Dual Loop versus Single, the facts - by Gabriel Rouchon, 6-30-10

The following series of tests represent Part II of the white paper published here

In this article, the question we wanted to answer was:

Are dual (dedicated) loops better than single loops?

Equipment:

- Loop 1: MCR320 Drive radiator, with built-in MCP355 pump, and an Apogee XT waterblock; the loop uses ½ lines. The fans are Gentle Typhoon's (D1225C12B5AP-15) running at 1850 rpm and rated at 28 dB.
- Loop 2: MCR220 Drive radiator, with built-in MCP355 pump,Gentle Typhoon fans (same model) and 1/2" lines.
- All components are connected to the loop with CPC quick-disconnect fittings; they are fairly restrictive, but the time they save in changing setups overshadows any other considerations.
- The CPU is an early Ci7 920, Revision C0/C1 stepping 4.
- The Graphic cards are (2) EVGA GTX470 FTW
- The Motherboard is a Gigabyte EX58-UD3R, and the OS is Windows 7 Ultimate 64 Bit.

Methodology:

- The CPU maximum stable overclock was well established, since we have been using this same 920 ever since its introduction. It is 4095 Mhz (Intel Turbo mode on, and HT enabled), at 1.424v (after droop).
- The GPU's maximum stable overclock was established in the previous graphics tests using Furmark in extreme burn mode at 1920x1050 for a minimum of two hours, and further validated by running 3D Marks Vantage.
- Max stable overclock for 2 cards in SLI was 825 MHz core and 1000 MHz memory, @1.087 Volts.

We conducted two series of tests, reflecting the following hardware configurations:

- Series I, with the Ci7 920@ 4.1Gb and (2) GTX470 FTW in SLI @825/1000, and
- Series II, with the Ci7 920@ 4.1Gb and (1) GTX470 FTW @825/1000.

Within each series, we tested three cooling loop configurations:

- Dual Loop with MCR320 Drive dedicated to cooling the CPU, and MCR220 Drive dedicated to cooling the GPU(s)
- Dual Loop with MCR220 Drive dedicated to cooling the CPU, and MCR320 Drive dedicated to cooling the GPU(s)
- Single loop combining MCR320 Drive, MCR220 Drive, CPU, and parallelly linked GPU's, in series

Within each loop configuration, we simulated three load scenarios consisted in:

- CPU load tests: In order to maintain consistency with previous test data, we ran our usual 8 instances of BurnK6. We logged the temperature results at 2 seconds intervals using CoreTemps. The average temperature of the 4 cores is reported.
- GPU load tests: We used Furmark in extreme burning mode, windowed in 1920x1050, post processing off to enable 100% load to both GPU's in SLI configuration, and logged the temperature results at 2 seconds intervals with GPUZ.
- Combined CPU + GPU load test: We used (7) instances of Burn K6 + Furmark in extreme burning mode - The combination of these two benchmarks placed ~100% load on all four CPU cores, and a load on both GPU cores varying between 98 and 100%.
- Graphics cards were hydraulically linked in parallel, as a result of the findings outlined in part I of this article.

The test results are compiled and summarized in two groups: Temps under load in typical computer use, and Temps under load in Extreme computer use.

- Typical computer use reflects the assumption that at the time of this writing, CPU maximum load and GPU maximum load are in the vast majority of the cases mutually exclusive of each other. In other words, the majority of games placing a heavy load on the GPU's use very few CPU resources, whereas the majority of CPU intensive applications use very little GPU resources.
- The extreme computer use scenario reflects the currently rare occurrences where both CPU and GPU(s) are under maximum load.
- Comparing these two groups provides an insight on the respective device load ratios relative to the heat exchangers and may provide guidance for further system configurations.

Environmental Temperature recording:

- Air temperature: each fan was equipped with a type T Thermocouples (accurate at +/- 0.1c) at the inlet, and the average of the 3 values is reported.
- Coolant temperature was measured at the radiator inlet with a Type T thermocouple (accurate at +/- 0.1°C).

