

Graphic Memory Dout Valid Window at DLL-off mode

A guide for user to use graphic memory at DLL-off mode

Application Note

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1. Introduction

The graphic industry keeps driving memory vendors to increase the memory frequency as fast as they can. Through continuous efforts, now GDDR3 hits over 2Gbps and GDDR5 over 5Gbps.

Samsung's GDDR5 uses DLL-off as a default mode, but most previous generation's graphic memories use DLL-on mode as a default one and require a fine tuned DLL for the stable high frequency operation. However, this fine tuned DLL has limited operating frequency range and this fact causes concern among the customers who need to run graphic DRAM at low frequency such as 166MHz. Especially, notebook graphics developers concern it because they need to vary memory frequency from high frequency to low frequency even below 166MHz depending on the application programs for efficient power management.

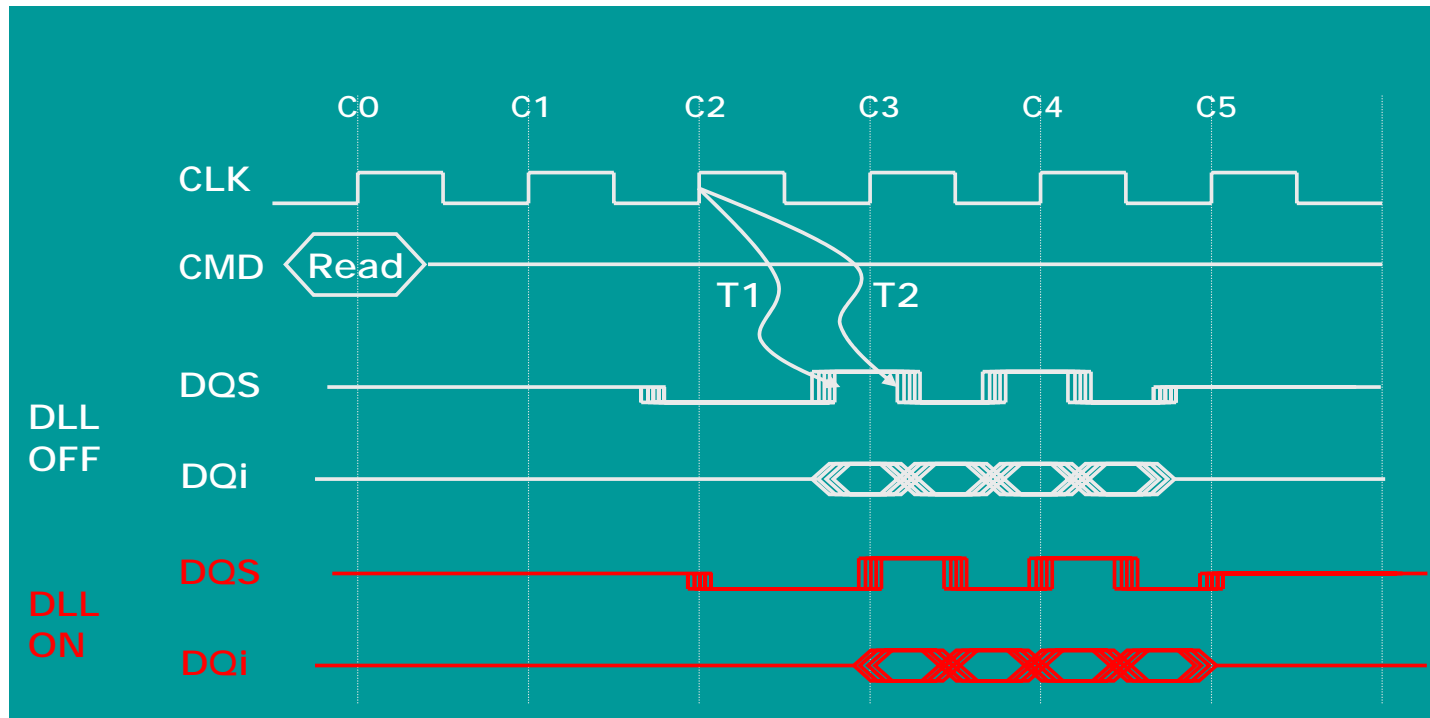
To overcome this concern, Samsung provides DLL-off mode guideline for low frequency operation with tDV window data. We list up each graphic DRAM's tDV at DLL-off mode so that the user can refer to it in configuring its system properly.

