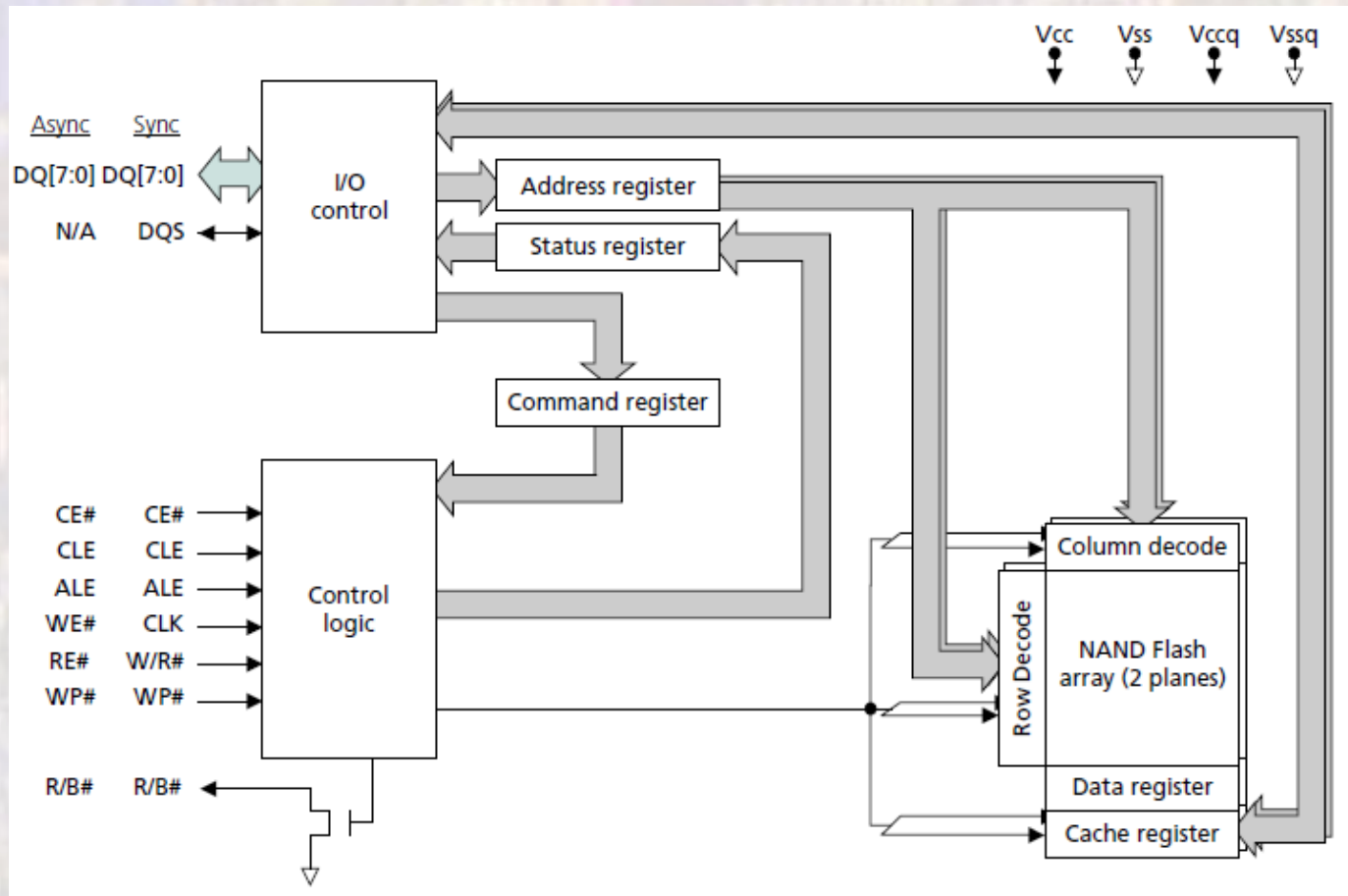


Flash Operation

Last updated 3/1/21

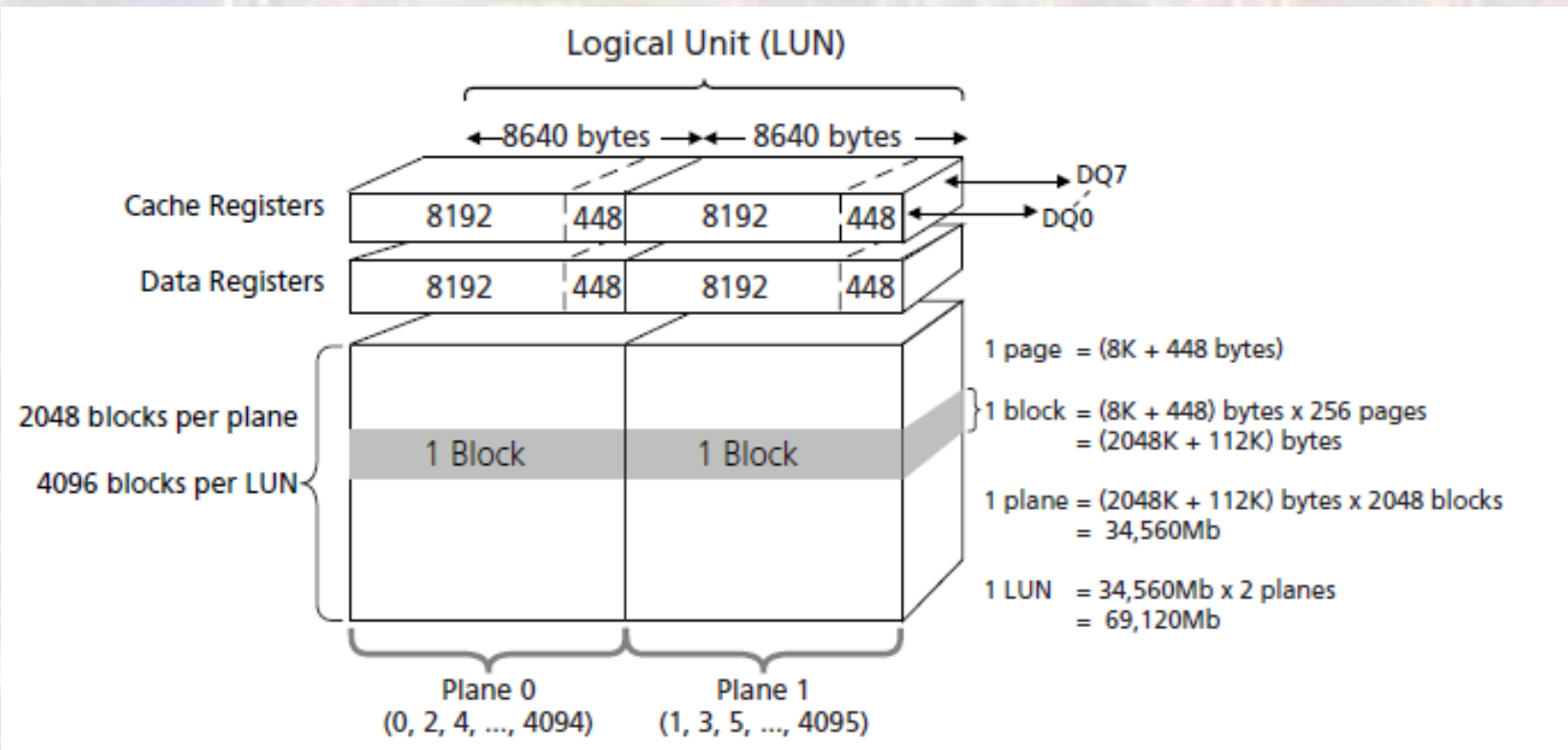
Memory – Flash Operation

- NAND