I. Series 1 test results, CPU + SLI configuration:

			SERIES I -	Dedicated loops:	MCR320-Driv	ve to (1) CPU: N	ACR220-Drive	e to (2) pa	rallelv lini	ked GPU's				
		:)		GPU DATA (°C)										
		Ci7 920@ 4.1Gb +											ΔΤ	
		(2) GTX470 FTW		MCR320 Drive							MCR220-Drive		Water	
		SLI @825/1000 in	Avg T	Avg T Air CPU	Avg T	∆T Water to		Avg T	Avg T	Avg TGPU	Avg T Air GPU	T Water	GPU to	
Test #	Benchmark	Parallel	CPU	loop1	Water CPU	Air	ΔT CPU Air	GPU1	GPU2	1+2	loop2	GPU loop 2	Air	ΔT GPU Air
1	(8) instances of BurnK6		66.9	23.5	27.7	4.2	43.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Furmark Max Burn N/A N/A			N/A	N/A	N/A	53.8	55.0	54.4	26.8	43.3	16.5	27.6	
3	Furmark MB + Burnk6 (x7) 67.8 24.7				29.1	4.3	43.1	52.0	54.0	53.0	25.5	41.8	16.3	27.5
			SERIES I -	Dedicated loops:	MCR220-Dri	ve to (1) CPU; N	ACR320-Drive	e to (2) pa	rallely lin	ked GPU's				
	Configuration			CPU DATA (°C)					GPU DATA (°C)					
		(2) CTV470 FTM		MCD220 Dates							MCD220 Dates			
		(2) GTX4/0 FTW		IVICR220 Drive				<u>а</u> т		A TONI	MICR320-Drive	T 111 .	water	
T	Development	SLI @825/1000 in	AVg I	Avg T Air CPU	AVg I	ΔI water to	AT COLLAIS	AVg I	AVg I	AVg T GPU	Avg T Air GPU	I Water	GPU to	AT COLLAIS
lest #	Benchmark	Parallel	CPU 70.0	100p1	Water CPU	Air		GPU1	GPUZ	1+2	loop2	GPU loop 2	Air	ΔT GPU Air
4	(8) Instances of BurnKb		70.0	25.2	31.1	6.0	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	Furmark Max Burn	7)	N/A	N/A	N/A	N/A	N/A	49.0	51.0	50.0	25.8	37.9	12.1	24.2
. 6	Furmark MB + Burnk6 (x7) 69.3 25.0				31.1	6.1	44.3	47.5	49.5	48.5	24.7	36.7	11.9	23.8
		SERIE	SI-Com	bined Loop : MCR	320-Drive +	MCR-220-Drive	+ (1) CPU + ()	2) paralle	v linked G	iPU's. in seri	es			
		SERIE Configuration	S I - Coml	bined Loop : MCR	320-Drive + CPU DATA (°C	MCR-220-Drive	+ (1) CPU + (2) paralle	y linked G	iPU's, in seri	GPU DATA (°C)			
		SERIE Configuration Ci7 920@ 4.1Gb +	S I - Comi	bined Loop : MCR	320-Drive + CPU DATA (°C	MCR-220-Drive	+ (1) CPU + (2) parallel	ly linked G	iPU's, in seri	es GPU DATA (°C)		ΔΤ	
		SERIE Configuration Ci7 920@ 4.1Gb + (2) GTX470 FTW	S I - Comi	MCR320+220	320-Drive + CPU DATA (°C	MCR-220-Drive	+ (1) CPU + (:	2) parallel	y linked G	iPU's, in seri	es GPU DATA (°C)		ΔT Water	
		SERIE Configuration Ci7 920@ 4.1Gb + (2) GTX470 FTW SLI @825/1000 in	S I - Comi	MCR320+220 Drive in series	320-Drive + CPU DATA (°C Avg T	MCR-220-Drive	+ (1) CPU + (;	2) parallel Avg T	y linked G Avg T	PU's, in seri Avg T GPU	es GPU DATA (°C)	T Water	ΔT Water GPU to	
Test #	Benchmark	SERIE Configuration Ci7 920@ 4.1Gb + (2) GTX470 FTW SLI @825/1000 in Parallel	Avg T CPU	MCR320+220 Drive in series Avg T Air	320-Drive + CPU DATA (°C Avg T Water	MCR-220-Drive ;) ΔT Water to Air	+ (1) CPU + (; ΔT CPU Air	2) paralle Avg T GPU1	y linked G Avg T GPU2	Avg T GPU 1+2	es GPU DATA (°C) T Air GPU	T Water GPU	ΔT Water GPU to Air	ΔT GPU Air
Test #	Benchmark (8) instances of BurnK6	SERIE Configuration Ci7 920@ 4.1Gb + (2) GTX470 FTW SLI @825/1000 in Parallel	Avg T CPU 65.8	MCR320+220 Drive in series Avg T Air 24.2	320-Drive + CPU DATA (°C Avg T Water 27.2	MCR-220-Drive) ΔT Water to Air 2.9	+ (1) CPU + (ΔΤ CPU Air 41.6	2) paralle Avg T GPU1 31.9	Avg T GPU2 31.6	Avg T GPU 1+2 31.7	GPU DATA (°C) T Air GPU N/A	T Water GPU N/A	ΔT Water GPU to Air N/A	ΔT GPU Air 7.5
Test # 7 8	Benchmark (8) instances of BurnK6 Furmark Max Burn	SERIE Configuration Ci7 920@ 4.1Gb + (2) GTX470 FTW SLI @825/1000 in Parallel	Avg T CPU 65.8 N/A	MCR320+220 Drive in series Avg T Air 24.2 25.2	320-Drive + 1 CPU DATA (°C Avg T Water 27.2 33.0	MCR-220-Drive) ΔT Water to Air 2.9 7.7	+ (1) CPU + (1) ΔT CPU Air 41.6 N/A	2) paralle Avg T GPU1 31.9 45.0	Avg T GPU2 31.6 47.0	Avg T GPU 1+2 31.7 46.0	GPU DATA (°C) T Air GPU N/A N/A	T Water GPU N/A N/A	ΔT Water GPU to Air N/A N/A	ΔT GPU Air 7.5 20.8