2. tDV at DLL-off Mode (In case of GDDR3, SDDR3, and 1Gb SDDR2)

□ Timing Diagram (Example : CL3 & BL4)

➤ Dout Valid Window = T1~T2

→ where T1 is the time delay from CL-1tCK



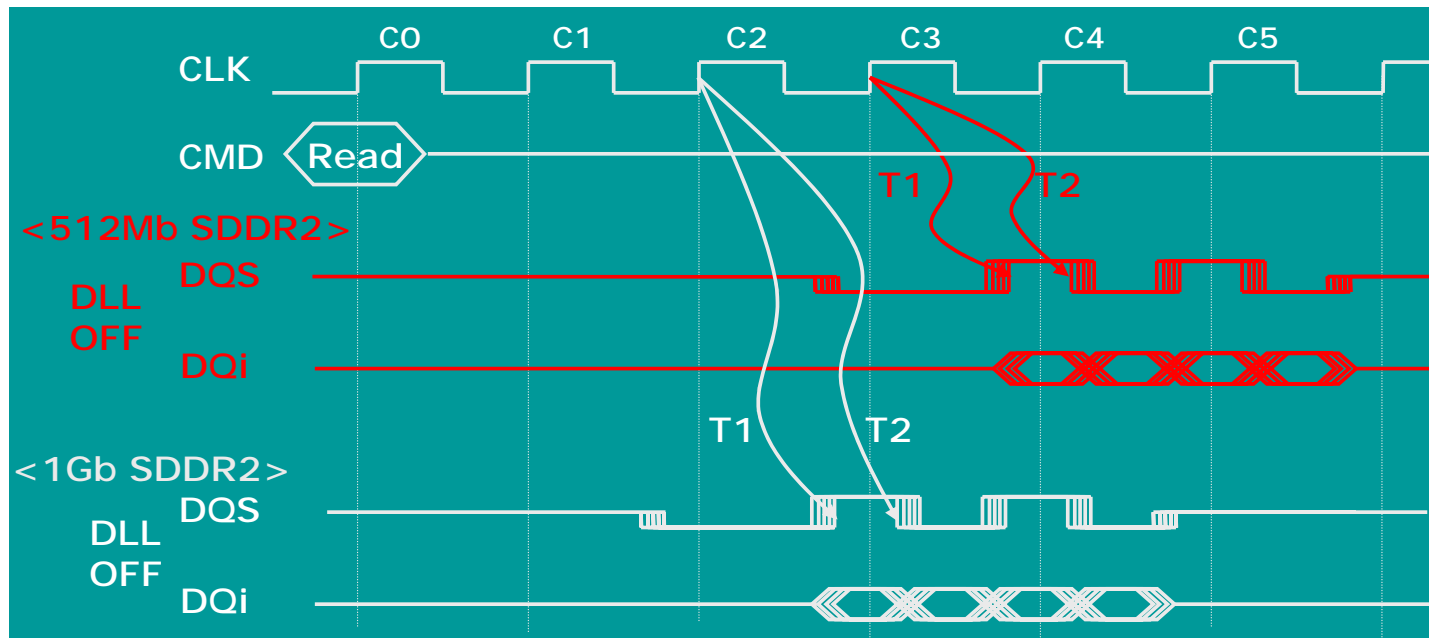
Above timing is just an example. Each device follows its own spec

3. tDV at DLL-off Mode (In case of 512Mb SDDR2)

□ Timing Diagram (Example : CL3 & BL4)

➤ Dout Valid Window = T1~T2

→ where T1 is the time delay from CL



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

4. 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	SDDR3	K4W2G1646B-HC	350MHz	250MHz	3.1ns	7.8ns	3.1ns	5.7ns	CL-1
1Gb	GDDR3	K4J10324KE-HC	200MHz	300MHz	2.8ns	7.6ns	2.8ns	5.6ns	CL-1
		K4J10324QD-HC	200MHz	300MHz	4.2ns	8.7ns	4.2ns	6.9ns	CL-1
	SDDR3	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
	SDDR2	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
		K4J52324KI-HC	200MHz	300MHz	3.0ns	7.8ns	3.1ns	5.8ns	CL-1
	SDDR2	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

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)

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