

## 4. Suspension

## 4.1 Suspension Parts List

## 4.1 Parts List - Chassis/Suspension Concepts



### ULSAB-AVC Chassis Suspension Concepts

Number	Name	Material Type	Grade (MPa)		Gage (mm)	No. of Parts	Part Variation		Mass (kg)			GADH Code
			Yield Strength	Tensile Strength			Gasoline	Diesel	Unit	Gasoline	Diesel	
13121	Assembly Module front axle						Variation 1	Variation 2		70.514	71.514	4010
13135	Subframe complete					2	Identical			17.112	17.112	4010
	Bolt M12x40 Sidemember					2			0.122			4010
	Bolt M14x60 rear					2			0.222			4010
	Subframe								15.738		15.738	4010
	U Pipe	DP *	350	600	2.0				6.706			4010
	Cross member rear	DP	350	600	2.0				0.960			4010
	Retaining plate	DP	350	600	2.0	2			0.023			4010
	Brackets Control arms+radiator	DP	350	600	2.0/1.0	2			0.956			4010
	Inner frame	DP	350	600	2.0	2			1.674			4010
	Outer frame	DP	350	600	2.0	2			1.214			4010
	Mounting pipe steering					2			0.044			4010
	Mounting pipe carbody					2			0.065			4010
	Weldnut M12 clamp					4			0.030			4010
	Clamp, transverse leaf spring					2			0.247			4010
	Bolts M12x25 clamp					4			0.048			4010
13143	Leaf spring with support rubber	GFK					Variation 1	Variation 2	2.300	2.300	2.300	4010
13123	Assembly damper					2	Variation 1	Variation 2	1.310	2.620	2.620	4010
	Damper								1.101			4010
	Damper stop spring mod.								0.011			4010
	Rubber for pin bearing								0.063			4010
	Protecting tube								0.019			4010
	Collar nut M8								0.007			4010
	2. washer								0.031			4010
	Collar bolt M12x60								0.078			4010
13125	Steering gear with track rod complete					1	Identical		14.150	14.150	14.150	4010
	Steering gear with track rod					1			6.650			4010
	Electric unit for power steering					1			7.500			4010
13171	Assembly-lower wishbone					2	LH/RH		4.256	8.516	8.516	4010
13173	Lower wishbone	SF	570	640	2.0/1.6		Identical		2.065			4010
13175	Sleeve joint						Identical		0.288			4010
13177	Rubber mount						Identical		0.156			4010
13179	Ball joint on wheelside with rivets						Identical		1.121			4010
13181	Spring console	DP	350	600	2.0		Identical		0.311			4010
	Collar bolt M12x60								0.098			4010
	Collar bolt M14x80								0.166			4010
	Collar nut M12								0.021			4010
	Collar nut M14								0.032			4010
13183	Assembly-upper wishbone					2	LH/RH		1.678	3.356	3.356	4010
13185	Upper wishbone	SF	570	600			LH/RH		0.823			4010
13187	Rubber mount front					2	Identical		0.146			4010
13189	Rubber mount rear						Identical		0.099			4010
13191	Ball joint						Identical		0.219			4010
	Collar nut M12					3			0.021			4010
	Collar bolt M12x70								0.087			4010
	Collar bolt M12x80								0.095			4010
13161	Steering knuckle complete					2	LH/RH			10.332	10.332	4010
13163	Inner shell	DP	350	600	3.0		LH/RH		0.989			4010
13165	Outer shell	DP	350	600	3.0		LH/RH		1.112			4010
	Distance sleeve								0.807			4010
	M10x45					4			0.044			4010
	M10x80					2			0.072			4010
	M10x35					4			0.038			4010
	Collar nut M10					10			0.012			4010
	Wheel bearing 2. generation								0.819			4010
	outer ring with flange								0.548			4010
	inner ring								0.143			4010
	24 balls 10mm diameter								0.098			4010
	Grease								0.01			4010
	Sealing								0.02			4010
	Wheel hub								0.847			4010
	Brakes											4610
13195	Assembly front axle brake caliper	Forged Steel				2	Variation 1	Variation 2	4.410	8.820	8.820	
	Front axle brake caliper								4.310			
	Collar bolt M10x35					2			0.038			
	Collar nut M10					2			0.012			
13251	Assembly-combined brake caliper rear axle					2	Variation 1	Variation 2	2.918	5.836	5.836	4610
	Collar nut M12x25 (2 per caliper)					1			0.048			
13251	Combined brake caliper rear axle	Aluminium					Variation 1	Variation 2	2.870			4610
13263	Brake cable left + right parking brake set						Identical		0.713			4350
13261	Actuator electrical parking brake						Identical		1.300			4350
13193	Electro Hydraulic Brake Unit (EHB)						Variation 1	Variation 2	5.100	5.100	5.100	4640
	Brake Fluid								0.500	0.500	0.500	
	Brake lines front and rear								2.500	2.500	2.500	
	Brake disk front	Iron				2	Identical		7.500	7.500	7.500	
	Brake disk rear	Iron				2	Identical		6.600			
	Drive shafts					2	Variation 1	Variation 2		7.064	8.064	
13131	Assembly-drive shaft left									3.450	3.950	
13132	Assembly-drive shaft right									3.400	3.900	
	Lock-nut					2			0.107			
13127	Steering column assembly						Identical		5.500	5.500	5.500	
13129	Assembly steering wheel						Identical		3.500	3.500	3.500	
13221	Assembly module rear axle complete						Variation 1	Variation 2		25.761	25.761	
13231	Twist-beam rear suspension						Identical		20.083			4210
13237	Trailing arm	DP	350	600	3.0/2.2	2	LH/RH		2.85			
13233	Twist-beam profile	MnB	1200	1600	2.5		Identical		6.967			
13235	Spring plate	DP	350	600	2.5	2	LH/RH		0.393			
13239	Wheel carrier	DP	350	600	5.0	2	LH/RH		1.035			
13225	Rubber bushing					2	Identical		0.353			4210
	Collar bolt M14x120					2			0.182			
	Collar nut M14					2			0.032			
13241	Wheel bearing 3. generation					2	Identical		1.585			
	Collar bolt M10x25					8			0.032			
13227	Spring					2	Variation 1	Variation 2	1.505	3.01	3.01	4220
13223	Damper					2	Variation 1	Variation 2	1.334	2.668	2.668	4220
	Protecting tube						Identical		0.020			
	Damper						Variation 1	Variation 2	1.124			
	Collar bolt M12x80 (4 per damper)					1	Identical		0.190			
13281	Wheels					4	Identical		10.552	42.208	42.208	
13283	Rim					1	Identical		3.720			4410
13285	Tire					1	Identical		6.500			4420
	Bolts (4 per wheel)								0.332			
	Tire Fit Kit					1	Identical		1.000			4430