Test # 7 8 9	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + BurnK6 (x3	State Configuration Ci7 920@ 4.1Gb + (2) GTX470 FTW SLI @825/1000 in Parallel 7)	Avg T CPU 65.8 N/A 72.0	MCR320+220 Drive in series Avg T Air 24.2 25.2 25.0	320-Drive + CPU DATA (°C Avg T Water 27.2 33.0 33.7	MCR-220-Drive ∴) ΔT Water to Air 2.9 7.7 8.8	+ (1) CPU + (1 ΔT CPU Air 41.6 N/A 47.1	2) paralle Avg T GPU1 31.9 45.0 46.1	Avg T GPU2 31.6 47.0 48.0	Avg T GPU 1+2 31.7 46.0 47.1	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔT GPU Air 7.5 20.8 22.1
Test # 7 8 9	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + Burnk6 (x7	SERIE Configuration C17 920@ 4.1Gb + (2) GTX470 FTW SLI @825/1000 in Parallel 7)	Avg T CPU 65.8 N/A 72.0	MCR320+220 Drive in series Avg T Air 24.2 25.2 25.0	320-Drive + CPU DATA (°C Avg T Water 27.2 33.0 33.7	MCR-220-Drive) ΔT Water to Air 2.9 7.7 8.8 Δα b c i c	+ (1) CPU + (ΔT CPU Air 41.6 N/A 47.1	2) paralle Avg T GPU1 31.9 45.0 46.1	Avg T GPU2 31.6 47.0 48.0	Avg T GPU 1+2 31.7 46.0 47.1	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔT GPU Air 7.5 20.8 22.1
Test # 7 8 9	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + Burnk6 (x)	State Configuration C17 920@ 4.1Gb + (2) GTX470 FTW SLI @825/1000 in Parallel 7)	Avg T CPU 65.8 N/A 72.0	MCR320+220 Drive in series Avg T Air 24.2 25.2 25.0	320-Drive + CPU DATA (°C Avg T Water 27.2 33.0 33.7	ΔCR-220-Drive	+ (1) CPU + (τ ΔT CPU Air 41.6 N/A 47.1	2) paralle Avg T GPU1 31.9 45.0 46.1	Avg T GPU2 31.6 47.0 48.0	Avg T GPU 1+2 31.7 46.0 47.1	CB GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔT GPU Air 7.5 20.8 22.1
Test # 7 8 9 Note #	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + Burnk6 (x7 With radiators and pun	State Configuration C17 920@ 4.1Gb + (2) GTX470 FTW SLI @825/1000 in Parallel 7) nps in series, CPU temps are	Avg T CPU 65.8 N/A 72.0	MCR320+220 Drive in series Avg T Air 24.2 25.2 25.0	320-Drive + CPU DATA (*C Avg T Water 27.2 33.0 33.7 Tem 1.8	MCR-220-Drive) ΔT Water to Air 2.9 7.7 8.8 Analysis berature * Clower than	+ (1) CPU + (τ ΔT CPU Air 41.6 N/A 47.1 Dual loop w	Avg T GPU1 31.9 45.0 46.1	Avg T GPU2 31.6 47.0 48.0	Avg T GPU 1+2 31.7 46.0 47.1	GU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔT GPU Air 7.5 20.8 22.1
Test # 7 8 9 Note # 1 2	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + BurnK6 (x7 With radiators and pun Under CPU stress only, Under CPU stress only,	SERIE Configuration CIT 920@ 4.1Gb + (2) GTX470 FTW SLI @825/1000 in Parallel 7) nps in series, CPU temps are CPU temps are	Avg T CPU 65.8 N/A 72.0	MCR320+220 Drive in series Avg T Air 24.2 25.2 25.0	320-Drive + (*C CPU DATA (*C Avg T Water 27.2 33.0 33.7 Tem 1.8 3.3	MCR-220-Drive) ΔT Water to Air 2.9 7.7 8.8 Analysis berature *C lower than	+ (1) CPU + (1 ΔT CPU Air 41.6 N/A 47.1 Dual loop w MCR320 drin MCR320 drin	2) parallel Avg T GPU1 31.9 45.0 46.1 we dedicat	Avg T GPU2 31.6 47.0 48.0	Avg T GPU 1+2 31.7 46.0 47.1	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔT GPU Air 7.5 20.8 22.1
Test # 7 8 9 Note # 1 2 3	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + BurnK6 (x) With radiators and pun Under CPU stress only, Under CPU stress only,	SERIE Configuration CIT 9200 4.1Gb + (2) GTX470 FTW SLI @825/1000 in Parallel 7) nps in series, CPU temps are CPU temps are GPU temps are	Avg T CPU 65.8 N/A 72.0	MCR320+220 Drive in series Avg T Air 24.2 25.2 25.0	320-Drive + (*C CPU DATA (*C Avg T Water 27.2 33.0 33.7 Tem 1.8 3.3 6.8	MCR-220-Drive ΔT Water to Air 2.9 7.7 8.8 Analysis berature °C lower than °C lower than	+ (1) CPU + (ΔT CPU Air 41.6 N/A 47.1 Dual loop w MCR320 dri MCR220 dri	2) parallel Avg T GPU1 31.9 45.0 46.1 ith: ve dedicative ve dedicative	Avg T GPU2 31.6 47.0 48.0 ted to CPU ted to CPU ted to CPU	Avg T GPU 1+2 31.7 46.0 47.1	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔT GPU Air 7.5 20.8 22.1
