru-hole rotor are available.
6. Leaded terminal type is available.
7. Ultra-thin size (2.1mm height)
8. Au plated terminals without Lead.

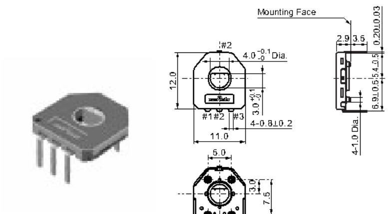
■ Applications

1. Animal robot
2. Switch for automotive
3. Motor drive unit
4. Radio control equipment
5. Electric motor-driven bicycle



SV01A

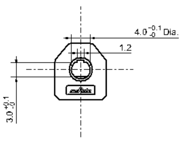
(Tolerance : ±0.3 in mm)



SV01L

(Tolerance : ±0.3 in mm)

■ T formation Thru-hole rotor



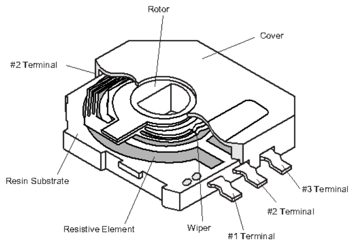
(Tolerance : ±0.3 in mm)

Part Number	Total Resistance Value (k ohm)	Linearity (%)	Effective Rotational Angle	TCR	Rotational Life
SV01A103□EA01	10 ±30%	±2	333.3° (Ref.)	±500ppm/°C	1M cycles
SV01L103□EA11	10 ±30%	±2	333.3° (Ref.)	±500ppm/°C	1M cycles

A blank column is filled with Rotor Formation Codes. (A: D formation thru-hole rotor C: T formation thru-hole rotor)

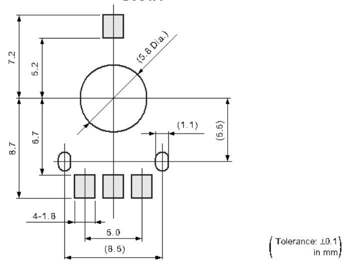
9

■ Construction



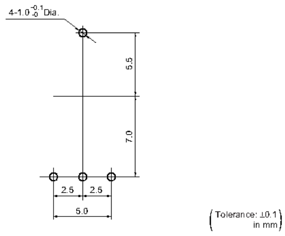
■ Standard Land Pattern

SV01A



■ Standard Mounting Holes

SV01L



■ Characteristics

Temperature Cycle (Thermal Shock)	ΔTR	±20%
	Linearity	±3%
Humidity	ΔTR	±20%
	Linearity	±3%
Vibration	ΔTR	±10%
	Linearity	±3%
Shock (20G)	ΔTR	±10%
	Linearity	±3%
Humidity Load Life	ΔTR	±20%
	Linearity	±3%
High Temperature Exposure	ΔTR	+5/-30%
	Linearity	±3%
Low Temperature Exposure	ΔTR	±20%
	Linearity	±3%
Rotational Life (1M cycles)	ΔTR	±20%
	Linearity	±3%

ΔTR: Total Resistance Change

muRata

■ Notice (Operating and Storage Conditions)

1. Store in temperatures of -10 to +40deg. C and relative humidity of 30-85%RH.
2. Do not store in or near corrosive gases.
3. Use within six months after delivery.
4. Open the package just before using.
5. Do not store under direct sunlight.
6. Do not use the rotary position sensor under the following environmental conditions. If you use the rotary position sensor in an environment other these listed below, please consult with Murata factory representative prior to using.

(1) Corrosive gasses atmosphere
(Ex. Chlorine gas, Hydrogen sulfide gas, Ammonia gas, Sulfuric acid gas, Nitric oxide gas, etc.)
(2) In liquid
(Ex. Water, Oil, Medical liquid, Organic solvent, etc.)
(3) Dusty / dirty atmosphere
(4) Direct sunlight
(5) Static voltage nor electric/magnetic fields
(6) Direct sea breeze
(7) Other variations of the above

■ Notice (Soldering and Mounting)

1. Soldering

(1) SV01 series can be soldered by reflow soldering method and soldering iron. Do not use flow soldering method (dipping).
(2) The dimension of land pattern used should be Murata's standard land pattern at reflow soldering. Excessive land area may cause displacement due to the effect of the surface tension of the solder. Insufficient land area may cause insufficient soldering strength on PCB. (SMD Type)
(3) Soldering condition
Refer to the temperature profile.
If the soldering conditions are not suitable, e.g., excessive time and/or excessive temperature, the rotary position sensor may deviate from the specified characteristics.
(4) The amount of solder is critical. Insufficient amounts of solder can lead to insufficient soldering strength on PCB. Excessive amounts of solder may cause bridging between the terminals.
(5) The soldering iron should not come in contact with the cover of the rotary position sensor. If such contact does occur, the rotary position sensor may be damaged.

2. Mounting

(1) Use PCB hole to meet the pin of the rotary position sensor. If the rotary position sensor is inserted into insufficient PCB hole, the rotary position sensor may be damaged by mechanical stress. (Lead type)
(2) Do not apply excessive force (preferable 9.8N (Ref.; 1kgf) max.), when the rotary position sensor is mounted to the PCB.
(3) Do not warp and/or bend PCB to prevent the rotary position sensor from breakage.

3. Cleaning

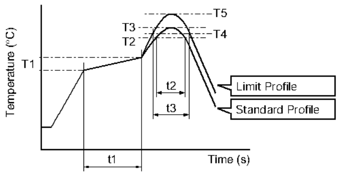
Cannot be cleaned because of open construction.

SV01 Series Notice

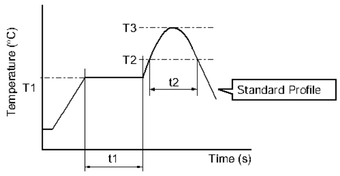
■ Soldering Profile

● Reflow Soldering Profile

1. Soldering profile for Lead-free solder (96.5Sn/3.0Ag/0.5Cu)



2. Soldering profile for Eutectic solder (63Sn/37Pb)
(Limit profile: refer to 1)



Standard Profile (Lead-free solder)

Pre-heating		Heating		Peak Temperature (T3)	Cycle of Reflow
Temp. (T1)	Time (t1)	Temp. (T2)	Time (t2)		
°C	sec.	°C	sec.	°C	Time
150 to 180	60 to 120	220	30 to 60	245±3	2

Standard Profile (Eutectic solder)

Pre-heating		Heating		Peak Temperature (T3)	Cycle of Reflow
Temp. (T1)	Time (t1)	Temp. (T2)	Time (t2)		
°C	sec.	°C	sec.	°C	Time
150	60 to 120	183	30	230	1

Limit Profile

Pre-heating		Heating		Peak Temperature (T5)	Cycle of Reflow
Temp. (T1)	Time (t1)	Temp. (T4)	Time (t3)		
°C	sec.	°C	sec.	°C	Time
150 to 180	60 to 120	230	30 to 50	260 +5/-0	2

● Soldering Iron

Standard Condition

Temperature of Soldering Iron Tip	Soldering Time	Soldering Iron Power Output	Cycle of Soldering Iron
°C	sec.	W	Time
350±10	3 max.	30 max.	1

■ Notice (Handling)

Uncontrolled mechanical force except usual rotation on the hollow rotor of product, may cause big change of electrical characteristic, big increase of rotational torque or mechanical damage of product.
Therefore, please pay your attention on the following points for your design.

1. The fixing method of product must be soldering by the terminals of product. And please don't fix by screw cramping of supporting board which might cause mechanical deformation of product.
2. Your connecting shaft must be sustained by your bearing and any uncontrolled force should not apply on the hollow rotor of product.

■ Notice (Other)

1. Please make sure the connecting impedance is not to be less than 10M ohm. The rotary position sensor is designed to connect the output terminal and A/D port of the microprocessor directly. Therefore, connecting impedance presupposes certain M ohm and the contact resistance is set high.
2. To minimize the processing error and noise influence which occur in rare cases, when data is installed through the product, please note the following items and program your software.
   (1) Data install should be done plural times and applied the mean value.
   (2) Data considered as error should be invalid.
   (3) If suspicious data is found, the data should be re-installed.
3. Before using rotary position sensor, please test after assembly in your particular mass production system.
4. MURATA cannot guarantee rotary position sensor integrity when used under conditions other than those specified in this document.

Anexo IV
Códigos CNC.

As colunas descritas a seguir foram geradas com o intuito de simplificar a programação para a usinagem. A coluna “Linha” corresponde ao número da linha que esta sendo atribuído um comando e o posicionamento, a coluna “Comando” insere o comando a ser executado pela máquina operatriz CNC, as colunas “X”, “Y” e “Z” referem-se ao posicionamento desejado que será executado pelo comando inserido na mesma linha e, a coluna “Comentários” é um local para acrescentar comentários no código (deve estar sempre entre parênteses, para que o programa assuma que for inserido um comentário e não uma instrução). Todo o código foi desenvolvido em G-Code para utilização na CNC da marca Sherline.

Furação da Coluna

Linha	Comando	X	Y	Z	Comentários
			(Coluna 01)		
N10	T17				(Broca de 2.5mm)
N20	G01	X0	Y0	Z1	
N30	G01	X14	Y6.86	Z1	
N40	G01	X14	Y6.86	Z-6	
N50	G01	X14	Y6.86	Z1	
N60	G01	X14	Y21.14	Z1	
N70	G01	X14	Y21.14	Z-6	
N80	G01	X14	Y21.14	Z1	
N90	G01	X6.86	Y14	Z1	
N100	G01	X6.86	Y14	Z-6	
N110	G01	X6.86	Y14	Z1	
N120	G01	X21.14	Y14	Z1	
N130	G01	X21.14	Y14	Z-6	
N140	G01	X21.14	Y14	Z1	
			(Coluna 02)		
N150	G01	X0	Y0	Z1	
N160	G01	X45	Y6.86	Z1	
N170	G01	X45	Y6.86	Z-6	
N180	G01	X45	Y6.86	Z1	
N190	G01	X45	Y21.14	Z1	
N200	G01	X45	Y21.14	Z-6	