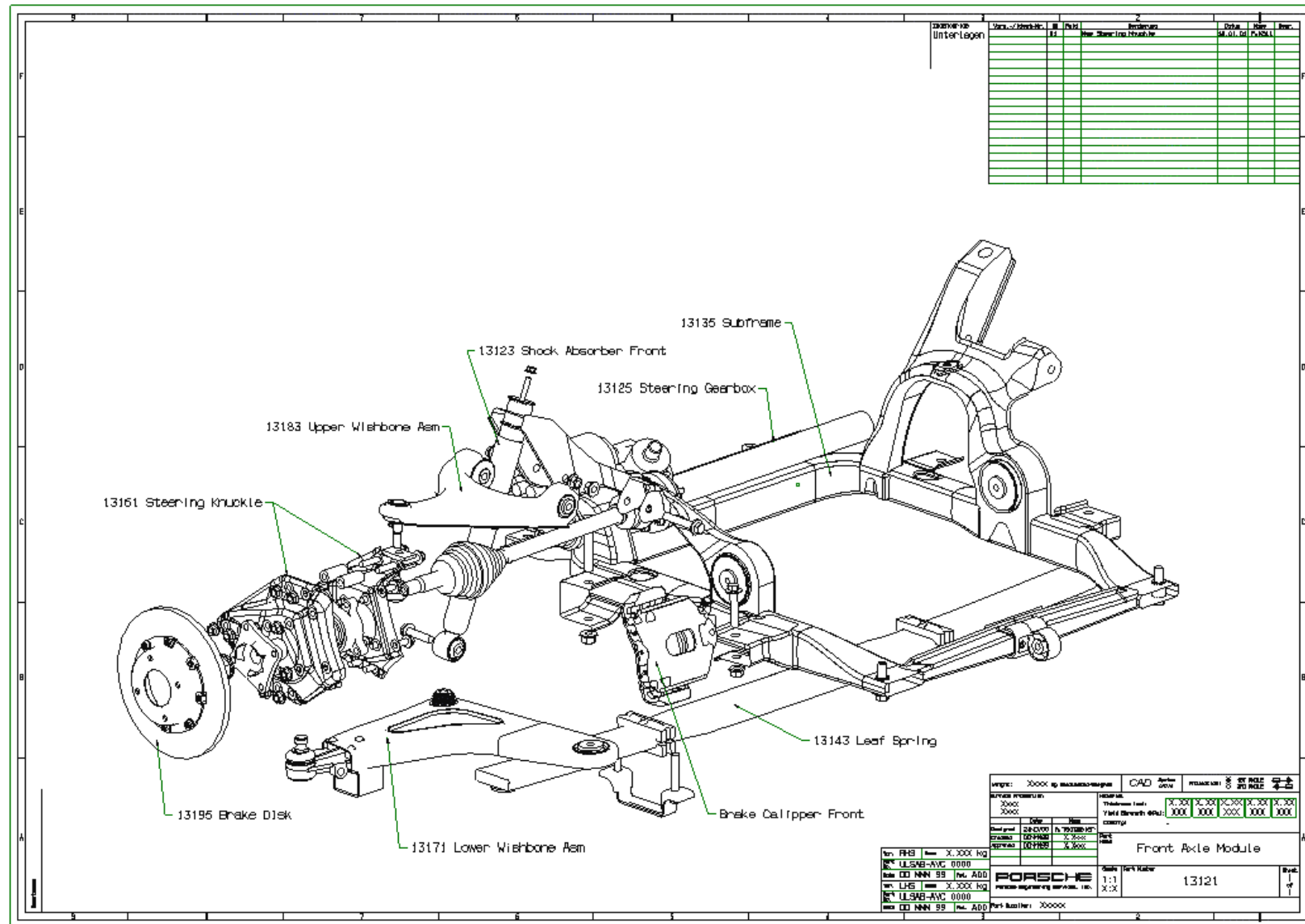
\* denotes tube

## 4.2 Suspension Drawings

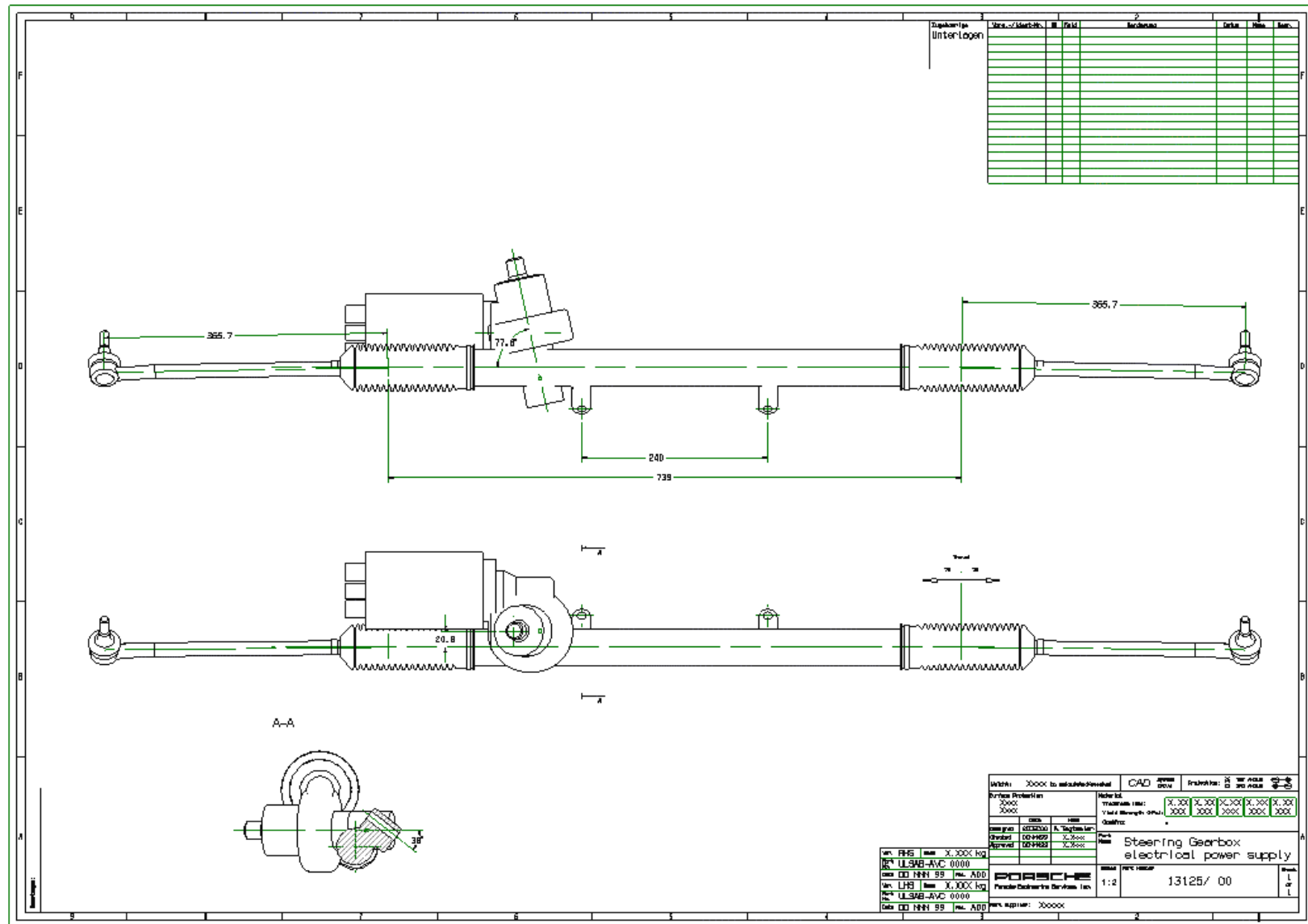
4.2.1 Suspension Drawing Index

Drawing No.	Drawing Name
13121	Front Axle Module
13125	Steering Gearbox, electrical power supply
13127	Steering Column
13135	Subframe
13161	Steering Knuckle complete
13183	Upper Wishbone
13171	Lower Wishbone complete
13143	Leaf Spring
13123	Shock Absorber Front
13131/13132	Drive Shaft Diesel and Gasoline
13221	Rear Axle Module
13231	Twistbeam Axle Welding Assembly
13223	Shock Absorber Rear