Test # 7 8 9 Note # 1 2 3 4	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + BurnK6 (x) With radiators and pun Under CPU stress only, Under CPU stress only, Under GPU stress only,	State Configuration C17 920@ 4.1Gb + (2) GTX470 FTW SLI @825/1000 in Parallel 7) nps in series, CPU temps are GPU temps are GPU temps are GPU temps are	Avg T CPU 65.8 N/A 72.0	MCR320+220 Drive in series Avg T Air 24.2 25.2 25.0	320-Drive + (*C CPU DATA (*C Avg T Water 27.2 33.0 33.7 Tem 1.8 3.3 6.8 3.4	MCR-220-Drive ΔT Water to Air 2.9 7.7 8.8 Analysis berature *C lower than *C lower than *C lower than	+ (1) CPU + (1 ΔT CPU Air 41.6 N/A 47.1 Dual loop w MCR320 drin MCR220 drin MCR220 drin MCR220 drin	2) parallel Avg T GPU1 31.9 45.0 46.1 ith: ve dedicative ve dedicative ve dedicative	Avg T GPU2 31.6 47.0 48.0 ted to CPU ted to CPU ted to CPU ted to GPU	Avg T GPU 1+2 31.7 46.0 47.1 J J's	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A	ΔΤ GPU Air 7.5 20.8 22.1
Test # 7 8 9 Note # 1 2 3 4 5	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + Burnk6 (x) With radiators and pun Under CPU stress only, Under CPU stress only, Under GPU stress only, Under GPU stress only,	State Configuration (217 920@ 4.1Gb + (2) GTX470 FTW SLI @825/1000 in Parallel 7) 7) 7) 7) 7) 70 temps are CPU temps are GPU temps are GPU temps are GPU temps are	Avg T CPU 65.8 N/A 72.0	MCR320+220 Drive in series Avg T Air 24.2 25.2 25.0	320-Drive + 1 CPU DATA (*C Avg T Water 27.2 33.0 33.7 Tem 1.8 3.3 6.8 3.4 4.0	MCR-220-Drive)	41.6 N/A 41.6 N/A 47.1 Dual loop и MCR320 drih MCR320 drih MCR320 drih MCR320 drih MCR320 drih	Avg T GPU1 31.9 45.0 46.1 ve dedicat ve dedicat ve dedicat	Avg T GPU2 31.6 47.0 48.0 ted to CPU ted to CPU ted to GPU ted to GPU ted to GPU	PU's, in seri	GPU DATA (°C) T Air GPU N/A N/A N/A N/A	T Water GPU N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔΤ GPU Air 7.5 20.8 22.1
Test # 7 8 9 Note # 1 2 3 4 5 6	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + BurnK6 (x: With radiators and purn Under CPU stress only, Under GPU stress only, Under GPU stress only, Under GPU stress only, Under CPU AND GPU st	State Configuration C17 920@ 4.1Gb + (2) GTX470 FTW SLI @825/1000 in Parallel 7) nps in series, CPU temps are GPU temps are GPU temps are GPU temps are sers, CPU temps are	Avg T CPU 65.8 N/A 72.0	MCR320+220 Drive in series Avg T Air 24.2 25.2 25.0	320-Drive + 1 CPU DATA (*C Avg T Water 27.2 33.0 33.7 Tem 1.8 3.3 6.8 3.4 4.0 2	MCR-220-Drive ΔT Water to Air 2.9 7.7 8.8 Analysis berature °C lower than °C lower than	<u>АТ СРU Air</u> <u>41.6</u> N/A 47.1 Dual loop w MCR320 drih MCR320 drih MCR320 drih MCR320 drih MCR320 drih	Avg T GPU1 31.9 45.0 46.1 ve dedicat ve dedicat ve dedicat ve dedicat	Avg T GPU2 31.6 47.0 48.0 ted to CPL ted to CPL ted to GPL ted to GPL ted to CPL	Avg T GPU 1+2 31.7 46.0 47.1 J J J J J J J J J J	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔΤ GPU Air 7.5 20.8 22.1
Test # 7 8 9 Note # 1 2 3 4 5 6 6 7	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + BurnK6 (x: With radiators and pun Under CPU stress only, Under CPU stress only, Under CPU stress only, Under CPU AND GPU st Under CPU AND GPU st	State Configuration C17 920@ 4.1Gb + (2) GTX470 FTW SLI @825/1000 in Parallel 7) nps in series, CPU temps are GPU temps are GPU temps are ress, CPU temps are ress, CPU temps are	Avg T CPU 65.8 N/A 72.0	MCR320+220 Drive in series Avg T Air 24.2 25.2 25.0	320-Drive + 1 CPU DATA (*C Avg T Water 27.2 33.0 33.7 Tem 1.8 3.3 6.8 3.4 4.0 2.8 5.4	MCR-220-Drive ΔT Water to Air 2.9 7.7 8.8 Analysis berature *C lower than *C lower than	<u>АТ СРU Air</u> <u>41.6</u> N/A 47.1 Dual loop w MCR320 drih MCR320 drih MCR320 drih MCR320 drih MCR320 drih	Avg T GPU1 31.9 45.0 46.1 ve dedicative dedicative dedicative ve dedicative dedicative dedicative	Avg T GPU2 31.6 47.0 48.0 ted to CPU ted to CPU ted to GPU ted to CPU ted to CPU ted to CPU	Avg T GPU 1+2 31.7 46.0 47.1 J's J's J's J's	CF GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔΤ GPU Air 7.5 20.8 22.1



