

AG Automation, LLC

The Automation Repair Company

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9/25/2007

Repetitive Positioning Accuracy Report

Test Conducted By: Jon Doe

Prepared For

**xxxx xxxxxx
ABC Company
2700 main Street
Anywhere USA 45442**

Manipulator Information

Customers Machine Number: _____

Serial Number: XXXXXXXXXX

Sales Order Number: XXXXXXX

Manipulator \ Controller Type

Manufacture: Motoman

Controller: ERC

Manipulator: K100S

Allowable Tolerance

Inches: 0.019880

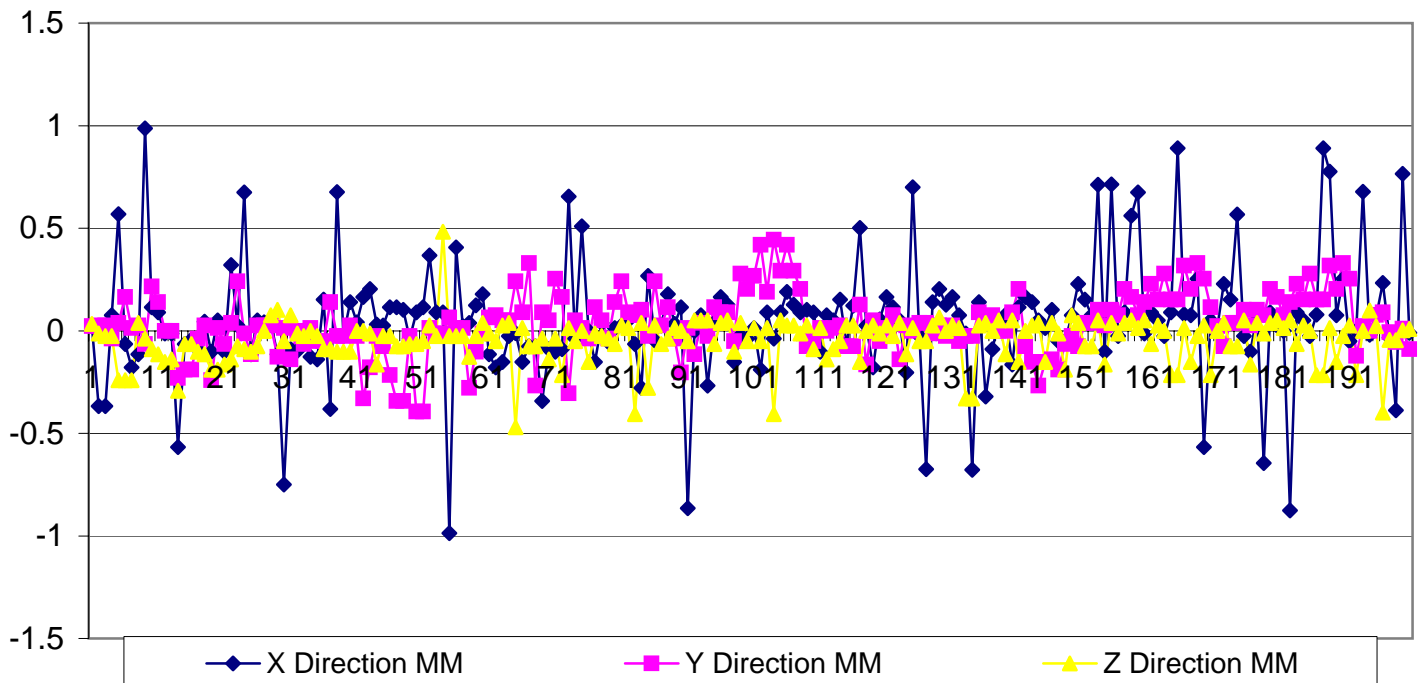
Millimeters: 0.5000

Microns: 500

Summery

Three dial indicators were used to test the repetitive positioning accuracy of the robotic system in the X, Y and Z directions. There were a total of 600 samples taken from the dial indicators. 200 samples were taken in the X - direction, 200 samples in the Y - direction and 200 samples were taken in the Z - direction.

Plotted data



Results

Data Collected	X - Direction		Y - Direction		Z - Direction	
	Millimeters	Inches	Millimeters	Inches	Millimeters	Inches
Average	0.0446	0.000176	0.0349	0.000138	-0.0470	-0.000185
largest	0.9870	0.003886	0.4440	0.001748	0.4830	0.001902
Smallest	-0.9870	-0.003886	-0.3940	-0.001551	-0.4700	-0.001850

27 samples were out of the tolerance range (Se List Below).

