



openMSP430

Area and speed analysis

Author: Olivier GIRARD

olgirard@gmail.com

Rev. 1.0

November 13, 2011

Revision History

Rev	Date	Author	Description
.			
1.0	November 13th, 2011	GIRARD	First version imported from the main documentation (revision 1.9)

Contents

1. AREA AND SPEED ANALYSIS1

1.

Area and Speed Analysis

Table of content

- [1. Overview](#)
 - [1.1 FPGAs](#)
 - [1.2 ASICs](#)
- [2. Detailed results](#)
 - [2.1 FPGAs](#)
 - [2.1.1 Xilinx](#)
 - [2.1.2 Altera](#)
 - [2.1.3 Actel](#)
 - [2.2 ASICs](#)
 - [2.2.1 180nm](#)

Notice: the results presented here might vary depending on the tool versions, applied timing constraints and exact configuration of the openMSP430 core.

The FPGA results were obtained using the free tool versions provided by the vendors (i.e ISE 11.1, QuartusII 9.1 & Libero 8.5).

The ASIC synthesis was run with Synopsys Design Compiler 2007.12 (**without dc_ultra or any special feature**).

1. Overview

1.1 FPGAs

			Utilization			
Manu- facturer	Devices	Info	Basic Config. (Core + Watchdog)	Hardware Multiplier	With debug interface (Software breakpoints)	Additional Hardware breakpoint unit
Xilinx	Spartan 3 Spartan 3E Spartan 3A Spartan 3A DSP Virtex 4	4-inputs LUTs	1 620	+ 200	+ 520	+ 80
	Spartan 6 Virtex 5 Virtex 6	6-inputs LUTs	1 240	+ 150	+ 350	+ 70
Altera	Cyclone II Cyclone III Cyclone IV GX Stratix	LEs	1 550	+ 210	+ 480	+ 110
	Arria GX Arria II GX Stratix II Stratix III	ALUTs	1 030	+ 115	+ 380	+ 90
Actel	ProASIC3E ProASIC3L ProASIC3 Fusion IGLOOe	Tiles	3 550	+ 1 060	+ 1 200	+ 220
-	-	Registers	470	+ 75	+ 140	+ 45

Speed (in MHz, min and max values across all speed grades)			
Manufacturer	Devices	Basic Configuration (Core + Watchdog + HW Multiplier)	With debug interface
Xilinx	Spartan 3 Spartan 3E Spartan 3A Spartan 3A DSP	30 - 40	25 - 35
	Spartan 6	40 - 65	35 - 60
	Virtex 4	50 - 70	45 - 60
	Virtex 5	75 - 100	65 - 85
	Virtex 6	90 - 115	75 - 100
Altera	Cyclone II	35 - 45	30 - 45
	Cyclone III Cyclone IV GX	40 - 55	35 - 50
	Arria II GX	65 - 85	60 - 80
	Stratix II	55 - 75	50 - 65
	Stratix III	75 - 95	70 - 90
Actel	ProASIC3E ProASIC3L ProASIC3 Fusion IGLOOe	15 - 25	15 - 25

1.2 ASICs

			Area			
Process	Target Frequency	Info	Basic Config. (Core + Watchdog)	Hardware Multiplier	With debug interface (Software breakpoints)	Additional Hardware breakpoint unit
180 nm	50 MHz	kGates	8	+ 2.5	+ 2	+ 0.8
	100 MHz	kGates	10	+ 4.4	+ 2	+ 1.2