N210	G01	X45	Y21.14	Z1
N220	G01	X37.86	Y14	Z1
N230	G01	X37.86	Y14	Z-6
N240	G01	X37.86	Y14	Z1
N250	G01	X52.14	Y14	Z1
N260	G01	X52.14	Y14	Z-6
N270	G01	X52.14	Y14	Z1
			(Coluna 03)	
N280	G01	X0	Y0	Z1
N290	G01	X76	Y6.86	Z1
N300	G01	X76	Y6.86	Z-6
N310	G01	X76	Y6.86	Z1
N320	G01	X76	Y21.14	Z1
N330	G01	X76	Y21.14	Z-6
N340	G01	X76	Y21.14	Z1
N350	G01	X68.86	Y14	Z1
N360	G01	X68.86	Y14	Z-6
N370	G01	X68.86	Y14	Z1
N380	G01	X83.14	Y14	Z1
N390	G01	X83.14	Y14	Z-6
N400	G01	X83.14	Y14	Z1
			(Coluna 04)	
N410	G01	X0	Y0	Z1
N420	G01	X14	Y37.86	Z1
N430	G01	X14	Y37.86	Z-6
N440	G01	X14	Y37.86	Z1
N450	G01	X14	Y52.14	Z1
N460	G01	X14	Y52.14	Z-6
N470	G01	X14	Y52.14	Z1
N480	G01	X6.86	Y45	Z1
N490	G01	X6.86	Y45	Z-6
N500	G01	X6.86	Y45	Z1
N510	G01	X21.14	Y45	Z1
N520	G01	X21.14	Y45	Z-6
N530	G01	X21.14	Y45	Z1
			(Coluna 05)	
N540	G01	X0	Y0	Z1
N550	G01	X45	Y37.86	Z1
N560	G01	X45	Y37.86	Z-6
N570	G01	X45	Y37.86	Z1
N580	G01	X45	Y52.14	Z1
N590	G01	X45	Y52.14	Z-6
N600	G01	X45	Y52.14	Z1
N610	G01	X37.86	Y45	Z1

N620	G01	X37.86	Y45	Z-6
N630	G01	X37.86	Y45	Z1
N640	G01	X52.14	Y45	Z1
N650	G01	X52.14	Y45	Z-6
N660	G01	X52.14	Y45	Z1

(Coluna 06)

N670	G01	X0	Y0	Z1
N680	G01	X76	Y37.86	Z1
N690	G01	X76	Y37.86	Z-6
N700	G01	X76	Y37.86	Z1
N710	G01	X76	Y52.14	Z1
N720	G01	X76	Y52.14	Z-6
N730	G01	X76	Y52.14	Z1
N740	G01	X68.86	Y45	Z1
N750	G01	X68.86	Y45	Z-6
N760	G01	X68.86	Y45	Z1
N770	G01	X83.14	Y45	Z1
N780	G01	X83.14	Y45	Z-6
N790	G01	X83.14	Y45	Z1

(Coluna 07)

N800	G01	X0	Y0	Z1
N810	G01	X14	Y68.86	Z1
N820	G01	X14	Y68.86	Z-6
N830	G01	X14	Y68.86	Z1
N840	G01	X14	Y83.14	Z1
N850	G01	X14	Y83.14	Z-6
N860	G01	X14	Y83.14	Z1
N870	G01	X6.86	Y76	Z1
N880	G01	X6.86	Y76	Z-6
N890	G01	X6.86	Y76	Z1
N900	G01	X21.14	Y76	Z1
N910	G01	X21.14	Y76	Z-6
N920	G01	X21.14	Y76	Z1

(Coluna 08)

N930	G01	X0	Y0	Z1
N940	G01	X45	Y68.86	Z1
N950	G01	X45	Y68.86	Z-6
N960	G01	X45	Y68.86	Z1
N970	G01	X45	Y83.14	Z1
N980	G01	X45	Y83.14	Z-6
N990	G01	X45	Y83.14	Z1
N1000	G01	X37.86	Y76	Z1
N1010	G01	X37.86	Y76	Z-6
N1020	G01	X37.86	Y76	Z1
N1030	G01	X52.14	Y76	Z1
N1040	G01	X52.14	Y76	Z-6
N1050	G01	X52.14	Y76	Z1

(Coluna 09)

N1060	G01	X0	Y0	Z1
N1070	G01	X76	Y68.86	Z1
N1080	G01	X76	Y68.86	Z-6
N1090	G01	X76	Y68.86	Z1
N1100	G01	X76	Y83.14	Z1
N1110	G01	X76	Y83.14	Z-6
N1120	G01	X76	Y83.14	Z1
N1130	G01	X68.86	Y76	Z1
N1140	G01	X68.86	Y76	Z-6
N1150	G01	X68.86	Y76	Z1
N1160	G01	X83.14	Y76	Z1
N1170	G01	X83.14	Y76	Z-6
N1180	G01	X83.14	Y76	Z1

Furação do Anel

Linha	Comando	X	Y	Z	Comentários
			(Coluna 01)		
N10	T17				(Broca de 4mm)
N20	G01	X0	Y0	Z1	
N30	G01	X25	Y9.13	Z1	
N40	G01	X25	Y9.13	Z-5.5	
N50	G01	X25	Y9.13	Z1	
N60	G01	X25	Y40.88	Z1	
N70	G01	X25	Y40.88	Z-5.5	
N80	G01	X25	Y40.88	Z1	
N90	G01	X9.13	Y25	Z1	
N100	G01	X9.13	Y25	Z-5.5	
N110	G01	X9.13	Y25	Z1	
N120	G01	X40.88	Y25	Z1	
N130	G01	X40.88	Y25	Z-5.5	
N140	G01	X40.88	Y25	Z1	
N150	T18				(Broca de 1.5mm)
N160	G01	X15.25	Y11.07	Z1	
N170	G01	X15.25	Y11.07	Z-12.75	
N180	G01	X15.25	Y11.07	Z1	
N190	G01	X12.98	Y12.98	Z1	
N200	G01	X12.98	Y12.98	Z-12.75	
N210	G01	X12.98	Y12.98	Z1	
N220	G01	X11.07	Y15.25	Z1	
N230	G01	X11.07	Y15.25	Z-12.75	
N240	G01	X11.07	Y15.25	Z1	

N250	G01	X34.75	Y11.07	Z1	
N260	G01	X34.75	Y11.07	Z-12.75	
N270	G01	X34.75	Y11.07	Z1	
N280	G01	X37.02	Y12.98	Z1	
N290	G01	X37.02	Y12.98	Z-12.75	
N300	G01	X37.02	Y12.98	Z1	
N310	G01	X38.93	Y15.25	Z1	
N320	G01	X38.93	Y15.25	Z-12.75	
N330	G01	X38.93	Y15.25	Z1	
N340	G01	X34.75	Y38.93	Z1	
N350	G01	X34.75	Y38.93	Z-12.75	
N360	G01	X34.75	Y38.93	Z1	
N370	G01	X37.02	Y37.02	Z1	
N380	G01	X37.02	Y37.02	Z-12.75	
N390	G01	X37.02	Y37.02	Z1	
N400	G01	X38.93	Y34.75	Z1	
N410	G01	X38.93	Y34.75	Z-12.75	
N420	G01	X38.93	Y34.75	Z1	
N430	G01	X15.25	Y38.93	Z1	
N440	G01	X15.25	Y38.93	Z-12.75	
N450	G01	X15.25	Y38.93	Z1	
N460	G01	X12.98	Y37.02	Z1	
N470	G01	X12.98	Y37.02	Z-12.75	
N480	G01	X12.98	Y37.02	Z1	
N490	G01	X11.07	Y34.75	Z1	
N500	G01	X11.07	Y34.75	Z-12.75	
N510	G01	X11.07	Y34.75	Z1	
			(Coluna 02)		
N520	T17				(Broca de 4mm)
N530	G01	X0	Y0	Z1	
N540	G01	X25	Y51.13	Z1	
N550	G01	X25	Y51.13	Z-5.5	
N560	G01	X25	Y51.13	Z1	
N570	G01	X25	Y82.87	Z1	
N580	G01	X25	Y82.87	Z-5.5	
N590	G01	X25	Y82.87	Z1	
N600	G01	X9.13	Y67.03	Z1	
N610	G01	X9.13	Y67.03	Z-5.5	
N620	G01	X9.13	Y67.03	Z1	
N630	G01	X40.88	Y67.03	Z1	
N640	G01	X40.88	Y67.03	Z-5.5	
N650	G01	X40.88	Y67.03	Z1	
N660	T18				(Broca de 1.5mm)
N670	G01	X15.25	Y53.09	Z1	
N680	G01	X15.25	Y53.09	Z-12.75	
N690	G01	X15.25	Y53.09	Z1	

N700	G01	X12.98	Y55	Z1	
N710	G01	X12.98	Y55	Z-12.75	
N720	G01	X12.98	Y55	Z1	
N730	G01	X11.07	Y57.28	Z1	
N740	G01	X11.07	Y57.28	Z-12.75	
N750	G01	X11.07	Y57.28	Z1	
N760	G01	X34.75	Y53.09	Z1	
N770	G01	X34.75	Y53.09	Z-12.75	
N780	G01	X34.75	Y53.09	Z1	
N790	G01	X37.02	Y55	Z1	
N800	G01	X37.02	Y55	Z-12.75	
N810	G01	X37.02	Y55	Z1	
N820	G01	X38.93	Y57.28	Z1	
N830	G01	X38.93	Y57.28	Z-12.75	
N840	G01	X38.93	Y57.28	Z1	
N850	G01	X34.75	Y80.94	Z1	
N860	G01	X34.75	Y80.94	Z-12.75	
N870	G01	X34.75	Y80.94	Z1	
N880	G01	X37.02	Y79.04	Z1	
N890	G01	X37.02	Y79.04	Z-12.75	
N900	G01	X37.02	Y79.04	Z1	
N910	G01	X38.93	Y76.78	Z1	
N920	G01	X38.93	Y76.78	Z-12.75	
N930	G01	X38.93	Y76.78	Z1	
N940	G01	X15.25	Y80.94	Z1	
N950	G01	X15.25	Y80.94	Z-12.75	
N960	G01	X15.25	Y80.94	Z1	
N970	G01	X12.98	Y79.04	Z1	
N980	G01	X12.98	Y79.04	Z-12.75	
N990	G01	X12.98	Y79.04	Z1	
N1000	G01	X11.07	Y76.78	Z1	
N1010	G01	X11.07	Y76.78	Z-12.75	
N1020	G01	X11.07	Y76.78	Z1	
			(Coluna 03)		
N1030	T17				(Broca de 4mm)
N1040	G01	X0	Y0	Z1	
N1050	G01	X67	Y51.13	Z1	
N1060	G01	X67	Y51.13	Z-5.5	
N1070	G01	X67	Y51.13	Z1	
N1080	G01	X67	Y82.87	Z1	
N1090	G01	X67	Y82.87	Z-5.5	
N1100	G01	X67	Y82.87	Z1	
N1110	G01	X51.13	Y67.03	Z1	
N1120	G01	X51.13	Y67.03	Z-5.5	
N1130	G01	X51.13	Y67.03	Z1	
N630	G01	X82.88	Y67.03	Z1	