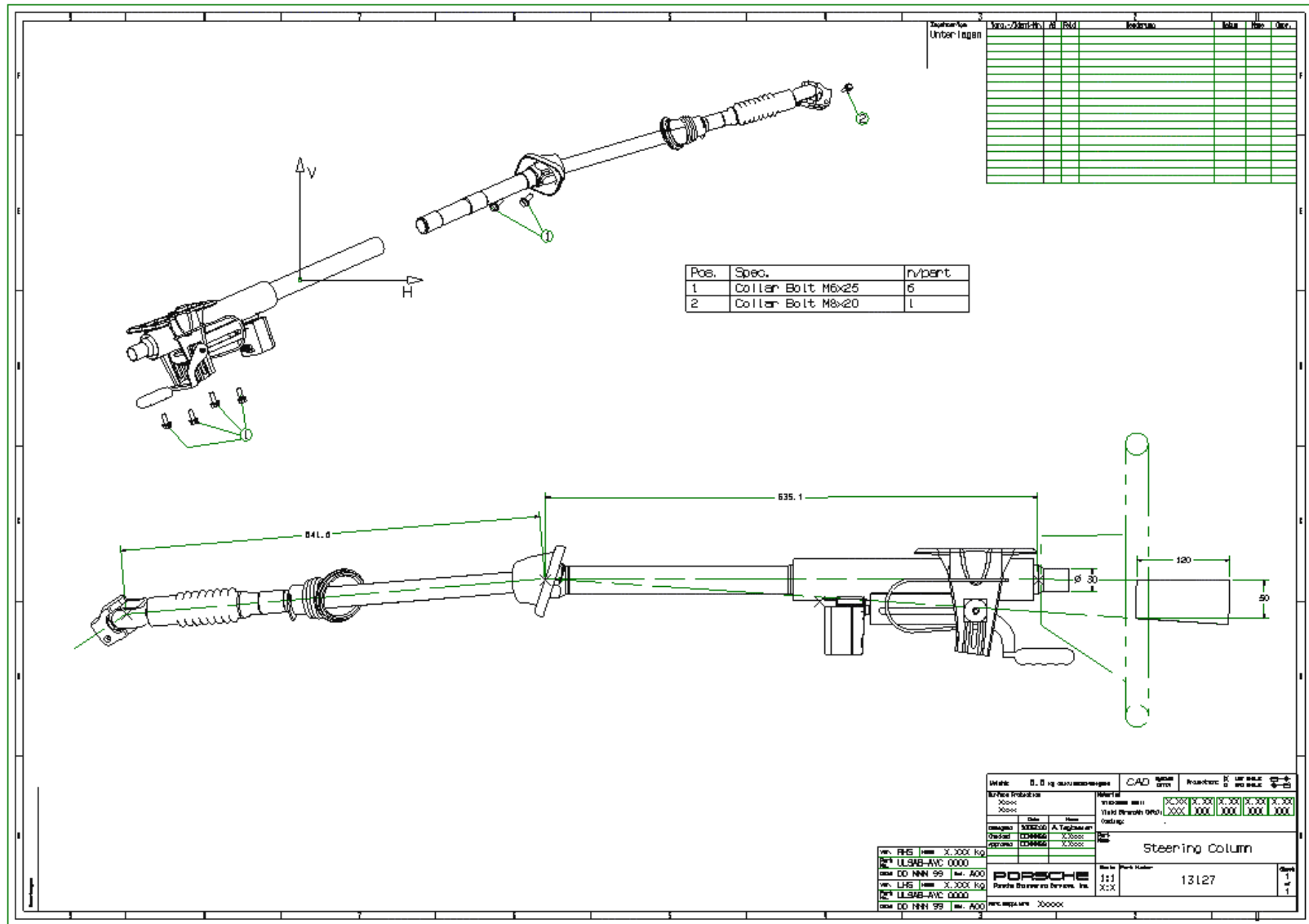
## 4.2.2 Suspension Drawings - Front Axle Module



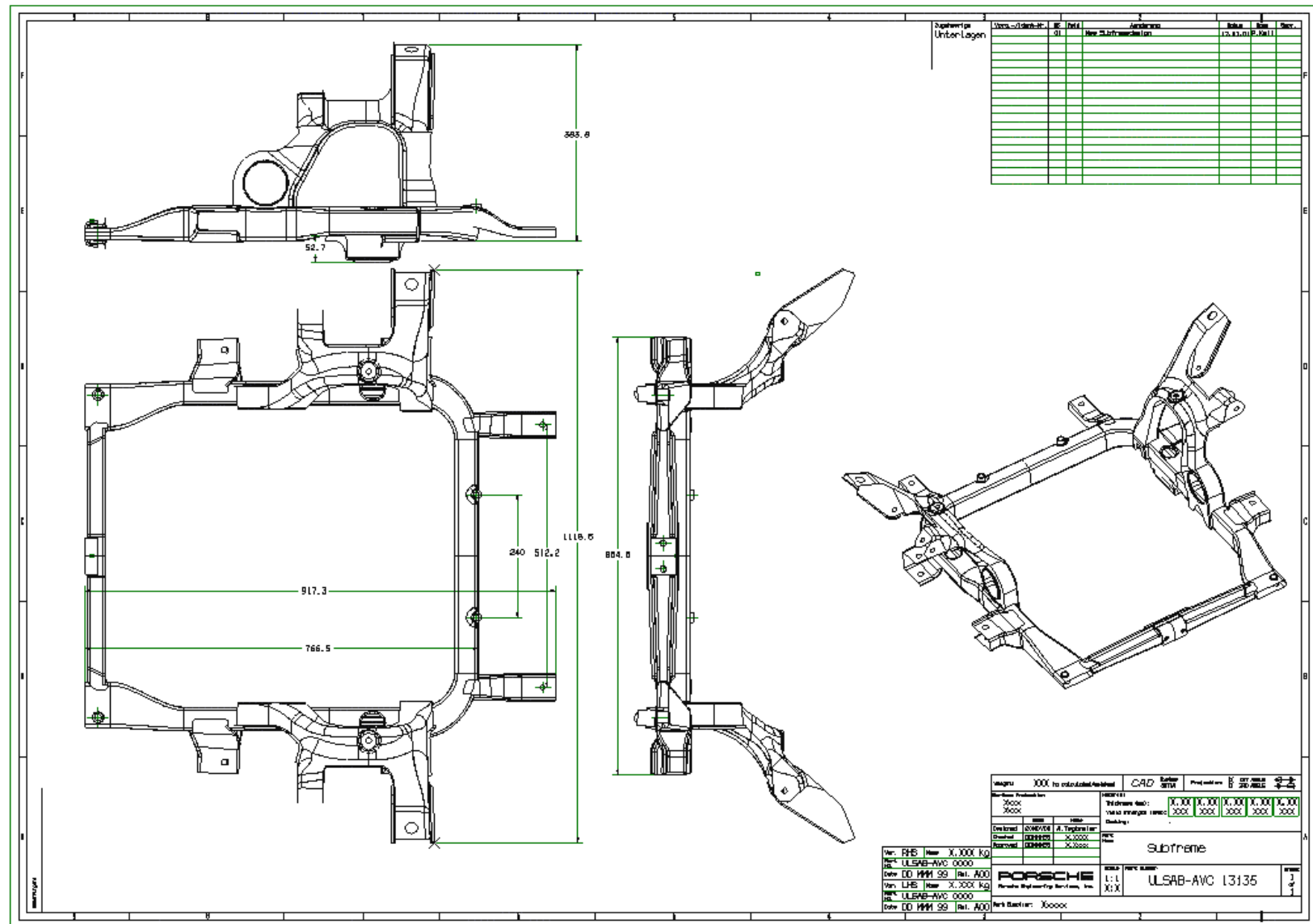
## 4.2.2 Suspension Drawings - Steering Gearbox