Analysis

<u>Under typical computer use</u>, the above test data suggests as a general rule that users would not benefit from setting up dedicated loops for CPU and GPU. Serializing pumps in the same loop also adds a redundancy factor that dedicated loops cannot provide. With superior reliability and lower temperatures at both CPU and GPU levels, single loops appear to win hands down.

<u>Under extreme computer use</u>, this setup recorded a notable advantage at the CPU temperature level for the dual loop, counterbalanced by the opposite effect at the GPU level. This extreme environment uncovered the critical importance of the respective load ratios

generated by CPU class devices vs. GPU class devices, relative to the heat exchangers to which they are connected. Clearly, a CPU generating 150 Watts solely dedicated to a triple radiator will cool substantially better than when mixed with another 400 watts generated by two GPU's even with a second dual radiator in the loop. Jedi Masters would say, "we need to bring balance to the force here", and they would be right.

We could define a simple mathematical method to properly configure a system accounting for loads, but that will be for another article. For now, we can simply illustrate the above in real life testing by removing one of the GPU's from the system. It has for effect to balance the heat load generated by CPU device more evenly against that of the GPU device and demonstrates how load ratios affects the results.

II. Series 2 test results, CPU + Single GPU configuration:

				ERIES II - Dodioate	od loops: MC	P220-Drive to	(1) CPUI: MCP	220-Drive	to (1) GP	1					
	Configuration CPU DATA (°C)								GPU DATA (°C)						
		comgaration				-/							ΔΤ		
		Ci7 920@ 4.1Gb +		MCR320 Drive							MCR220-Drive		Water		
		(1) GTX470 FTW	Avg T	Avg T Air CPU	Avg T	∆T Water to		Avg T	Avg T	Avg TGPU	Avg T Air GPU	T Water	GPU to		
Test #	Benchmark	@825/1000	CPU	loop1	Water CPU	Air	ΔT CPU Air	GPU1	GPU2	1+2	loop2	GPU loop 2	Air	ΔT GPU Air	
10	(8) instances of BurnK6		67.2	23.8	27.9	4.1	43.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
11	Furmark Max Burn		N/A	N/A	N/A	N/A	N/A	44.3	N/A	44.3	25.9	34.5	8.6	18.4	
12	12 Furmark MB + Burnk6 (x7) 66.7			23.8	28.0	4.2	42.9	42.1	N/A	42.1	24.1	32.6	8.5	18.0	
			S	ERIES II - Dedicat	ed loops: MC	R220-Drive to	(1) CPU; MCR	320-Drive	to (1) GP	J					
	Configuration			CPU DATA (°C)							GPU DATA (°C)				
													ΔΤ		
		Ci7 920@ 4.1Gb +		MCR220 Drive							MCR320-Drive		Water		
		(1) GIX4/0 FIW	Avg I	Avg I Air CPU	Avg I	ΔI Water to		Avg I	Avg I	Avg I GPU	Avg I Air GPU	I Water	GPU to		
lest #	Benchmark	@825/1000	CPU	loop1	Water CPU	Air	ΔT CPU Air	GPU1	GPU2	1+2	loop2	GPU loop 2	Air	Δ1 GPU Air	
13	(8) instances of BurnK6		69.3	24.7	30.9	6.2	44.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
14	Furmark Max Burn	-1	N/A	N/A	N/A	N/A	N/A	40.4	N/A	40.4	23.6	29.7	6.2	16.8	
15	Furmark MB + Burnk6 (x	/)	70.0	25.9	31.8	6.0	44.2	42.0	N/A	42.0	24.7	31.0	6.3	17.2	
			SERIES	SIL - Combined Lo	on MCR320	-Drive + MCR-2	20-Drive + (1	1) CPU + (1)	GPU in	series					
		Configuration	SERIES	5 II - Combined Lo	OP : MCR320 CPU DATA (°C	-Drive + MCR-2	20-Drive + (1	l) CPU + (1	.) GPU, in	series	GPU DATA (°C)				
		Configuration	SERIES	S II - Combined Lo	op : MCR320 CPU DATA (°C	-Drive + MCR-2 :)	20-Drive + (1	l) CPU + (1	.) GPU, in	series	GPU DATA (°C)		ΔΤ		
		Configuration Ci7 920@ 4.1Gb +	SERIES	MCR320+220	CPU DATA (°C	-Drive + MCR-2	20-Drive + (1	L) CPU + (1	.) GPU, in	series	GPU DATA (°C)		ΔT Water		
		Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW	SERIES Avg T	MCR320+220 Drive in series	OP : MCR320 CPU DATA (°C Avg T	- Drive + MCR-2 :) ΔT Water to	220-Drive + (1	L) CPU + (1 Avg T	.) GPU, in Avg T	series Avg T GPU	GPU DATA (°C)	T Water	ΔT Water GPU to		
Test #	Benchmark	Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW @825/1000	Avg T CPU	MCR320+220 Drive in series Avg T Air	OP : MCR320 CPU DATA (°C Avg T Water	-Drive + MCR-2 ;) ΔT Water to Air	2 20-Drive + (1 ΔT CPU Air	L) CPU + (1 Avg T GPU1	.) GPU, in Avg T GPU2	Avg T GPU 1+2	GPU DATA (°C) T Air GPU	T Water GPU	ΔT Water GPU to Air	ΔT GPU Aiı	
Test # 16	Benchmark (8) instances of BurnK6	Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW @825/1000	Avg T CPU 67.1	MCR320+220 Drive in series Avg T Air 25.3	OP : MCR320 CPU DATA (°C Avg T Water 28.1	-Drive + MCR-2) ΔT Water to Air 2.8	20-Drive + (1 ΔT CPU Air 41.8	Avg T GPU1 N/A	Avg T GPU2 N/A	Avg T GPU 1+2 N/A	GPU DATA (°C) T Air GPU N/A	T Water GPU N/A	ΔT Water GPU to Air N/A	ΔT GPU Air N/A	
Test # 16 17	Benchmark (8) instances of BurnK6 Furmark Max Burn	Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW @825/1000	Avg T CPU 67.1 N/A	MCR320+220 Drive in series Avg T Air 25.3 25.6	OP : MCR320 CPU DATA (°C Avg T Water 28.1 30.1	-Drive + MCR-2) ΔT Water to Air 2.8 4.5	220-Drive + (1 ΔT CPU Air 41.8 N/A	Avg T GPU1 N/A 42.0	Avg T GPU2 N/A N/A	Avg T GPU 1+2 N/A 42.0	GPU DATA (°C) T Air GPU N/A N/A	T Water GPU N/A N/A	ΔT Water GPU to Air N/A N/A	ΔΤ GPU Air N/A 16.4	
Test # 16 17 18	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + Burnk6 (x	Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW @825/1000 7)	Avg T CPU 67.1 N/A 69.9	MCR320+220 Drive in series Avg T Air 25.3 25.6 25.8	Avg T 28.1 30.1 31.2	-Drive + MCR-2) ΔT Water to Air 2.8 4.5 5.4	220-Drive + (1 ΔT CPU Air 41.8 N/A 44.1	Avg T GPU1 N/A 42.0 43.0	Avg T GPU2 N/A N/A N/A	Avg T GPU 1+2 N/A 42.0 43.0	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔΤ GPU Air N/A 16.4 17.2	
Test # 16 17 18	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + Burnk6 (x	Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW @825/1000 7)	Avg T CPU 67.1 N/A 69.9	MCR320+220 Drive in series Avg T Air 25.3 25.6 25.8	op : MCR320 CPU DATA (°C Avg T Water 28.1 30.1 31.2	Drive + MCR-2 ΔT Water to Air 2.8 4.5 5.4 Analysis	20-Drive + (1 ΔT CPU Air 41.8 N/A 44.1	Avg T GPU1 N/A 42.0 43.0	Avg T GPU2 N/A N/A N/A	Avg T GPU 1+2 N/A 42.0 43.0	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔT GPU Air N/A 16.4 17.2	
Test # 16 17 18 Note #	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + Burnk6 (x With radiators and pur	Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW @825/1000 7) mps in series,	Avg T CPU 67.1 N/A 69.9	MCR320+220 Drive in series Avg T Air 25.3 25.6 25.8	op : MCR320 CPU DATA (*C Avg T Water 28.1 30.1 31.2 Tem	-Drive + MCR-2 ΔT Water to Air 2.8 4.5 5.4 Analysis berature	20-Drive + (1 ΔT CPU Air 41.8 N/A 44.1 Dual loop w	Avg T GPU1 N/A 42.0 43.0	Avg T GPU2 N/A N/A N/A	Avg T GPU 1+2 N/A 42.0 43.0	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔT GPU Air N/A 16.4 17.2	