- Configuration



Memory – Flash Operation

- NAND
- Configuration – 64Gb



Memory – Flash Operation

- NAND

- Key Signals

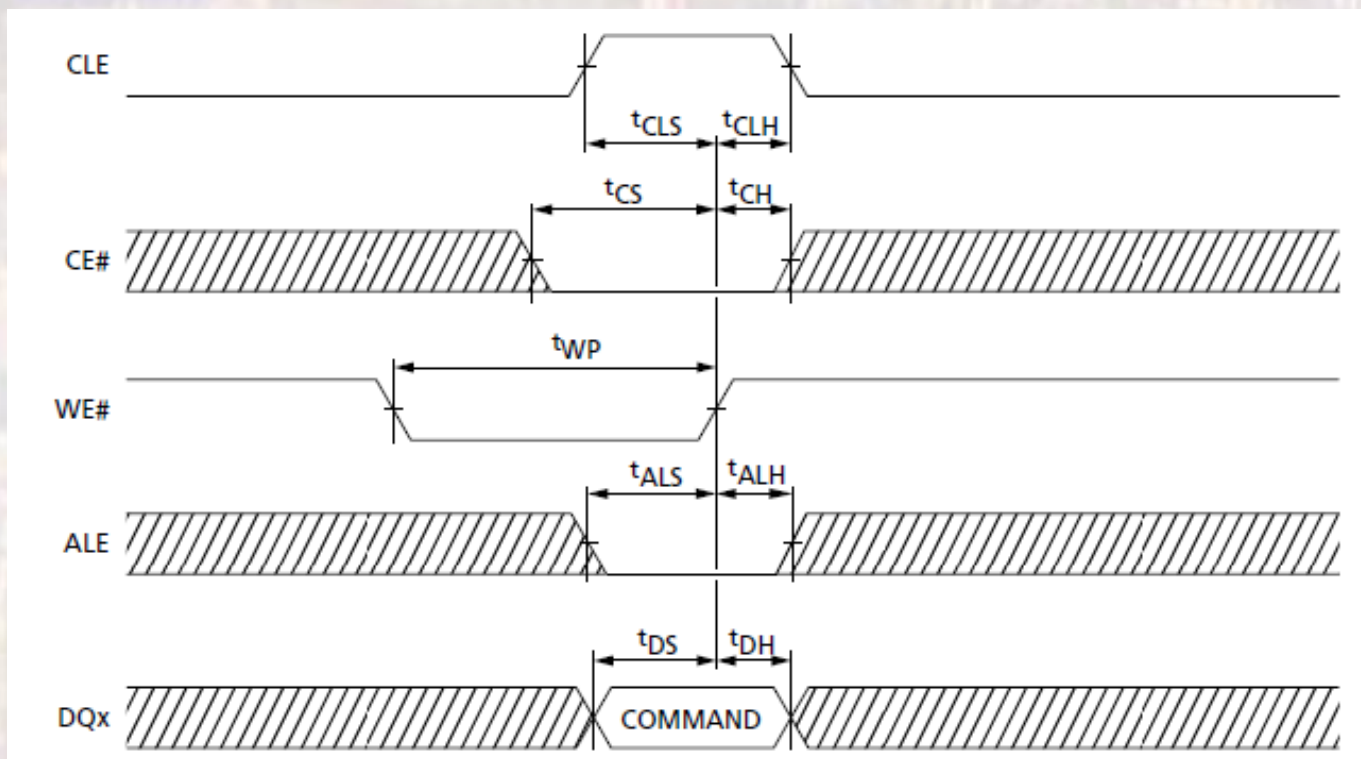
- CE# - Chip Enable bar
- CLE – Command Latch Enable
- ALE – Address Latch Enable
- WE# - Write Enable bar
- RE# - Read Enable bar
- RDY - Ready