N640	G01	X82.88	Y67.03	Z-5.5	
N650	G01	X82.88	Y67.03	Z1	
N660	T18				(Broca de 1.5mm)
N670	G01	X57.25	Y53.09	Z1	
N680	G01	X57.25	Y53.09	Z-12.75	
N690	G01	X57.25	Y53.09	Z1	
N700	G01	X54.98	Y55	Z1	
N710	G01	X54.98	Y55	Z-12.75	
N720	G01	X54.98	Y55	Z1	
N730	G01	X53.07	Y57.28	Z1	
N740	G01	X53.07	Y57.28	Z-12.75	
N750	G01	X53.07	Y57.28	Z1	
N760	G01	X76.75	Y53.09	Z1	
N770	G01	X76.75	Y53.09	Z-12.75	
N780	G01	X76.75	Y53.09	Z1	
N790	G01	X79.02	Y55	Z1	
N800	G01	X79.02	Y55	Z-12.75	
N810	G01	X79.02	Y55	Z1	
N820	G01	X80.93	Y57.28	Z1	
N830	G01	X80.93	Y57.28	Z-12.75	
N840	G01	X80.93	Y57.28	Z1	
N850	G01	X76.75	Y80.94	Z1	
N860	G01	X76.75	Y80.94	Z-12.75	
N870	G01	X76.75	Y80.94	Z1	
N880	G01	X79.02	Y79.04	Z1	
N890	G01	X79.02	Y79.04	Z-12.75	
N900	G01	X79.02	Y79.04	Z1	
N910	G01	X80.93	Y76.78	Z1	
N920	G01	X80.93	Y76.78	Z-12.75	
N930	G01	X80.93	Y76.78	Z1	
N940	G01	X57.25	Y80.94	Z1	
N950	G01	X57.25	Y80.94	Z-12.75	
N960	G01	X57.25	Y80.94	Z1	
N970	G01	X54.98	Y79.04	Z1	
N980	G01	X54.98	Y79.04	Z-12.75	
N990	G01	X54.98	Y79.04	Z1	
N1000	G01	X53.07	Y76.78	Z1	
N1010	G01	X53.07	Y76.78	Z-12.75	
N1020	G01	X53.07	Y76.78	Z1	

(Coluna 04)

N10	T17				(Broca de 4mm)
N20	G01	X0	Y0	Z1	
N30	G01	X67	Y9.13	Z1	
N40	G01	X67	Y9.13	Z-5.5	
N50	G01	X67	Y9.13	Z1	
N60	G01	X67	Y40.88	Z1	
N70	G01	X67	Y40.88	Z-5.5	

N80	G01	X67	Y40.88	Z1	
N90	G01	X51.13	Y25	Z1	
N100	G01	X51.13	Y25	Z-5.5	
N110	G01	X51.13	Y25	Z1	
N120	G01	X82.88	Y25	Z1	
N130	G01	X82.88	Y25	Z-5.5	
N140	G01	X82.88	Y25	Z1	
N150	T18				(Broca de 1.5mm)
N160	G01	X57.25	Y11.07	Z1	
N170	G01	X57.25	Y11.07	Z-12.75	
N180	G01	X57.25	Y11.07	Z1	
N190	G01	X54.98	Y12.98	Z1	
N200	G01	X54.98	Y12.98	Z-12.75	
N210	G01	X54.98	Y12.98	Z1	
N220	G01	X53.07	Y15.25	Z1	
N230	G01	X53.07	Y15.25	Z-12.75	
N240	G01	X53.07	Y15.25	Z1	
N250	G01	X76.75	Y11.07	Z1	
N260	G01	X76.75	Y11.07	Z-12.75	
N270	G01	X76.75	Y11.07	Z1	
N280	G01	X79.02	Y12.98	Z1	
N290	G01	X79.02	Y12.98	Z-12.75	
N300	G01	X79.02	Y12.98	Z1	
N310	G01	X80.93	Y15.25	Z1	
N320	G01	X80.93	Y15.25	Z-12.75	
N330	G01	X80.93	Y15.25	Z1	
N340	G01	X76.75	Y38.93	Z1	
N350	G01	X76.75	Y38.93	Z-12.75	
N360	G01	X76.75	Y38.93	Z1	
N370	G01	X79.02	Y37.02	Z1	
N380	G01	X79.02	Y37.02	Z-12.75	
N390	G01	X79.02	Y37.02	Z1	
N400	G01	X80.93	Y34.75	Z1	
N410	G01	X80.93	Y34.75	Z-12.75	
N420	G01	X80.93	Y34.75	Z1	
N430	G01	X57.25	Y38.93	Z1	
N440	G01	X57.25	Y38.93	Z-12.75	
N450	G01	X57.25	Y38.93	Z1	
N460	G01	X54.98	Y37.02	Z1	
N470	G01	X54.98	Y37.02	Z-12.75	
N480	G01	X54.98	Y37.02	Z1	
N490	G01	X53.07	Y34.75	Z1	
N500	G01	X53.07	Y34.75	Z-12.75	
N510	G01	X53.07	Y34.75	Z1	

Anexo V
Código do Protocolo de Transmissão.

Tabela de códigos de comunicação do servomotor AX-12+, retirado de seu manual.

	Address	Item	Access	Initial Value
	0(0X00)	Model Number(L)	RD	12(0x0C)
	1(0X01)	Model Number(H)	RD	0(0x00)
	2(0X02)	Version of Firmware	RD	?
	3(0X03)	ID	RD,WR	1(0x01)
	4(0X04)	Baud Rate	RD,WR	1(0x01)
	5(0X05)	Return Delay Time	RD,WR	250(0xFA)
	6(0X06)	CW Angle Limit(L)	RD,WR	0(0x00)
	7(0X07)	CW Angle Limit(H)	RD,WR	0(0x00)
	8(0X08)	CCW Angle Limit(L)	RD,WR	255(0xFF)
	9(0X09)	CCW Angle Limit(H)	RD,WR	3(0x03)
	10(0x0A)	(Reserved)	-	0(0x00)
EEPROM Area	11(0X0B)	the Highest Limit Temperature	RD,WR	85(0x55)
	12(0X0C)	the Lowest Limit Voltage	RD,WR	60(0X3C)
	13(0X0D)	the Highest Limit Voltage	RD,WR	190(0xBE)
	14(0X0E)	Max Torque(L)	RD,WR	255(0XFF)
	15(0X0F)	Max Torque(H)	RD,WR	3(0x03)
	16(0X10)	Status Return Level	RD,WR	2(0x02)
	17(0X11)	Alarm LED	RD,WR	4(0x04)
	18(0X12)	Alarm Shutdown	RD,WR	4(0x04)
	19(0X13)	(Reserved)	RD,WR	0(0x00)
	20(0X14)	Down Calibration(L)	RD	?
	21(0X15)	Down Calibration(H)	RD	?
	22(0X16)	Up Calibration(L)	RD	?
	23(0X17)	Up Calibration(H)	RD	?
	24(0X18)	Torque Enable	RD,WR	0(0x00)
	25(0X19)	LED	RD,WR	0(0x00)
	26(0X1A)	CW Compliance Margin	RD,WR	0(0x00)
	27(0X1B)	CCW Compliance Margin	RD,WR	0(0x00)
	28(0X1C)	CW Compliance Slope	RD,WR	32(0x20)
	29(0X1D)	CCW Compliance Slope	RD,WR	32(0x20)
	30(0X1E)	Goal Position(L)	RD,WR	[Addr36]value
	31(0X1F)	Goal Position(H)	RD,WR	[Addr37]value
	32(0X20)	Moving Speed(L)	RD,WR	0
	33(0X21)	Moving Speed(H)	RD,WR	0
	34(0X22)	Torque Limit(L)	RD,WR	[Addr14] value
	35(0X23)	Torque Limit(H)	RD,WR	[Addr15] value
RAM Area	36(0X24)	Present Position(L)	RD	?
	37(0X25)	Present Position(H)	RD	?
	38(0X26)	Present Speed(L)	RD	?
	39(0X27)	Present Speed(H)	RD	?
	40(0X28)	Present Load(L)	RD	?
	41(0X29)	Present Load(H)	RD	?
	42(0X2A)	Present Voltage	RD	?
	43(0X2B)	Present Temperature	RD	?
	44(0X2C)	Registered Instruction	RD,WR	0(0x00)
	45(0X2D)	(Reserved)	-	0(0x00)
	46[0x2E)	Moving	RD	0(0x00)
	47[0x2F)	Lock	RD,WR	0(0x00)
	48[0x30)	Punch(L)	RD,WR	32(0x20)
	49[0x31)	Punch(H)	RD,WR	0(0x00)

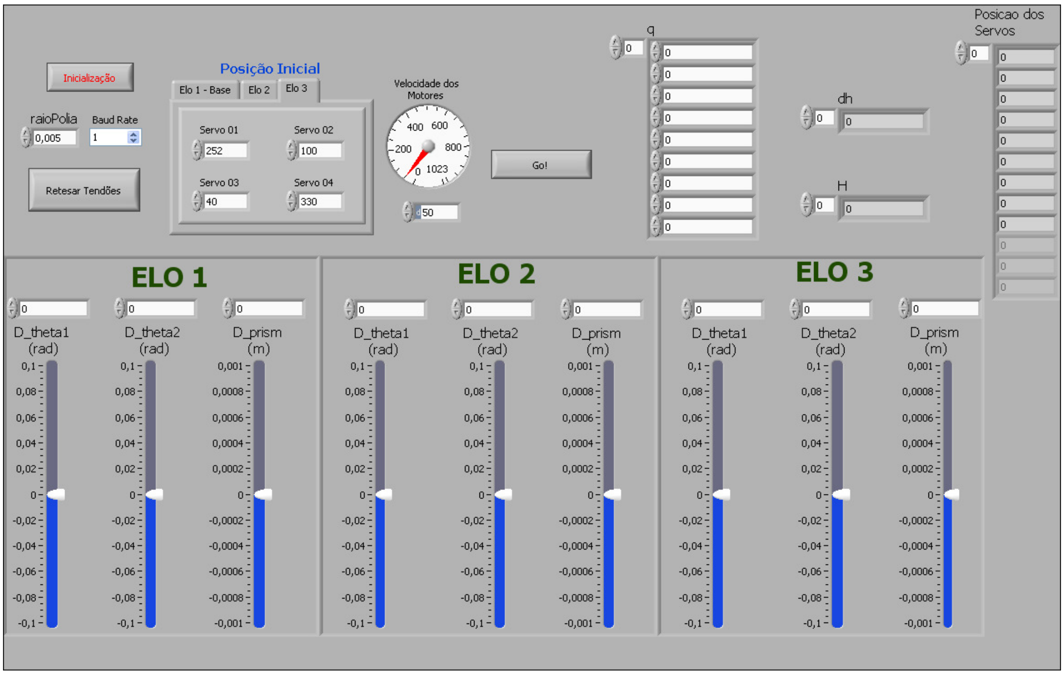
Anexo VI
Cabeçalhos de Funções.