27 in the X Direction

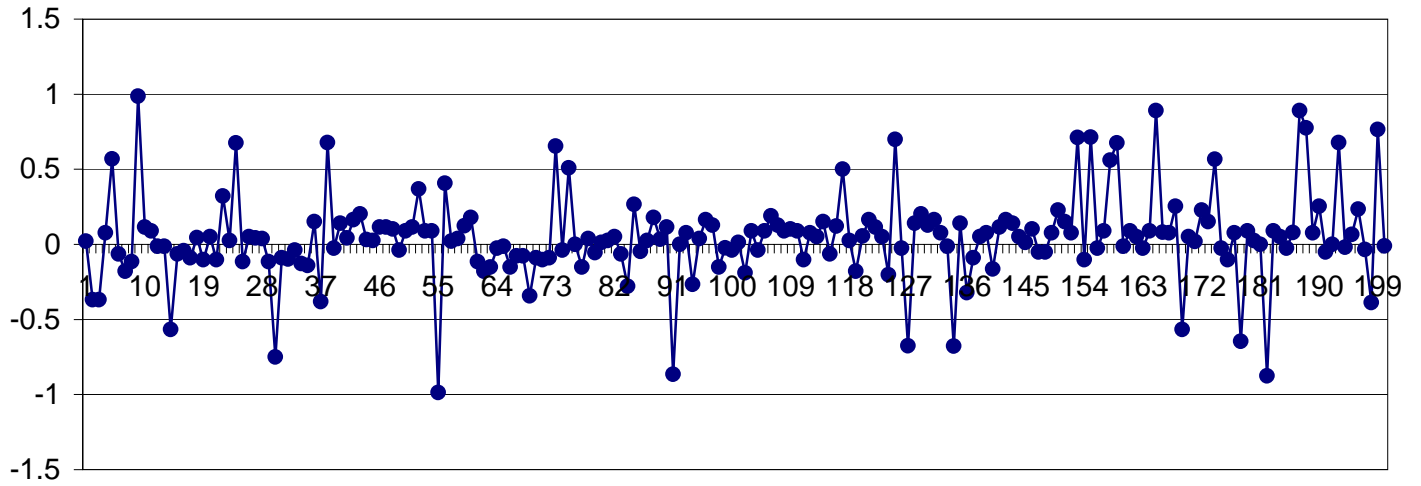
0 in the Y Direction

0 in the Z Direction

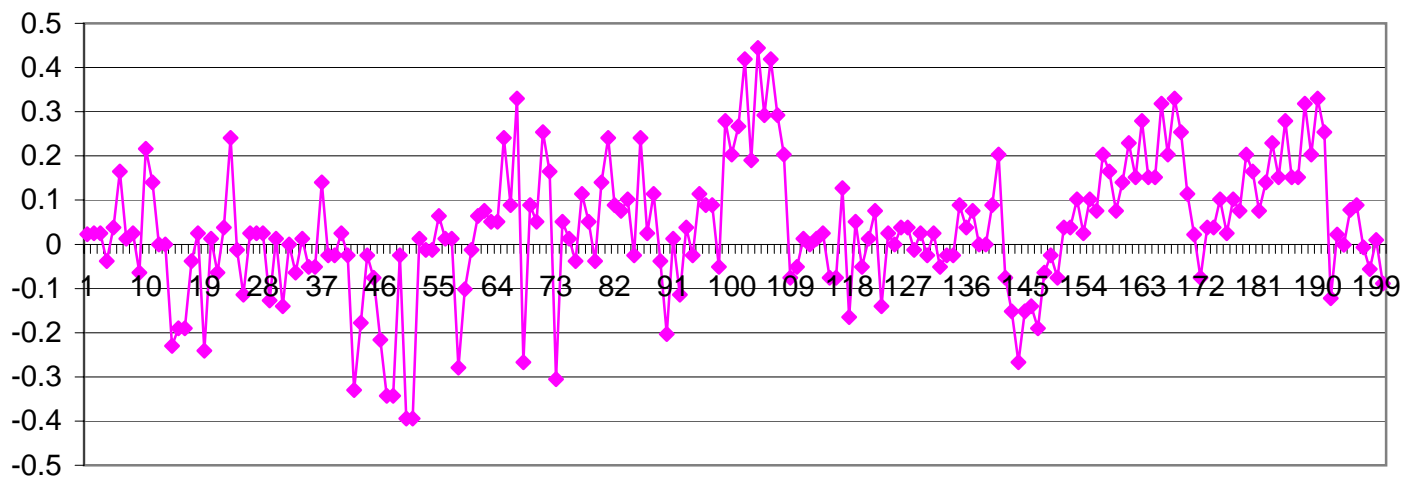
Below 50% over Tolerance Black
Above 50% over Tolerance Blue
Above 75% over Tolerance Green
100% and above over Tolerance Red