- DQx – Output Data, Command Input, Address Input
- DQS – Data Strobe

- CLK – Clock – only used in Synchronous mode

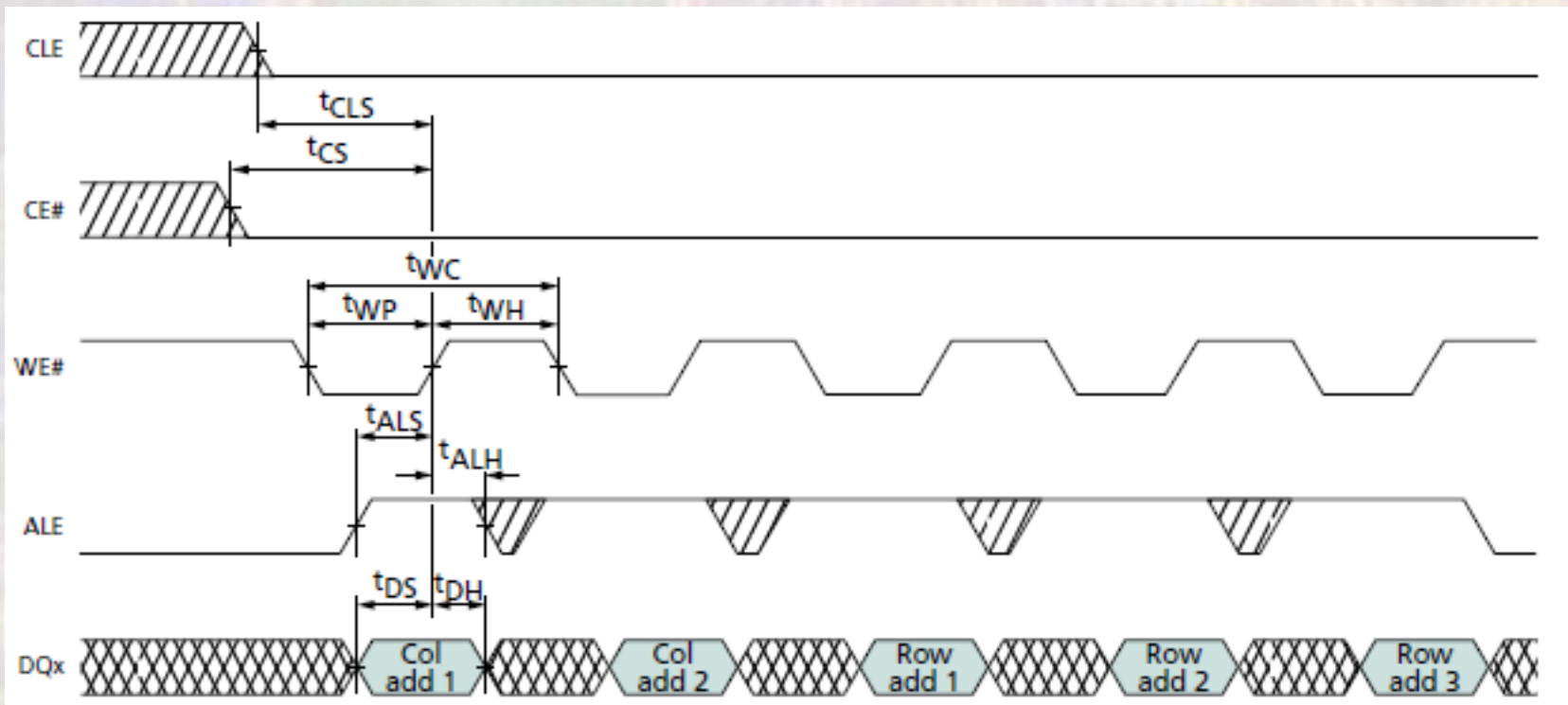
Memory – Flash Operation

