

4 Bar Linkage Calculator v3.0

Bump Travel 4.00 in
Droop Travel 12.00 in

Static Geometry:

Upper Links				
	x	y	z	
Frame End	24.000	16.000	27.000	in
Axle End	1.000	7.000	28.500	in
Vector	23.000	9.000	-1.500	in
Length	24.744	in		
Separation	10.920			
Unit Vector	0.9295	0.3637	-0.0606	1.0000
Intercept	-16.8889	6.6087	28.5652	in
Roll Point	-16.8889	0.0000	29.6667	in
Forces	4313	1688	-281	lb
Vertical Slope	0.3913	in/in		
Horizontal Slope	-0.0652	in/in		
Link Force	4639	lb		
Lower Links				
	x	y	z	
Frame End	33.000	12.000	21.000	in
Axle End	4.000	16.000	18.000	in
Vector	29.000	-4.000	3.000	in
Link Length	29.428	in		
Unit Vector	0.9855	-0.1359	0.1019	1.0000
Intercept	120.000	16.552	17.586	in
Roll Point	120.000	0.000	30.000	in
Vertical Slope	-0.1379	in/in		
Horizontal Slope	0.1034	in/in		
Geometry Summary:				
Anti-Squat	83.469	%		
Roll Axis Slope	0.0024	in/in (Roll Oversteer)		
Roll Center Height	29.708	in		
Roll Axis Angle	0.140	degrees (Roll Oversteer)		
Instant Center X-Axis	65.093	in		
Instant Center Z-Axis	24.320	in		

Bump Geometry:

Upper Links				
	x	y	z	
Frame End	24.000	16.000	27.000	in
Axle End	1.339	7.000	35.175	in
Vector	22.661	9.000	-8.175	in
Length	25.717	in		
Separation	13.415			
Length ₀ -Length ₁	-0.973	in		
Unit Vector	0.8812	0.3500	-0.3179	1.0000
Intercept	-16.2867	6.4683	35.6580	in
Roll Point	-16.2867	0.0000	41.5335	in
Forces	4333.395	1721.024	-1563.278	lb
Vertical Slope	0.3972	in/in		
Horizontal Slope	-0.3608	in/in		
Link Force	4918	lb		
Lower Links				
	x	y	z	
Frame End	33.000	12.000	21.000	in
Axle End	3.862	16.000	22.000	in
Vector	29.138	-4.000	-1.000	in
Link Length	29.428	in		
Unit Vector	0.9901	-0.1359	-0.0340	1.0000
Intercept	120.413	16.530	22.133	in
Roll Point	120.413	0.000	18.000	in
Vertical Slope	-0.1373	in/in		
Horizontal Slope	-0.0343	in/in		
Geometry Summary:				
Anti-Squat	99.243	%		
Roll Axis Slope	-0.1722	in/in (Roll Understeer)		
Roll Center Height	38.730	in		
Roll Axis Angle	-9.768	degrees (Roll Understeer)		
Instant Center X-Axis	41.434	in		
Instant Center Z-Axis	20.711	in		

Droop Geometry:

Upper Links			
	x	y	z
Frame End	24.000	16.000	27.000
Axle End	0.042	7.000	19.755
Vector	23.958	9.000	7.245
Length	26.598	in	
Separation	15.892		
Length ₀ -Length ₂	-1.855	in	
Unit Vector	0.9316	0.3500	0.2817 1.0343
Intercept	-18.5924	6.9843	19.7428 in
Roll Point	-18.5924	0.0000	14.1208 in
Forces	4581	1721	1385 lb
Vertical Slope	0.3757	in/in	
Horizontal Slope	0.3024	in/in	
Link Force	1169	lb	
Lower Links			
	x	y	z
Frame End	33.000	12.000	21.000
Axle End	8.000	16.000	6.000
Vector	25.000	-4.000	15.000
Link Length	29.428	in	
Unit Vector	0.8495	-0.1359	0.5097 1.0000
Intercept	108.000	17.280	1.200 in
Roll Point	108.000	0.000	66.000 in
Vertical Slope	-0.1600	in/in	
Horizontal Slope	0.6000	in/in	
Geometry Summary:			
Anti-Squat	142.102	%	
Roll Axis Slope	0.4098	in/in (Roll Oversteer)	
Roll Center Height	21.740	in	
Roll Axis Angle	22.284	degrees (Roll Oversteer)	
Instant Center X-Axis	62.304	in	
Instant Center Z-Axis	38.582	in	

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Vehicle Specifications:

Wheelbase	97.0 in
Tire Diameter	38.00 in
Tire Rolling Radius	19.00 in
Vehicle CG Height	40.00 in
Vehicle Mass	5,000 lb
Front Unsprung Mass	600 lb
Rear Unsprung Mass	700 lb

Suspension Geometry:

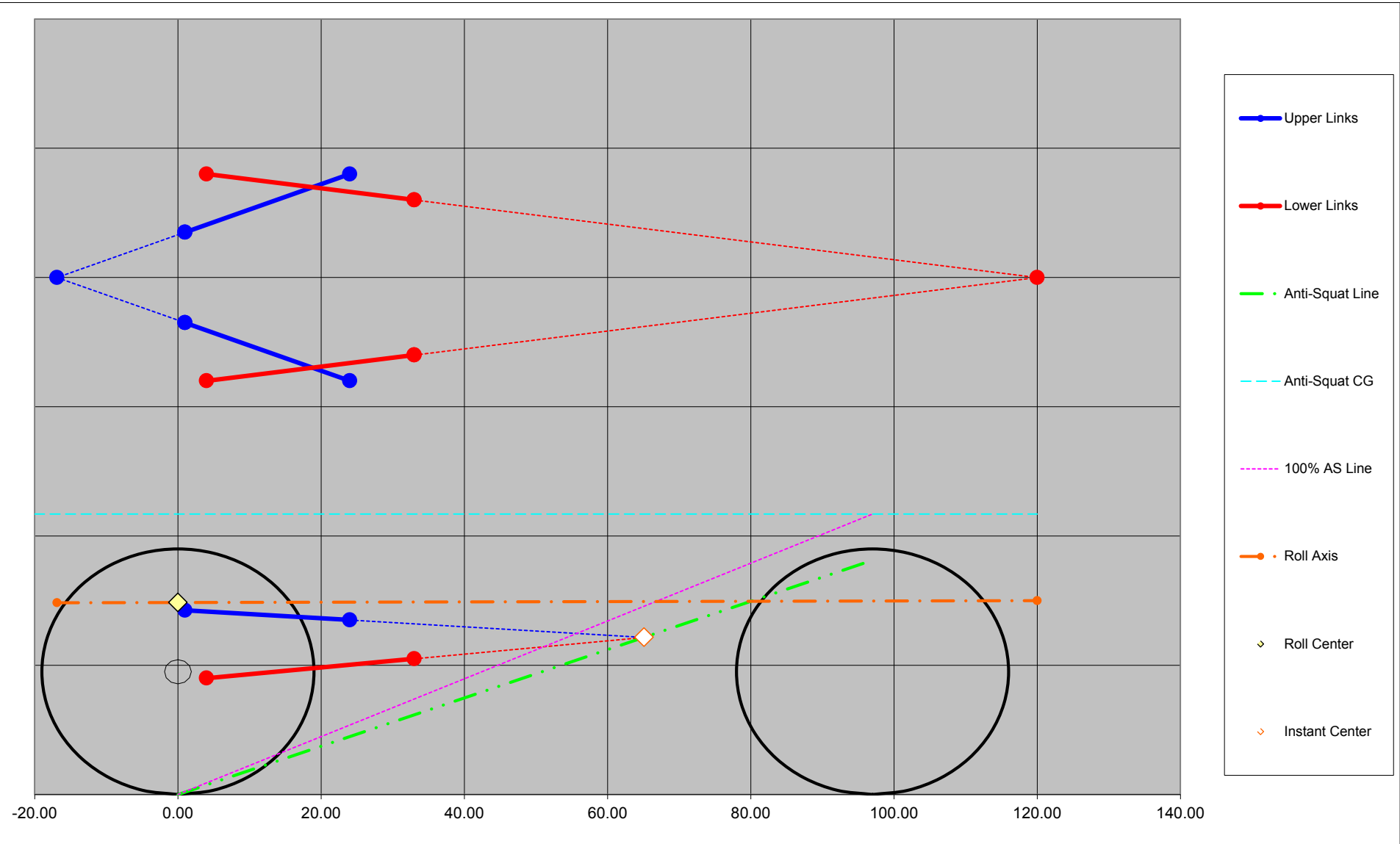
Upper Links		x	y	z	
Frame End		24.00	16.00	27.00	in
Axle End		1.00	7.00	28.50	in
Lower Links		x	y	z	
Frame End		33.00	12.00	21.00	in
Axle End		4.00	16.00	18.00	in

Geometry Summary:

Anti-Squat	83 %
Roll Center Height	30 in
Roll Axis Angle	0 degrees (Roll Oversteer)
Instant Center X-Axis	65 in
Instant Center Z-Axis	24 in