X - Direction			Y - Direction			Z - Direction		
S #	MM	Inches	S #	MM	Inches	S #	MM	Inches
5	0.568	0.022362						
9	0.987	0.038858						
14	-0.567	-0.022323						
24	0.675	0.026575						
30	-0.750	-0.029528						
38	0.677	0.026653						
55	-0.987	-0.038858						
73	0.654	0.025748						
75	0.510	0.020079						
91	-0.865	-0.034055						
117	0.501	0.019724						
125	0.699	0.027520						
127	-0.675	-0.026575						
134	-0.678	-0.026693						
153	0.712	0.028031						
155	0.713	0.028071						
158	0.561	0.022087						
159	0.675	0.026575						
165	0.890	0.035039						
169	-0.567	-0.022323						
174	0.567	0.022323						
178	-0.645	-0.025394						
182	-0.876	-0.034488						
187	0.890	0.035039						
188	0.776	0.030551						
193	0.678	0.026693						
199	0.765	0.030118						

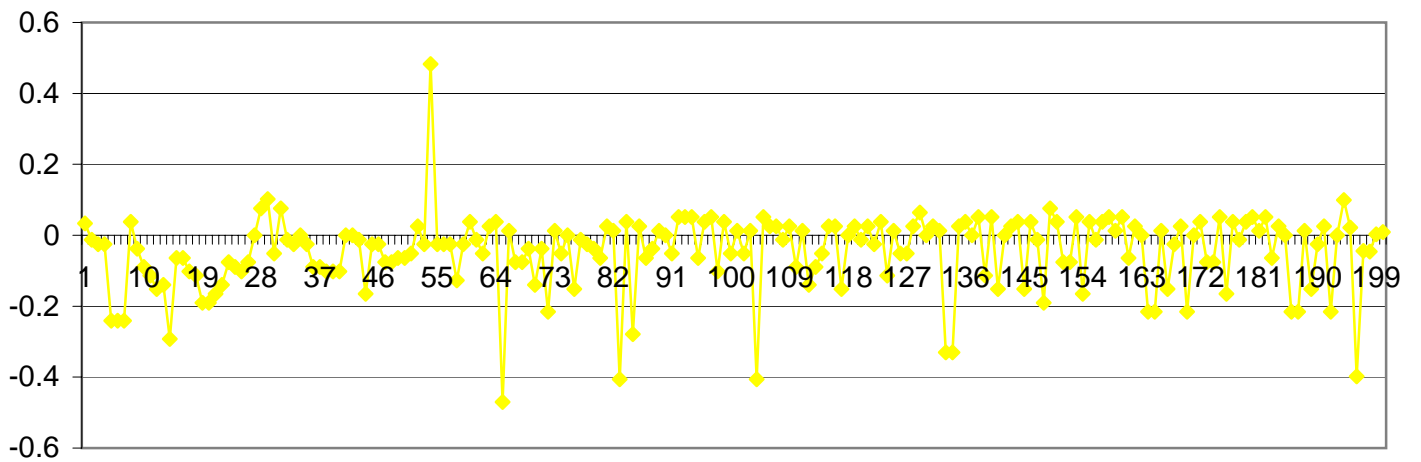
X - Direction (millimeters)



Y Direction (millimeters)



Z Direction (millimeters)



Recommendations

There was 27 touches in the X-direction that were out of the tolerance range and two touches in the Z-direction were 10% within the tolerance limits. This indicates a possible problem in either J2 and J3 axis joints.

1) Check the robot base for signs of movement. Tighten mounting bolts.

2) Check for loose bolts on axis J2 and J3.

A) Motor Bolts

B) Casting bolts

C) Drive bolts

3) Check the drive deflection (backlash) in J2 and J3 axis.