- NAND
 - Asynchronous Command



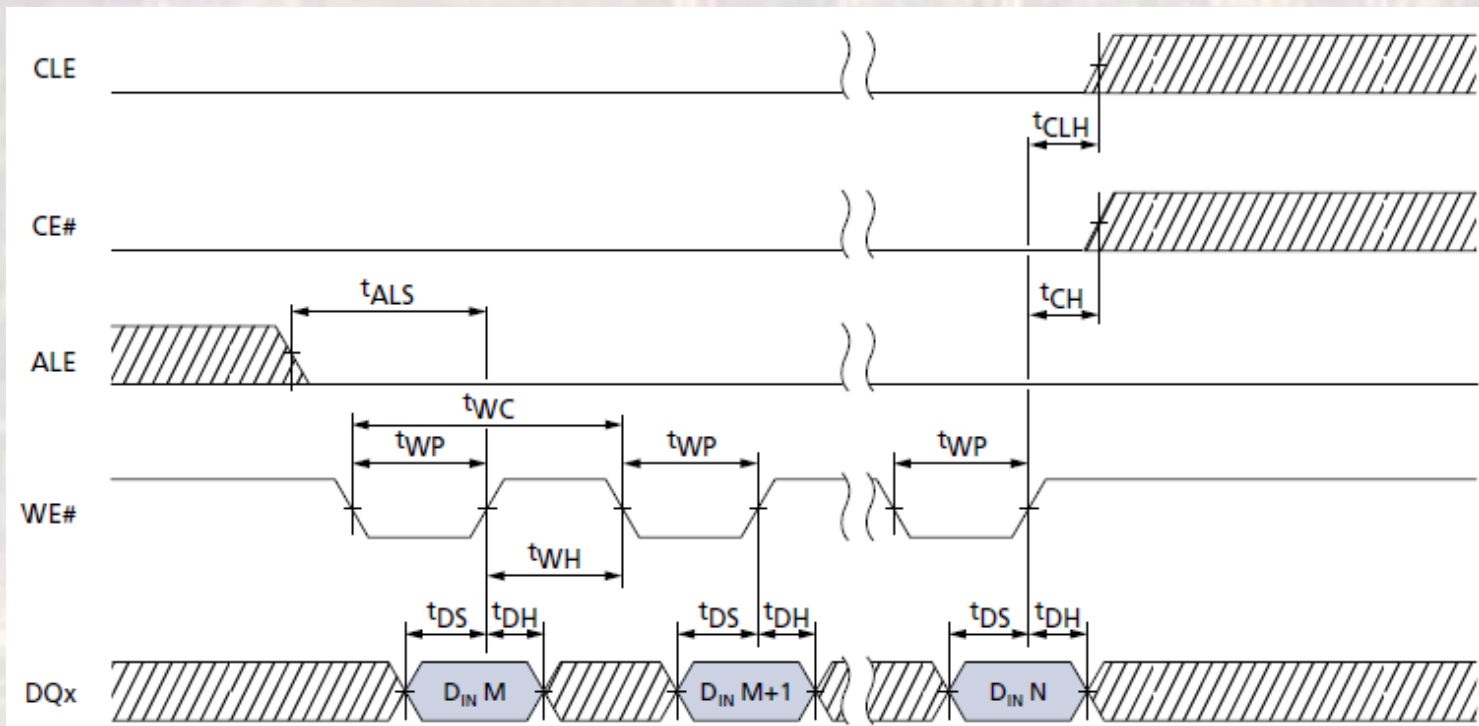
Memory – Flash Operation

- NAND
- Asynchronous Address



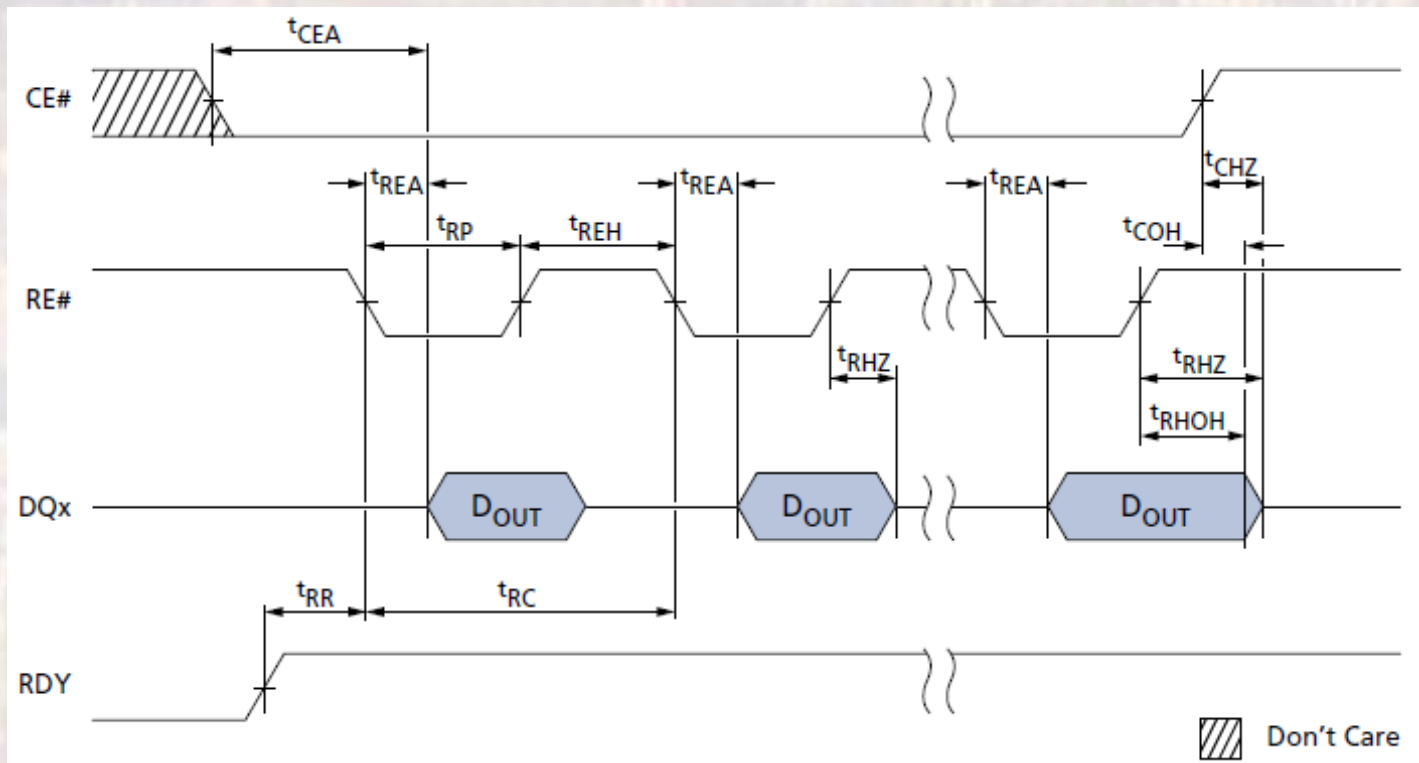
