



# ROBOT DESIGN SHEET

## Inspiration for This Sheet and other designs sheets

[2232 Master Reference Sheet \(Basis for this sheet\)](#)

[JVN Design Calculator](#)

[FRC Mechanical Design Calculator \(By Dillon Carey and Aren Hill\)](#)

[AMB Design Spreadsheet \(pneumatics, Chain, mechanisms\)](#)

## Recommend Reading

[Spectrum Mechanical Design](#)

[Fundamental Principles of Mechanical Design by K. Craig](#)

[FUNdaMental Principles](#)

[610 Design Tutorials](#)

[1241 Playbook](#)

[How to Build your "Everything" Really Really Fast](#)

[WCProducts.net How To's and Videos](#)

[FRC Electrical Bible by Millilanirobotics](#)

[FRC Survival Guide](#)

[FRC 1923 MidKnight U](#)

[Ed's Machining Notebook](#)

[SDP-SI Timing Belt Handbook](#)

[Spectrum FRC Mechanism Gallery](#)

[Killer Bees 90deg drive adapter](#)

[Killer Bees Motor Tester from old Drill](#)

[Simbots CAD Tutorials](#)

[Greybots RAMP CAD Tutorials](#)

## FAQ

The Spectrum Robot Design Sheet is designed to be a centralized resource to use while designing FRC robots. Each page includes part specifications and calculations that you can use to help in the design process. Many of the COTS parts common to FRC robots have their size and other design parameters included here so you don't have to open up the part in CAD to measure or find and download the drawings every time you need to quickly add something to a sketch or prototype. We keep a copy of this sheet for each robot that we build and then add new pages for each module/subsystem on our robot. That way we can keep track of our design decisions, variables, part numbers, etc in one centralized place. You can add new pages for part references or inventory for your team. Timelines or simple gantt charts could be made to help keep everyone on schedule. If you make a cool page and want to suggest we add it to our public template just send us an email [team@spectrum3847.org](mailto:team@spectrum3847.org) and we'll look at it.

Please use the "File" menu to make a copy of this sheet in your google drive or download a copy of this sheet to your computer.





Double Acting Cylinders [McMaster Air Cylinders = https://www.mcmaster.com/automation-direct-air-cylinders/](https://www.mcmaster.com/automation-direct-air-cylinders/)

Bore	Stroke	Pivot Type		Base Length			Retracted Length			Extended Length									
1 1/4	5	Pivot + Clevis		6.03			11.03			16.03									
Bore	OD	Base Length	Back to Pivot	Rod Thread Length	Clevis Length	MC Clevis Link	AD Clevis Link	Rod End Length	MC Rod End Link	Rod Thread	Pivot Mount Thread	Nose Mount Thread	Port	Pivot Length	Pivot + Clevis	Pivot + Rod	Automation Direct Strokes	McMasterCarr Strokes	Bore Decimal
5/16	0.36	2.57	0.16	0.38	0.44	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>				5-40	3/8-24	3/8-24	10-32	2.03	2.47		NA	0.5,1,1.5,2,2.5,3,4	0.3125
7/16	0.74	3.31	0.25	0.5	0.75	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	1.0625	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	10-32	7/16-20	7/16-20	10-32	2.56	3.31	3.6225	0.5,1,1.5,2,3	0.5,1,1.5,2,2.5,3,4,5,6,8,10,12	0.4375
9/16	0.62	3.25	0.19	0.5	0.75	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	1.0625	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	10-32	7/16-20	7/16-20	10-32	2.56	3.31	3.6225	0.5,1,2,3,4,6	0.5,1,1.5,2,2.5,3,4,5,6,8,10,12	0.5625
3/4	0.86	4.53	0.28	0.5	0.94	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	1.3125	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	1/4-28	5/8"-18	5/8"-18	1/8 NPT	3.75	4.69	5.0625	0.5,1,1.5,2,3,4,5,6,8,10,12	0.5,1,1.5,2,2.5,3,4,5,6,7,8,9,10,12,14,16,18,24	0.75
7/8		4.34	0.28	0.5	0.94	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	1.3125	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	1/4-28	5/8"-18	5/8"-18	1/8 NPT	3.56	4.5	4.8725	1,2,3,4	NA	0.875
1 1/16	1.12	4.62	0.28	0.5	0.94	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	1.375	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	5/16-24	5/8"-18	5/8"-18	1/8 NPT	3.89	4.78	5.215	1,2,3,4,5,6,8,10,12	0.5,1,1.5,2,2.5,3,4,5,6,7,8,9,10,12,14,16,18,22,24	1.0625
1 1/4	1.75	5.88	0.41	0.75	1.31	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	1.8125	<a href="https://www.mcmaster.com/automation-direct-air-cylinders/">https://www.mcmaster.com/automation-direct-air-cylinders/</a>	7/16-20	3/4-16	3/4-16	3/8 NPT	4.72	6.03	6.5325	1,2,3,4,5,6,8,10,12	0.5,1,1.5,2,2.5,3,4,5,6,7,8,9,10,12,14,16,18,22,24	1.25

Pivot Length = Distance from Pivot to the bottom of the threads on the Cylinder Rod  
 Pivot + Clevis = Distance from the center of the rear pivot to the center of the clevis pivot  
 Pivot + Rod = Distance from the center of the rear pivot to the center of the Rod End pivot

Name	Bore (in)	Length (in)	QTY / Robot	Single / Double Acting	Actuations / Match	Pressure (psi)	Bore Decimal	Extend Force (lb)	Volume / cylinder (in3)	Total Volume / Match (in3)
Action 1	7/16	1	2	2	15	60	0.44	9.02	0.16	9.60
Action 2	9/16	1	2	2	15	60	0.56	14.92	0.25	15.00
Action 3	3/4	0	0	0	0	0	0.75	0.00	0.00	0.00
Action 4	3/4	0	0	0	0	0	0.75	0.00	0.00	0.00
Action 5	3/4	0	0	0	0	0	0.75	0.00	0.00	0.00
Action 6	3/4	0	0	0	0	0	0.75	0.00	0.00	0.00
Action 7	3/4	0	0	0	0	0	0.75	0.00	0.00	0.00
Action 8	3/4	0	0	0	0	0	0.75	0.00	0.00	0.00

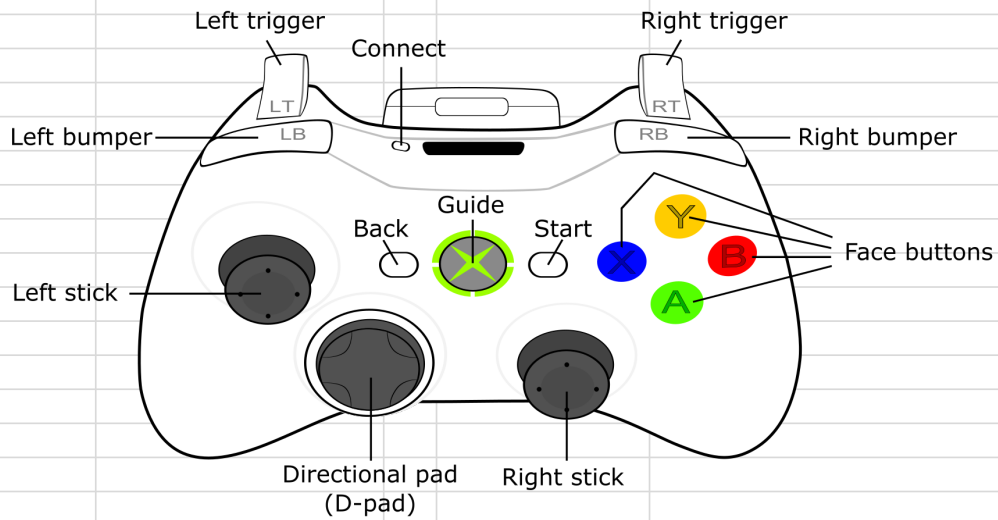
Air Tank Type	Air Tank Qty	Tanks Volume (in3)
Poweraire 36in3	0	0
Clippard 35in3	0	0