How to check the backlash in an Rotary Vector or Harmonic Drive.

The drive deflection is measured by using a dial indicator to convert the backlash into arc minutes. The manufactures documentation indicates that 2 or more arc minutes indicates a worn drive and should be replaced.

Place the dial indicator against the casting as close to the center of the drive as possible. Push the axis in the opposite direction from that being measured. Reset the dial indicator and pull the axis toward the dial indicator. This is the deflection amount. Measure the distance from the center of the drive to the dial indicator. This is the distance measurement. The formula to convert the results to arc minutes:

$$(\text{Deflection} / \text{Distance}) * (180 / 3.14159) * 60$$

Appendix 1

Sample Number	X - Direction			Y - Direction			Z - Direction		
	Micron	Millimeter	Inches	Micron	Millimeter	Inches	Micron	Millimeter	Inches
1	22	0.0220	0.000866	23	0.0230	0.000906	33	0.0330	0.001299
2	-368	-0.3680	-0.014488	25	0.0250	0.000984	-13	-0.0130	-0.000512
3	-368	-0.3680	-0.014488	25	0.0250	0.000984	-25	-0.0250	-0.000984
4	76	0.0760	0.002992	-38	-0.0380	-0.001496	-25	-0.0250	-0.000984
5	568	0.5680	0.022362	38	0.0380	0.001496	-241	-0.2410	-0.009488
6	-64	-0.0640	-0.002520	165	0.1650	0.006496	-241	-0.2410	-0.009488
7	-178	-0.1780	-0.007008	13	0.0130	0.000512	-241	-0.2410	-0.009488
8	-114	-0.1140	-0.004488	25	0.0250	0.000984	38	0.0380	0.001496
9	987	0.9870	0.038858	-64	-0.0640	-0.002520	-38	-0.0380	-0.001496
10	114	0.1140	0.004488	216	0.2160	0.008504	-89	-0.0890	-0.003504
11	89	0.0890	0.003504	140	0.1400	0.005512	-114	-0.1140	-0.004488
12	-13	-0.0130	-0.000512	0	0.0000	0.000000	-152	-0.1520	-0.005984
13	-13	-0.0130	-0.000512	0	0.0000	0.000000	-140	-0.1400	-0.005512
14	-567	-0.5670	-0.022323	-230	-0.2300	-0.009055	-292	-0.2920	-0.011496
15	-64	-0.0640	-0.002520	-190	-0.1900	-0.007480	-64	-0.0640	-0.002520
16	-43	-0.0430	-0.001693	-190	-0.1900	-0.007480	-64	-0.0640	-0.002520
17	-89	-0.0890	-0.003504	-38	-0.0380	-0.001496	-102	-0.1020	-0.004016
18	45	0.0450	0.001772	25	0.0250	0.000984	-114	-0.1140	-0.004488
19	-102	-0.1020	-0.004016	-241	-0.2410	-0.009488	-190	-0.1900	-0.007480
