ROTARY AXIS ATTACHMENT (rev0)

This attachment shows the progression from using a spread sheet for basic calculations associated with motor tuning, actual testing of a rotary, rationalization of velocity and acceleration settings, graphing and calculation of feed rates.

1. Calculated the steps per degree, confirmed the calculated value using the axis calibration feature of Mach, and calculated the max velocity for initial use for motor tuning of the A axis.

Rotary ~ A, B, C

Degrees

Required inputs

Stepper Motor	Deg/step -	1.8
	Steps/rev -	200
Micro Stepping	Pulse/step -	10
	Pulse/rev -	2000
Rotary Table	Gear reduction -	72
	Deg/rev -	5
Result	*Steps per deg -	400
	Resolution (deg/step) -	0.0025

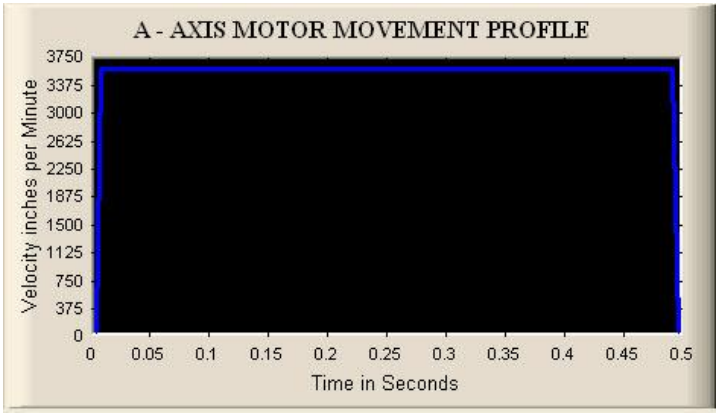
Input:		**Result:**
Feed - deg/min	360	pulse/sec = 2400. deg/sec = 6. stepper rpm = 72.
Stepper RPM	720	deg/min = 3600. deg/sec = 60. pulse/sec = 24000.
Pulse/sec	25000	stepper rpm = 750. deg/min = 3750. deg/sec = 62.5

2. Used the spread sheet to calc the max velocity at lowest Kernel Speed. The stepper didn't skip at 3750 deg/min with a low acceleration value. Thus just doubled the acceleration until it skipped.

400	3750	400		10
400	3750	800		10
400	3750	1600		10
400	3750	3200		12
400	3750	6400		12
400	3750	12000		SKIPS
400	3750	8000		SKIPS
400	3750	7500		SKIPS
400	3750	7000		12
Motor skips at 3750 deg/min and 7500 accel				

I set the max velocity at 3600 deg/min because that gave an accurate max rpm value and didn't skip. The stepper skipped at V= 3750 with A= 7500.

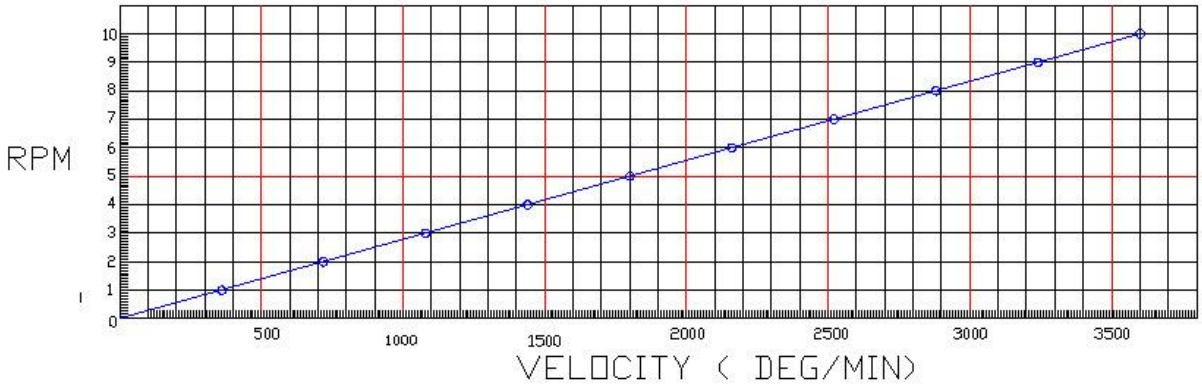
3. The difference in accel time for 3600 and 7500 has a small time impact for my hobby use. One can compare different accel values and see the ramp time in motor tuning.



If one had 1000 axis moves you would have 2000 ramps (one up and one down for each move) and if the difference of accel was say 0.01 seconds, then total difference would be 20 seconds for all the moves.