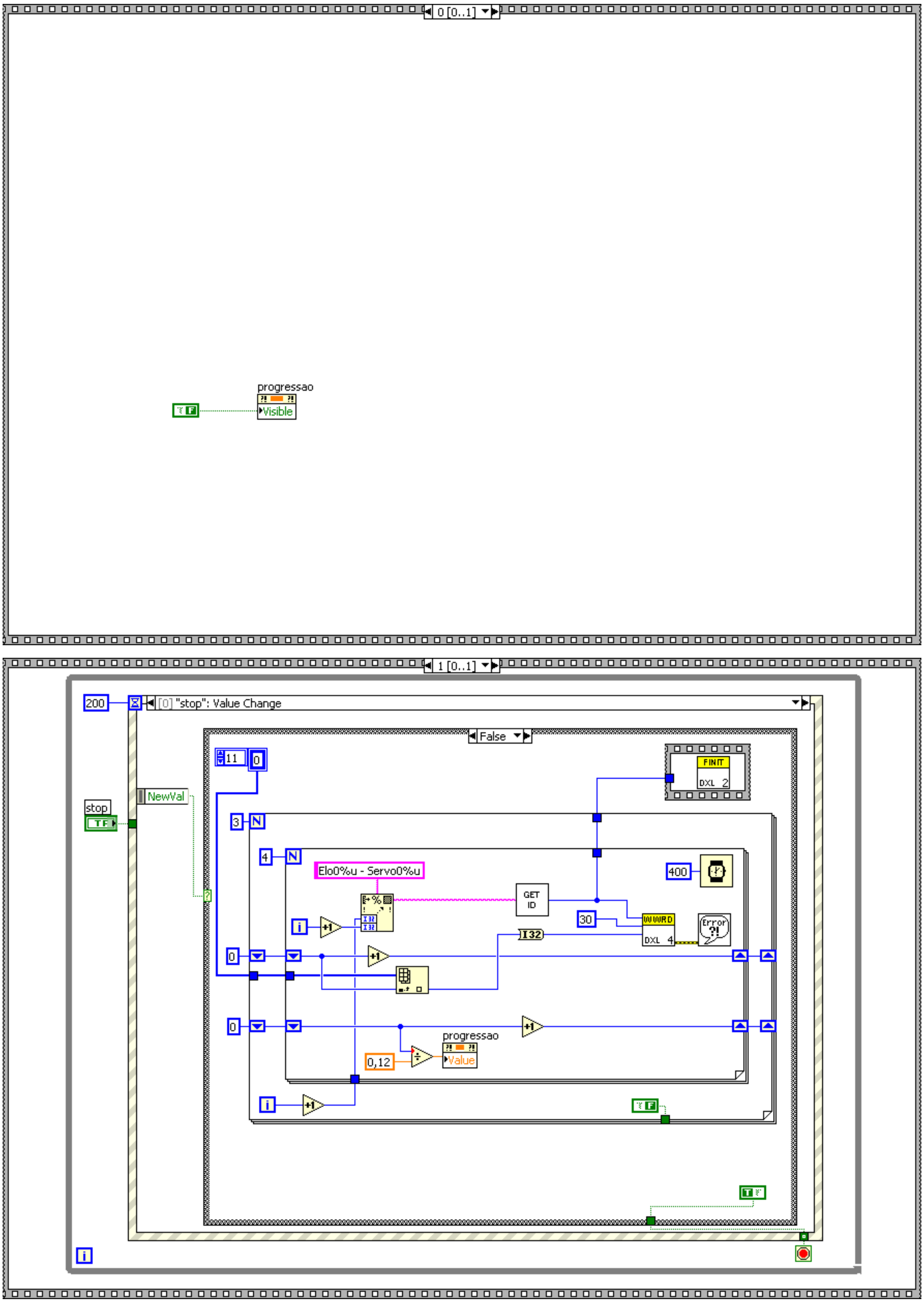
Neste anexo, são apresentados os cabeçalhos das funções criadas para a comunicação entre os servos e o computador.

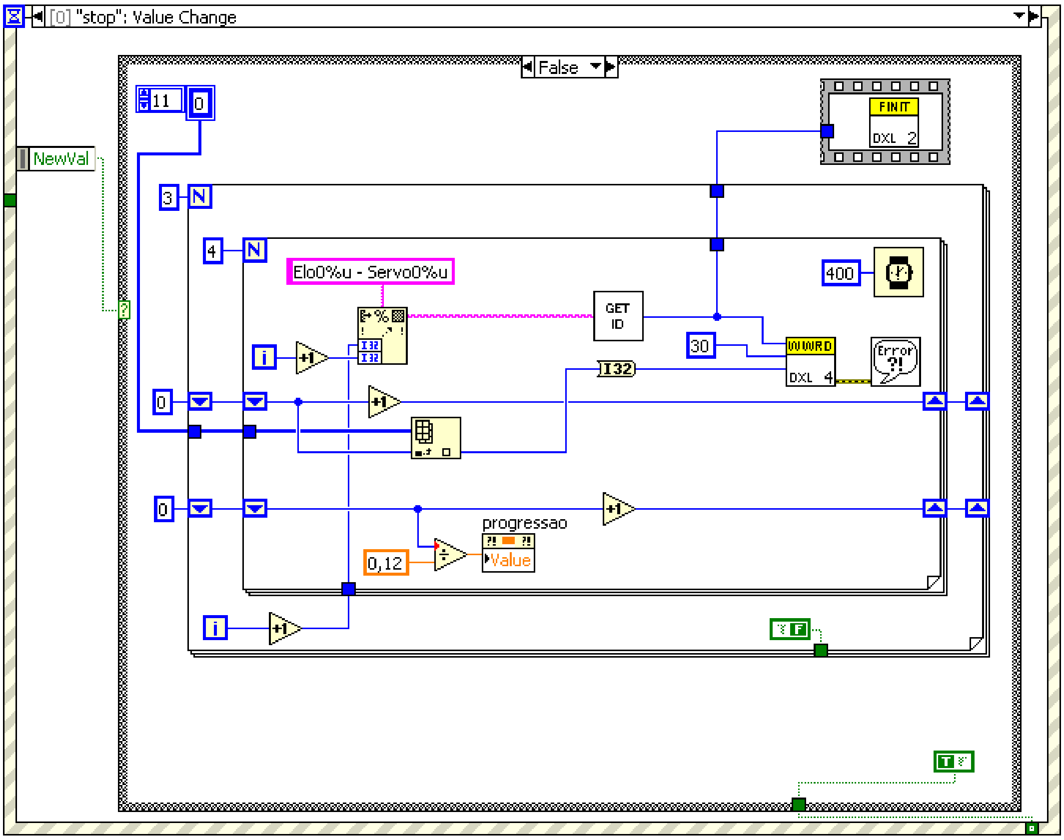
```
int dxl_initialize( );
void dxl_terminate( );
int dxl_get_baud( );
void dxl_set_baud(int baudnum);
void dxl_set_txpacket_id(int id);
void dxl_set_txpacket_instruction(int instruction);
void dxl_set_txpacket_parameter(int índex, int value);
void dxl_set_txpacket_length(int length);
int dxl_get_rxpacket_error(int errbit);
int dxl_get_rxpacket_length( );
int dxl_get_rxpacket_parameter(int index);
int dxl_makeword(int lowbyte, int highbyte);
int dxl_get_lowbyte(int word);
int dxl_get_highbyte(int word);
void dxl_tx_packet( );
void dxl_rx_packet( );
void dxl_txrx_packet( );
void dxl_get_result( );
void dxl_ping(int id);
int dxl_read_byte(int id, int address);
void dxl_write_byte(int id, int address, int value);
int dxl_read_word(int id, int address);
void dxl_write_word(int id, int address, int value);
```

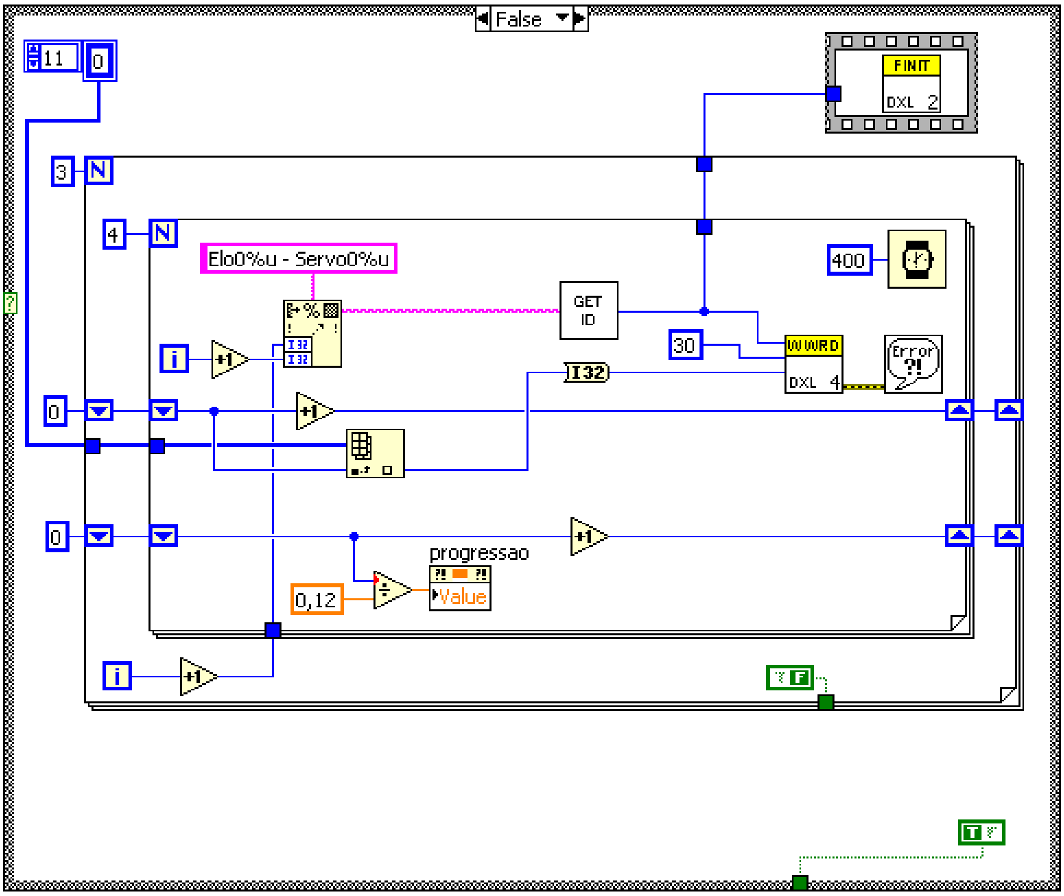
Anexo VII
Programação no LabView.

