

Date : May, 2003

## Application Note

***Title : x32 GDDR/GDDR2 SDRAM Operation  
at DLL-Off Mode***

**Product Planning & Application Eng.Team  
Memory Technology & Product Division  
Samsung Electronics Co., Ltd  
San24, Nongseo-Ree, Kiheung-Eup,  
Yongin-Si, Kyungki-Do, Korea(R.O.K)  
Tel : 82-31-208-6362  
Fax : 82- 31-208-6799**

## Introduction

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 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 which make GDDR works 100MHz below. There's one key different parameter between DLL-On mode and DLL-Off mode, which is tDQSCK. We list up each GDDR device's tDQSCK at DLL-Off mode so that the user can refer to it in configuring its system properly.

### x32 GDDR tDQSCK at DLL-Off mode

Device	Generation	Status	Min Frequency at DLL-On	Max Frequency at DLL-Off	tDQSCK on non-DLL
2Mx32	A-die	EOLed	125Mhz	183Mhz	2.5 ~ 5.5ns
	B-die	EOLed	100Mhz	<100Mhz	4.5 ~ 7.5ns
4Mx32	M-die	EOLed	100Mhz	<100Mhz	4.5 ~ 7.5ns
	A-die	EOLed	100Mhz	<100Mhz	4.5 ~ 7.5ns
	D-die	MP Now	100Mhz	<100Mhz	2.5 ~ 5.5ns
	E-Die	MP Now	100Mhz	<100Mhz	3.0 ~ 6.0ns
8Mx32	E-Die	2Q03 CS	100Mhz	<100Mhz	3.5 ~ 6.5ns

### x32 GDDR2 tDQSCK at DLL-Off mode

Device	Generation	Status	Min Frequency at DLL-On	Max Frequency at DLL-Off	tDQSCK on non-DLL
4Mx32	E-Die	MP Now	250Mhz	<100Mhz	5.5 ~ 8.0ns
8Mx32	E-Die	3Q03 CS	330Mhz	<200Mhz	5.0 ~ 8.0ns*

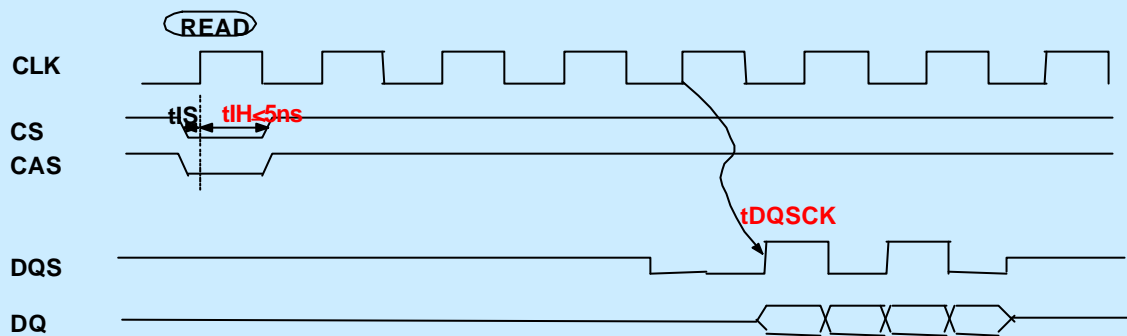
\* This is a simulation data. The actual value can be different . It will be updated later once the part is available

In case that 4Mx32 GDDR2 uses input DLL, it also requires larger input hold time( $t_{IH}$ ) and  $t_{DQSS}$  window at DLL-off mode than DLL-on mode. Other than those parameters, all are same for both DLL-On and DLL-Off mode case. However, 8Mx32 GDDR2 doesn't use input DLL. Thus, these parameters are same for both DLL on/off case.

Device	4Mx32 GDDR2	8Mx32 GDDR2
$t_{IH}$	~5.0ns	Same as DLL-On
$t_{DQSS}$	$t_{DQSS@DLL-on} + 2ns$	Same as DLL-On

*This is a simulation data. The actual value can be different*

### DLL-off mode @ Read(CL5)



### DLL-off mode @ Write(CL5)