If a program has 1000's of code lines code the difference in total program run time can be significant.

4. Tuning all done, I timed some rotations at different velocity settings to confirm rpm's. The green values are actual tests and the others are easily calculated. Since a graph of rpm to velocity is linear, then for 9 rpm, required velocity would be a % of max velocity.
ie; 0.9 (3600)=3240.9



GRAPH OF RPM TO VELOCITY

5. Familiar thinking is in terms RPM and not some other terms of movement. To relate the table rpm to a Feedrate = inches/min for different work diameters a spread sheet calcs's the values. The F's in yellow color are greater than the 60 ipm max velocity settings of my other axes. Comments will be made latter on about using this chart for feedrates when coding.

Just must note it only applies to my rotary A axis!

		LINEAR INCHES PER MIN AT TABLE RPM								
		TABLE RPM								
WORK DIAMETER INCHES	CIRCUMFERENCE INCHES	10	9	8	6	5	4	3	2	1
1	3.14	31.416	28.2744	25.1328	18.8496	15.708	12.5664	9.4248	6.2832	3.14
2	6.28	62.832	56.5488	50.2656	37.6992	31.416	25.1328	18.8496	12.5664	6.28
3	9.42	94.248	84.8232	75.3984	56.5488	47.124	37.6992	28.2744	18.8496	9.42
4	12.57	125.664	113.0976	100.5312	75.3984	62.832	50.2656	37.6992	25.1328	12.57
5	15.71	157.08	141.372	125.664	94.248	78.54	62.832	47.124	31.416	15.71
6	18.85	188.496	169.6464	150.7968	113.0976	94.248	75.3984	56.5488	37.6992	18.85
7	21.99	219.912	197.9208	175.9296	131.9472	109.956	87.9648	65.9736	43.9824	21.99
8	25.13	251.328	226.1952	201.0624	150.7968	125.664	100.5312	75.3984	50.2656	25.13
9	28.27	282.744	254.4696	226.1952	169.6464	141.372	113.0976	84.8232	56.5488	28.27
10	31.42	314.16	282.744	251.328	188.496	157.08	125.664	94.248	62.832	31.42
0.5	1.57	15.708	14.1372	12.5664	9.4248	7.854	6.2832	4.7124	3.1416	1.5708

REFERENCE MATERIAL

Davidson Optronics, Inc.

ANGULAR CONVERSION

	seconds	minutes	degrees	milliradians	microradians
1 second (sec.)	—	0.016 667	0.000 277	0.004 848 136	4.848 136 817
1 minute (min.)	60	—	0.016 667	0.290 888	290.888 209
1 degree (deg.)	3 600	60	000-000	17.453 293	17 453. 292 541
1 milliradian (mrad.)	206.264 806	3.437 746 771	0.057 295 783	—	1 000
1 microradian (μrad.)	.206 264 806	0.003 437 747	0.000 057 296	0.001 000	—

LINEAR CONVERSION - Inches to Metric

	nanometers (nm)	micrometers (μm)	millimeters (mm)
1 microinch (.000 001")	25.40	.025 40	0.000 025 40
1 Thousandth (.001")	25 400	25.400	0.025 40
1 inch (1.000")	25 400 000	25 400	25.400

LINEAR CONVERSION - Metric to Inches

	microinches (μin)	thousandths (.001")	inches (in)
1 millimeter (1×10^{-3} m)	39 370	39.370	.039 370
1 micrometer (1×10^{-6} m)	39.370	.039 370	.000 039 370
1 nanometer (1×10^{-9} m)	.039 370	.000 039 370	.000 000 039 370

CONVERSION - Angular to Linear Measure (units in inches)

	per Inch	per 3 inches	per 4 inches	per foot	per yard
1 second	.000 004 848	.000 014 544	.000 019 393	.000 058 178	.000 174 532 9
6 seconds	.000 029 088	.000 087 266	.000 116 355	.000 349 066	.001 047 197 5
10 seconds	.000 048 481	.000 145 444	.000 193 925	.000 581 776	.001 745 329 0
30 seconds	.000 145 444	.000 436 332	.000 581 776	.001 745 328	.005 235 987 8
1 minute	.000 290 888	.000 872 667	.001 163 553	.003 490 656	.010 471 975 8
1 microradian	.000 001 000	.000 003 000	.000 004 000	.000 012 000	.000 036 000 0
1 milliradian	.001 000 000	.003 000 000	.004 000 000	.012 000 000	.036 000 000 0