2. Detailed results

2.1 FPGAs

2.1.1 Xilinx

FPGA Device	Speed Grade	Info	openMSP430 Configuration						
			No Debug	No Debug with HW multiplier	With debug interface (no HW breakpoints)	With debug interface (# hardware breakpoint units)			
						1	2	3	4
Spartan 3	-4	4-LUTs	1 609	1 811	2 125	2 165	2 272	2 366	2 458
		Registers	458	533	594	637	679	721	763
		Speed (MHz)	30.06	30.05	28.29	22.26	25.59	25.19	23.50
	-5	4-LUTs	1 609	1 811	2 127	2 166	2 276	2 367	2 459
		Registers	458	533	594	637	679	721	763
		Speed (MHz)	32.69	34.11	32.63	27.09	28.90	27.68	27.63
Spartan 3E	-4	4-LUTs	1 615	1 816	2 131	2 185	2 298	2 383	2 474
		Registers	458	533	594	637	679	721	763
		Speed (MHz)	32.03	32.09	28.00	27.26	27.23	27.36	24.80
	-5	4-LUTs	1 615	1 816	2 131	2 184	2 295	2 383	2 474
		Registers	458	533	594	637	679	721	763
		Speed (MHz)	37.27	37.71	32.51	32.34	29.51	30.26	29.29
Spartan 3A	-4	4-LUTs	1 629	1 832	2 139	2 191	2 304	2 396	2 489
		Registers	459	534	595	638	680	722	764
		Speed (MHz)	31.23	31.05	29.08	26.45	26.39	24.87	24.47
	-5	4-LUTs	1 622	1 827	2 138	2 187	2 302	2 388	2 483
		Registers	459	534	595	638	680	722	764
		Speed (MHz)	36.03	36.14	33.50	30.65	30.79	29.70	27.70

Spartan 3A DSP	-4	4-LUTs	1 628	1 831	2 140	2 197	2 310	2 402	2 497
		Registers	459	534	595	638	680	722	764
		Speed (MHz)	31.18	31.26	29.51	26.61	26.48	24.30	24.56
	-5	4-LUTs	1 621	1 826	2 136	2 196	2 312	2 400	2 495
		Registers	459	534	595	638	680	722	764
		Speed (MHz)	39.31	37.59	33.59	32.61	33.00	28.86	28.49
Spartan 6	-2	6-LUTs	1 277	1 436	1 620	1 705	1 774	1 851	1 905
		Registers	459	533	595	638	680	722	764
		Speed (MHz)	41.06	41.03	39.09	34.88	34.40	26.89	33.86
	-3	6-LUTs	1 271	1 425	1 603	1 685	1 753	1 829	1 876
		Registers	459	533	595	638	680	722	764
		Speed (MHz)	58.19	58.21	50.01	46.45	45.84	41.76	43.33
	-4	6-LUTs	1 267	1 424	1 603	1 681	1 750	1 828	1 873
		Registers	459	533	595	638	680	722	764
		Speed (MHz)	64.96	67.62	57.38	51.11	50.07	42.97	43.61
Virtex 4	-10	4-LUTs	1 629	1 829	2 151	2 200	2 305	2 395	2 490
		Registers	459	534	595	638	680	722	764
		Speed (MHz)	50.12	51.17	45.61	43.60	41.67	42.34	39.18
	-11	4-LUTs	1 632	1 810	2 152	2 202	2 307	2 396	2 491
		Registers	459	534	595	638	680	722	764
		Speed (MHz)	57.27	56.14	53.79	48.82	48.59	48.70	47.39
	-12	4-LUTs	1 627	1 819	2 152	2 199	2 305	2 394	2 489
		Registers	459	534	595	638	680	722	764
		Speed (MHz)	66.56	64.59	57.46	59.27	50.78	54.40	53.87

