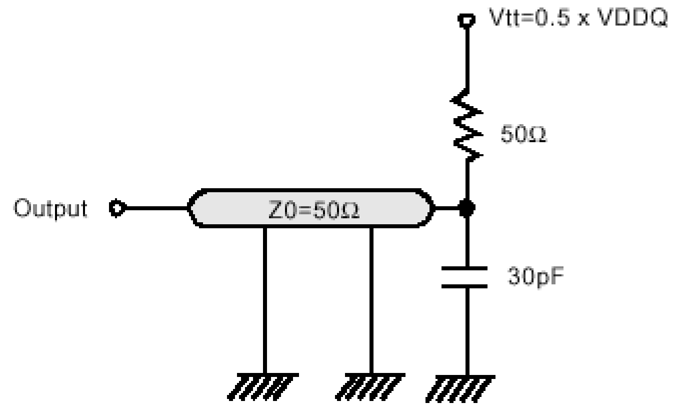
Introduction

Mobile market is booming and booming and its development speed is too fast for nobody to expect it exactly specially to cellular phone market. Cellular phone set makers have used SRAM and NOR Flash for memory solution because there is no big demands to support multimedia functions up to 2000~2001. From 2002, the cellular phone market has moved to 3G whose features are to support multimedia functions and to require high speed data transmission with wireless telecommunication.

Mobile applications should cover high performance due to the needs of supporting multimedia functions like MPEG-4, 3D Gaming, Video conferencing and etc. To support multimedia, the system requires Mobile-SDRAM with high speed and high density which is from the application software size plus operating software size increment. Mobile-SDRAM is the right solution considering speed and density with low cost.

Output Loading Condition.

Basically, mobile applications are based on PTP(point-to-point) net not multi-points net like desktop PC and server applications. Point-to-point net has a small loading capacitance compared with multi-points net. A big loading capacitance value makes long propagation delay time(tPD),long tR(Rising time) and tF(Falling time) of any signal. Any interface logic accepts its high and low state with its Vih/Vil(Input Voltage High/Input Voltage Low) level. Vih/Vil level is different from voltage by voltage and tR means the reaching time from Vil to Vih.



[Figure 1. AC Output Load Circuit of Mobile-SDRAM]

Mobile-SDRAM's input/output signal has its tR and tF to interface with the chipset and its tR/tF is really dependent on output loading capacitance value. Most Mobile-SDRAM vendors think the output loading will be 30pF when considering PDA, DSC and other consumer applications[See Figure 1]. Just thinking about the cellular phone, the assumed value is a little bit too big, which makes overshoot and undershoot in signal integrity point in the lower output load condition. In Figure 1, output point is Mobile-SDRAM's side and Mobile-SDRAM drives its data signal with the assumption of 30pF(Line Capacitance + Chipset's input capacitance + Alpha due to sharing its line with the other components). Some cellular phone makers are really concerned about Mobile-SDRAM's big output driver strength which doest not consider its real set environment and want to reduce Mobile-SDRAM's output driver strength with other methods like DS(Driver Strength) control.

JEDEC already defined DS with DDR features, but that function is more useful to Mobile Application than to desktop PC and Server applications. Every mobile-SDRAM vendors support the function with EMRS(Extended Mode Register Setting) which should be done at power up sequence right after setting normal MRS[See Figure 2.]. DS in EMRS can be controlled by using A5 and A6 address during power up sequence. If want to get more detailed information how to use it, please refer to the datasheet.

Address	BA1, BA0	An - A10/AP	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
Extended MRS	1 , 0	RFU : Must be set " 0 "				DS Control		TCSR		PASR		
					Full	0	0					
					1/2	0	1					
					RFU	1	0					
					RFU	1	1					

[Figure 2.- EMRS]

Impacts of output loading condition.

Every circuit has its Vih/Vil which is Input High and Input Low value for accepting its level and the level is dependent on the voltage level and the interface method. Mobile application doesn't use terminations like DDR, Rambus and etc due to its considering power consumption. In other words, Mobile-SDRAM uses full swing interface like LVTTL and LVCMOS interface.

More output loading capacitance value, more time is required to leach its suitable level. The response time of the signal can be easily calculated with the formula; T = RC.

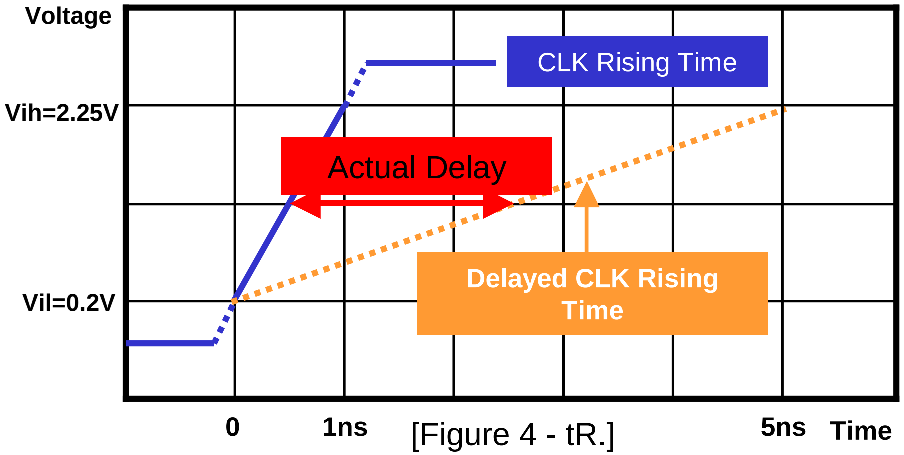
AC OPERATING TEST CONDITIONS (V_{DD} = 2.5V±0.2V, T_A = -25°C to 70°C)