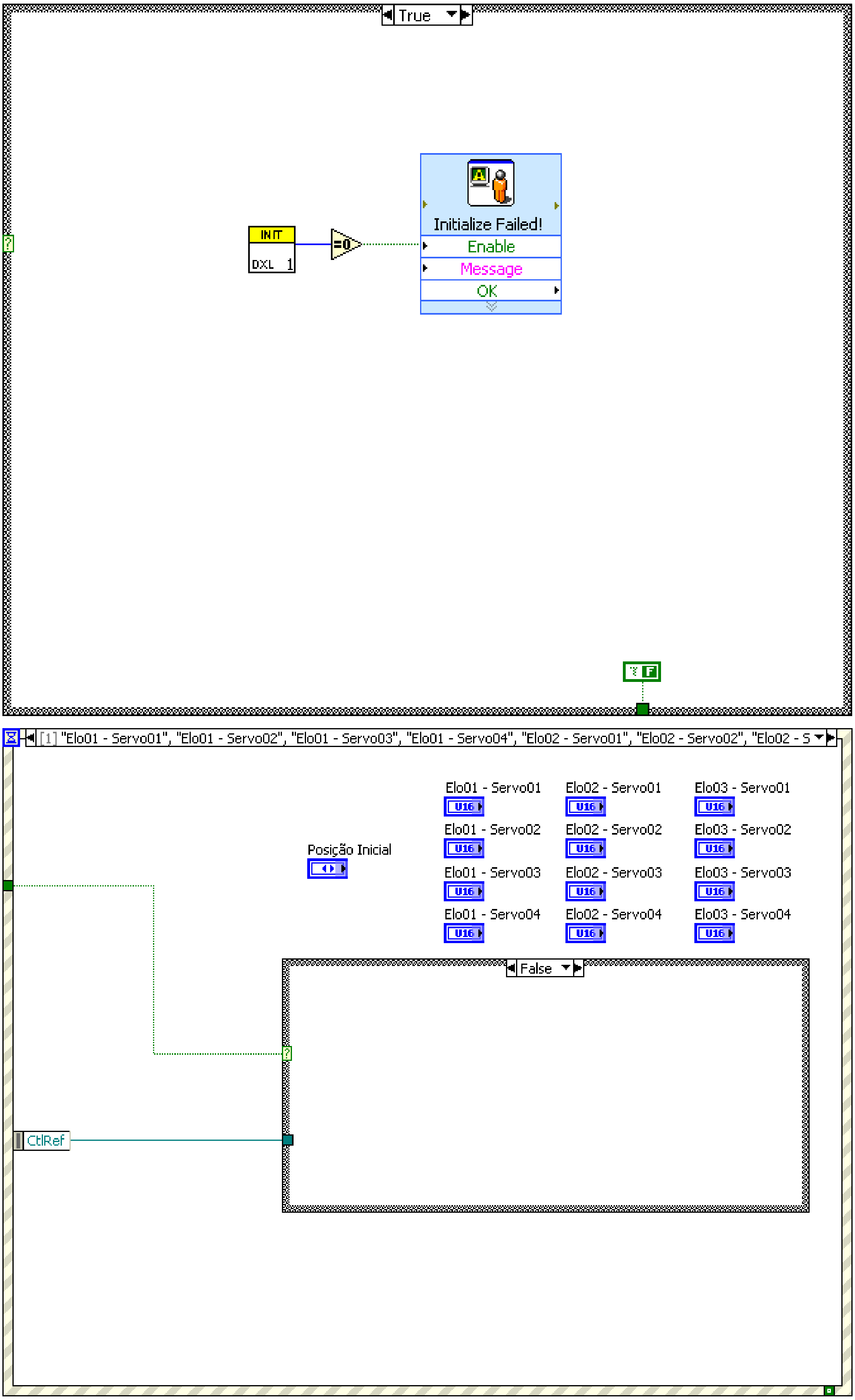
Neste anexo, é apresentada a programação principal do *software* desenvolvido para o controle das variações das entradas dos DoFs. A ordem das imagens é relacionada à presença dos *loops* na programação.

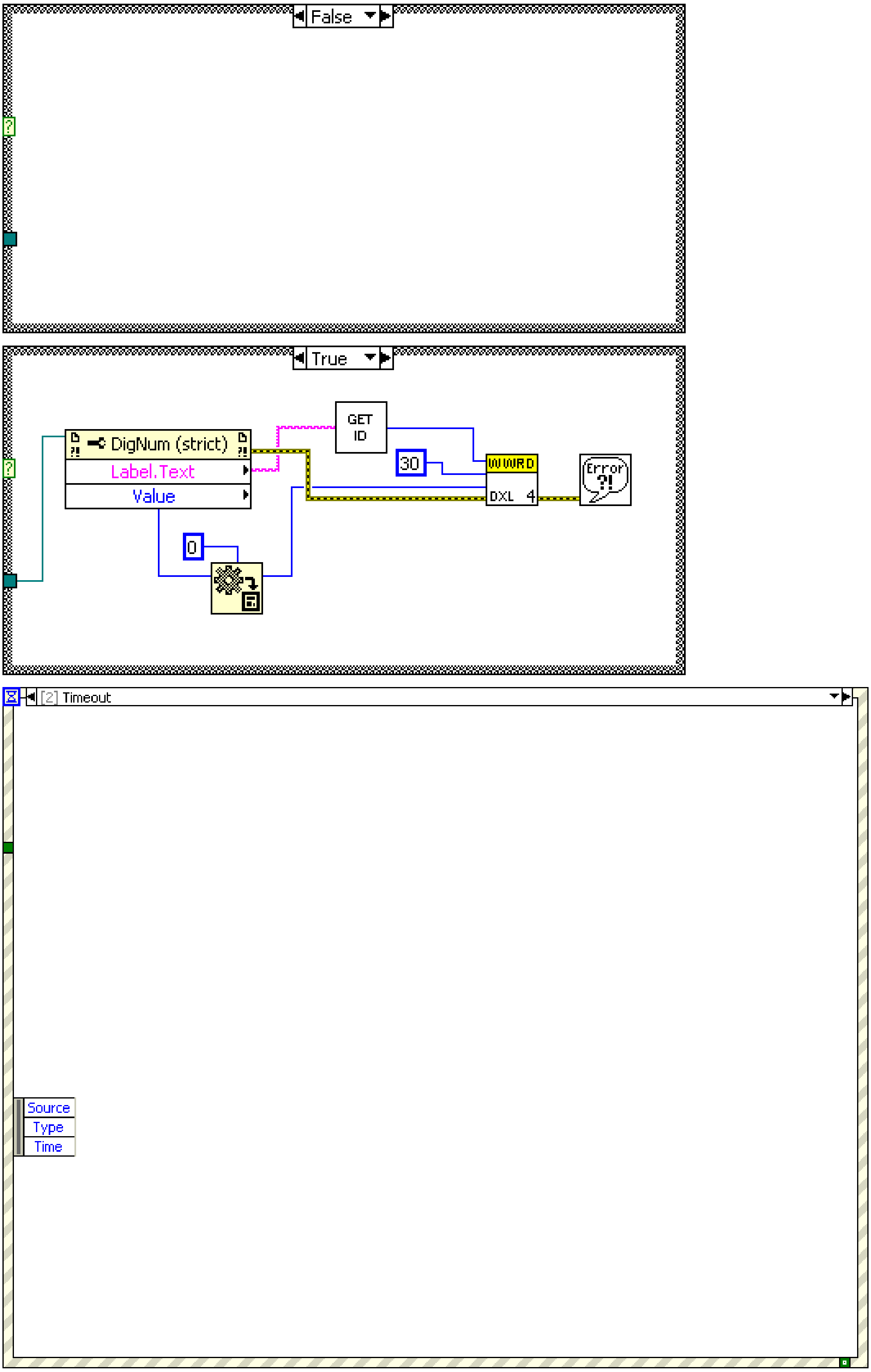


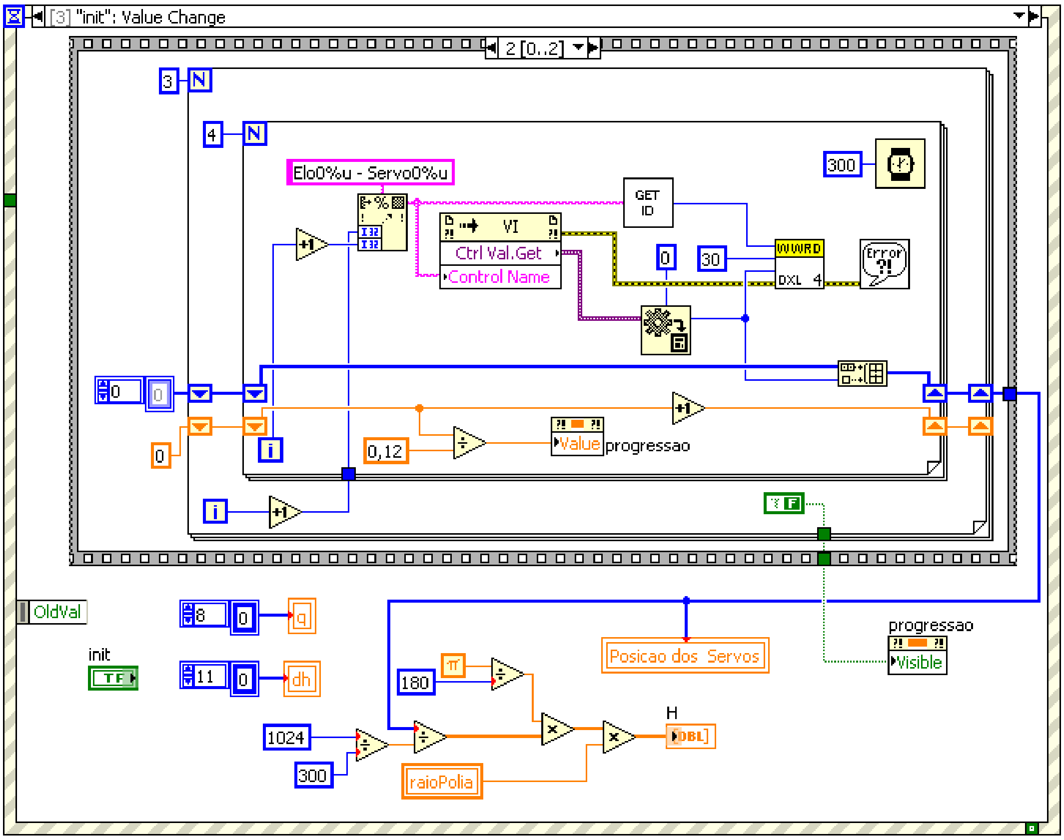

0 [0..1]
progressao
Visible
1 [0..1]
200
[0] "stop": Value Change
False
stop
NewVal
11
0
FINIT
DXL 2
3
N
4
Elo0%u - Servo0%u
GET ID
400
30
WWRD
DXL 4
Error
I32
0,12
progressao
Value
i