No Compressor Air Usage	
Max Tank Pressure (psi)	120
Min Tank Pressure (psi)	30
Required Volume (in3)	16.40
Air Tank Volume (in3)	36
Required Air Tanks	0.45

Spectrum Conventions	
White	Extend
Clear	Retract
Black	High Pressure
Even Solenoid	Retract
Odd Solenoid	Extend
Pneumatics Components	
Required Components	
Pressure Relief Valve	0.11 lbs
Pressure Switch	0.16 lbs
Pressure Vent Plugs	
AM Plastic Vent Valve	
AD Inline Valve	
AD Inline Valve - 2	
Pressure Gauges	
AD Inline Gauge	
AM Gauge	
Pressure Regulators	
AD Inline Regulator	
Norgren Regulator	
Compressors	
Wair 50c	
2.11" x 5.94" x 4.53"	2.4 lbs
AM 1.1 Pump	
3.27" x 6.75" x 5.25"	3.37 lbs
White Plastic Tanks	
SMC	Coastal Pneumatic
2.0x6 - 10.3 in3	AM Link
2.5x6 - 17.7 in3	
2.0x10 - 18.3 in3	
2.5x8 - 20.7 in3	
2.5x10 - 30.5 in3	
2.5x12 - 36 in3	
Clippard Black Tank	
2.5x12 25 in3	0.64 lbs
Manifolds	
Plastic Manifolds	
Ball Rod Ends	
MidwestControl	
WCProducts	
McMaster-Carr	MC Plastic Ball Ends
Plastic Rod Ends	

Compressed Lg.	Extended Lg.	Stroke Lg.	Body Dia.	Dia.	Thread Size	Plastic Clevis Length	Clevis Part Number	Pivot Retracted + Clevis	Pivot Extended + Clevis	Extension Forces, lbs.	McMaster Part#
3.54	5.510	1.97	0.73"	0.31"	M6	0.551	<a href="#">2449K72</a>	4.642	6.612	15,20,30,40,50,60,70,80,90,100,110,120,130	<a href="#">9416K14</a>
3.54	5.9	2.36	0.59"	0.23"	M6	0.551	<a href="#">2449K72</a>	4.642	7.002	15,20,30,40,50,60,70,80	<a href="#">9416K11</a>
4.61	8.15	3.54	0.59"	0.23"	M6	0.551	<a href="#">2449K72</a>	5.712	9.252	15,20,30,40,50,60,70,80	<a href="#">9416K12</a>
5.2	8.35	3.15	0.73"	0.31"	M6	0.551	<a href="#">2449K72</a>	6.302	9.452	15,20,30,40,50,60,70,80,90,100,110,120,130	<a href="#">9416K24</a>
6.77	10.71	3.94	0.73"	0.31"	M6	0.551	<a href="#">2449K72</a>	7.872	11.812	15,20,30,40,50,60,70,80,90,100,110,120,130	<a href="#">9416K15</a>
8.27	13.74	5.47	0.73"	0.31"	M6	0.551	<a href="#">2449K72</a>	9.372	14.842	15,20,30,40,50,60,70,80,90,100,110,120,130	<a href="#">9416K16</a>
9.33	15.63	6.3	0.73"	0.31"	M6	0.551	<a href="#">2449K72</a>	10.432	16.732	15,20,30,40,50,60,70,80,90,100,110,120,130	<a href="#">9416K17</a>
10.31	18.18	7.87	0.85"	0.39"	M8	0.551	<a href="#">2449K72</a>	11.412	19.282	25,50,75,100,125,150,175,200,225,250	<a href="#">9416K28</a>
10.35	18.22	7.87	0.73"	0.31"	M6	0.551	<a href="#">2449K72</a>	11.452	19.322	15,20,30,40,50,60,70,80,90,100,110,120,130	<a href="#">9416K18</a>
10.35	18.62	8.27	0.73"	0.31"	M6	0.551	<a href="#">2449K72</a>	11.452	19.722	15,20,30,40,50,60,70,80,90,100,110,120,130	<a href="#">9416K19</a>
12.52	22.36	9.84	0.73"	0.31"	M6	0.551	<a href="#">2449K72</a>	13.622	23.462	15,20,30,40,50,60,70,80,90,100,110,120,130	<a href="#">9416K2</a>
16.14	26.38	10.24	0.85"	0.39"	M8	1.260	<a href="#">2449K73</a>	18.660	28.900	25,50,75,100,125,150,175,200,225,250	<a href="#">9416K21</a>
15.2	28	12.8	0.85"	0.39"	M8	1.260	<a href="#">2449K73</a>	17.720	30.520	25,50,75,100,125,150,175,200,225,250	<a href="#">9416K22</a>
17.8	33.94	16.14	0.85"	0.39"	M8	1.260	<a href="#">2449K73</a>	20.320	36.460	25,50,75,100,125,150,175,200,225,250	<a href="#">9416K23</a>

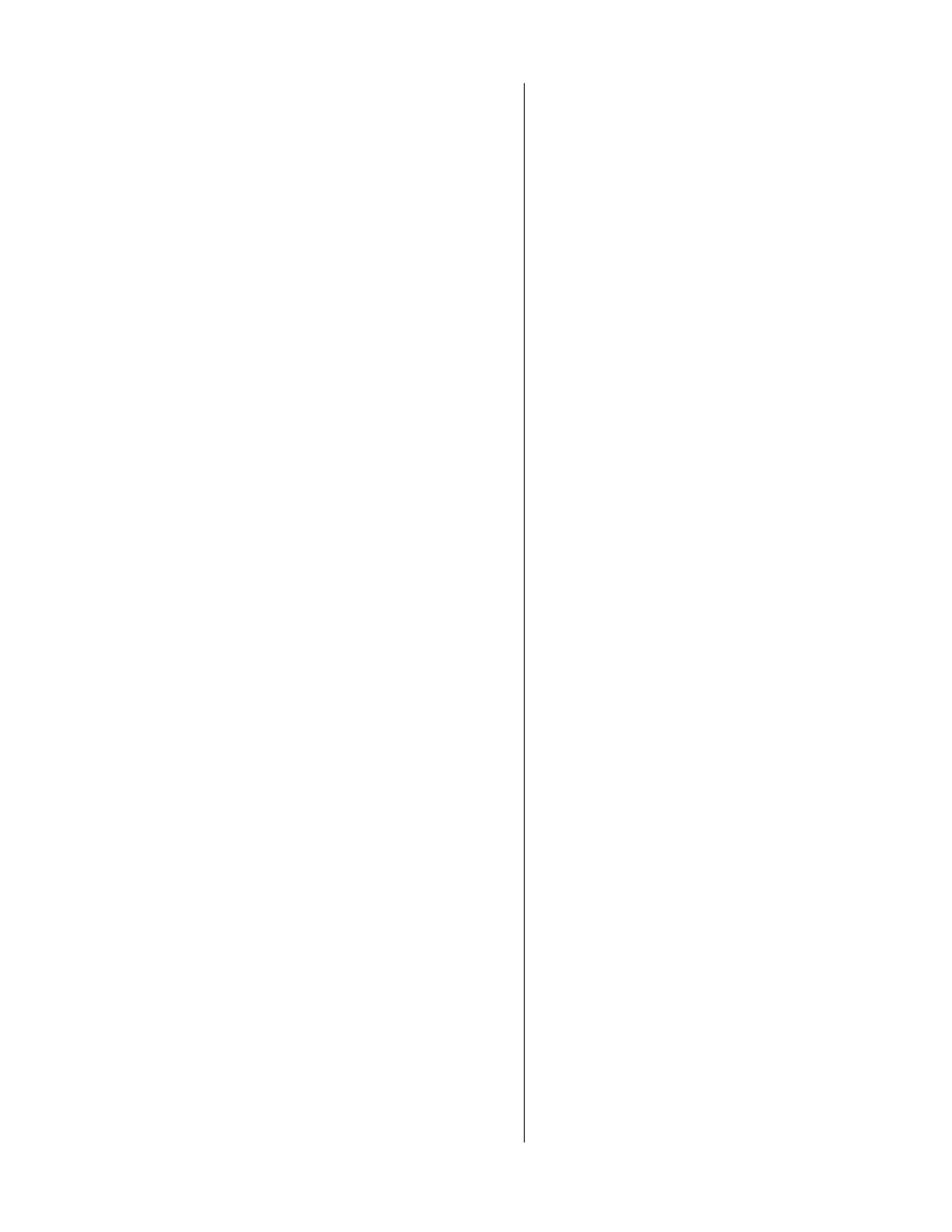
Driver Controller	Operator Controller
Left Y	Left Y
Left X	Left X
Right Y	Right Y
Right X	Right X
Left Bumper	Left Bumper
Left Trigger	Left Trigger
Right Bumper	Right Bumper
Right Trigger	Right Trigger
A	A
B	B
Y	Y
X	X
Start	Start
Back	Back
Left Stick Click	Left Stick Click
Right Stick Click	Right Stick Click
Dpad Up	Dpad Up
Dpad Down	Dpad Down
Dpad Left	Dpad Left
Dpad Right	Dpad Right