20	51	0.0510	0.002008	13	0.0130	0.000512	-190	-0.1900	-0.007480
21	-102	-0.1020	-0.004016	-64	-0.0640	-0.002520	-165	-0.1650	-0.006496
22	321	0.3210	0.012638	38	0.0380	0.001496	-140	-0.1400	-0.005512
23	25	0.0250	0.000984	241	0.2410	0.009488	-76	-0.0760	-0.002992
24	675	0.6750	0.026575	-13	-0.0130	-0.000512	-89	-0.0890	-0.003504
25	-114	-0.1140	-0.004488	-114	-0.1140	-0.004488	-102	-0.1020	-0.004016
26	51	0.0510	0.002008	25	0.0250	0.000984	-76	-0.0760	-0.002992
27	42	0.0420	0.001654	25	0.0250	0.000984	0	0.0000	0.000000
28	38	0.0380	0.001496	25	0.0250	0.000984	76	0.0760	0.002992
29	-114	-0.1140	-0.004488	-127	-0.1270	-0.005000	102	0.1020	0.004016
30	-750	-0.7500	-0.029528	13	0.0130	0.000512	-51	-0.0510	-0.002008
31	-89	-0.0890	-0.003504	-140	-0.1400	-0.005512	76	0.0760	0.002992
32	-98	-0.0980	-0.003858	0	0.0000	0.000000	-13	-0.0130	-0.000512
33	-38	-0.0380	-0.001496	-64	-0.0640	-0.002520	-25	-0.0250	-0.000984
34	-127	-0.1270	-0.005000	13	0.0130	0.000512	0	0.0000	0.000000
35	-140	-0.1400	-0.005512	-51	-0.0510	-0.002008	-25	-0.0250	-0.000984
36	152	0.1520	0.005984	-51	-0.0510	-0.002008	-89	-0.0890	-0.003504
37	-381	-0.3810	-0.015000	140	0.1400	0.005512	-89	-0.0890	-0.003504
38	677	0.6770	0.026653	-25	-0.0250	-0.000984	-102	-0.1020	-0.004016
39	-25	-0.0250	-0.000984	-25	-0.0250	-0.000984	-102	-0.1020	-0.004016
40	140	0.1400	0.005512	25	0.0250	0.000984	-102	-0.1020	-0.004016
41	42	0.0420	0.001654	-25	-0.0250	-0.000984	0	0.0000	0.000000
42	165	0.1650	0.006496	-330	-0.3300	-0.012992	0	0.0000	0.000000
43	203	0.2030	0.007992	-178	-0.1780	-0.007008	-13	-0.0130	-0.000512
44	31	0.0310	0.001220	-25	-0.0250	-0.000984	-165	-0.1650	-0.006496
45	25	0.0250	0.000984	-76	-0.0760	-0.002992	-25	-0.0250	-0.000984
46	114	0.1140	0.004488	-216	-0.2160	-0.008504	-25	-0.0250	-0.000984
47	114	0.1140	0.004488	-343	-0.3430	-0.013504	-76	-0.0760	-0.002992
48	102	0.1020	0.004016	-343	-0.3430	-0.013504	-76	-0.0760	-0.002992
49	-38	-0.0380	-0.001496	-25	-0.0250	-0.000984	-64	-0.0640	-0.002520
50	89	0.0890	0.003504	-394	-0.3940	-0.015512	-64	-0.0640	-0.002520
51	114	0.1140	0.004488	-394	-0.3940	-0.015512	-51	-0.0510	-0.002008
52	368	0.3680	0.014488	13	0.0130	0.000512	25	0.0250	0.000984