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Dan Barcroft
& Greg Blanchette



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Vehicle CG 40.00
 Sprung Mass CG 47.38 in
 Anti-Squat CG 43.42 in

Suspension Geometry:

<u>Upper Links</u>	x	y	z	
Frame End	24.000	16.000	27.000	in
Axle End	1.000	7.000	28.500	in
Vector	23.000	9.000	-1.500	in
Length	24.744			in
Unit Vector	0.9295	0.3637	-0.0606	1.0000
Intercept	-16.8889	6.6087	28.5652	in
Roll Point	-16.8889	0.0000	29.6667	in
Force	4639.441	lb (Tension)		
Force Vector	4312.500	1687.500	-281.250	lb
Vertical Slope	0.3913	in/in		
Horizontal Slope	-0.0652	in/in		
<u>Lower Links</u>	x	y	z	
Frame End	33.000	12.000	21.000	in
Axle End	4.000	16.000	18.000	in
Vector	29.000	-4.000	3.000	in
Length	29.428			in
Unit Vector	0.9855	-0.1359	0.1019	1.0000
Intercept	120.0000	16.5517	17.5862	in
Roll Point	120.0000	0.0000	30.0000	in
Force	-6624.759	lb (Compression)		
Force Vector	-6528.436	900.474	-675.355	lb
Vertical Slope	-0.1379	in/in		
Horizontal Slope	0.103	in/in		

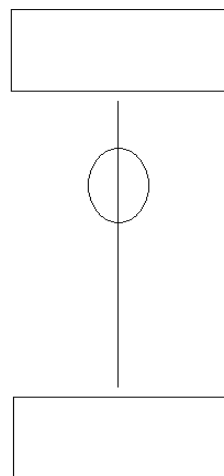
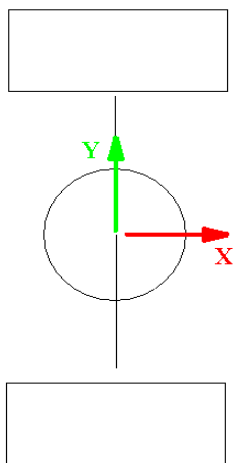
Geometry Summary:

Anti-Squat	83.469 %
Roll Axis Slope	0.0024 in/in (Roll Oversteer)
Roll Center Height	29.708 in
Roll Axis Angle	0.140 degrees (Roll Oversteer)
Instant Center X-Axis	65.093 in
Instant Center Z-Axis	24.320 in

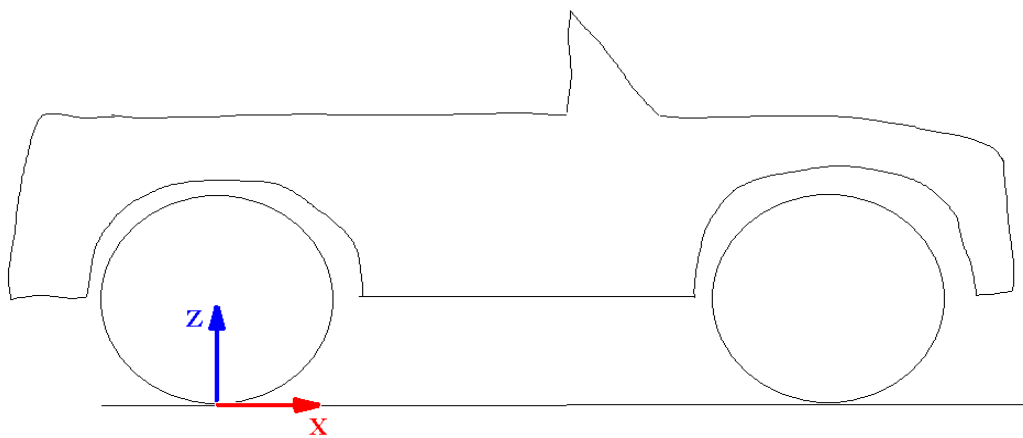
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Side View							
angle	Front Tire		Rear Tire		IC Trace Upper		Infinity 4000
	x	z	x	z	x	z	Rear Axle 3.75
0	97.00	0.00	0.00	0.00	24.00	27.00	x z
15	92.08	0.65	4.92	0.65	65.09	24.32	0.00 20.88
30	87.50	2.55	9.50	2.55	IC Trace Lower		0.94 20.62
45	83.56	5.56	13.44	5.56	x	z	1.62 19.94
60	80.55	9.50	16.45	9.50	33.00	21.00	1.88 19.00
75	78.65	14.08	18.35	14.08	65.09	24.32	1.62 18.06
90	78.00	19.00	19.00	19.00	Anti-Squat Line		0.94 17.38
105	78.65	23.92	18.35	23.92	x	z	0.00 17.13
120	80.55	28.50	16.45	28.50	0.00	0.00	-0.94 17.38
135	83.56	32.44	13.44	32.44	65.09	24.32	-1.62 18.06
150	87.50	35.45	9.50	35.45	97.00	36.24	-1.88 19.00
165	92.08	37.35	4.92	37.35	Anti-Squat CG		-1.62 19.94
180	97.00	38.00	0.00	38.00	x	z	-0.94 20.62
195	101.92	37.35	-4.92	37.35	-20.00	43.42	0.00 20.88
210	106.50	35.45	-9.50	35.45	120.00	43.42	
225	110.44	32.44	-13.44	32.44	100% AS Line		
240	113.45	28.50	-16.45	28.50	x	z	
255	115.35	23.92	-18.35	23.92	0.00	0.00	
270	116.00	19.00	-19.00	19.00	97.00	43.42	
285	115.35	14.08	-18.35	14.08	Roll Axis		
300	113.45	9.50	-16.45	9.50	x	z	
315	110.44	5.56	-13.44	5.56	-16.89	29.67	
330	106.50	2.55	-9.50	2.55	0.00	29.71	
345	101.92	0.65	-4.92	0.65	120.00	30.00	
360	97.00	0.00	0.00	0.00			

