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Application Note

Graphic Memory Dout Valid Window at DLL-Off Mode

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Introduction

The graphic industry keeps driving memory vendors to increase the memory frequency as fast as they can. Through a continuous efforts, now the conventional GDDR can achieve 800Mbps operation while GDDR2/3 hits over 1Gbps throughout the industry.

For the stable high frequency memory operation, the graphic DDR requires a fine tuned DLL and it limits the memory's DLL operating range narrow, however this causes concern among the customers who need to run GDDR below 100MHz. Especially, notebook graphic developers concern it because they need to vary memory frequency from high frequency to low frequency even below 100MHz depending on the application programs.

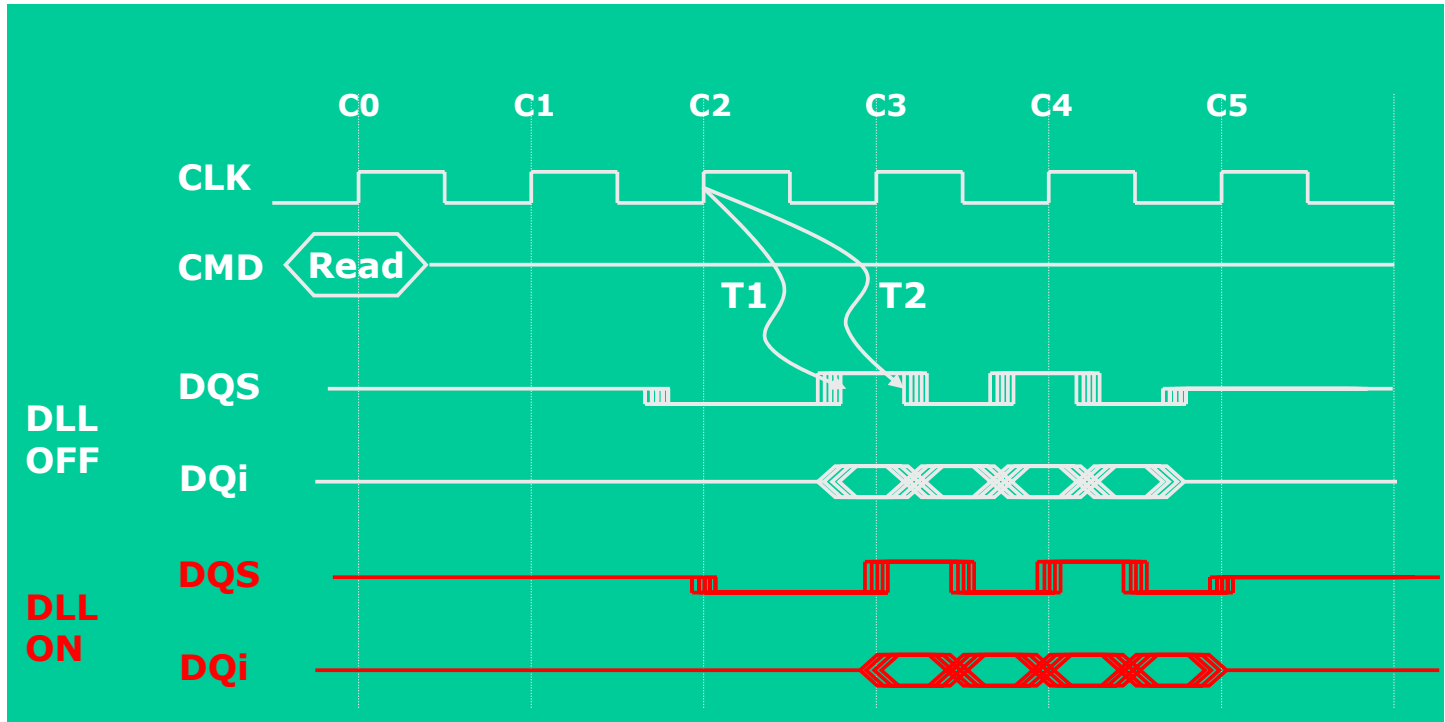
To overcome this concern, Samsung provides DLL-Off mode guideline for lower frequency and changed the format which represent tDV instead of tDQSCK before. We list up each GDDR device's tDV at DLL-Off mode so that the user can refer to it in configuring its system properly.

x32 GDDR tDV at DLL-Off Mode

□ Timing Diagram (Example : CL3 & BL4)