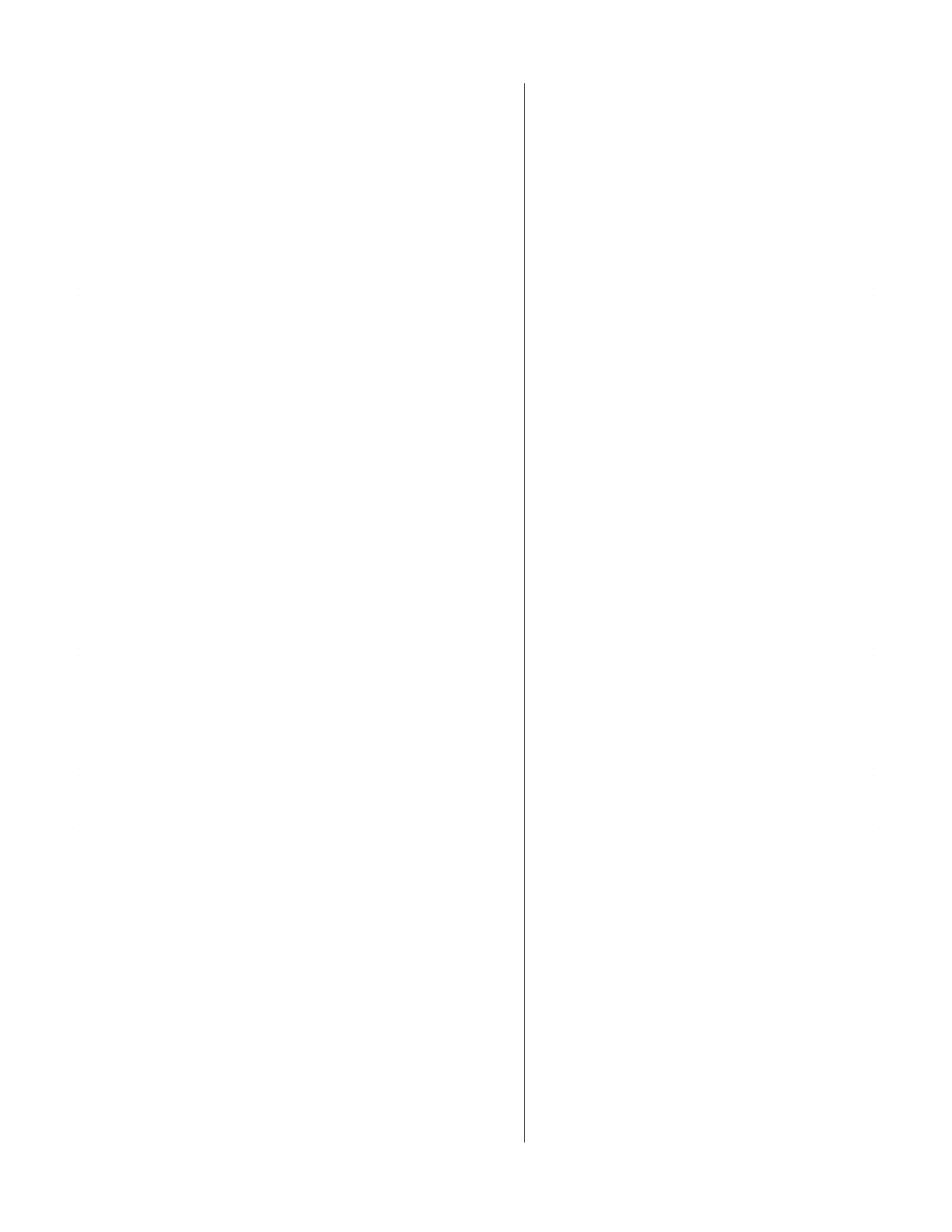




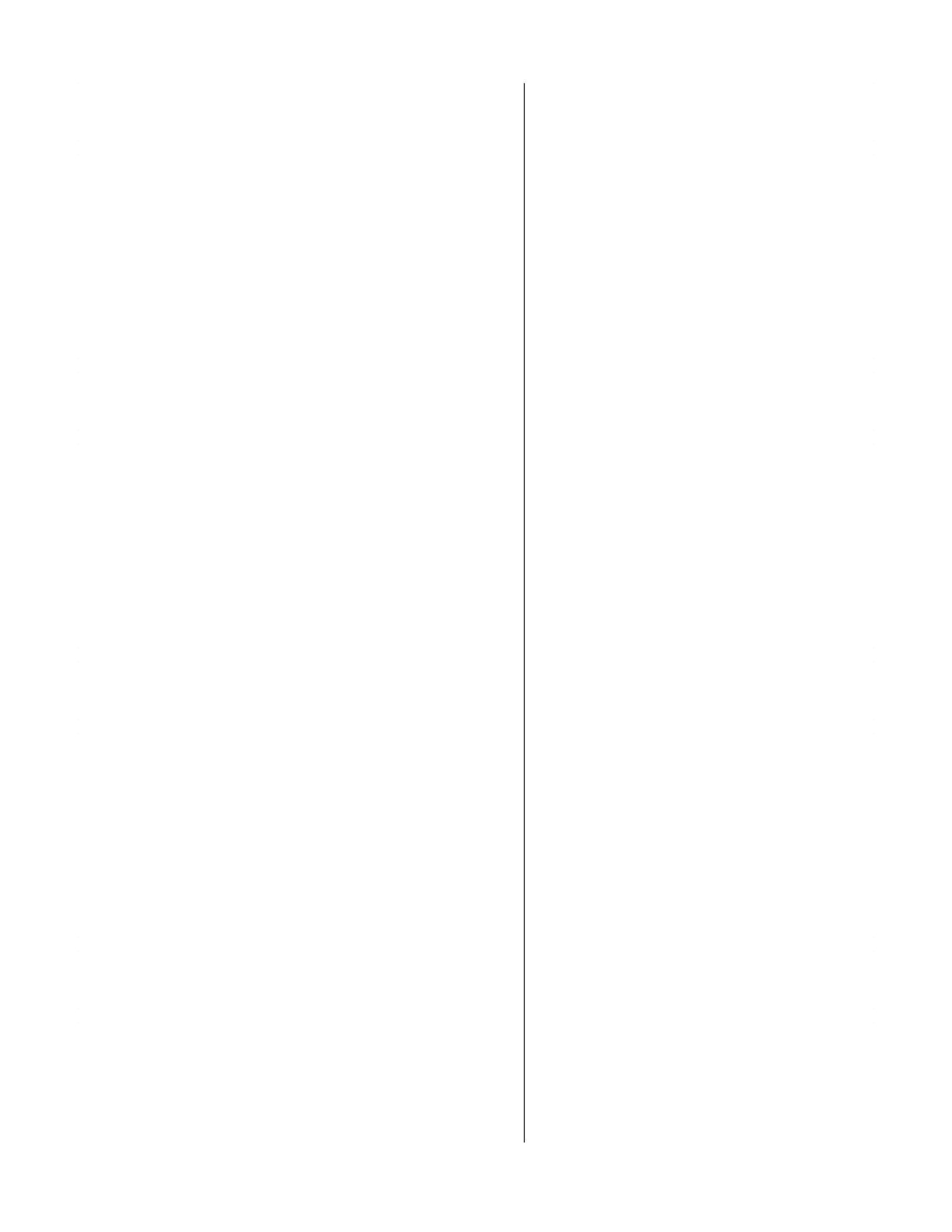


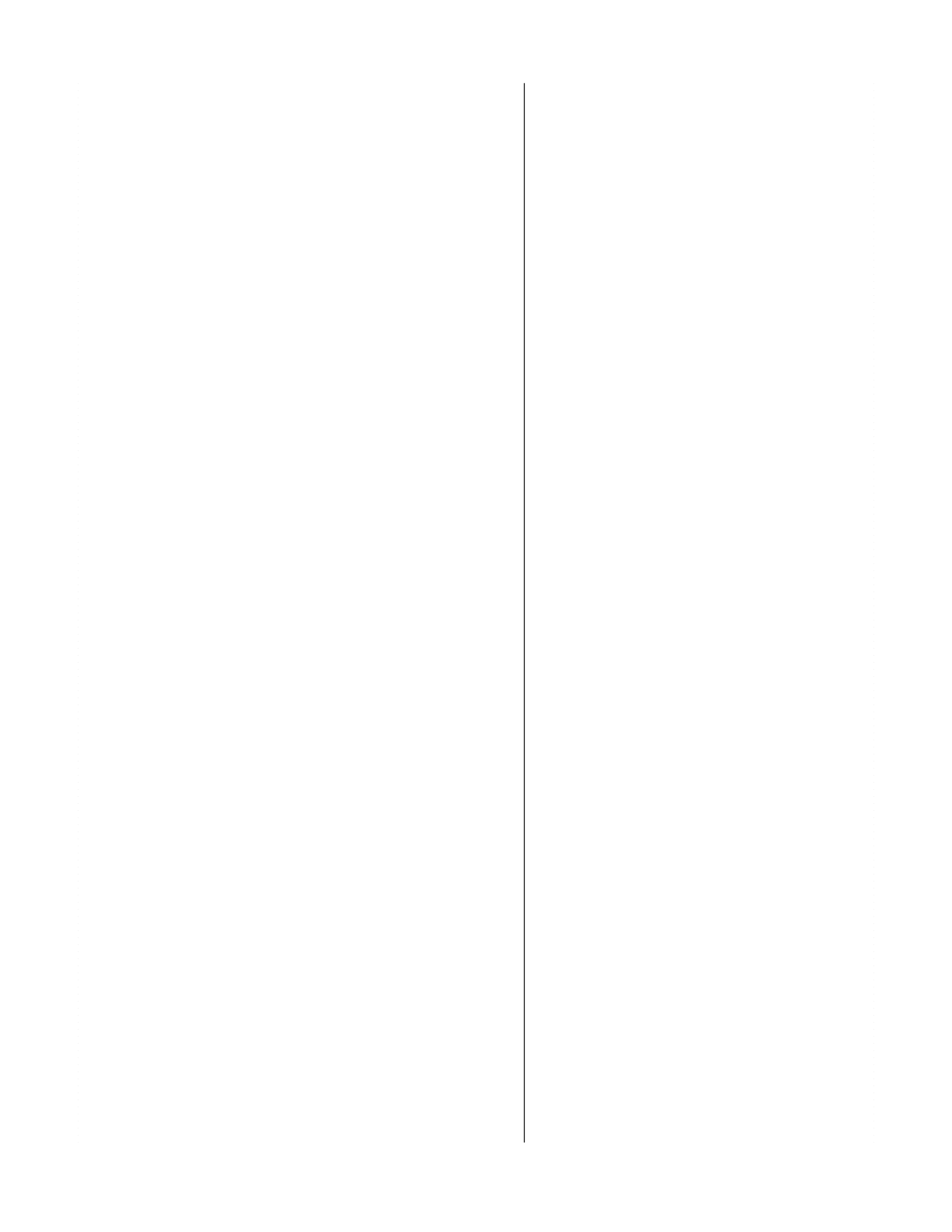


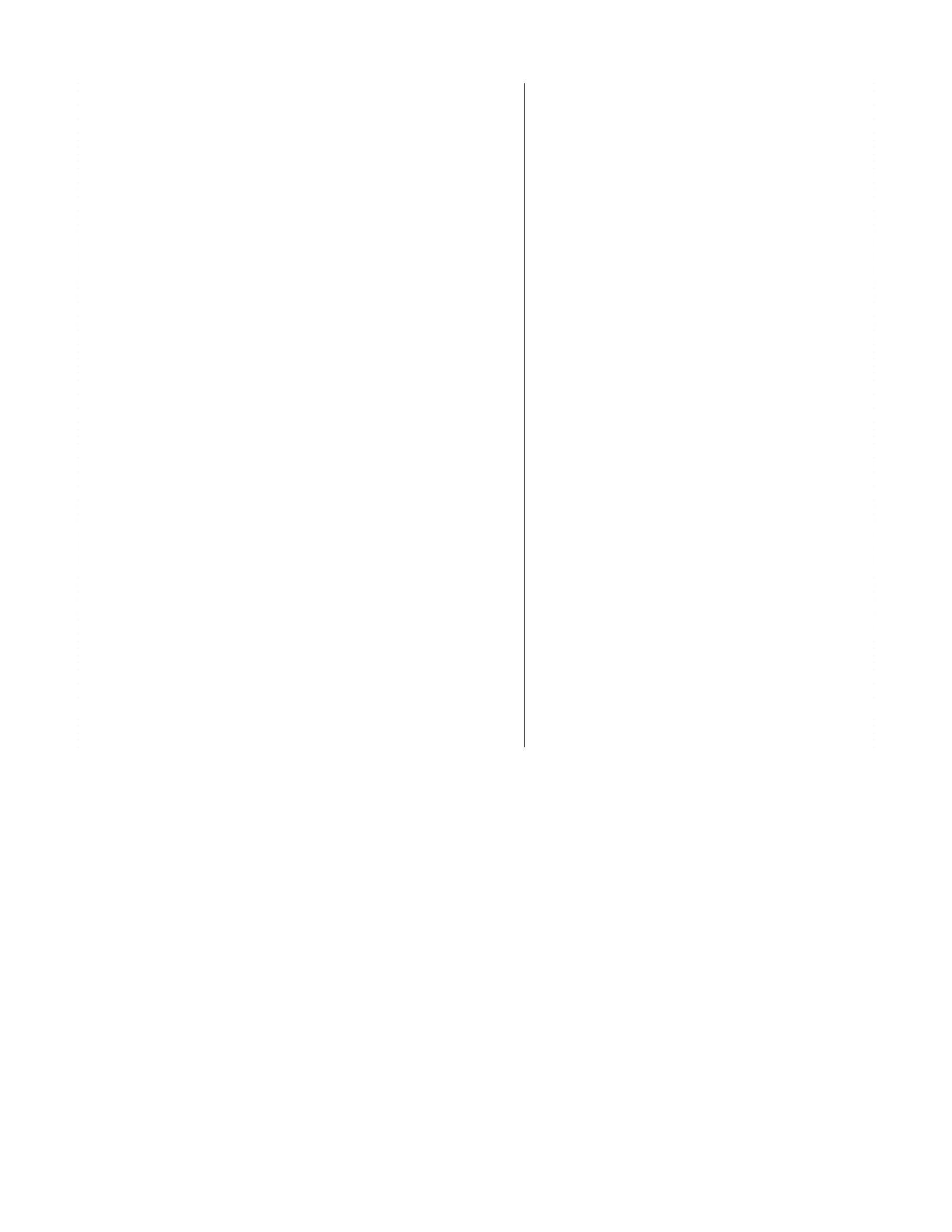




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Bolt Type	Diameter	Close	Drill	Fractional	Free	Drill	Tap	Drill	Fractional
6-32	0.138	0.144	27	5/32	0.1495	25	0.1065	36	7/64
8-32	0.164	0.1695	18	11/64	0.177	16	0.136	29	9/64
10-24	0.19	0.196	9	3/16	0.201	7	0.15	25	5/32
1/4-20	0.25	0.257	F	1/4	0.266	H	0.201	7	13/64