53	89	0.0890	0.003504	-13	-0.0130	-0.000512	-25	-0.0250	-0.000984
54	89	0.0890	0.003504	-13	-0.0130	-0.000512	483	0.4830	0.019016
55	-987	-0.9870	-0.038858	64	0.0640	0.002520	-25	-0.0250	-0.000984
56	406	0.4060	0.015984	13	0.0130	0.000512	-25	-0.0250	-0.000984
57	22	0.0220	0.000866	13	0.0130	0.000512	-25	-0.0250	-0.000984
58	38	0.0380	0.001496	-279	-0.2790	-0.010984	-127	-0.1270	-0.005000
59	124	0.1240	0.004882	-102	-0.1020	-0.004016	-25	-0.0250	-0.000984
60	178	0.1780	0.007008	-13	-0.0130	-0.000512	38	0.0380	0.001496
61	-114	-0.1140	-0.004488	64	0.0640	0.002520	-13	-0.0130	-0.000512
62	-178	-0.1780	-0.007008	76	0.0760	0.002992	-51	-0.0510	-0.002008
63	-152	-0.1520	-0.005984	51	0.0510	0.002008	25	0.0250	0.000984
64	-25	-0.0250	-0.000984	51	0.0510	0.002008	38	0.0380	0.001496
65	-12	-0.0120	-0.000472	241	0.2410	0.009488	-470	-0.4700	-0.018504
66	-152	-0.1520	-0.005984	89	0.0890	0.003504	13	0.0130	0.000512
67	-76	-0.0760	-0.002992	330	0.3300	0.012992	-76	-0.0760	-0.002992
68	-76	-0.0760	-0.002992	-267	-0.2670	-0.010512	-76	-0.0760	-0.002992
69	-343	-0.3430	-0.013504	89	0.0890	0.003504	-38	-0.0380	-0.001496
70	-89	-0.0890	-0.003504	51	0.0510	0.002008	-140	-0.1400	-0.005512
71	-102	-0.1020	-0.004016	254	0.2540	0.010000	-38	-0.0380	-0.001496
72	-90	-0.0900	-0.003543	165	0.1650	0.006496	-216	-0.2160	-0.008504
73	654	0.6540	0.025748	-305	-0.3050	-0.012008	13	0.0130	0.000512
74	-38	-0.0380	-0.001496	51	0.0510	0.002008	-51	-0.0510	-0.002008
75	510	0.5100	0.020079	13	0.0130	0.000512	0	0.0000	0.000000
76	0	0.0000	0.000000	-38	-0.0380	-0.001496	-152	-0.1520	-0.005984
77	-152	-0.1520	-0.005984	114	0.1140	0.004488	-13	-0.0130	-0.000512
78	38	0.0380	0.001496	51	0.0510	0.002008	-25	-0.0250	-0.000984
79	-56	-0.0560	-0.002205	-38	-0.0380	-0.001496	-38	-0.0380	-0.001496
80	13	0.0130	0.000512	140	0.1400	0.005512	-64	-0.0640	-0.002520
81	25	0.0250	0.000984	241	0.2410	0.009488	25	0.0250	0.000984
82	51	0.0510	0.002008	89	0.0890	0.003504	13	0.0130	0.000512
83	-64	-0.0640	-0.002520	76	0.0760	0.002992	-406	-0.4060	-0.015984
84	-279	-0.2790	-0.010984	102	0.1020	0.004016	38	0.0380	0.001496
85	267	0.2670	0.010512	-25	-0.0250	-0.000984	-279	-0.2790	-0.010984
86	-47	-0.0470	-0.001850	241	0.2410	0.009488	25	0.0250	0.000984
87	25	0.0250	0.000984	25	0.0250	0.000984	-64	-0.0640	-0.002520
88	178	0.1780	0.007008	114	0.1140	0.004488	-38	-0.0380	-0.001496
89	34	0.0340	0.001339	-38	-0.0380	-0.001496	13	0.0130	0.000512
90	114	0.1140	0.004488	-203	-0.2030	-0.007992	0	0.0000	0.000000
91	-865	-0.8650	-0.034055	13	0.0130	0.000512	-51	-0.0510	-0.002008
92	0	0.0000	0.000000	-114	-0.1140	-0.004488	51	0.0510	0.002008
93	76	0.0760	0.002992	38	0.0380	0.001496	51	0.0510	0.002008
94	-267	-0.2670	-0.010512	-25	-0.0250	-0.000984	51	0.0510	0.002008
95	38	0.0380	0.001496	114	0.1140	0.004488	-64	-0.0640	-0.002520
96	165	0.1650	0.006496	89	0.0890	0.003504	38	0.0380	0.001496
97	127	0.1270	0.005000	89	0.0890	0.003504	51	0.0510	0.002008
98	-152	-0.1520	-0.005984	-51	-0.0510	-0.002008	-102	-0.1020	-0.004016
99	-23	-0.0230	-0.000906	279	0.2790	0.010984	38	0.0380	0.001496
100	-38	-0.0380	-0.001496	203	0.2030	0.007992	-51	-0.0510	-0.002008
101	13	0.0130	0.000512	267	0.2670	0.010512	13	0.0130	0.000512
102	-190	-0.1900	-0.007480	419	0.4190	0.016496	-51	-0.0510	-0.002008
103	89	0.0890	0.003504	190	0.1900	0.007480	13	0.0130	0.000512
104	-38	-0.0380	-0.001496	444	0.4440	0.017480	-406	-0.4060	-0.015984
105	89	0.0890	0.003504	292	0.2920	0.011496	51	0.0510	0.002008
106	190	0.1900	0.007480	419	0.4190	0.016496	25	0.0250	0.000984
107	127	0.1270	0.005000	292	0.2920	0.011496	25	0.0250	0.000984
108	89	0.0890	0.003504	203	0.2030	0.007992	-13	-0.0130	-0.000512
109	102	0.1020	0.004016	-76	-0.0760	-0.002992	25	0.0250	0.000984
110	89	0.0890	0.003504	-51	-0.0510	-0.002008	-89	-0.0890	-0.003504