Test # 16 17 18 Note # 1	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + BurnK6 (x With radiators and pur Under CPU stress only,	Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW @825/1000 7) mps in series, CPU temps are	Avg T CPU 67.1 N/A 69.9	MCR320+220 Drive in series Avg T Air 25.3 25.6 25.8	op : MCR320 CPU DATA (*C Avg T Water 28.1 30.1 31.2 Tem, 1.7	-Drive + MCR-2) ΔT Water to Air 2.8 4.5 5.4 Analysis berature *C lower than	20-Drive + (2 ΔT CPU Air 41.8 N/A 44.1 Dual loop w MCR320 dri	Avg T GPU1 N/A 42.0 43.0 vith: ve dedicat	Avg T GPU2 N/A N/A N/A N/A	Avg T GPU 1+2 N/A 42.0 43.0	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔΤ GPU Air N/A 16.4 17.2	
Test # 16 17 18 Note # 1 2	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + Burnk6 (x With radiators and pur Under CPU stress only, Under CPU stress only,	Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW @825/1000 7) mps in series, CPU temps are CPU temps are	Avg T CPU 67.1 N/A 69.9	MCR320+220 Drive in series Avg T Air 25.3 25.6 25.8	Op : MCR320 CPU DATA (*C Avg T Water 28.1 30.1 31.2 Temp 1.7 2.9	-Drive + MCR-2) ΔT Water to Air 2.8 4.5 5.4 Analysis berature °C lower than °C lower than	20-Drive + (2 ΔT CPU Air 41.8 N/A 44.1 Dual loop w MCR320 dri MCR320 dri	Avg T GPU1 N/A 42.0 43.0 ve dedicat ve dedicat	Avg T GPU2 N/A N/A N/A ted to CPU ted to CPU	Avg T GPU 1+2 N/A 42.0 43.0	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A	ΔΤ GPU Air N/A 16.4 17.2	
Test # 16 17 18 Note # 1 2 3	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + BurnK6 (x With radiators and pur Under CPU stress only, Under CPU stress only, Under GPU stress only,	Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW @825/1000 7) mps in series, CPU temps are CPU temps are GPU temps are	Avg T CPU 67.1 N/A 69.9	MCR320+220 Drive in series Avg T Air 25.3 25.6 25.8	Op : MCR320 CPU DATA (*C Avg T Water 28.1 30.1 31.2 Temp 1.7 2.9 2.0	Drive + MCR-2 ΔT Water to Air 2.8 4.5 5.4 Analysis berature *C lower than *C lower than	20-Drive + (2 ΔT CPU Air 41.8 N/A 44.1 Dual loop w MCR320 dri MCR220 dri MCR220 dri	Avg T GPU1 N/A 42.0 43.0 we dedicat we dedicat	Avg T GPU2 N/A N/A N/A N/A ted to CPL ted to CPL ted to GPl	Avg T GPU 1+2 N/A 42.0 43.0 J's	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A	ΔΤ GPU Ain N/A 16.4 17.2	
Test # 16 17 18 Note # 1 2 3 4	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + BurnK6 (x With radiators and pur Under CPU stress only, Under CPU stress only, Under GPU stress only,	Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW @825/1000 7) mps in series, CPU temps are GPU temps are GPU temps are GPU temps are	Avg T CPU 67.1 N/A 69.9	5 II - Combined Lo MCR320+220 Drive in series Avg T Air 25.3 25.6 25.8	CPU DATA (*C Avg T Water 28.1 30.1 31.2 Temp 1.7 2.9 2.0 0.4	Drive + MCR-2 AT Water to Air 2.8 4.5 5.4 Analysis Derature *C lower than *C lower than *C lower than	20-Drive + (2 ΔT CPU Air 41.8 N/A 44.1 Dual loop w MCR320 dri MCR220 dri MCR220 dri MCR320 dri	Avg T GPU1 N/A 42.0 43.0 ve dedicat ve dedicat ve dedicat	Avg T GPU, in GPU2 N/A N/A N/A N/A ted to CPL ted to CPL ted to GPl ted to GPl	Avg T GPU 1+2 N/A 42.0 43.0 J's	GPU DATA (*C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A	ΔΤ GPU Air N/A 16.4 17.2	
Test # 16 17 18 Note # 1 2 3 4 5	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + BurnK6 (x With radiators and pur Under CPU stress only, Under CPU stress only, Under GPU stress only, Under CPU stress only, Under CPU stress only, Under CPU stress only,	Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW @825/1000 7) mps in series, CPU temps are GPU temps are GPU temps are ress, CPU temps are	Avg T CPU 67.1 N/A 69.9	K II - Combined Lo MCR320+220 Drive in series Avg T Air 25.3 25.6 25.8	CPU DATA (*C PU DATA (*C Avg T Water 28.1 30.1 31.2 Tem 1.7 2.9 2.0 0.4 1.2 0.4	Drive + MCR-2 ΔT Water to Air 2.8 4.5 5.4 Analysis berature *C lower than *C lower than *C lower than *C lower than *C lower than	20-Drive + (2 AT CPU Air 41.8 N/A 44.1 Dual loop w MCR320 dri MCR320 dri MCR320 dri MCR320 dri	Avg T GPU1 N/A 42.0 43.0 with: ve dedicative	Avg T GPU2 N/A N/A N/A N/A ted to CPL ted to CPL ted to GPL ted to GPL ted to CPL	Avg T GPU 1+2 N/A 42.0 43.0	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	АТ GPU Ан N/A 16.4 17.2	