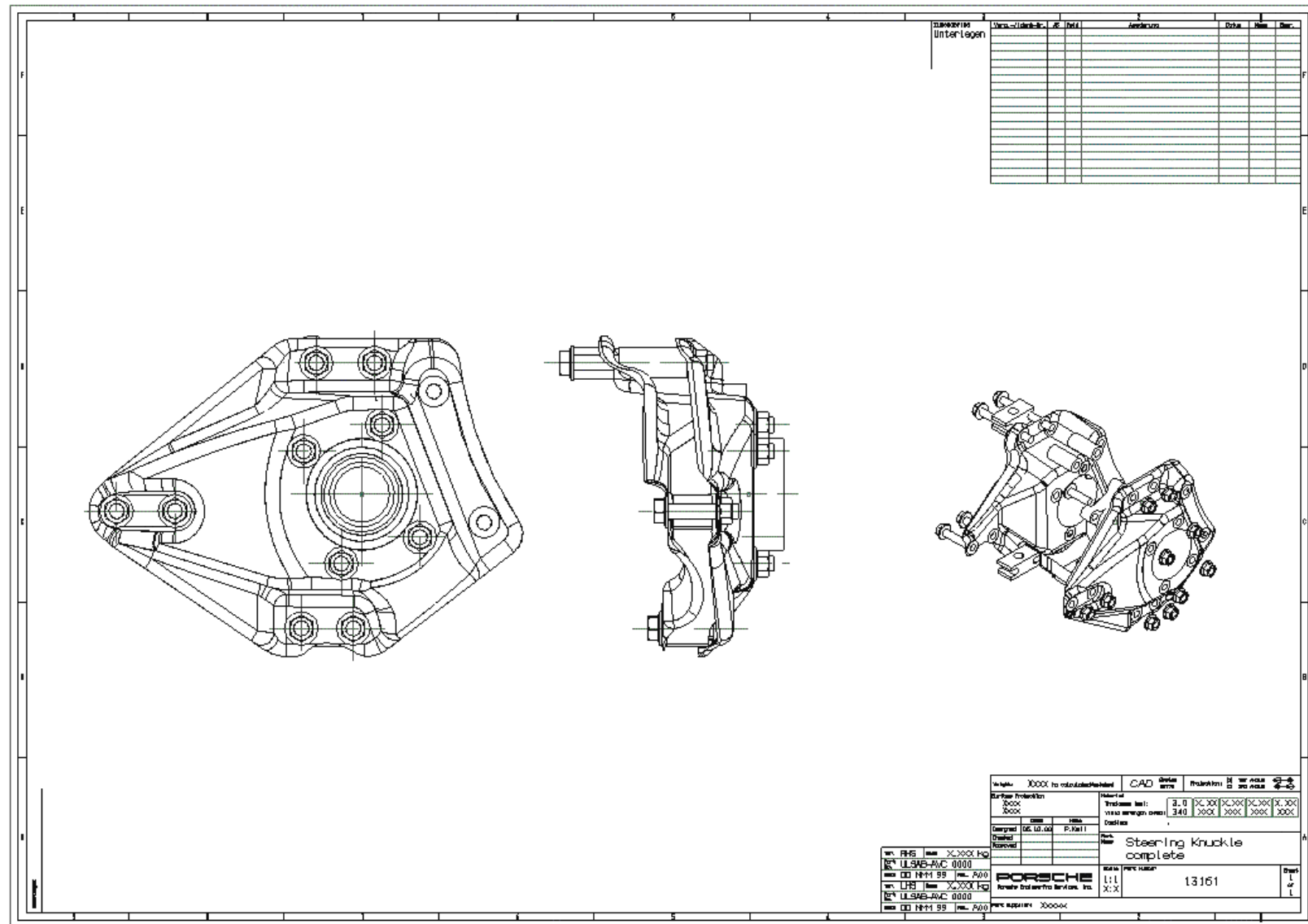
## 4.2.2 Suspension Drawings - Steering Column



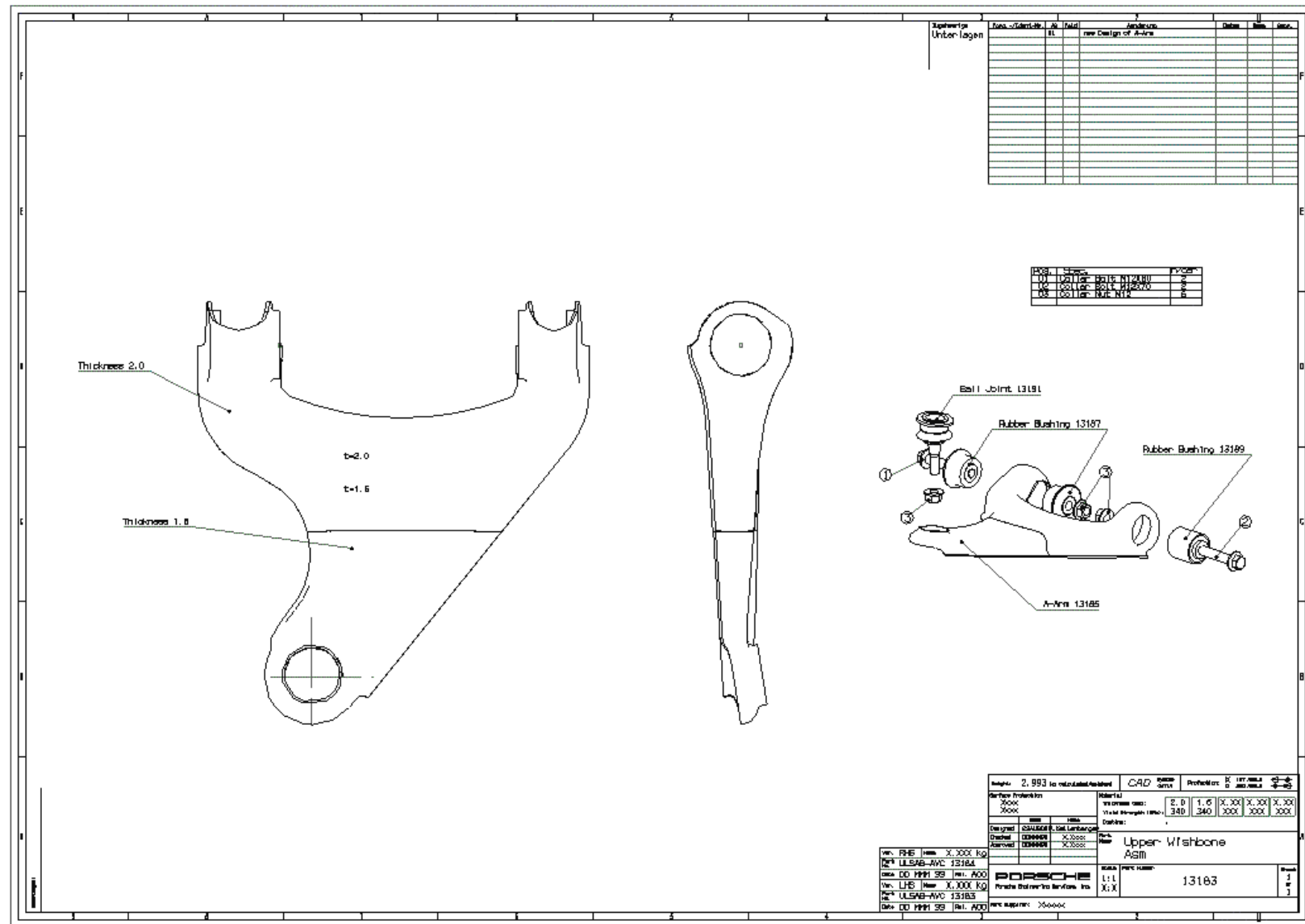
## 4.2.2 Suspension Drawings - Subframe



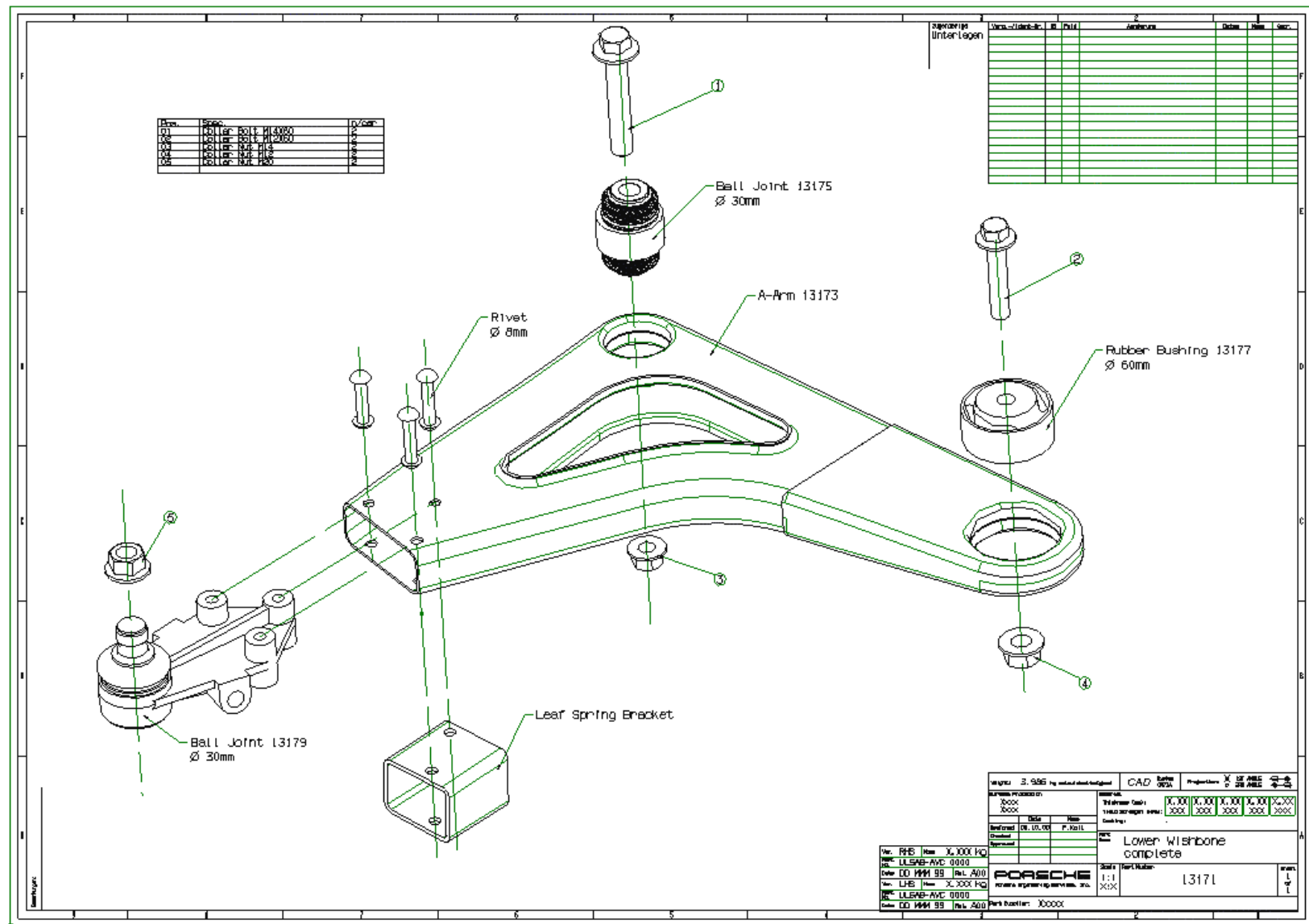
## 4.2.2 Suspension Drawings - Steering Knuckle Complete