111	-102	-0.1020	-0.004016	13	0.0130	0.000512	13	0.0130	0.000512
112	76	0.0760	0.002992	0	0.0000	0.000000	-140	-0.1400	-0.005512
113	51	0.0510	0.002008	13	0.0130	0.000512	-89	-0.0890	-0.003504
114	152	0.1520	0.005984	25	0.0250	0.000984	-51	-0.0510	-0.002008
115	-64	-0.0640	-0.002520	-76	-0.0760	-0.002992	25	0.0250	0.000984
116	122	0.1220	0.004803	-76	-0.0760	-0.002992	25	0.0250	0.000984
117	501	0.5010	0.019724	127	0.1270	0.005000	-152	-0.1520	-0.005984
118	25	0.0250	0.000984	-165	-0.1650	-0.006496	0	0.0000	0.000000
119	-178	-0.1780	-0.007008	51	0.0510	0.002008	25	0.0250	0.000984
120	56	0.0560	0.002205	-51	-0.0510	-0.002008	-13	-0.0130	-0.000512
121	165	0.1650	0.006496	13	0.0130	0.000512	25	0.0250	0.000984
122	114	0.1140	0.004488	76	0.0760	0.002992	-25	-0.0250	-0.000984
123	51	0.0510	0.002008	-140	-0.1400	-0.005512	38	0.0380	0.001496
124	-203	-0.2030	-0.007992	25	0.0250	0.000984	-114	-0.1140	-0.004488
125	699	0.6990	0.027520	0	0.0000	0.000000	13	0.0130	0.000512
126	-25	-0.0250	-0.000984	38	0.0380	0.001496	-51	-0.0510	-0.002008
127	-675	-0.6750	-0.026575	38	0.0380	0.001496	-51	-0.0510	-0.002008
128	140	0.1400	0.005512	-13	-0.0130	-0.000512	25	0.0250	0.000984
129	203	0.2030	0.007992	25	0.0250	0.000984	64	0.0640	0.002520
130	127	0.1270	0.005000	-25	-0.0250	-0.000984	0	0.0000	0.000000
131	165	0.1650	0.006496	25	0.0250	0.000984	25	0.0250	0.000984
132	76	0.0760	0.002992	-51	-0.0510	-0.002008	13	0.0130	0.000512
133	-13	-0.0130	-0.000512	-25	-0.0250	-0.000984	-330	-0.3300	-0.012992
134	-678	-0.6780	-0.026693	-25	-0.0250	-0.000984	-330	-0.3300	-0.012992
135	140	0.1400	0.005512	89	0.0890	0.003504	25	0.0250	0.000984
136	-321	-0.3210	-0.012638	38	0.0380	0.001496	38	0.0380	0.001496
137	-89	-0.0890	-0.003504	76	0.0760	0.002992	0	0.0000	0.000000
138	51	0.0510	0.002008	0	0.0000	0.000000	51	0.0510	0.002008
139	77	0.0770	0.003031	0	0.0000	0.000000	-114	-0.1140	-0.004488
140	-165	-0.1650	-0.006496	89	0.0890	0.003504	51	0.0510	0.002008
141	114	0.1140	0.004488	203	0.2030	0.007992	-152	-0.1520	-0.005984
142	165	0.1650	0.006496	-76	-0.0760	-0.002992	0	0.0000	0.000000
143	140	0.1400	0.005512	-152	-0.1520	-0.005984	25	0.0250	0.000984
144	51	0.0510	0.002008	-267	-0.2670	-0.010512	38	0.0380	0.001496
145	13	0.0130	0.000512	-152	-0.1520	-0.005984	-152	-0.1520	-0.005984
146	102	0.1020	0.004016	-140	-0.1400	-0.005512	38	0.0380	0.001496
147	-51	-0.0510	-0.002008	-190	-0.1900	-0.007480	-13	-0.0130	-0.000512
148	-51	-0.0510	-0.002008	-64	-0.0640	-0.002520	-190	-0.1900	-0.007480
149	76	0.0760	0.002992	-25	-0.0250	-0.000984	76	0.0760	0.002992
150	229	0.2290	0.009016	-76	-0.0760	-0.002992	38	0.0380	0.001496
151	152	0.1520	0.005984	38	0.0380	0.001496	-76	-0.0760	-0.002992
152	76	0.0760	0.002992	38	0.0380	0.001496	-76	-0.0760	-0.002992
153	712	0.7120	0.028031	102	0.1020	0.004016	51	0.0510	0.002008
154	-102	-0.1020	-0.004016	25	0.0250	0.000984	-165	-0.1650	-0.006496
155	713	0.7130	0.028071	102	0.1020	0.004016	38	0.0380	0.001496
156	-25	-0.0250	-0.000984	76	0.0760	0.002992	-13	-0.0130	-0.000512
157	89	0.0890	0.003504	203	0.2030	0.007992	38	0.0380	0.001496
158	561	0.5610	0.022087	165	0.1650	0.006496	51	0.0510	0.002008
159	675	0.6750	0.026575	76	0.0760	0.002992	13	0.0130	0.000512
160	-13	-0.0130	-0.000512	140	0.1400	0.005512	51	0.0510	0.002008
161	89	0.0890	0.003504	229	0.2290	0.009016	-64	-0.0640	-0.002520
162	51	0.0510	0.002008	152	0.1520	0.005984	25	0.0250	0.000984
163	-25	-0.0250	-0.000984	279	0.2790	0.010984	0	0.0000	0.000000
164	89	0.0890	0.003504	152	0.1520	0.005984	-216	-0.2160	-0.008504
165	890	0.8900	0.035039	152	0.1520	0.005984	-216	-0.2160	-0.008504
166	81	0.0810	0.003189	318	0.3180	0.012520	13	0.0130	0.000512
167	76	0.0760	0.002992	203	0.2030	0.007992	-152	-0.1520	-0.005984
168	254	0.2540	0.010000	330	0.3300	0.012992	-25	-0.0250	-0.000984