Screw Size/Thread	O.D. Decimal	Tap Size *	Decimal	Close Fit Size	Decimal	Free Fit Size	Decimal
000-120	0.0340"	71	0.0260"	65	0.0350"	62	0.0380"
00-90	0.044	65	0.035	3/64"	0.0469	55	0.052
0-80	0.06	3/64" (56)	0.0469	52	0.0635	50	0.07
1-72	0.073	53	0.0595	48	0.076	46	0.081
2-56	0.086	50	0.07	43	0.089	41	0.096
3-48	0.099	47	0.079	37	0.104	36	0.1065
4-40	0.112	43	0.089	32	0.116	30	0.1285
5-40	0.125	38	0.102	29	0.136	28 (9/64)	0.1405
6-32	0.138	36	0.1065	27	0.144	25	0.1495
8-32	0.164	29	0.136	18 (11/64)	0.1695	16	0.177
10-24	0.19	25	0.15	9	0.196	7 (13/64)	0.201
10-32	0.19	21	0.159	9	0.196	7 (13/64)	0.201
1/4-20	0.25	7	0.201	F	0.257	H (17/64)	0.266
1/4-28	0.25	3	0.213	F	0.257	H (17/64)	0.266
5/16-18	0.3125	F	0.257	P	0.323	Q	0.332
3/8-16	0.375	5/16"	0.3125	W	0.386	X	0.397
1/2-13	0.5	27/64"	0.4219	33/64"	0.5156	17/32"	0.5312

## VEX PRO DRILL & TAP SIZE CHART

BOLT		CLOSE FIT		FREE FIT		TAP SIZE	
Type	Diameter	Close Fit	Drill Size	Nearest Fractional Drill Size	Free Fit	Drill Size	Tap Size
6-32	0.138	0.144	27	5/32	0.1495	25	0.1065
8-32	0.164	0.1695	18	11/64	0.177	16	0.136
10-32	0.19	0.196	9	3/16	0.201	7	0.159
10-24	0.19	0.196	9	3/16	0.201	7	0.15
1/4-20	0.25	0.257	F	1/4	0.266	H	0.201

All measurements are in inches.

### FASTENER FAMILIES

5/32 Drill Size		9 Drill Size		1/4 Drill Size	
8-32 Bolt	Close Fit	10-32 Bolt	Free Fit	1/4-20 Bolt	Close Fit
5/32 Rivet	Free Fit	3/16 Rivet	Free Fit	1/4 Rivet	Close Fit
10-# Bolt	Tap Size	1/4-20 Bolt	Tap Size	5/16-18 Bolt	Tap Size

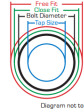
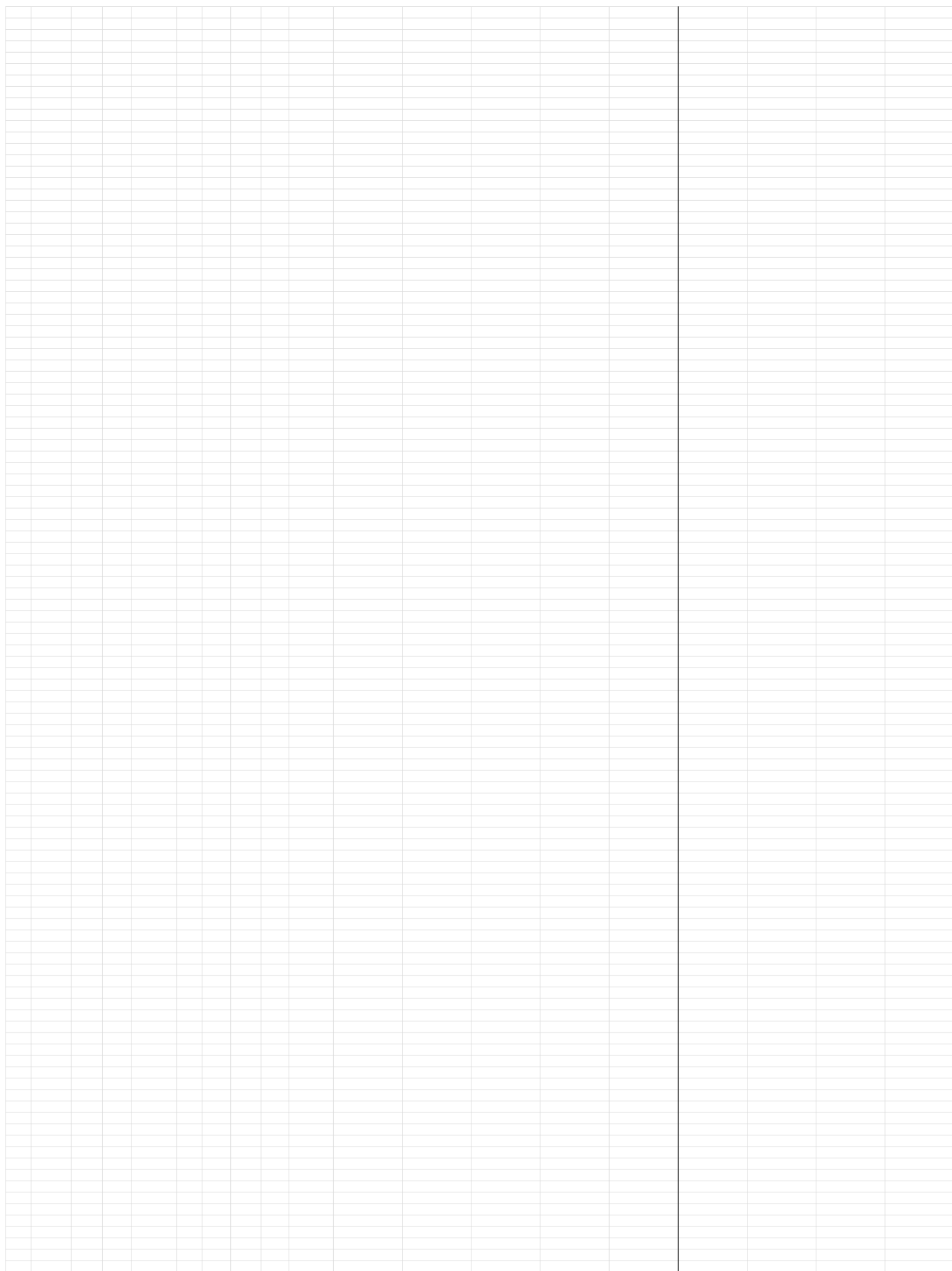