Test # 16 17 18 Note # 1 2 3 4 5 6 7	Benchmark (8) Instances of BurnK6 Furmark Max Burn Furmark MB + BurnK6 (x With radiators and pur Under CPU stress only, Under CPU stress only, Under GPU stress only, Under CPU stress only, Under CPU AND GPU st Under CPU AND GPU st	Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW @825/1000 7) mps in series, CPU temps are GPU temps are GPU temps are ress, CPU temps are ress, CPU temps are	Avg T CPU 67.1 N/A 69.9	Avg T Air 25.3 25.6 25.8	CPU DATA (*C PU DATA (*C Avg T Water 28.1 30.1 31.2 Temy 1.7 2.9 2.0 0.4 1.2 0.4	Drive + MCR-2 ΔT Water to Air 2.8 4.5 5.4 Analysis berature °C lower than °C lower tha	<u>ΔT CPU Air</u> <u>41.8</u> N/A <u>44.1</u> Dual loop w MCR320 dri MCR320 dri MCR320 dri MCR320 dri MCR320 dri MCR320 dri MCR320 dri MCR320 dri	Avg T GPU1 N/A 42.0 43.0 with: we dedicat we dedicat we dedicat we dedicat	Avg T GPU2 N/A N/A N/A N/A ted to CPU ted to CPU ted to CPU ted to CPU ted to CPU ted to CPU	Avg T GPU 1+2 N/A 42.0 43.0	GPU DATA (°C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔΤ GPU Air N/A 16.4 17.2	
Test # 16 17 18 Note # 1 2 3 4 5 6 7 7	Benchmark (8) instances of BurnK6 Furmark Max Burn Furmark MB + BurnK6 (x With radiators and pur Under CPU stress only, Under CPU stress only, Under GPU stress only, Under GPU stress only, Under GPU stress only, Under CPU AND GPU st Under CPU AND GPU st	Configuration Ci7 920@ 4.1Gb + (1) GTX470 FTW @825/1000 7) mps in series, CPU temps are GPU temps are GPU temps are GPU temps are ress, CPU temps are ress, CPU temps are ress, CPU temps are ress, CPU temps are	Avg T CPU 67.1 N/A 69.9	S II - Combined Lo MCR320+220 Drive in series Avg T Air 25.3 25.6 25.8	CPU DATA (*C CPU DATA (*C Water 28.1 30.1 31.2 Tem; 1.7 2.9 2.0 0.4 1.2 0.1 0.8 0.2	Drive + MCR-2) AT Water to Air 2.8 4.5 5.4 Analysis Derature *C lower than *C lower than	20-Drive + (2 AT CPU Air 41.8 N/A 44.1 Dual loop w MCR320 dri MCR320 dri MCR320 dri MCR320 dri MCR320 dri MCR320 dri	Avg T GPU1 N/A 42.0 43.0 with: we dedicat we dedicat we dedicat we dedicat we dedicat we dedicat	Avg T GPU2 N/A N/A N/A N/A ted to CPL ted to CPL	Avg T GPU 1+2 N/A 42.0 43.0 ''''''''''''''''''''''''''''''''''''	GPU DATA (*C) T Air GPU N/A N/A N/A	T Water GPU N/A N/A N/A	ΔT Water GPU to Air N/A N/A N/A	ΔΤ GPU Air N/A 16.4 17.2	



What we see above is that even under extreme use, the dual loop has all but lost its performance advantage against the single loop. Incidentally, the same type of trend could have also been obtained by adding a second CPU in the loop instead of removing a GPU.

Conclusions:

Under extreme performance scenarios, and from a pure performance standpoint, dual loops versus single loop are neither better nor worse, under the strict condition that the load ratios are evenly balanced.

Under the most commonly encountered loads though, single loops do win.

Under both of the above use scenarios, single loops also win from a reliability standpoint because of pump redundancy.

The choice is yours to make.