169	-567	-0.5670	-0.022323	254	0.2540	0.010000	25	0.0250	0.000984
170	51	0.0510	0.002008	114	0.1140	0.004488	-216	-0.2160	-0.008504
171	20	0.0200	0.000787	22	0.0220	0.000866	0	0.0000	0.000000
172	229	0.2290	0.009016	-76	-0.0760	-0.002992	38	0.0380	0.001496
173	152	0.1520	0.005984	38	0.0380	0.001496	-76	-0.0760	-0.002992
174	567	0.5670	0.022323	38	0.0380	0.001496	-76	-0.0760	-0.002992
175	-25	-0.0250	-0.000984	102	0.1020	0.004016	51	0.0510	0.002008
176	-102	-0.1020	-0.004016	25	0.0250	0.000984	-165	-0.1650	-0.006496
177	76	0.0760	0.002992	102	0.1020	0.004016	38	0.0380	0.001496
178	-645	-0.6450	-0.025394	76	0.0760	0.002992	-13	-0.0130	-0.000512
179	89	0.0890	0.003504	203	0.2030	0.007992	38	0.0380	0.001496
180	25	0.0250	0.000984	165	0.1650	0.006496	51	0.0510	0.002008
181	0	0.0000	0.000000	76	0.0760	0.002992	13	0.0130	0.000512
182	-876	-0.8760	-0.034488	140	0.1400	0.005512	51	0.0510	0.002008
183	89	0.0890	0.003504	229	0.2290	0.009016	-64	-0.0640	-0.002520
184	51	0.0510	0.002008	152	0.1520	0.005984	25	0.0250	0.000984
185	-25	-0.0250	-0.000984	279	0.2790	0.010984	0	0.0000	0.000000
186	79	0.0790	0.003110	152	0.1520	0.005984	-216	-0.2160	-0.008504
187	890	0.8900	0.035039	152	0.1520	0.005984	-216	-0.2160	-0.008504
188	776	0.7760	0.030551	318	0.3180	0.012520	13	0.0130	0.000512
189	76	0.0760	0.002992	203	0.2030	0.007992	-152	-0.1520	-0.005984
190	254	0.2540	0.010000	330	0.3300	0.012992	-25	-0.0250	-0.000984
191	-51	-0.0510	-0.002008	254	0.2540	0.010000	25	0.0250	0.000984
192	0	0.0000	0.000000	-122	-0.1220	-0.004803	-216	-0.2160	-0.008504
193	678	0.6780	0.026693	22	0.0220	0.000866	0	0.0000	0.000000
194	-20	-0.0200	-0.000787	-1	-0.0010	-0.000039	99	0.0990	0.003898
195	66	0.0660	0.002598	78	0.0780	0.003071	22	0.0220	0.000866
196	234	0.2340	0.009213	89	0.0890	0.003504	-398	-0.3980	-0.015669
197	-34	-0.0340	-0.001339	-7	-0.0070	-0.000276	-44	-0.0440	-0.001732
198	-387	-0.3870	-0.015236	-56	-0.0560	-0.002205	-46	-0.0460	-0.001811
199	765	0.7650	0.030118	10	0.0100	0.000394	3	0.0030	0.000118
200	-10	-0.0100	-0.000394	-89	-0.0890	-0.003504	9	0.0090	0.000354