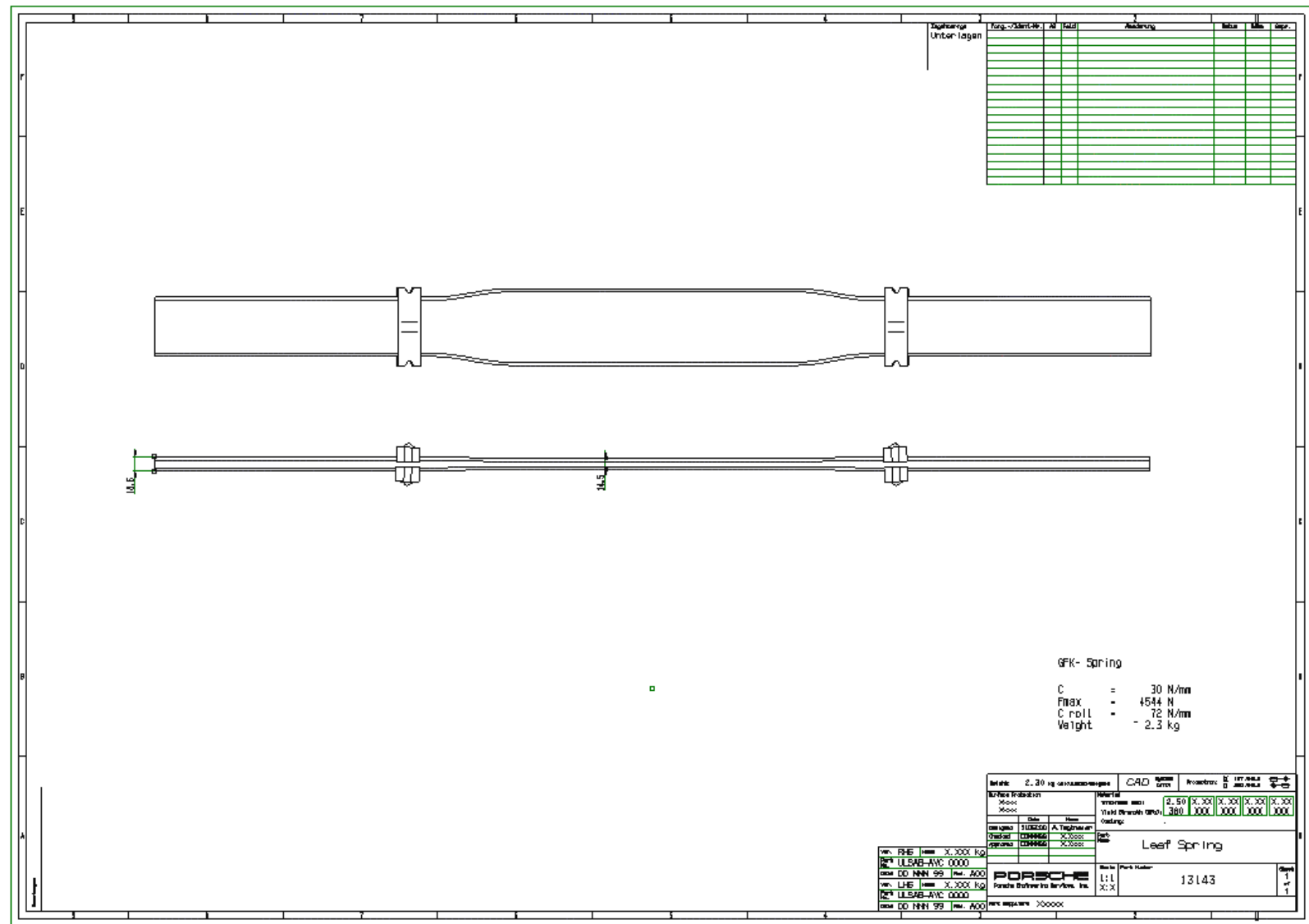
## 4.2.2 Suspension Drawings - Upper Wishbone Ash



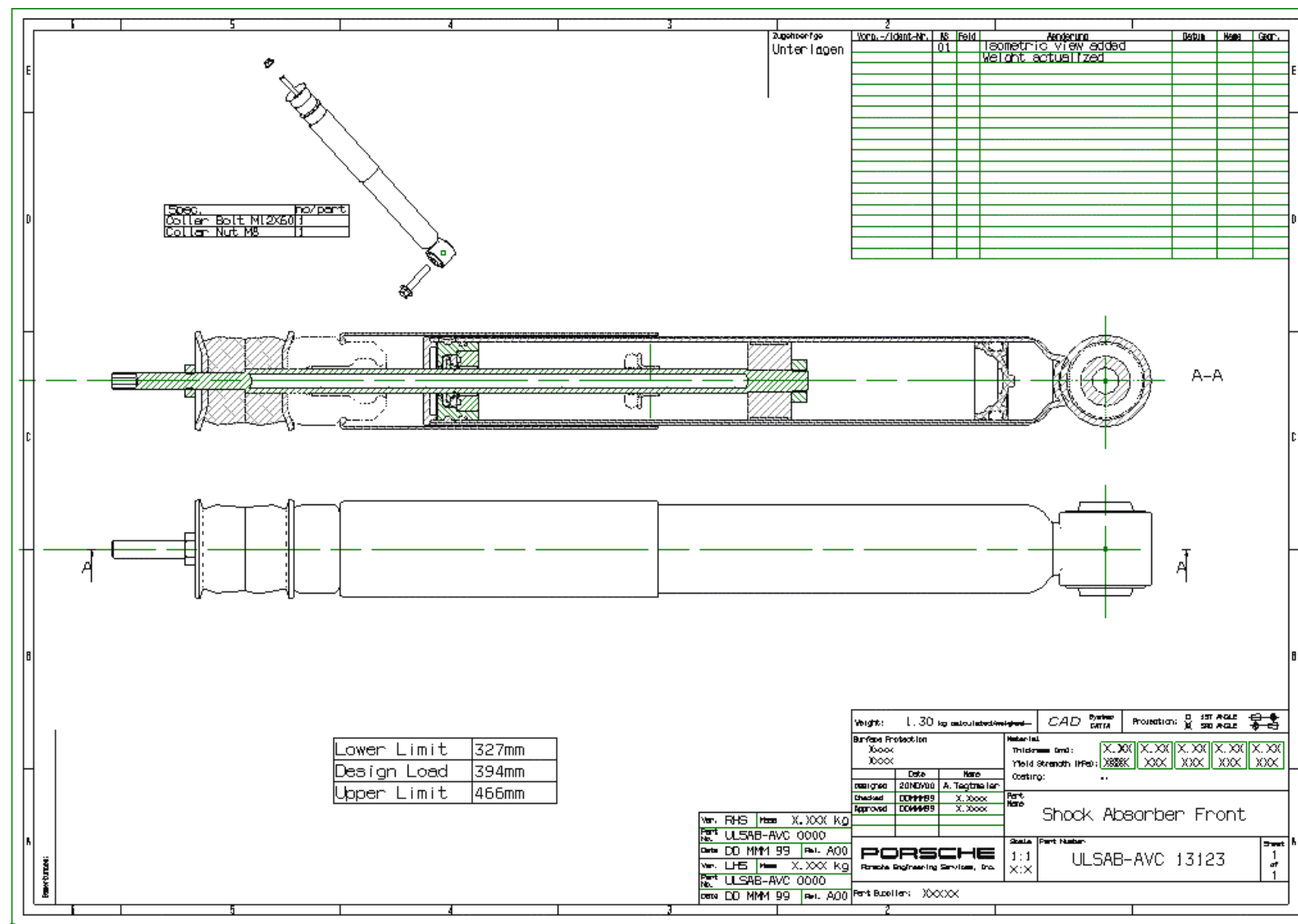
#### 4.2.2 Suspension Drawings - Lower Wishbone Complete