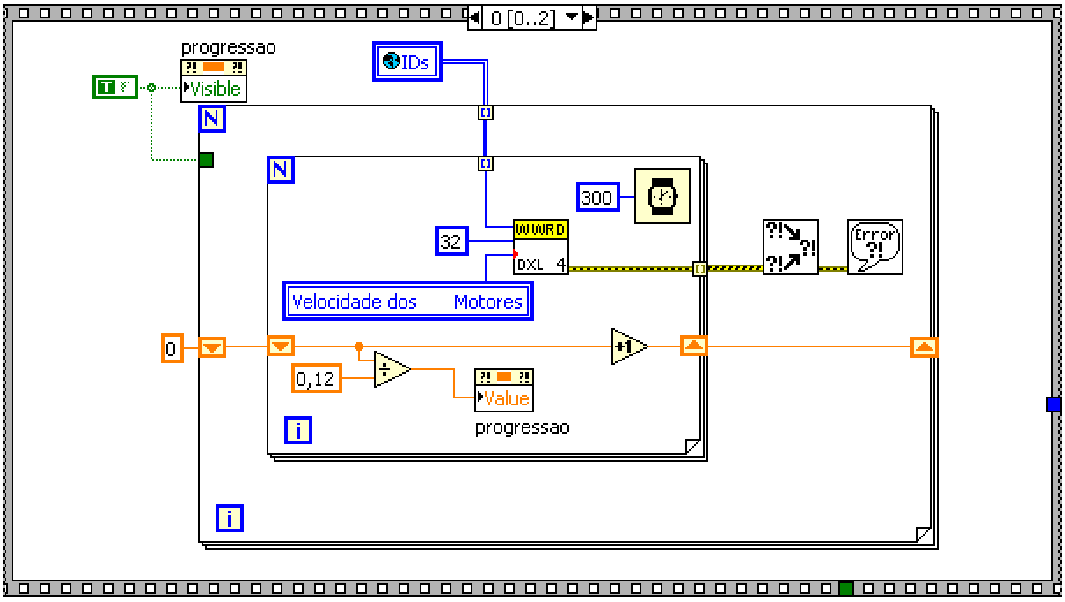

[0] "stop": Value Change
False
11
0
NewVal
FINIT
DXL 2
3
N
4
Elo0%u - Servo0%u
GET ID
400
30
WWRD
DXL 4
Error
I32
progressao
Value
0,12

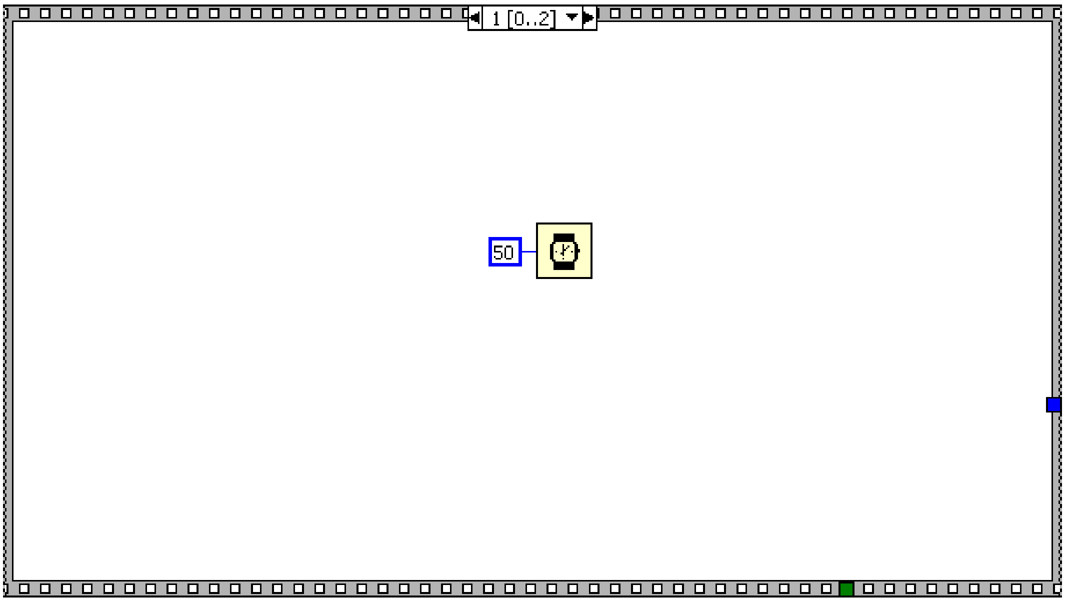

False
11
0
FINIT
DXL 2
3
N
4
Elo0%u - Servo0%u
GET ID
400
30
WWRD
DXL 4
Error
I32
progressao
Value
0,12

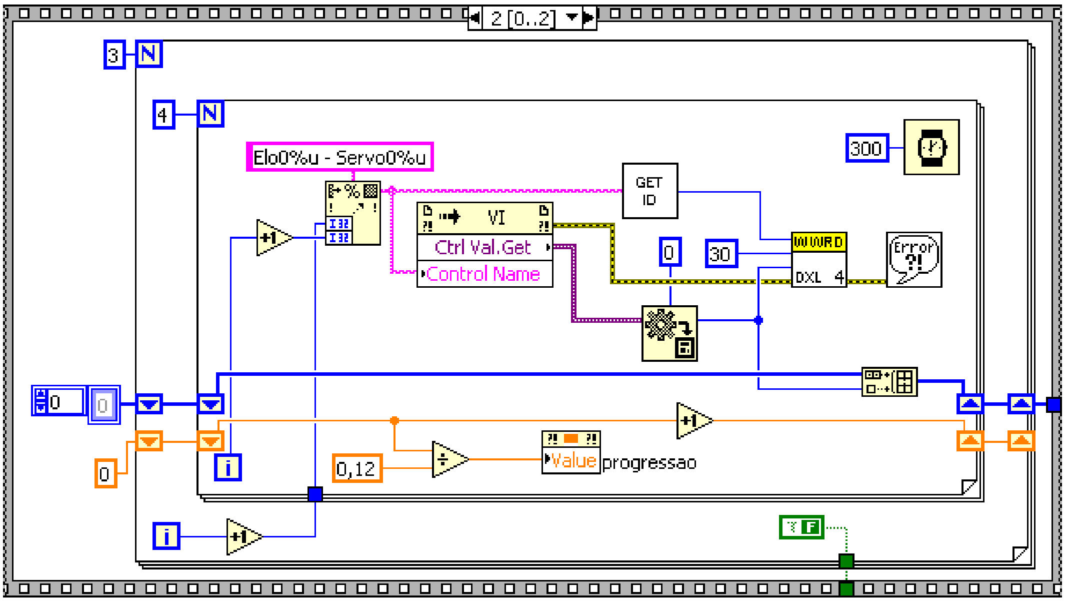

True
INIT
DXL 1
Initialize Failed!
Enable
Message
OK
[1] "Elo01 - Servo01", "Elo01 - Servo02", "Elo01 - Servo03", "Elo01 - Servo04", "Elo02 - Servo01", "Elo02 - Servo02", "Elo02 - S
Posição Inicial
Elo01 - Servo01
Elo01 - Servo02
Elo01 - Servo03
Elo01 - Servo04
Elo02 - Servo01
Elo02 - Servo02
Elo02 - Servo03
Elo02 - Servo04
Elo03 - Servo01
Elo03 - Servo02
Elo03 - Servo03
Elo03 - Servo04
U16
False
CtlRef

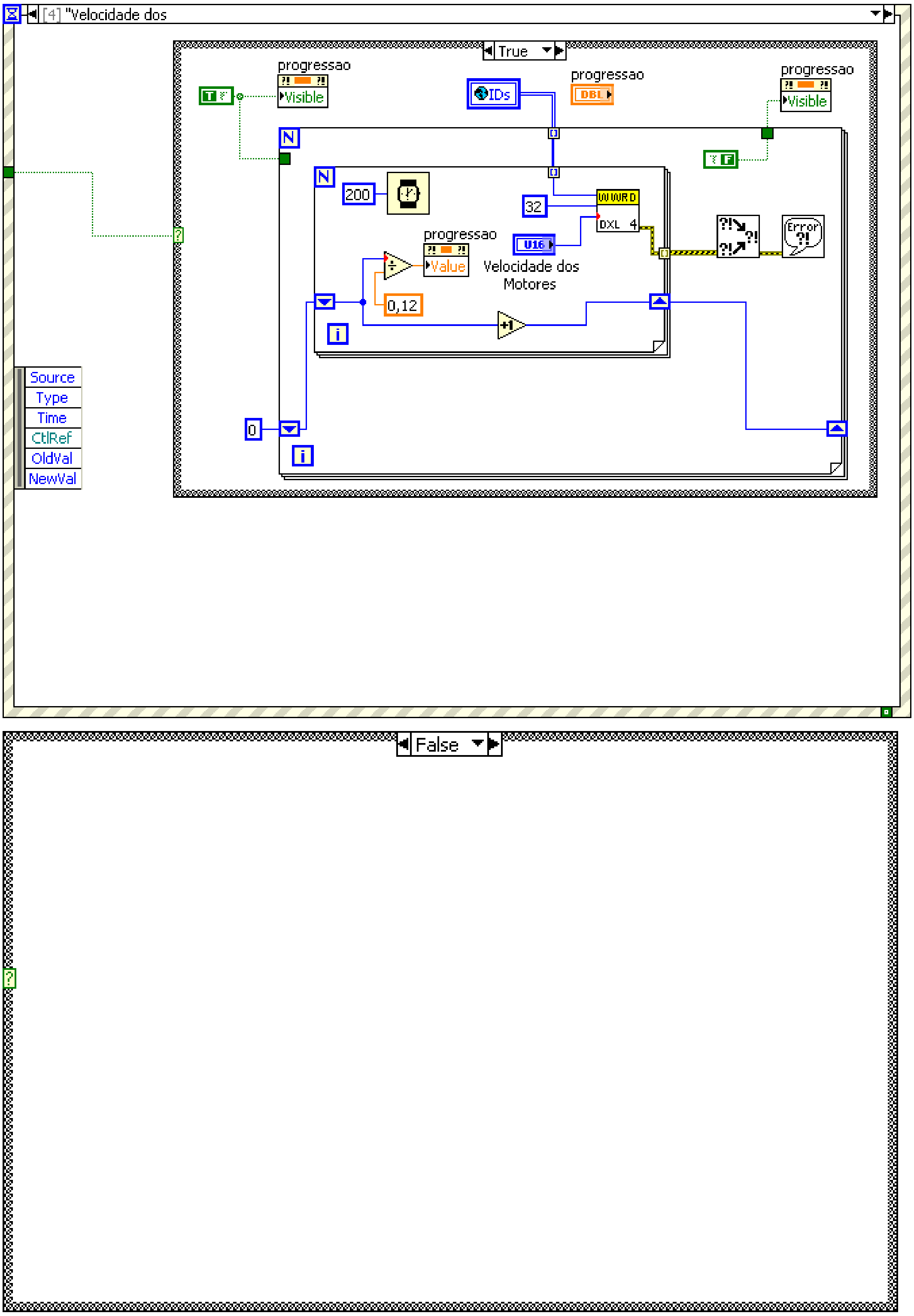

False
True
DigNum (strict)
Label.Text
Value
GET ID
30
WWRD
DXL 4
Error ?!
0
[2] Timeout
Source
Type
Time

