Overview

IBM's Extended Data Out (EDO) DRAMs, VRAMs and DRAM Modules can improve memory performance up to 60% over equivalent Fast Page Mode devices. Unlike FPM, the data output drivers on EDO devices are not turned off when $\overline{CAS}$ can go high before data-out is valid. Therefore, a new address can be provided for the next access cycle before completing the current cycle allowing a shorter $\overline{CAS}$ pulse width, dramatically decreasing cycle times.

The Advantage

Using EDO instead of FPM allows the use of less costly components to increase system performance. For example, Figure 1 shows that a -50 component has a FPM cycle time of 35ns, which is equal to the EDO cycle time of a -80 component.
Both FPM and EDO allow operations within a row; the difference being treatment of the column addresses and data out.

Cycle Time Comparison (Figure 1)

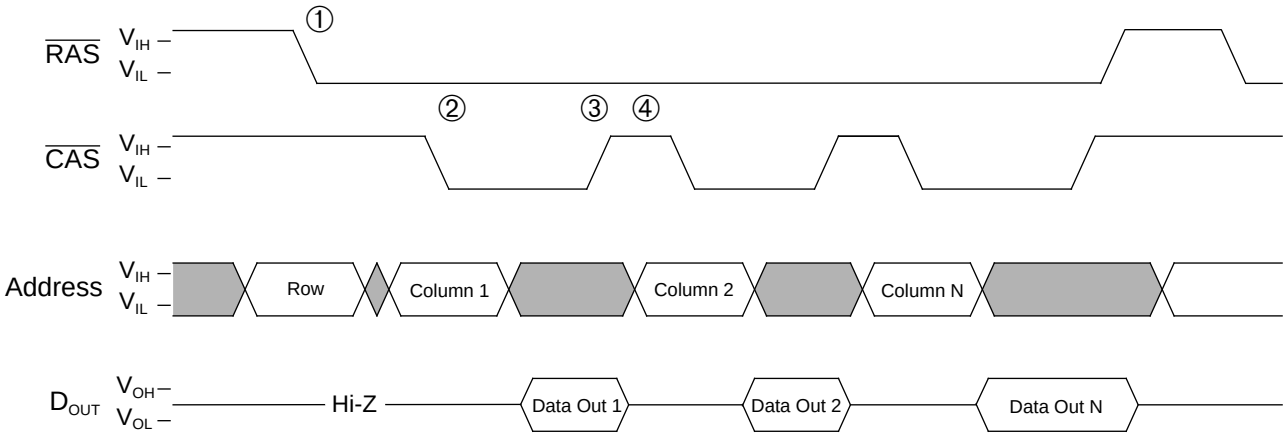
T_{RAC}	FPM	EDO
-50	35ns	20ns
-60	40ns	25ns
-70	45ns	30ns
-80	50ns	35ns

Figure 2 & 3 shows simplified timing comparisons between the two, and in the following sections a brief description is given of how FPM and EDO operate when reading within a page.

Fast Page Mode Read Operation

FPM Read begins when the row address is strobed as $\overline{RAS}$ falls, this is followed by the column address being strobed as $\overline{CAS}$ falls. To continue Fast Page within the same row address, the column address changes while cycling $\overline{CAS}$. Each time $\overline{CAS}$ goes high the output drivers are turned off, which then disables the data.

Fast Page Mode Read Cycle (Figure 2)



① Row Addresses are trapped when $\overline{RAS}$ goes low.

② Column Addresses are trapped when $\overline{CAS}$ goes low.

③ Data is disabled when $\overline{CAS}$ goes high.

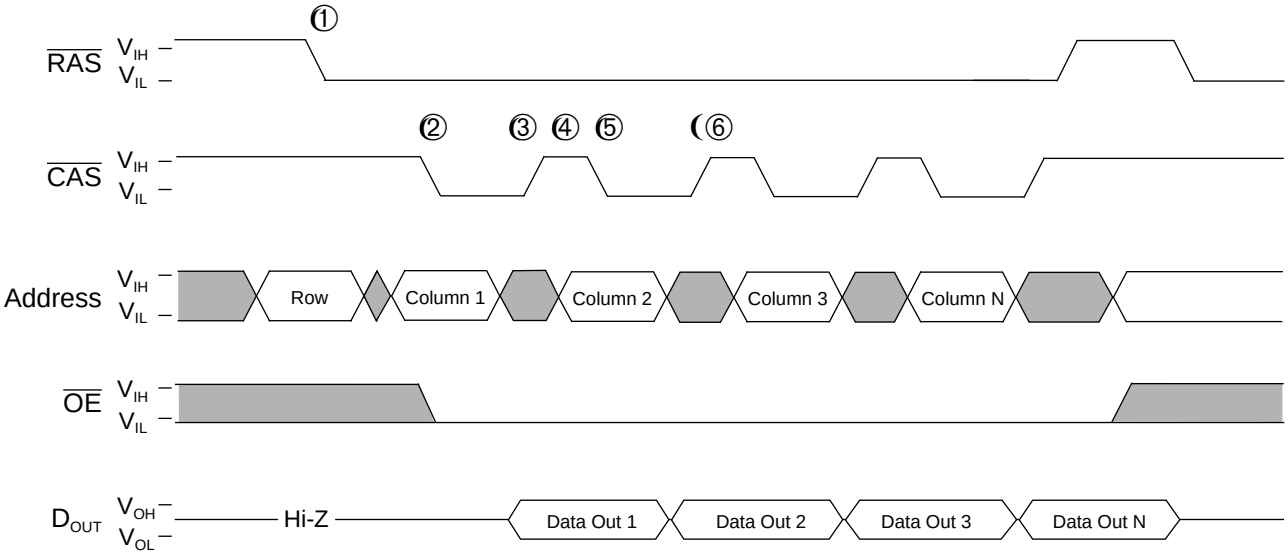
④ Column Address 2 is set up during $\overline{CAS}$ high.

Extended Data Out Read Operation

As with FPM, the row address is strobed when $\overline{RAS}$ falls and the column address is strobed when $\overline{CAS}$ falls. But unlike FPM, the output drivers are not turned off when $\overline{CAS}$ goes high so the data is not disabled. This feature allows a new access to begin at the next column address while strobing for data in the current column address. This time savings allows a faster page cycle time, therefore increasing performance.

Similar to a FPM Read, OE can tri-state the output drivers whenever OE is high. Data is valid only when OE is low. When interleaving devices (shared I/O bus) control of the outputs is important. With FPM $\overline{CAS}$ can be used to control the output; but with HPM, OE must be used.

Extended Data Out Read Cycle (Figure 3)



① Row Addresses are trapped when $\overline{RAS}$ goes low.
② Column Addresses are trapped when $\overline{CAS}$ goes low.
③ Data stays valid when $\overline{CAS}$ goes high.
④ Column Address 2 is set up during $\overline{CAS}$ high.
⑤ Column Address 2 is trapped when $\overline{CAS}$ goes low.
⑥ Data Out 2 stays valid when $\overline{CAS}$ goes high.

: "H" or "L"