Virtex 5	-1	6-LUTs	1 219	1 372	1 601	1 691	1 753	1 832	1 881
		Registers	458	532	594	637	679	721	763
		Speed (MHz)	74.39	74.69	70.25	63.09	59.89	53.00	53.53
	-2	6-LUTs	1 221	1 372	1 601	1 692	1 752	1 831	1 881
		Registers	458	532	594	637	679	721	763
		Speed (MHz)	82.16	82.12	77.42	69.06	64.99	58.40	70.06
	-3	6-LUTs	1 215	1 367	1 602	1 692	1 751	1 831	1 882
		Registers	458	532	594	637	679	721	763
		Speed (MHz)	97.85	97.25	85.67	72.33	76.99	71.20	69.05
Virtex 6	-1	6-LUTs	1 237	1 390	1 585	1 673	1 746	1 818	1 866
		Registers	458	532	594	637	679	721	763
		Speed (MHz)	89.32	92.59	87.64	68.59	77.03	73.56	66.47
	-2	6-LUTs	1 235	1 388	1 582	1 668	1 737	1 816	1 860
		Registers	458	532	594	637	679	721	763
		Speed (MHz)	102.40	97.51	98.05	86.74	79.95	77.19	74.94
	-3	6-LUTs	1 234	1 387	1 579	1 668	1 737	1 815	1 860
		Registers	458	532	594	637	679	721	763
		Speed (MHz)	111.74	115.71	102.04	88.93	89.90	84.47	90.80

2.1.2 Altera

FPGA Device	Speed Grade	Info	openMSP430 Configuration						
			No Debug	No Debug with HW multiplier	With debug interface (no HW breakpoints)	With debug interface (# hardware breakpoint units)			
						1	2	3	4
Cyclone II	-6	LEs	1 552	1 785	2 040	2 179	2 286	2 418	2 507
		Registers	467	537	610	653	695	737	779
		Speed (MHz)	45.10	47.32	42.79	43.81	41.57	42.10	40.71
	-7	LEs	1 556	1 781	2 049	2 191	2 298	2 414	2 508
		Registers	467	537	610	653	695	737	779
		Speed (MHz)	40.53	40.24	37.39	38.39	34.23	35.54	33.96
	-8	LEs	1 555	1 779	2 047	2 192	2 290	2 406	2 524
		Registers	467	537	610	653	695	737	779
		Speed (MHz)	33.07	32.97	32.00	30.62	29.78	29.63	26.38
Cyclone III	-6	LEs	1 539	1 752	2 021	2 148	2 251	2 357	2 450
		Registers	467	537	610	653	695	737	779
		Speed (MHz)	51.87	54.11	48.26	49.95	48.39	48.43	45.61
	-7	LEs	1 539	1 750	2 022	2 147	2 244	2 363	2 443
		Registers	467	537	610	653	695	737	779
		Speed (MHz)	46.25	43.88	44.28	41.64	39.18	40.59	40.86
	-8	LEs	1 542	1 752	2 020	2 158	2 243	2 380	2 448
		Registers	467	537	610	653	695	737	779
		Speed (MHz)	40.56	38.68	38.0	38.38	33.94	33.57	32.86
Cyclone IV GX	-6	LEs	1 541	1 750	2 024	2 148	2 246	2 364	2 459
		Registers	467	537	610	653	695	737	779

		Speed (MHz)	50.58	51.77	51.16	49.6	47.38	47.07	46.67
	-7	LEs	1 540	1 749	2 024	2 148	2 247	2 366	2 448
		Registers	467	537	610	653	695	737	779
		Speed (MHz)	47.09	44.19	44.43	42.63	42.49	41.6	39.03
	-8	LEs	1 544	1 747	2 020	2 147	2 244	2 363	2 444
		Registers	467	537	610	653	695	737	779
Speed (MHz)		40.09	37.67	39.76	36.86	37.27	34.69	37.03	
Arria GX	-6	ALUTs	1 044	1 160	1 414	1 525	1 588	1 675	1 765
		Registers	468	539	612	656	708	744	791
		Speed (MHz)	48.71	49.23	44.58	44.38	41.88	42.51	42.18
Arria II GX	-4	ALUTs	1 031	1 146	1 407	1 507	1 577	1 668	1 754
		Registers	469	540	611	654	706	749	793
		Speed (MHz)	84.37	83.22	78.81	75.19	75.75	76.3	79.81
	-5	ALUTs	1 025	1 148	1 404	1 503	1 600	1 670	1 742
		Registers	467	539	612	654	708	744	805
		Speed (MHz)	76.17	72.65	68.86	65.58	67.96	66.81	65.35
	-6	ALUTs	1 032	1 143	1 403	1 506	1 590	1 677	1 755
		Registers	469	539	611	659	704	753	793
		Speed (MHz)	62.63	61.59	59.66	57.2	55.76	59.04	57.41
Stratix	-5	LEs	1 525	1 730	1 989	2 081	2 185	2 279	2 378
		Registers	-	-	-	-	-	-	-
		Speed (MHz)	44.00	43.38	43.64	42.92	40.58	41.70	39.71
	-6	LEs	1 525	1 730	1 989	2 081	2 185	2 279	2 378
		Registers	-	-	-	-	-	-	-
		Speed (MHz)	39.88	40.74	39.82	37.18	37.42	36.97	36.81