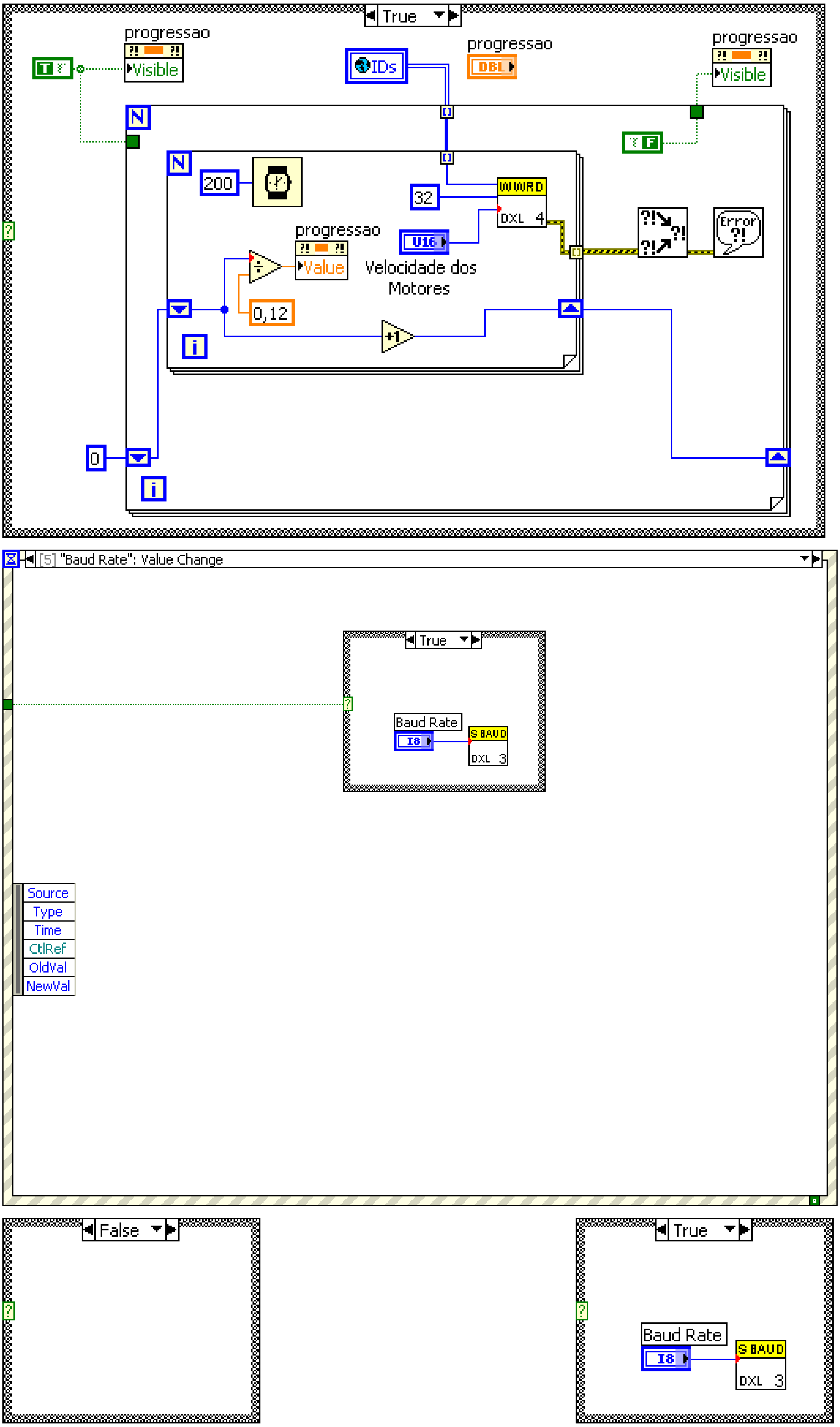

[3] "init": Value Change
2 [0..2]
Elo0%u - Servo0%u
GET ID
VI
Ctrl Val.Get
Control Name
300
0
30
DXL 4
0,12
Value
progressao
OldVal
init
8
q
11
dh
180
Posicao dos Servos
progressao
Visible
1024
300
raioPolia
H

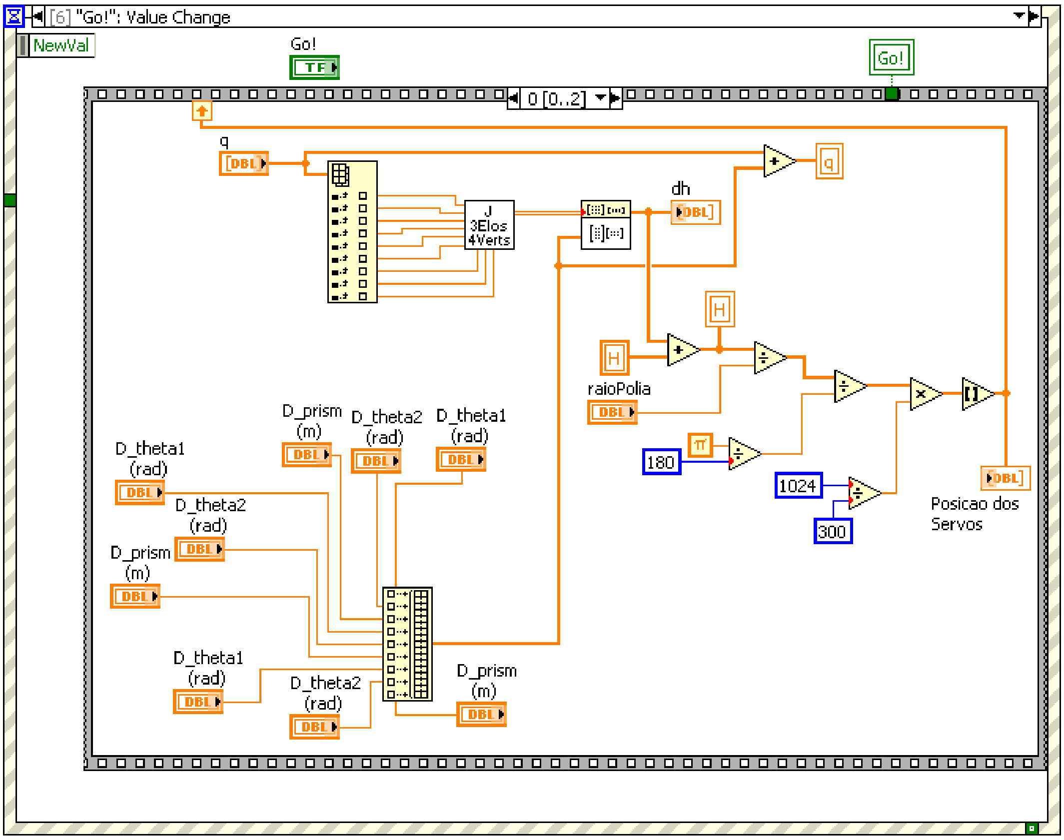

0 [0..2]
progressao
Visible
IDs
300
32
DXL 4
Velocidade dos Motores
0,12
Value
progressao