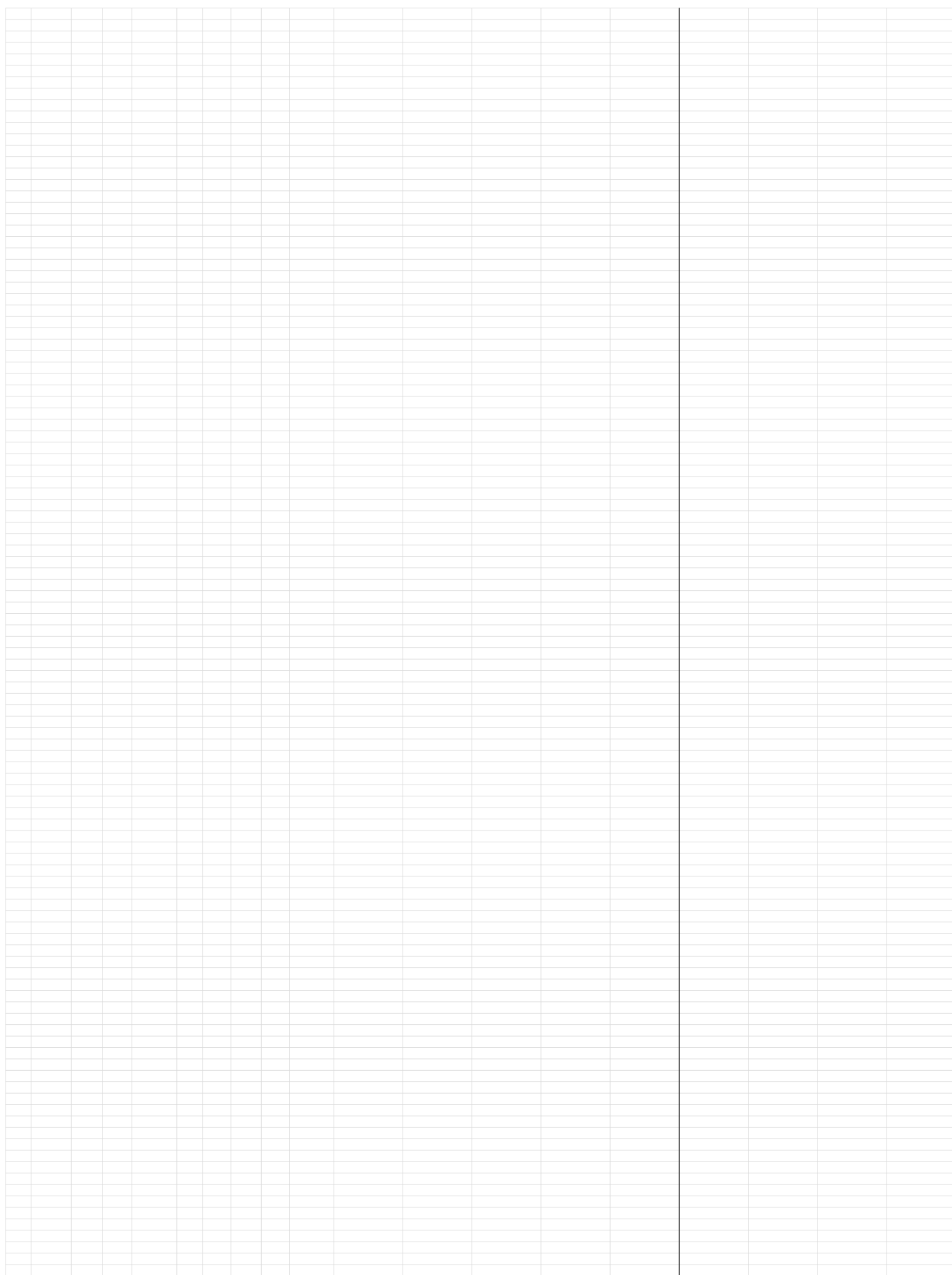
Diagram not to scale.