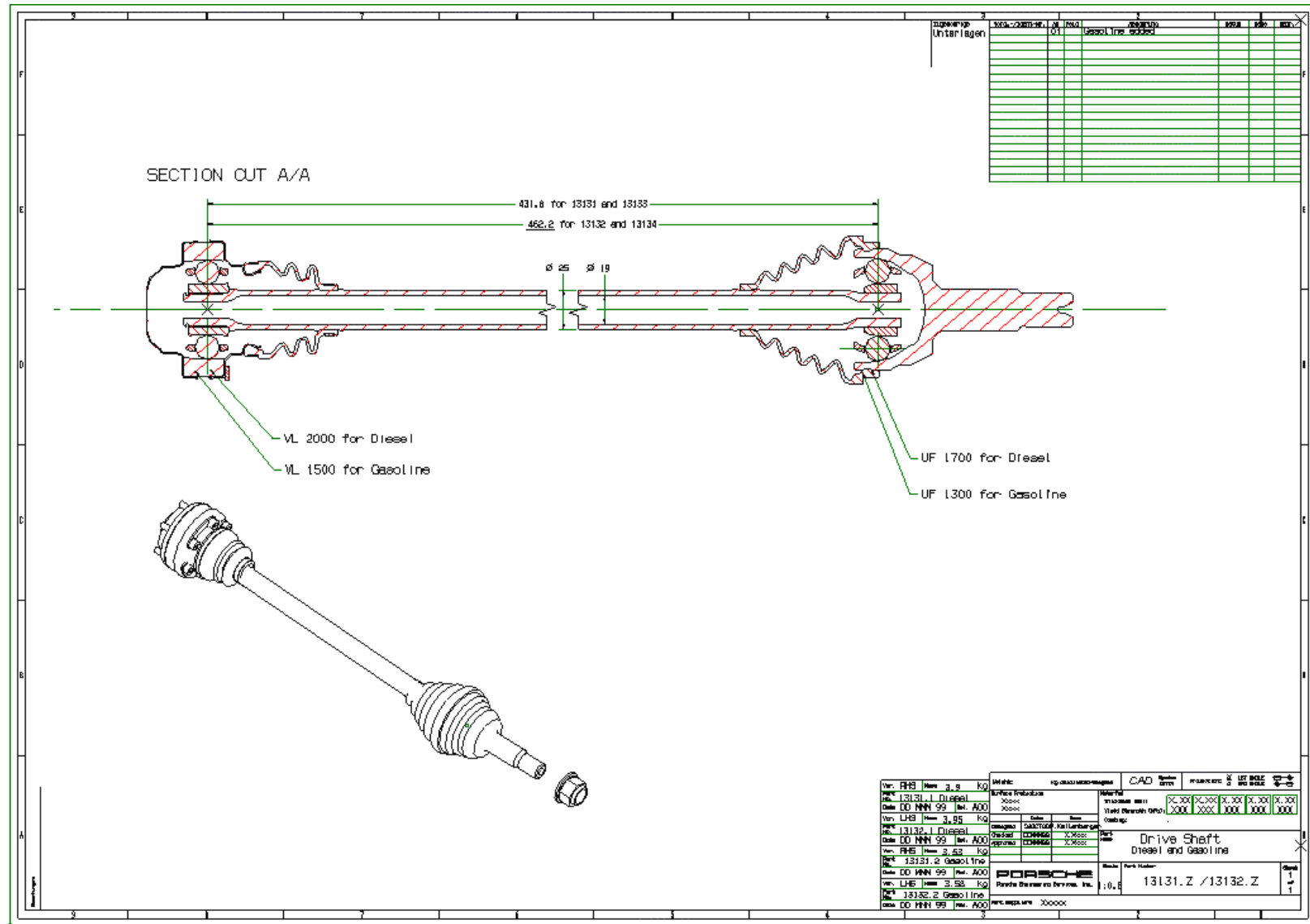
#### 4.2.2 Suspension Drawings - Leaf Spring



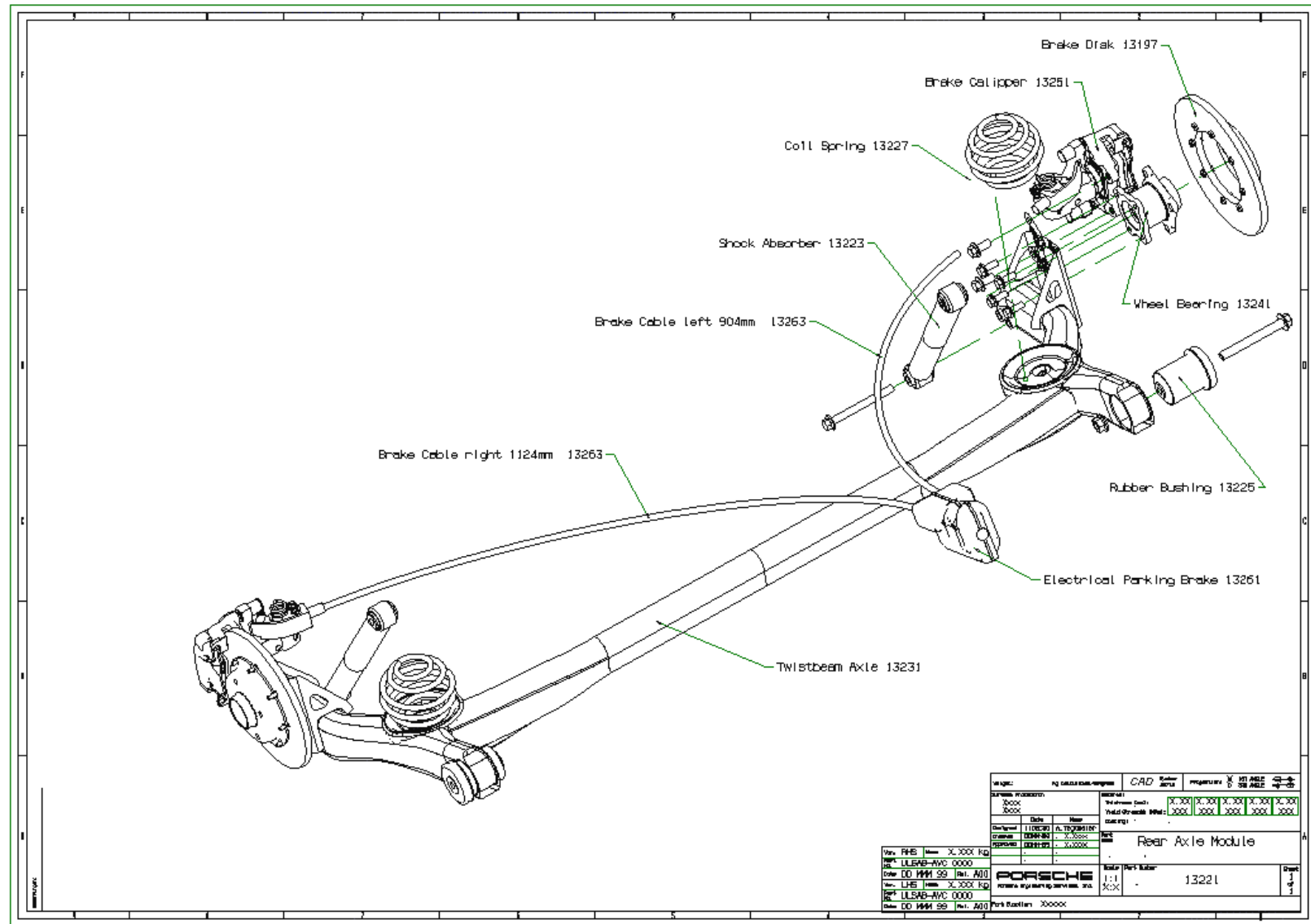
#### 4.2.2 Suspension Drawings - Shock Absorber Front