Parameter	Value	Unit
AC input levels (Vih/Vil)	0.9 x VDDQ / 0.2	V
Input timing measurement reference level	0.5 x VDDQ	V
Input rise and fall time	tr/tf = 1/1	ns
Output timing measurement reference level	0.5 x VDDQ	V
Output load condition	See Fig. 2	

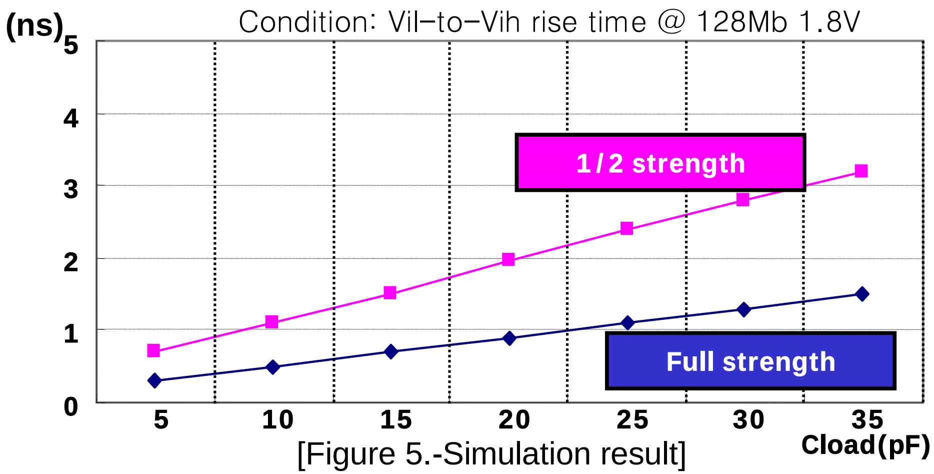
[Figure 3.]

For example, in case of 2.5V Mobile-SDRAM, the datasheet describes its tR/tF with 1ns, which means the leaching time from Vil to Vih or from Vih to Vil level[See Figure 3]. tR is (0.9x VDDQ – 0.2V)/1ns, which means approximately 2V/1ns. If more time is consumed to reach to Vih level, it impacts to the receiver sied's setup time, which reduces setup time or leads to miss its signal at the worst case. The input buffer of Mobile-SDRAM has its margin and that value is different device by device.

All internal control signals of Mobile-SDRAM are synchronized with the external CLK signal[See Figure 4]. If the external CLK signal is delayed due to output loading variations, every internal control signal of Mobile-SDRAM is also delayed according to external CLK signal delay time. The delay time of the external CLK signal makes output delay to the controller side, which reduces the controller's setup time and can make system failure at the worst case. The datasheet already described this with the notes; "If clock rising time is longer than 1ns, (tR/2-0.5ns) should be added to the parameters like tSAC, tOH and tSHZ". For more information,



[Figure 4 - tR.]



[Figure 5.-Simulation result]

please refer to the datasheet.

Simulation results with output load variations.

The output loading condition of Mobile-SDRAM is really different from and smaller than desktop PC and server applications. tR is dependent on the output load variations. A big output load capacitance makes longer tR in the same driver strength[See Figure 5]. Mobile-SDRAM can support its driver strength with EMRS and the effect is to deliver clean signal to the receiver side. Full driver strength which is based on 30pF will cover higher frequency compared with lower driver strength. The simulation result shows the co-relation with the driver strength and output load condition even though the graph is not a real but just simulation result. If the output load can't exceed 15pF in cellular phone set, there is no need to use full driver strength. But, even though Mobile-SDAM vendor can fix default value according to Mobile application, more better solution is to provide method to control DS control with EMRS to fit into its application's specific small output load condition.

Conclusion

Mobile application is really different from Desktop PC and server application in output loading condition point. The capacitance value of mobile application specially like cellular phone is much smaller than other mobile applications. Most mobile-SDRAM vendors have assumed the value should be 30pF to cover other mobile applications like PDA,DSC and etc because some mobile applications use shared bus architecture with the other components due to system's efficiency and space limit.

The output loading conditions in mobile applications are different application by application. JEDEC already considered their application characteristics and defined DS control function with EMRS to solve their mismatching output loading conditions according to applications.

Mobile application set makers can control Mobile-SDRAM's driver strength With EMRS to fit into the real output loading conditions.

Output loading conditions decides every signal's tR/tF and it is dependent on the output loading conditions and makes setup time and hold time to the receiver side. Current cellular phone requires higher bandwidth to support multimedia functions like MPEG-4, digital still image, 3D gaming, video teleconferencing and etc and higher bandwidth means higher frequency to Mobile-SDRAM venders' side. To support higher frequency, tR/tF should be shorter and it is dependent on its loading condition. The decrement of output load is really important to get higher bandwidth.

For more information

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