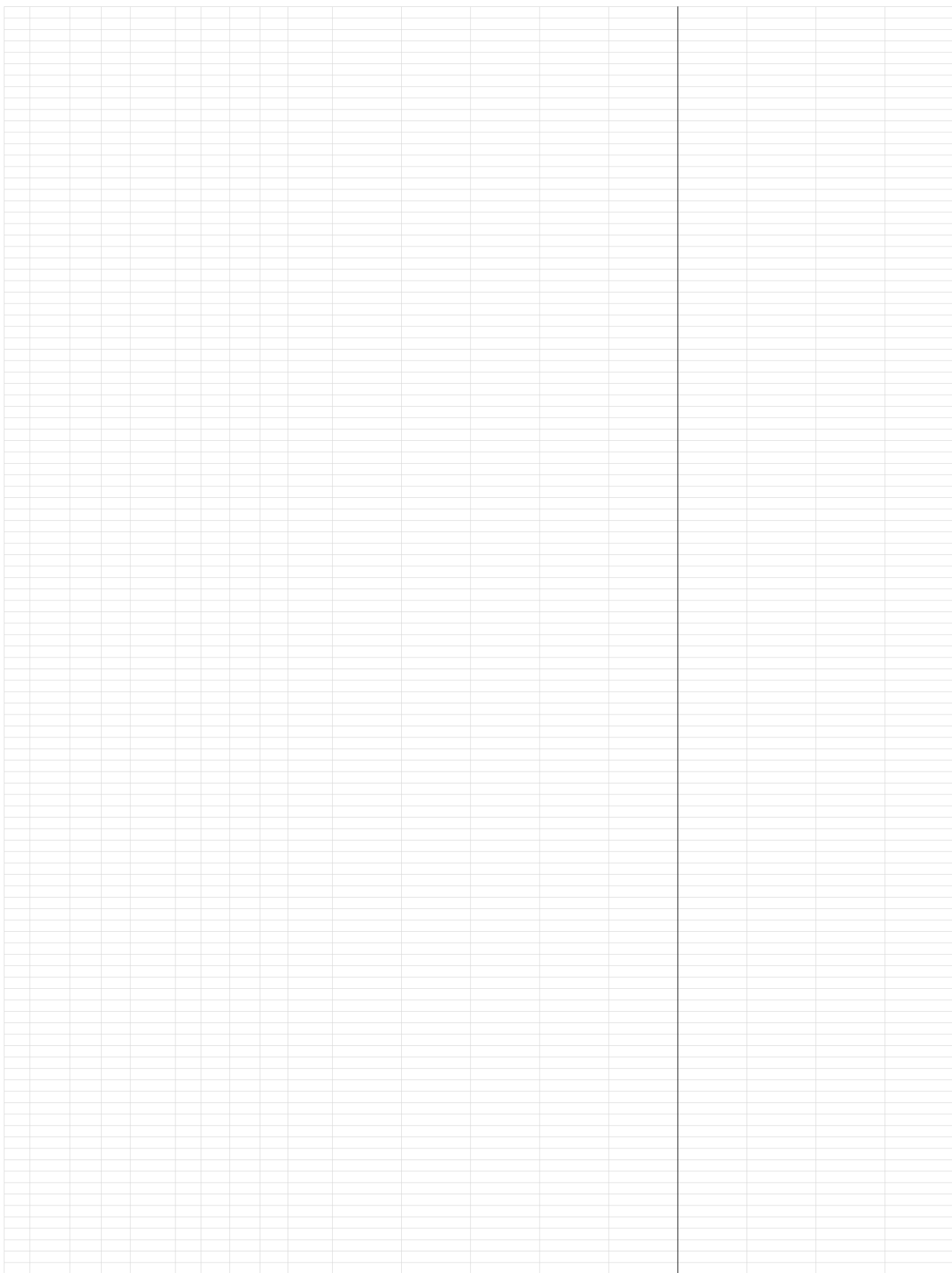




















FRACTION	DECIMAL IN	#	SIZE	DECIMAL IN	LETTER	DECIMAL IN	METRIC	DECIMAL IN	FRACTION	#	SIZE	LETTER	METRIC	DECIMAL IN
1/64	0.0156	80		0.0135	A	0.234	.5	0.0197			80			0.0135
1/32	0.0312	79		0.0145	B	0.238	.75	0.0295			79			0.0145
3/64	0.0469	78		0.016	C	0.242	1	0.0394	1/64					0.0156
1/16	0.0625	77		0.018	D	0.246	1.25	0.0492			78			0.016
5/64	0.0781	76		0.02	E	0.25	1.5	0.0591			77			0.018
3/32	0.0938	75		0.021	F	0.257	1.75	0.0689					.5	0.0197
7/64	0.1094	74		0.0225	G	0.261	2	0.0787			76			0.02
1/8	0.125	73		0.024	H	0.266	2.25	0.0886			75			0.021
9/64	0.1406	72		0.025	I	0.272	2.5	0.0984			74			0.0225
5/32	0.1562	71		0.026	J	0.277	2.75	0.1083			73			0.024
11/64	0.1719	70		0.028	K	0.281	3	0.1181			72			0.025
3/16	0.1875	69		0.0292	L	0.29	3.25	0.128			71			0.026
13/64	0.2031	68		0.031	M	0.295	3.5	0.1378			70			0.028
7/32	0.2188	67		0.032	N	0.302	3.75	0.1476			69			0.0292
15/64	0.2344	66		0.033	O	0.316	4	0.1575					.75	0.0295
1/4	0.25	65		0.035	P	0.323	4.25	0.1673			68			0.031
17/64	0.2656	64		0.036	Q	0.332	4.5	0.1772	1/32					0.0312
9/32	0.2812	63		0.037	R	0.339	4.75	0.187			67			0.032
19/64	0.2969	62		0.038	S	0.348	5	0.1969			66			0.033
5/16	0.3125	61		0.039	T	0.358	5.25	0.2067			65			0.035
21/64	0.3281	60		0.04	U	0.368	5.5	0.2165			64			0.036
11/32	0.3438	59		0.041	V	0.377	5.75	0.2264			63			0.037
23/64	0.3594	58		0.042	W	0.386	6	0.2362			62			0.038
3/8	0.375	57		0.043	X	0.397	6.25	0.2461			61			0.039
25/64	0.3906	56		0.0465	Y	0.404	6.5	0.2559					1	0.0394
13/32	0.4063	55		0.052	Z	0.413	6.75	0.2657			60			0.04
27/64	0.4219	54		0.055			7	0.2756			59			0.041
7/16	0.4375	53		0.0595			7.25	0.2854			58			0.042
29/64	0.4531	52		0.0635			7.5	0.2953			57			0.043
15/32	0.4688	51		0.067			7.75	0.3051			56			0.0465
31/64	0.4844	50		0.07			8	0.315	3/64					0.0469
1/2	0.5	49		0.073			8.25	0.3248					1.25	0.0492
33/64	0.5156	48		0.076			8.5	0.3346			55			0.052
17/32	0.5312	47		0.0785			8.75	0.3445			54			0.055
35/64	0.5469	46		0.081			9	0.3543					1.5	0.0591
9/16	0.5625	45		0.082			9.25	0.3642			53			0.0595
37/64	0.5781	44		0.086			9.5	0.374	1/16					0.0625
19/32	0.5938	43		0.089			9.75	0.3839			52			0.0635
39/64	0.6094	42		0.0935			10	0.3937			51			0.067
5/8	0.625	41		0.096			10.5	0.4134					1.75	0.0689
41/64	0.6406	40		0.098			11	0.4331			50			0.07
21/32	0.6562	39		0.0995			11.5	0.4528			49			0.073
43/64	0.6719	38		0.1015			12	0.4724			48			0.076
11/16	0.6875	37		0.104			12.5	0.4921	5/64					0.0781
45/64	0.7031	36		0.1065			13	0.5118			47			0.0785
23/32	0.7188	35		0.11			13.5	0.5315					2	0.0787
47/64	0.7344	34		0.111			14	0.5512			46			0.081
3/4	0.75	33		0.113			14.5	0.5709			45			0.082
49/64	0.7656	32		0.116			15	0.5906			44			0.086
25/32	0.7813	31		0.12			15.5	0.6102					2.25	0.0886
51/64	0.7969	30		0.1285			16	0.6299			43			0.089
13/16	0.8125	29		0.136			16.5	0.6496			42			0.0935
53/64	0.8281	28		0.1405			17	0.6693	3/32					0.0938
27/32	0.8438	27		0.144			17.5	0.689			41			0.096
55/64	0.8594	26		0.147			18	0.7087			40			0.098
7/8	0.875	25		0.1495			18.5	0.7283					2.5	0.0984
57/64	0.8906	24		0.152			19	0.748			39			0.0995
29/32	0.9062	23		0.154			19.5	0.7677			38			0.1015
59/64	0.9219	22		0.157			20	0.7874			37			0.104
15/16	0.9375	21		0.159			20.5	0.8071			36			0.1065
61/64	0.9531	20		0.161			21	0.8268					2.75	0.1083
31/32	0.9688	19		0.166			21.5	0.8465	7/64					0.1094
63/64	0.9844	18		0.1695			22	0.8661			35			0.11
1	1	17		0.173			22.5	0.8858			34			0.111
		16		0.177			23	0.9055			33			0.113
		15		0.18			23.5	0.9252			32			0.116
		14		0.182			24	0.9449					3	0.1181
		13		0.185			24.5	0.9646			31			0.12
		12		0.189			25	0.9843	1/8					0.125
		11		0.191									3.25	0.128
		10		0.1935							30			0.1285
		9		0.196							29			0.136
		8		0.199									3.5	0.1378
		7		0.201							28			0.1405
		6		0.204					9/64					0.1406
		5		0.2055							27			0.144
		4		0.209							26			0.147



						23/64				0.3594
									9,25	0.3642
							U			0.368
									9,5	0.374
						3/8				0.375
							V			0.377
									9,75	0.3839
							W			0.386
						25/64				0.3906
									10	0.3937
							X			0.397
							Y			0.404
						13/32				0.4063
							Z			0.413
									10,5	0.4134
						27/64				0.4219
									11	0.4331
						7/16				0.4375
									11,5	0.4528
						29/64				0.4531
						15/32				0.4688
									12	0.4724
						31/64				0.4844
									12,5	0.4921
						1/2				0.5
									13	0.5118
						33/64				0.5156
						17/32				0.5312
									13,5	0.5315
						35/64				0.5469
									14	0.5512
						9/16				0.5625
									14,5	0.5709
						37/64				0.5781
									15	0.5906
						19/32				0.5938
						39/64				0.6094
									15,5	0.6102
						5/8				0.625
									16	0.6299
						41/64				0.6406
									16,5	0.6496
						21/32				0.6562
									17	0.6693
						43/64				0.6719
						11/16				0.6875
									17,5	0.689
						45/64				0.7031
									18	0.7087
						23/32				0.7188
									18,5	0.7283
						47/64				0.7344
									19	0.748
						3/4				0.75
						49/64				0.7656
									19,5	0.7677
						25/32				0.7813
									20	0.7874
						51/64				0.7969
									20,5	0.8071
						13/16				0.8125
									21	0.8268
						53/64				0.8281
						27/32				0.8438
									21,5	0.8465
						55/64				0.8594
									22	0.8661
						7/8				0.875
									22,5	0.8858
						57/64				0.8906
									23	0.9055
						29/32				0.9062
						59/64				0.9219
									23,5	0.9252
						15/16				0.9375
									24	0.9449
						61/64				0.9531
									24,5	0.9646
						31/32				0.9688























	Nut	Socket	Button/Flat	Low Socket	Set Screw
#4	1/4	3/32	1/16	0.050	0.05
#6	5/16	7/64	5/64	1/16	1/16
#8	11/32	9/64	3/32	5/64	5/64
#10	3/8	5/32	1/8	3/32	3/32
1/4"	7/16	3/16	5/32	1/8	1/8
5/16"	1/2	1/4	3/16	5/32	5/32
3/8"	9/16	5/16	7/32	3/16	3/16
7/16"	11/16	3/8	1/4	7/32	7/32
1/2"	3/4	3/8	5/16	1/4	1/4
Color	Fraction		Metric Size	Colors	
Black 1	1/16		1.5	Black	Red
Blue 1	5/64		2	Blue	Red
Green 1	3/32		2.5	Green	Red
Yellow 1	7/64		3	Yellow	Red
Red 1	1/8		3.5	Red	Green
Black 2	9/64		4	Black	Green
Blue 2	5/32		4.5	Blue	Green
Green 2	3/16		5	Green	Yellow
Yellow 2	7/32		5.5	Yellow	Blue
Red 2	1/4		6	Red	Blue
Black 3	5/16		8	Black	Blue