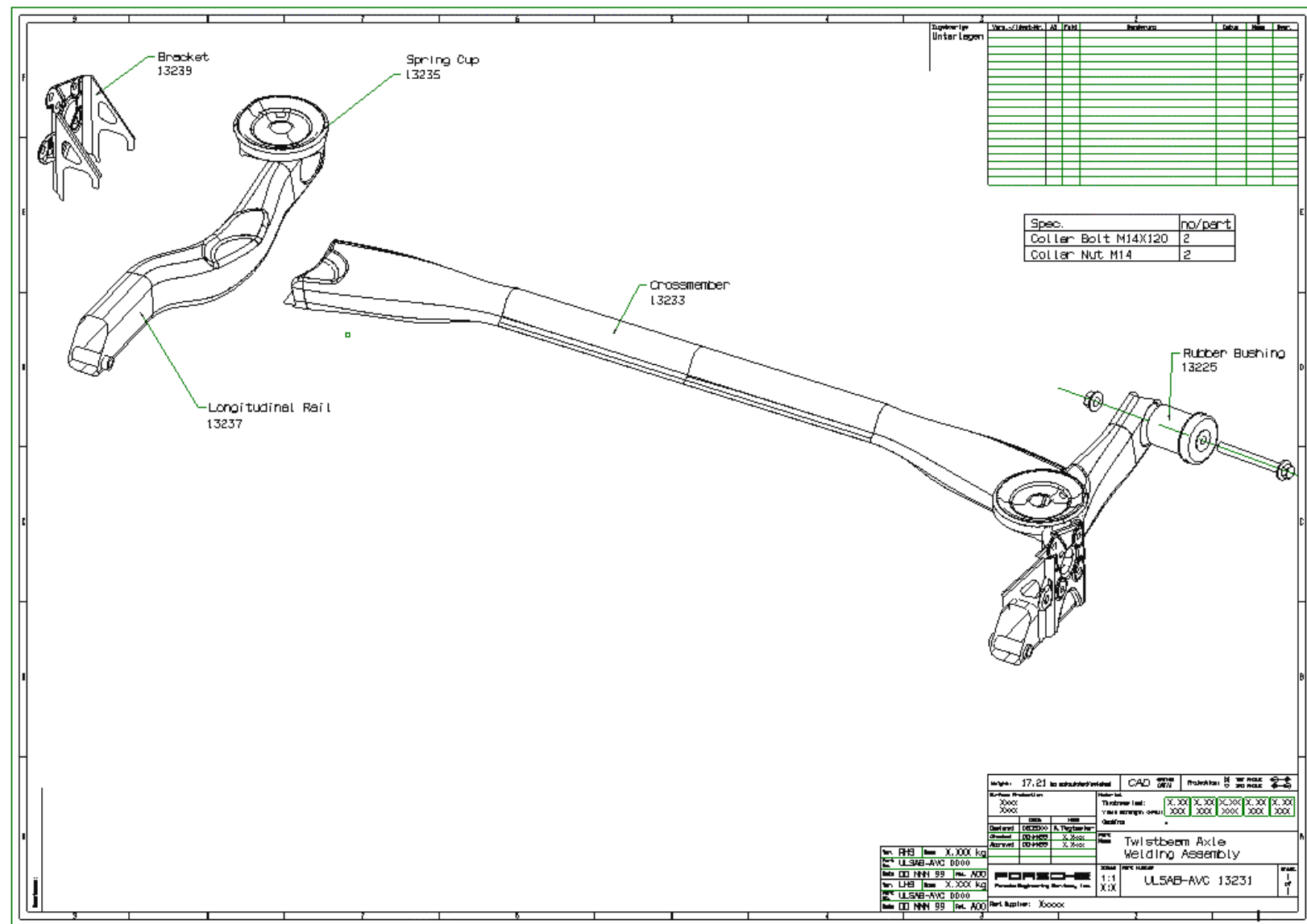
## 4.2.2 Suspension Drawings - Drive Shafts



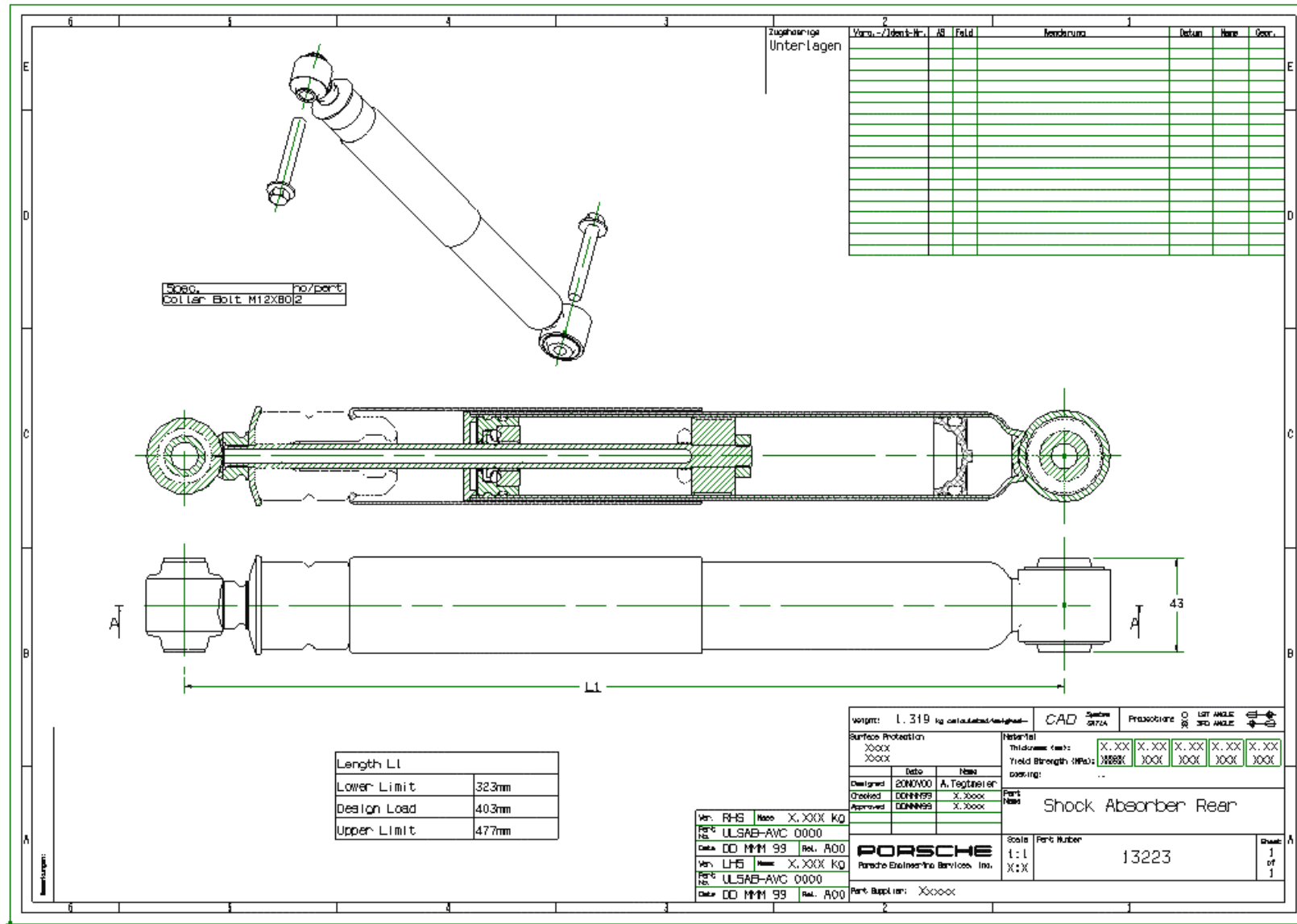
#### 4.2.2 Suspension Drawings - Rear Axle Module