	-7	LEs	1 525	1 730	1 989	2 081	2 185	2 279	2 378	
		Registers	-	-	-	-	-	-	-	
		Speed (MHz)	32.97	34.67	33.27	32.83	33.06	31.54	30.66	
Stratix II	-3	ALUTs	1 040	1 145	1 422	1 523	1 590	1 665	1 753	
		Registers	469	540	610	655	698	739	783	
		Speed (MHz)	73.79	73.28	72.38	65.89	67.11	66.09	65.75	
	-4	ALUTs	1 039	1 157	1 424	1 529	1 601	1 671	1 762	
		Registers	469	540	613	658	699	741	781	
		Speed (MHz)	63.75	63.29	60.31	58.10	56.84	59.57	59.26	
	-5	ALUTs	1 039	1 155	1 419	1 527	1 592	1 678	1 763	
		Registers	469	541	617	655	698	741	783	
		Speed (MHz)	54.04	54.82	51.89	50.81	49.89	50.02	49.31	
	Stratix III	-2	ALUTs	1 029	1 147	1 408	1 511	1 597	1 666	1 748
			Registers	468	538	611	656	702	752	799
			Speed (MHz)	93.84	97.68	89.59	84.5	86.24	86.72	85.01
-3		ALUTs	1 033	1 142	1 414	1 506	1 588	1 675	1 754	
		Registers	469	539	610	656	699	753	807	
		Speed (MHz)	83.68	80.16	75.77	71.9	76.64	73.49	75.35	
-4		ALUTs	1 030	1 147	1 411	1 505	1 587	1 670	1 760	
		Registers	469	539	614	654	700	754	803	
		Speed (MHz)	73.17	72.42	72.63	66.91	68.49	65.19	68.43	

2.1.3 Actel

FPGA Device	Speed Grade	Info	openMSP430 Configuration						
			No Debug	No Debug with HW multiplier	With debug interface (no HW breakpoints)	With debug interface (# hardware breakpoint units)			
						1	2	3	4
ProASIC3E	Std	Tiles	3 585	4 734	4 884	5 014	5 263	5 571	5 747
		Registers	479	550	623	666	709	750	793
		Speed (MHz)	16.81	16.14	13.98	16.22	16.66	14.89	15.24
	-1	Tiles	3 635	4 585	4 742	5 004	5 246	5 345	5 713
		Registers	479	552	624	667	708	750	793
		Speed (MHz)	18.01	18.97	17.92	16.03	19.03	19.08	18.29
	-2	Tiles	3 556	4 573	4 811	5 002	5 210	5 446	5 625
		Registers	479	553	623	666	707	750	792
		Speed (MHz)	22.45	20.84	21.42	21.24	24.01	22.85	19.45
ProASIC3L	Std	Tiles	3 549	4 665	4 774	5 012	5 183	5 453	5 638
		Registers	480	552	623	667	709	750	792
		Speed (MHz)	14.31	14.27	15.14	14.42	14.74	14.15	14.05
	-1	Tiles	3 535	4 595	4 776	5 032	5 174	5 418	5 706
		Registers	479	551	623	666	708	750	793
		Speed (MHz)	18.13	17.31	15.90	18.34	17.14	17.69	16.27
ProASIC3	Std	Tiles	3 585	4 734	4 884	5 014	5 263	5 571	5 747
		Registers	479	550	623	666	709	750	793
		Speed (MHz)	16.47	15.62	15.03	16.55	16.00	14.63	15.38
	-1	Tiles	3 635	4 585	4 742	5 004	5 246	5 345	5 713
		Registers	479	552	624	667	708	750	793