➤ **Dout Valid Window = T1~T2**

→ whereas T1 is the time delay from **CL-1tCK**



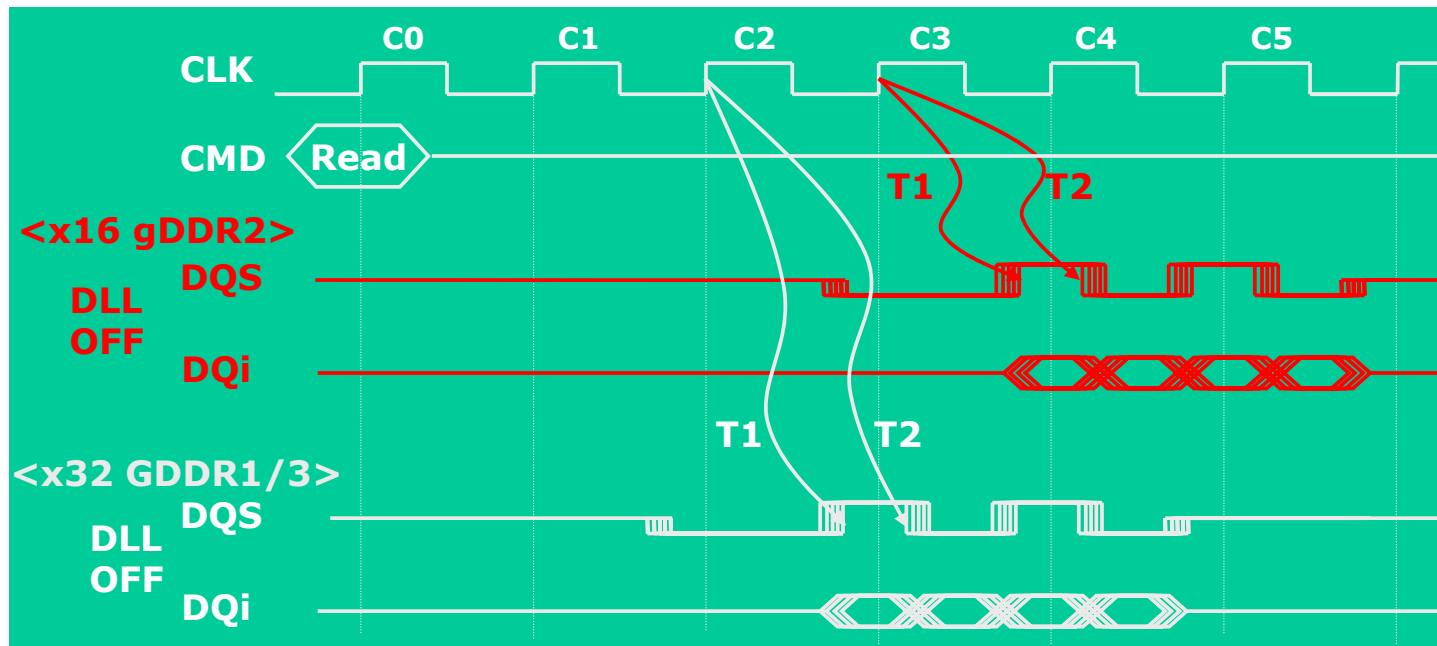
Above timing is just an example. Each device follows its own spec

x16 gDDR tDV at DLL-Off Mode

□ Timing Diagram (Example : CL3 & BL4)

➤ **Dout Valid Window = T1~T2**

→ whereas T1 start from **CL case**



* In case of 32Mx16gDDR2 G-die, it follows T1 from CLtCk rule.

Valid Data Window at DLL-Off Mode

Density	Type	Generation	DLL-On (min)	DLL-Off (max)	DLL-Off Mode tDV				
					100MHz		166Mhz		T1 Basis(tCK)
					T1	T2	T1	T2	
2Gb	gDDR3	K4W2G1646B-HC	350MHz	250MHz	3.1ns	7.8ns	3.1ns	5.7ns	CL-1
1Gb	GDDR3	K4J10324QD-HC	200MHz	300MHz	4.2ns	8.7ns	4.2ns	6.9ns	CL-1
	gDDR3	K4W1G1646D-EC	300MHz	166MHz	3.8ns	8.2ns	3.8ns	6.1ns	CL-1
		K4W1G1646E-HC	200MHz	250MHz	2.8ns	7.5ns	2.8ns	5.4ns	CL-1
	gDDR2	K4N1G164QQ-HC	100MHz	166MHz	5.4ns	10ns	5.4ns	8.0ns	CL-1
		K4N1G164QE-HC	100MHz	166MHz	7.6ns	13ns	5.8ns	9.0ns	CL-1
512Mb	GDDR3	K4J52324QH-HC	200MHz	300MHz	3.8ns	8.4ns	3.8ns	6.4ns	CL-1
		K4J52324QE-BC	220MHz	252MHz	4.6ns	8.3ns	4.6ns	6.3ns	CL-1
	gDDR2	K4N51163QG-HC	100MHz	166MHz	4.0ns	8.6ns	4.0ns	6.6ns	CL
		K4N51163QE-ZC	100MHz	166MHz	5.3ns	8.4ns	5.3ns	6.4ns	CL
256M	GDDR3	K4J55323QI-BC	200MHz	252MHz	4.6ns	8.3ns	4.6ns	6.3ns	CL-1
	gDDR2	K4N56163QG-GC	100MHz	166MHz	5.1ns	8.3ns	5.1ns	6.3ns	CL-1

How to extract valid data window at a certain frequency other than stated above

-T1 : Fixed regardless of frequency as shown on the table

-T2 : Related with operating frequency.(Assumed default tCC=10ns)

$$T2(\text{Required tCC}) = T2(\text{@default tCC}) + (\text{Required tCC} - \text{default tCC})/2$$