1K/2K/4K Refresh On 16Mb DRAMs

What is 1K/2K/4K Refresh?

The JEDEC 16Mb DRAM 'Standards' allow two addressing options for each DRAM organization. These different addressing schemes result in different 'Refresh' rates for parts with the same organization.

Organization/Refresh vs. Addressing

	4K	2K	1K
4M x 4	12/10	11/11	
2M x 8	12/9*	11/10	
1M x 16	12/8		10/10

*Not offered by IBM.

The table above shows, for example, that a '4K Refresh' 4M x 4 DRAM is one requiring 12 Row Addresses and 10 Column Addresses, while a '2K Refresh' version requires 11 Row and 11 Column Addresses. The term '4K Refresh' indicates the number of refresh cycles required to refresh all sections of the array and is determined by the number of Rows; in this case, 12 Row Addresses = 4096 refresh cycles. A 2K refresh DRAM refreshes all cells in the array in 2048 cycles (11 Rows) and a 1K DRAM refreshes the array in 1024 cycles (10 Rows).

How do 1K/2K/4K Refresh DRAMs differ?

The different numbers of Rows AND Columns account for the differences seen between parts with 4K, 2K and 1K refresh. The 4M x 4 device will be used again as an example. The additional Row Address needed by a 4K vs. a 2K device results in the selection of a smaller segment of the array during a refresh cycle. For each cycle (Row), a 4K device refreshes 1024 Columns (10 Column Addresses) vs. 2048 Columns for a 2K device (11 Column Addresses). This smaller section draws less operating current and, therefore, dissipates less power. This is because the column address circuitry requires more power than the row address circuitry so selecting fewer columns is advantageous in terms of operating current.

This advantage is most significant for single cycle read/write users. The difference in average operating current (ICC1) can be as high as 2.3x between 1M x 16 4K refresh and 1M x 16 1K refresh devices. The advantage quickly disappears for 'Page Mode' customers. Using the previous example, the average page mode current difference is 1.2x. This indicates the efficiency of using page mode.

The cost of this lower operating current and decreased power consumption is a reduction in the 'Page Depth'. Page depth is determined by the number of Columns so the depth of a 4K device is half that of a 2K device and is reduced to one quarter of the depth of a 1K device, for a given organization. This impacts applications which run in page mode.

In summary, the differences between 4K, 2K, and 1K devices are: addressing, power consumption, and page depth. The selection of a particular 16Mb DRAM will depend, in part, on whether decreased power consumption or increased page depth is more important in a given application. Another important factor is the configuration of the Memory Controller, which is discussed in the next section.

Are parts with different Refresh rates interchangeable?

To understand the answer to this question, consider the 4M x 4 16Mb DRAM. For proper memory operation, the system must provide correct addressing. Some Memory Controllers are designed to support 2K Refresh only, some support 4K only, and some allow either. In order to support either, the controller needs to duplicate one of the address bits. It generates 12 Row Addresses and 11 Column Addresses; the highest order Row Address is duplicated as the highest order Column Address at Column time. Therefore, the proper number of addresses are generated (22), and both the 12/10 addressing and the 11/11 addressing can be supported. The page depth is limited, however, to 1024 addresses. So, if a controller can support both addressing options, the parts can be mixed.

Controllers designed for 2K Refresh (11/11) cannot be made to function with 4K Refresh (12/10) DRAMs. There are insufficient Row Addresses available at Row time to correctly activate the 4K Refresh part and the page size is too small.

A 2K part can be used in lieu of a 4K part if the necessary logic has been designed to latch the 12th Row Address until Column time, thereby providing 11/11 addressing. The resulting page depth is 2048 which meets the 1024 requirement, noted above. As mentioned earlier, because of the 11/11 addressing, the power consumption would be higher with the substitution of a 2K part for a 4K part.

Which applications use 1K/2K/4K Refresh?

Devices with 1K and 2K refresh rates are often used in PC applications. Those applications requiring ‘Parity’ often use 2K Refresh devices. This is because parity bits are provided by 4M x 1 DRAMs which require 2K Refresh (11/11). Otherwise, a controller which provides redundant addressing to allow mixing of 2K and 4K devices would be required.

4K Refresh DRAMs are used widely by Portable systems, Workstations, Hi-end PC Servers (that use ECC), Mid-Range and Mainframe or Supercomputer applications. These parts consume less power and will generally run at slightly lower temperatures.