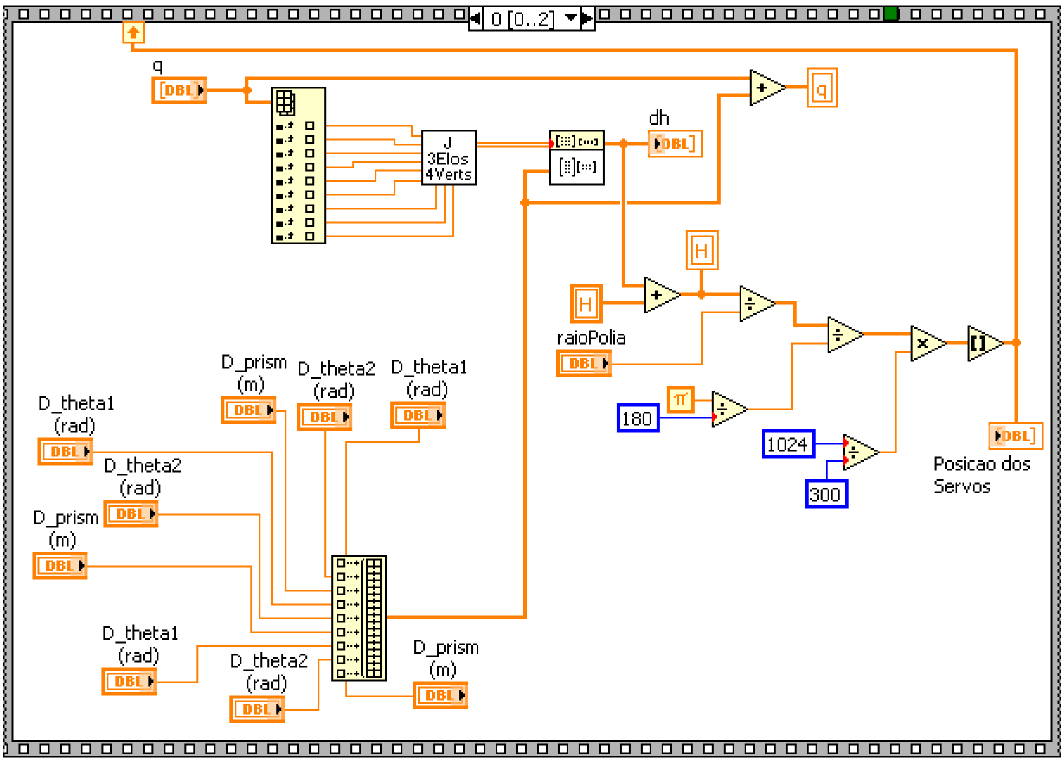

1 [0..2]
50

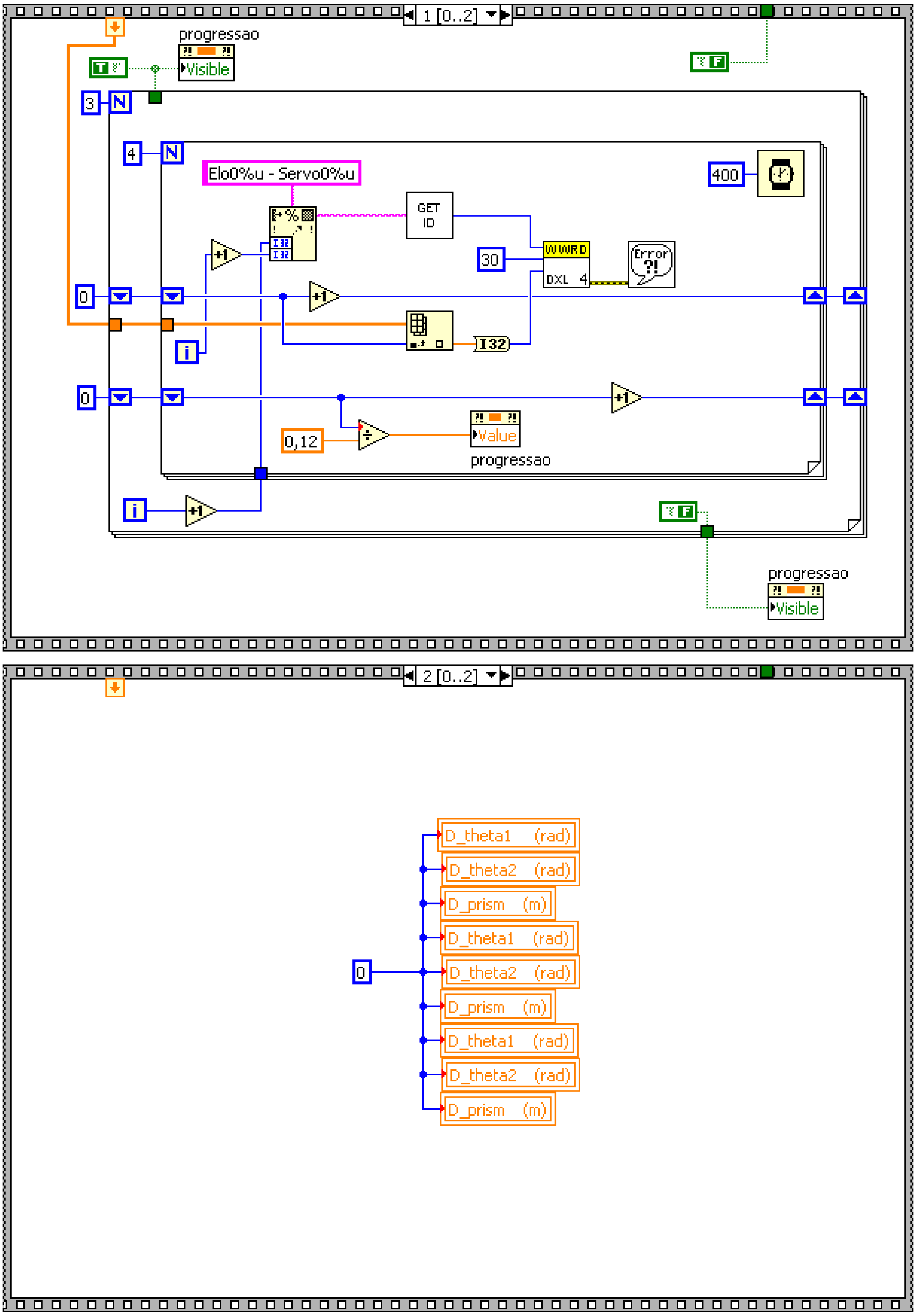

2 [0..2]
3
4
Elo0%u - Servo0%u
GET ID
VI
Ctrl Val.Get
Control Name
300
0
30
DXL 4
Error
0
0,12
Value
progressao


[4] "Velocidade dos
True
progressao
Visible
IDs
progressao
DBL
progressao
Visible
200
32
W WRD
DXL 4
progressao
Value
U16
Velocidade dos
Motores
0,12
+1
Error
0
Source
Type
Time
CtlRef
OldVal
NewVal
False


True
progressao
Visible
IDs
progressao
DBL
progressao
Visible
N
N
200
32
W WRD
DXL 4
U16
progressao
Value
Velocidade dos Motores
0,12
+1
i
0
i
Error
[5] "Baud Rate": Value Change
True
Baud Rate
I8
S BAUD
DXL 3
Source
Type
Time
CtlRef
OldVal
NewVal
False
True
Baud Rate
I8
S BAUD
DXL 3


[6] "Go!": Value Change
NewVal
Go!
Go!
0 [0..2]
q
J
3Elos
4Verts
dh
q
H
H
raioPolia
180
1024
300
Posicao dos
Servos
D_prism
(m)
D_theta2
(rad)
D_theta1
(rad)
D_theta1
(rad)
D_theta2
(rad)
D_prism
(m)
D_theta1
(rad)
D_theta2
(rad)
D_prism
(m)


0 [0..2]
q
J
3Elos
4Verts
dh
q
H
H
raioPolia
180
1024
300
Posicao dos
Servos
D_prism
(m)
D_theta2
(rad)
D_theta1
(rad)
D_theta1
(rad)
D_theta2
(rad)
D_prism
(m)
D_theta1
(rad)
D_theta2
(rad)
D_prism
(m)



1 [0..2]
progressao
Visible
3
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Elo0%u - Servo0%u
GET ID
400
30
WWRD
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Error
0
+1
+1
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+1
0,12
Value
progressao
i
+1
progressao
Visible
2 [0..2]
0
D_theta1 (rad)
D_theta2 (rad)
D_prism (m)
D_theta1 (rad)
D_theta2 (rad)
D_prism (m)
D_theta1 (rad)
D_theta2 (rad)
D_prism (m)

Anexo VIII

Funções *Toolbox Robot*

For an n-axis manipulator the following matrix naming and dimensional conventions apply.

Symbol	Dimensions	Description
l	**link**	manipulator link object
q	$1 \times n$	joint coordinate vector
q	$m \times n$	m-point joint coordinate trajectory
qd	$1 \times n$	joint velocity vector
qd	$m \times n$	m-point joint velocity trajectory
qdd	$1 \times n$	joint acceleration vector
qdd	$m \times n$	m-point joint acceleration trajectory
robot	**robot**	robot object
T	4×4	homogeneous transform
T	$4 \times 4 \times m$	m-point homogeneous transform trajectory
Q	**quaternion**	unit-quaternion object
M	1×6	vector with elements of 0 or 1 corresponding to Cartesian DOF along X, Y, Z and around X, Y, Z. 1 if that Cartesian DOF belongs to the task space, else 0.
v	3×1	Cartesian vector
t	$m \times 1$	time vector
d	6×1	differential motion vector

Object names are shown in bold typeface.

A trajectory is represented by a matrix in which each row corresponds to one of m time steps. For a joint coordinate, velocity or acceleration trajectory the columns correspond to the robot axes. For homogeneous transform trajectories we use 3-dimensional matrices where the last index corresponds to the time step.

Units

All angles are in radians. The choice of all other units is up to the user, and this choice will flow on to the units in which homogeneous transforms, Jacobians, inertias and torques are represented.

Homogeneous Transforms	
angvec2tr	angle/vector form to homogeneous transform
eul2tr	Euler angle to homogeneous transform
oa2tr	orientation and approach vector to homogeneous transform
rpy2tr	Roll/pitch/yaw angles to homogeneous transform
tr2angvec	homogeneous transform or rotation matrix to angle/vector form
tr2eul	homogeneous transform or rotation matrix to Euler angles
t2r	homogeneous transform to rotation submatrix
tr2rpy	homogeneous transform or rotation matrix to roll/pitch/yaw angles
trotx	homogeneous transform for rotation about X-axis
troty	homogeneous transform for rotation about Y-axis
trotz	homogeneous transform for rotation about Z-axis
transl	set or extract the translational component of a homogeneous transform
trnorm	normalize a homogeneous transform
trplot	plot a homogeneous transformas a coordinate frame

Note that functions of the form `tr2X` will also accept a rotation matrixas the argument.

Rotation matrices	
angvecr	angle/vector form to rotation matrix
eul2r	Euler angle to rotation matrix
oa2r	orientation and approach vector to homogeneous transform
rotx	rotation matrix for rotation about X-axis
roty	rotation matrix for rotation about Y-axis
rotz	rotation matrix for rotation about Z-axis
rpy2r	Roll/pitch/yaw angles to rotation matrix
r2t	rotation matrix to homogeneous transform

Trajectory Generation	
ctraj	Cartesian trajectory
jtraj	joint space trajectory
trinterp	interpolate homogeneous transforms

Quaternions	
+	elementwise addition
-	elementwise addition
/	divide quaternion by quaternion or scalar
*	multiply quaternion by a quaternion or vector
inv	invert a quaternion
norm	norm of a quaternion
plot	display a quaternion as a 3D rotation
q2tr	quaternion to homogeneous transform
quaternion	construct a quaternion
qinterp	interpolate quaternions
unit	unitize a quaternion

General serial link manipulators	
link	construct a robot link object
nofriction	remove friction from a robot object
perturb	randomly modify some dynamic parameters
robot	construct a robot object
showlink	show link/robot data in detail

Manipulator Models	
Fanuc10L	Fanuc 10L arm data (DH, kine)
MotomanHP6	Motoman HP6 arm data (DH, kine)
puma560	Puma 560 data (DH, kine, dyn)
puma560akb	Puma 560 data (MDH, kine, dyn)
S4ABB2p8	ABB S4 2.8 arm data (DH, kine)
stanford	Stanford arm data (DH, kine, dyn)
twolink	simple 2-link example (DH, kine)

Kinematics	
diff2tr	differential motion vector to transform
fkine	compute forward kinematics
ftrans	transform force/moment
ikine	compute inverse kinematics
ikine560	compute inverse kinematics for Puma 560 like arm
jacob0	compute Jacobian in base coordinate frame
jacobn	compute Jacobian in end-effector coordinate frame
tr2diff	homogeneous transform to differential motion vector
tr2jac	homogeneous transform to Jacobian

Graphics	
drivebot	drive a graphical robot
plot	plot/animate robot

Dynamics	
accel	compute forward dynamics
cinertia	compute Cartesian manipulator inertia matrix
coriolis	compute centripetal/coriolis torque
fdyn	forward dynamics (motion given forces)
friction	joint friction
gravload	compute gravity loading
inertia	compute manipulator inertia matrix
itorque	compute inertia torque
rne	inverse dynamics (forces given motion)

Other	
ishomog	test if argument is 4×4
isrot	test if argument is 3×3
isvec	test if argument is a 3-vector
maniplty	compute manipulability
rtdemo	toolbox demonstration
unit	unitize a vector