		Speed (MHz)	18.03	19.21	18.39	18.40	18.95	17.13	18.59
	-2	Tiles	3 556	4 573	4 811	5 002	5 210	5 446	5 625
		Registers	479	553	623	666	707	750	792
		Speed (MHz)	22.80	21.97	21.67	21.24	22.57	23.27	20.75
IGLOOe	Std	Tiles	3 646	4 844	4 857	5 016	5 214	5 467	5 739
		Registers	479	552	623	666	709	751	791
		Speed (MHz)	14.01	14.51	13.61	13.85	14.29	14.44	14.10
Fusion	Std	Tiles	3 585	4 734	4 884	5 014	5 263	5 571	5 747
		Registers	479	550	623	666	709	750	793
		Speed (MHz)	16.65	15.84	14.25	15.60	15.62	15.20	15.50
	-1	Tiles	3 635	4 585	4 742	5 004	5 246	5 345	5 713
		Registers	479	552	624	667	708	750	793
		Speed (MHz)	17.90	18.46	17.79	17.86	17.81	18.69	17.98
	-2	Tiles	3 556	4 573	4 811	5 002	5 210	5 446	5 625
		Registers	479	553	623	666	707	750	792
		Speed (MHz)	22.30	21.34	20.58	20.27	21.48	21.39	20.59

2.2 ASICs

2.2.1 180nm

Target Frequency	Info	openMSP430 Configuration						
		No Debug	No Debug with HW multiplier	With debug interface (no HW breakpoints)	With debug interface (# hardware breakpoint units)			
					1	2	3	4
25 MHz	kgates	8 042	10 457	9 995	10 744	11 487	12 189	12 905
	μm^2	80 256	104 352	99 742	107 223	114 637	121 643	128 784
	timing	clean	clean	clean	clean	clean	clean	clean
33 MHz	kgates	8 039	10 458	9 976	10 839	11 584	12 293	13 022
	μm^2	80 226	104 365	99 552	108 164	115 602	122 677	129 956
	timing	clean	clean	clean	clean	clean	clean	clean
50 MHz	kgates	8 187	10 753	10 149	11 189	11 929	12 651	13 405
	μm^2	81 703	107 305	101 285	111 660	119 048	126 253	133 778
	timing	clean	clean	clean	clean	clean	clean	clean
66 MHz	kgates	8 535	11 837	10 591	12 042	12 873	13 489	14 299
	μm^2	85 172	118 130	105 693	120 176	128 465	134 606	142 692
	timing	clean	clean	clean	clean	clean	clean	clean
100 MHz	kgates	10 019	14 468	12 095	14 386	15 197	16 027	16 936
	μm^2	99 988	144 382	120 698	143 560	151 660	159 936	169 014
	timing	clean	-0.98 ns	clean	clean	clean	clean	clean
125 MHz	kgates	11 851	16 142	13 838	16 502	17 209	17 660	18 718
	μm^2	118 270	161 087	138 095	164 676	171 738	176 229	186 793
	timing	-0.75 ns	-2.85 ns	-0.62 ns	-1.46 ns	-1.66 ns	-1.81 ns	-1.81 ns