Top View			
Offset Up		80.00	
Upper Links			
x	y	y'	
24.00	16.00	96.00	
1.00	7.00	87.00	
24.00	-16.00	64.00	
1.00	-7.00	73.00	
IC Trace Upper			
x	y		
1.00	7.00	87.00	
-16.89	0.00	80.00	
1.00	-7.00	73.00	
Lower Links			
x	y		
33.00	12.00	92.00	
4.00	16.00	96.00	
33.00	-12.00	68.00	
4.00	-16.00	64.00	
IC Trace Lower			
x	y		
33.00	12.00	92.00	
120.00	0.00	80.00	
33.00	-12.00	68.00	

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Material Selection:

Upper Links			Lower Links		
Outside Diameter	2.000	in	Outside Diameter	2.000	in
Wall Thickness	0.250	in	Wall Thickness	0.250	in
Material Used	Steel 1018		Material Used	Steel 4130T	
Rod End Rated Load	32,000	lb	Rod End Rated Load	55,000	lb
Modulus of Elasticity	29,000,000	psi	Modulus of Elasticity	29,700,000	psi
Yield Strength	50,000	psi	Yield Strength	110,000	psi
Density	0.2840	lbm/in^3	Density	0.2840	lbm/in^3
Moment of Inertia	0.537	in^4	Moment of Inertia	0.537	in^4
Area	1.374	in^2	Area	1.374	in^2
Pyield	68,722	lb	Pyield	151,189	lb
Pbuckling	250,990	lb	Pbuckling	181,730	lb
Pbending	4,340	lb	Pbending	8,028	lb
Link Length	24.7437	in	Link Length	29.4279	in
Link Weight	9.66	lb	Link Weight	11.49	lb
Link Force	4,639	lb (Tension)	Link Force	-6,625	lb (Compression)
F.S. Yield	14.81	(link stretching)	F.S. Yield	22.82	(link compressing)
F.S. Buckling	54.10	(link buckling under braking)	F.S. Buckling	27.43	(link buckling under acceleration)
F.S. Bending	1.74	(somewhat irrelevant for an UPPER link)	F.S. Bending	3.21	(link bending w/ 1/2 the vehicle weight on it)
F.S. Rod End	6.90	(rod end breaking)	F.S. Rod End	8.30	(rod end breaking)

Material Specifications:

	Elastic Modulus (psi)	Yield Strength	Density (Lbs/in^3)	
Alum 2024-T6	10,500,000	50,000	0.1000	
Alum 6061-T6	10,000,000	39,900	0.0975	
Alum 7075-T6	10,400,000	73,200	0.1020	
Steel 1018	29,000,000	50,000	0.2840	Cold Drawn
Steel 4130N	29,700,000	63,100	0.2840	Normalized
Steel 4130T	29,700,000	110,000	0.2840	Water Quenched and Tempered
Steel 4340N	29,700,000	114,000	0.2840	Normalized
Steel 4340T	29,700,000	160,000	0.2840	Oil Quenched & Tempered
Titanium 6Al-4V	16,500,000	128,000	0.1600	6% Aluminum, 4% Vanadium

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