VEXpro Gears (20DP 14.5° Pressure Angle)					VEX Pulleys 5mm HTD						VEXpro HTD 5mm Belts			
Part #	Tooth Count	Pitch Diameter	Outer Diameter	Material	Part #	Tooth Count	Pitch Diameter (ref)	Outer Diameter	Inner Width	Overall Width	9mm Part#	15mm Part #	Tooth Count	Pitch Length (mm)
217-3209	18	0.9	1	Aluminum	217-3225	18	[28.65] 1.128	[32] 1.260	[11] .433	[14.50].571	217-3293	217-3294	60	300
217-5460	18	0.9	1	Steel	217-3226	18	[28.65] 1.128	[32] 1.260	[17] .669	[20.50].807	217-3455	217-3472	70	350
217-2702	20	1	1.1	Aluminum	217-4100	18	[28.65] 1.128	[32] 1.260	[18.50] .728	[22].866	217-3456	217-3473	80	400
217-5461	20	1	1.1	Steel	217-3227	24	[38.20] 1.504	[42] 1.654	[11] .433	[14.50].571	217-3457	217-3474	90	450
217-5463	22	1.1	1.2	Steel	217-3228	24	[38.20] 1.504	[42] 1.654	[17] .669	[20.50].807	217-3458	217-3475	100	500
217-2704	24	1.2	1.3	Aluminum	217-4101	24	[38.20] 1.504	[42] 1.654	[18.50] .728	[22].866	217-3459	217-3476	104	520
217-5464	24	1.2	1.3	Steel	217-3229	30	[47.75] 1.880	[51] 2.008	[11] .433	[14.50].571	217-3460	217-3477	110	550
217-5466	26	1.3	1.4	Steel	217-3230	30	[47.75] 1.880	[51] 2.008	[17] .669	[20.50].807	217-3461	217-3478	120	600
217-5468	28	1.4	1.5	Steel	214-4102	30	[47.75] 1.880	[51] 2.008	[18.50] .728	[22].866	217-3462	217-3479	130	650
217-2705	30	1.5	1.6	Aluminum	217-3231	36	[57.30] 2.256	[60] 2.362	[11] .433	[14.50].571	2147-3463	217-3480	140	700
217-5469	30	1.5	1.6	Steel	217-3232	36	[57.30] 2.256	[60] 2.362	[17] .669	[20.50].807	217-3464	217-3481	150	750
217-2706	34	1.7	1.8	Aluminum	217-4103	36	[57.30] 2.256	[60] 2.362	[18.50] .728	[22].866	217-3465	217-3482	160	800
217-3214	36	1.8	1.9	Aluminum							217-3466	217-3483	170	850
217-2708	40	2	2.1	Aluminum							217-3467	217-3484	180	900
217-3216	42	2.1	2.2	Aluminum							217-3468	217-3485	200	1000
217-2710	44	2.2	2.3	Aluminum							217-3469	217-3486	225	1125
217-3218	48	2.4	2.5	Aluminum							217-3470	217-3487	250	1250
217-3572	50	2.5	2.6	Aluminum										
217-3573	54	2.7	2.8	Aluminum										
217-3574	60	3	3.1	Aluminum										
217-3575	64	3.2	3.3	Aluminum										
217-3576	72	3.6	3.7	Aluminum										
217-3577	84	4.2	4.3	Aluminum										

	Free Speed (RPM)	Free Current (A)	Maximum Power (W)	Stall Torque (N · m)	Stall Current (A)
<b>CIM Motor</b>	5330	2.7	337	2.41	131
<b>Mini CIM Motor</b>	5840	3	215	1.41	89
<b>BAG Motor</b>	13180	1.8	149	0.43	53
<b>775pro</b>	18730	0.7	347	0.71	134
<b>AndyMark RS775-125</b>	5800	1.6	43	0.28	18
<b>BaneBots RS-775 18V</b>	13050	2.7	246	0.72	97
<b>AndyMark 9015</b>	14270	3.7	134	0.36	71
<b>BaneBots RS-550</b>	19000	0.4	190	0.38	84

<b>CIM Motor</b>	
<b>Mini CIM Motor</b>	
<b>BAG Motor</b>	
<b>775pro</b>	
<b>AndyMark RS775-125</b>	
<b>BaneBots RS-775 18V</b>	
<b>AndyMark 9015</b>	
	



**BaneBots RS-550**




RoboRIO	
Power Green	Power Good
Power Amber	Brownout protection
Power Red	Power Fault
Status On - Booting	Normal
Status Off	Normal
Status 2 Blinks	Software Error, Reimage
Status 3 Blinks	Safe Mode, Retart
Status 4 Blinks	Software crashed twice, reboot
Status Flash or Solid On	Unrecoverable Error
Comm - Off	No Communication
Comm - Red Solid	Comm with DS, No user code
Comm Red Blinking	E-Stop
Comm Green Solid	Good Comm with DS
Mode - Off	Outputs Disabled
Mode - Amber/organe	Auton Enabled
Mode - Green	Telop Enabled
Mode - Red	Test Enabled
RSL	Same as RSL Light Above

Power	
Blue	On or Powering Up
Blue Blinking	Powering Up
Eth Link	
Blue	Link Up
Blue Blinking	Traffic Present
WiFi	
Off	Bridge Mode, Unlinked or non-FRC firmware
Red	AP, Unlinked
Yellow/Orange	AP, Linked
Green	Bridge Mode, Linked



WiFi light only works after radio has been power cycled.

The STAT and COMM LEDs are multi-color LEDs that can blink green, orange, or red.



The two LEDs are always the same color/blink pattern. The only exception to this is when the device is in boot-loader.

LED Blink/Color	Description
Fast Green Blink	Robot is enabled.
Slow Green Blink	Robot is disabled.
Slow Orange Blink	Robot is disabled, Sticky Fault present.
Slow Red Blink	No CAN Comm.
(COMM LED only) Green/Orange Blink	Device is in boot-loader. Field upgrade necessary.
Both LEDs off	Device is NOT powered.

PDP	
Fast Green	Robot Encabled
Slow Green	Robot Disabled
Slow Orange	Robot Disabled+Sticky Fault
Slow Red	No CAN
Green/Orange	Firmware Needed
Off	No Power

VRM	
Green	Good
Either off or dim	Short or current overload

PCM	
Status Green Strobe	Robot Enabled
Status Green Slow	Robot Disabled
Status Orange Slow	Sticky Fault
Status Red	Active Fault, Comp Fault, no CAN
Status Red Blinking	Solenoid Fault (Blinks the #)
Status Red/Orange	Damaged Hardware
Status Green/Orange	Bootloader, reimage
Compressor Green	Compressor Output On
Compressor Off	Compressor Output Off



LED Fault Table

LED	Strobe	Slow	Long
Green	No Fault - Robot Enabled	No Fault - Robot Disabled	NA
Orange	NA	Sticky Fault	NA
Red	NA	No CAN Comm OR Solenoid Fault (Blinks Solenoid Index)	Compressor Fault

\*If PCM LED contains more than one color, see LED Special States Table

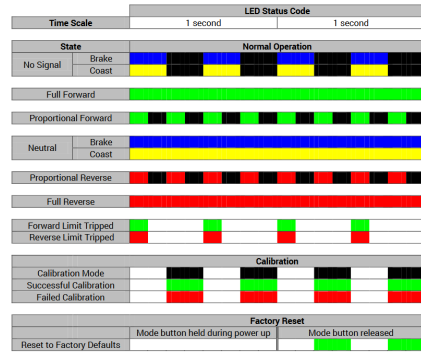
LED Special States Table

LED Colors	Problem
Red/Orange	Damaged Hardware
Green/Orange	In Bootloader
No LED	No Power / Incorrect Polarity

## 2.6 STATUS LED

The SPARK can display information about its current mode of operation via its tri-colored STATUS LED. The STATUS LED is located next to the motor output terminals and is labeled as STATUS with raised lettering on the SPARK housing.

Figure 2-6 shows the status codes associated with each operating state of the SPARK.



Blink Codes During Calibration	
Status LEDs Blink Code	Talon SRX State
Flashing Red/Green	Calibration Mode
Blinking Green	Successful Calibration
Blinking Red	Failed Calibration

Blink Codes During Normal Operation		
LEDs	Colors	Talon SRX State
Both	Blinking Green	Forward throttle is applied. Blink rate is proportional to Duty Cycle
Both	Blinking Red	Reverse throttle is applied. Blink rate is proportional to Duty Cycle
None	None	No Power is being applied to Talon SRX
LEDs Alternate <sup>1</sup>	Off/Orange	CAN bus detected, robot disabled
LEDs Alternate <sup>1</sup>	Off/Slow Red	CAN bus/PWM is not detected
LEDs Alternate <sup>1</sup>	Off/Fast Red	Fault Detected
LEDs Alternate <sup>1</sup>	Red/Orange	Damaged Hardware
LEDs Strobe "towards" (M+) <sup>2</sup>	Off/Red	Forward Limit Switch or Forward Soft Limit
LEDs Strobe "towards" (M-) <sup>2</sup>	Off/Red	Reverse Limit Switch or Reverse Soft Limit
LED1 Only "closest" to M+/V+	Green/Orange	In Boot-loader

B/C CAL Blink Codes	
B/C CAL Button Color	Talon SRX State
Solid Red	Brake Mode
Off	Coast Mode