#### 4.2.2 Suspension Drawings - Twistbeam Axle Welding Assembly



## 4.2.2 Suspension Drawings - Shock Absorber Rear



## 4.3 Suspension Section Forces

## 4.3 Suspension Forces - Front Suspension

### Front Suspension - Loads on Left Wheel Center

Load Case	Acceleration [g]	Forces [N]			Momentum [Nm]			
		direction	x	y	z	x	y	z
Vertical Push	3.4		0	0	12144	0	0	0
Steady State Cornering	1		0	7144	7144	2046	0	143
Braking Rearward	0.9		-4755	0	3962	0	1362	0
Braking Forward	-1		8104	0	6753	0	-2321	0
Acceleration	0.45		-5592	0	4660	0	0	0
Curbstone Push	0		0	3572	3572	23	0	1704

### Section Forces

Load Case	Mount / Part	Acting on Part	Fx	Fy	Fz	Fres	Mx	My	Mz
Vertical Push	Lower Wishbone front	Body	1674	-8952	-5771	10782	-	-	-
Vertical Push	Lower Wishbone rear	Body	-943	1177	1783	2335	-	-	-
Vertical Push	Lower Wishbone outer joint	Lower Wishbone	829	-2025	12178	12373	-	-	-
Vertical Push	Upper Wishbone front	Body	-664	2034	-61	2141	-	-	-
Vertical Push	Upper Wishbone rear	Body	-166	-525	21	550	-	-	-
Vertical Push	Upper Wishbone outer joint	Upper Wishbone	-830	1510	-40	1723	-	-	-
Vertical Push	Tie Rod	Steering Rack	1	515	6	515	-	-	-
Vertical Push	Spring	Lower Wishbone	-98	-5750	-16167	17159	-	-	-
Steady State Cornering	Lower Wishbone front	Body	719	8371	-2931	8899	-	-	-
Steady State Cornering	Lower Wishbone rear	Body	-290	978	1018	1441	-	-	-
Steady State Cornering	Lower Wishbone outer joint	Lower Wishbone	514	12510	7078	14383	-	-	-
Steady State Cornering	Upper Wishbone front	Body	-407	-1888	59	1932	-	-	-
Steady State Cornering	Upper Wishbone rear	Body	-101	-1306	38	1310	-	-	-
Steady State Cornering	Upper Wishbone outer joint	Upper Wishbone	-508	-3193	97	3235	-	-	-
Steady State Cornering	Tie Rod	Steering Rack	-6	-2173	-32	2174	-	-	-
Steady State Cornering	Spring	Lower Wishbone	-85	-3161	-8992	9531	-	-	-
Braking Rearward	Lower Wishbone front	Body	-6533	4466	-2085	8183	-	-	-
Braking Rearward	Lower Wishbone rear	Body	-1304	-6912	424	7047	-	-	-
Braking Rearward	Lower Wishbone outer joint	Lower Wishbone	-7742	-449	4022	8736	-	-	-
Braking Rearward	Upper Wishbone front	Body	2393	-2732	25	3632	-	-	-
Braking Rearward	Upper Wishbone rear	Body	596	3332	-83	3386	-	-	-
Braking Rearward	Upper Wishbone outer joint	Upper Wishbone	2989	600	-58	3049	-	-	-
Braking Rearward	Tie Rod	Steering Rack	-1	-150	-1	150	-	-	-
Braking Rearward	Spring	Lower Wishbone	-95	-1997	-5683	6025	-	-	-

Load Case	Mount / Part	Acting on Part	Fx	Fy	Fz	Fres	Mx	My	Mz
Braking Forward	Lower Wishbone front	Body	12479	-17620	-2879	21783	-	-	-
Braking Forward	Lower Wishbone rear	Body	1625	13061	1260	13221	-	-	-
Braking Forward	Lower Wishbone outer joint	Lower Wishbone	14062	-1591	6656	15639	-	-	-
Braking Forward	Upper Wishbone front	Body	-4759	6838	-123	8332	-	-	-
Braking Forward	Upper Wishbone rear	Body	-1193	-6171	193	6288	-	-	-
Braking Forward	Upper Wishbone outer joint	Upper Wishbone	-5951	668	70	5989	-	-	-
Braking Forward	Tie Rod	Steering Rack	-7	923	27	924	-	-	-
Braking Forward	Spring	Lower Wishbone	41	-2969	-8275	8792	-	-	-
Acceleration	Lower Wishbone front	Body	-1916	-2936	-2311	4199	-	-	-
Acceleration	Lower Wishbone rear	Body	-535	-2057	632	2217	-	-	-
Acceleration	Lower Wishbone outer joint	Lower Wishbone	-2381	-2792	4545	5842	-	-	-
Acceleration	Upper Wishbone front	Body	-2584	3144	-38	4070	-	-	-
Acceleration	Upper Wishbone rear	Body	-646	-3524	95	3584	-	-	-
Acceleration	Upper Wishbone outer joint	Upper Wishbone	-3231	-380	57	3254	-	-	-
Acceleration	Tie Rod	Steering Rack	20	3172	57	3173	-	-	-
Acceleration	Spring	Lower Wishbone	-70	-2201	-6224	6602	-	-	-
Curbstone Push	Lower Wishbone front	Body	234	8483	-1485	8615	-	-	-
Curbstone Push	Lower Wishbone rear	Body	-98	524	559	772	-	-	-
Curbstone Push	Lower Wishbone outer joint	Lower Wishbone	187	10724	3959	11433	-	-	-
Curbstone Push	Upper Wishbone front	Body	-121	5443	-125	5446	-	-	-
Curbstone Push	Upper Wishbone rear	Body	-31	1475	-34	1476	-	-	-
Curbstone Push	Upper Wishbone outer joint	Upper Wishbone	-152	6919	-159	6922	-	-	-
Curbstone Push	Tie Rod	Steering Rack	-35	-14070	-229	14072	-	-	-
Curbstone Push	Spring	Lower Wishbone	-51	-1717	-4886	5179	-	-	-

## 4.3 Suspension Forces - Rear Suspension

### Rear Suspension - Loads on Left Wheel Center

Load Case	Acceleration [g]	Forces [N]			Momentum [Nm]			
		direction	x	y	z	Mx	My	Mz
Vertical Push	3.4		0	0	13702	0	0	0
Steady State Cornering	1		0	8060	8060	2326	0	161
Braking Rearward	0.9		-8937	0	7447	0	2579	0
Braking Forward	-1		5571	0	4643	0	-1608	0
Acceleration	0.45		-8095	0	6746	0	0	0
Curbstone Push	0		0	4030	4030	34	0	1922

Section Forces									
Load Case	Mount / Part	Acting on Part	Fx	Fy	Fz	Fres	Mx	My	Mz
Vertical Push	Trailing Arm	Body	5111	-870	2852	5917	-	-	-
Vertical Push	Spring	Wheel Left	5111	-937	-10850	12030	-	-	-
Steady State Cornering	Trailing Arm	Body	4987	7624	1653	9260	-	-	-
Steady State Cornering	Spring	Wheel Left	2840	-485	-6029	6682	-	-	-
Braking Rearward	Trailing Arm	Body	-7922	-132	5279	9521	-	-	-
Braking Rearward	Spring	Wheel Left	1014	-192	-2169	2402	-	-	-
Braking Forward	Trailing Arm	Body	8396	-492	-1345	8517	-	-	-
Braking Forward	Spring	Wheel Left	2825	-506	-5987	6640	-	-	-
Acceleration	Trailing Arm	Body	-4623	-602	-668	4709	-	-	-
Acceleration	Spring	Wheel Left	3473	-657	-7414	8213	-	-	-
Curbstone Push	Trailing Arm	Body	3177	3890	1648	5286	-	-	-
Curbstone Push	Spring	Wheel Left	1535	-259	-3262	3615	-	-	-