Memory – Flash Operation

- NAND
 - Asynchronous Data In - to Cache



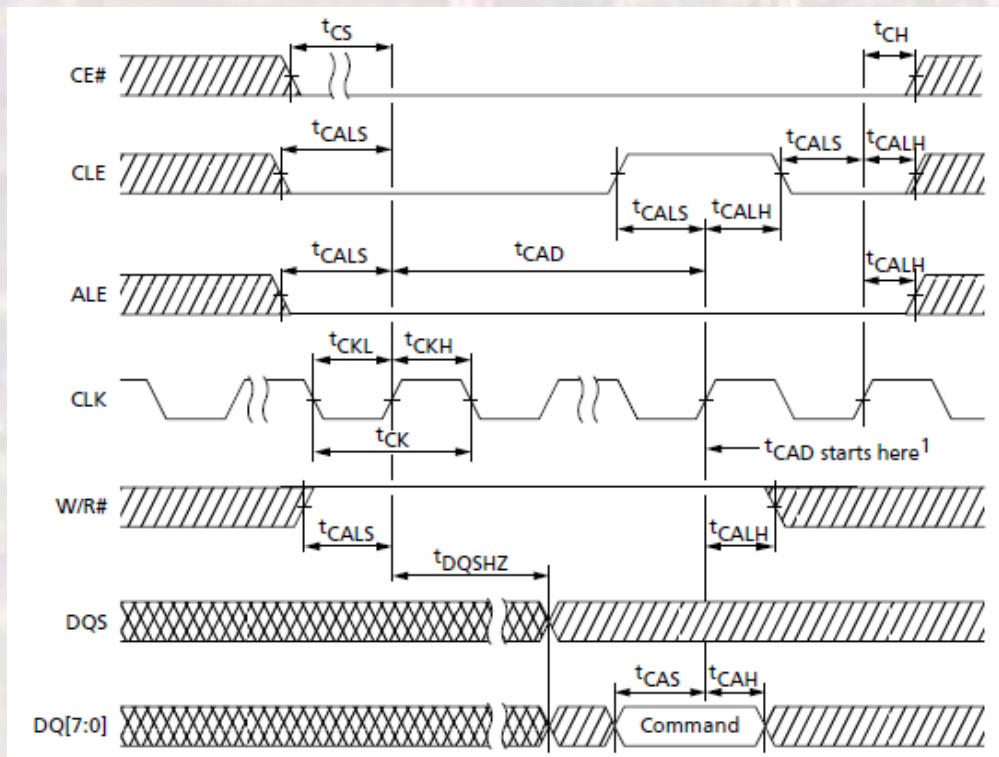
Memory – Flash Operation

- NAND
 - Asynchronous Data Out - from Cache



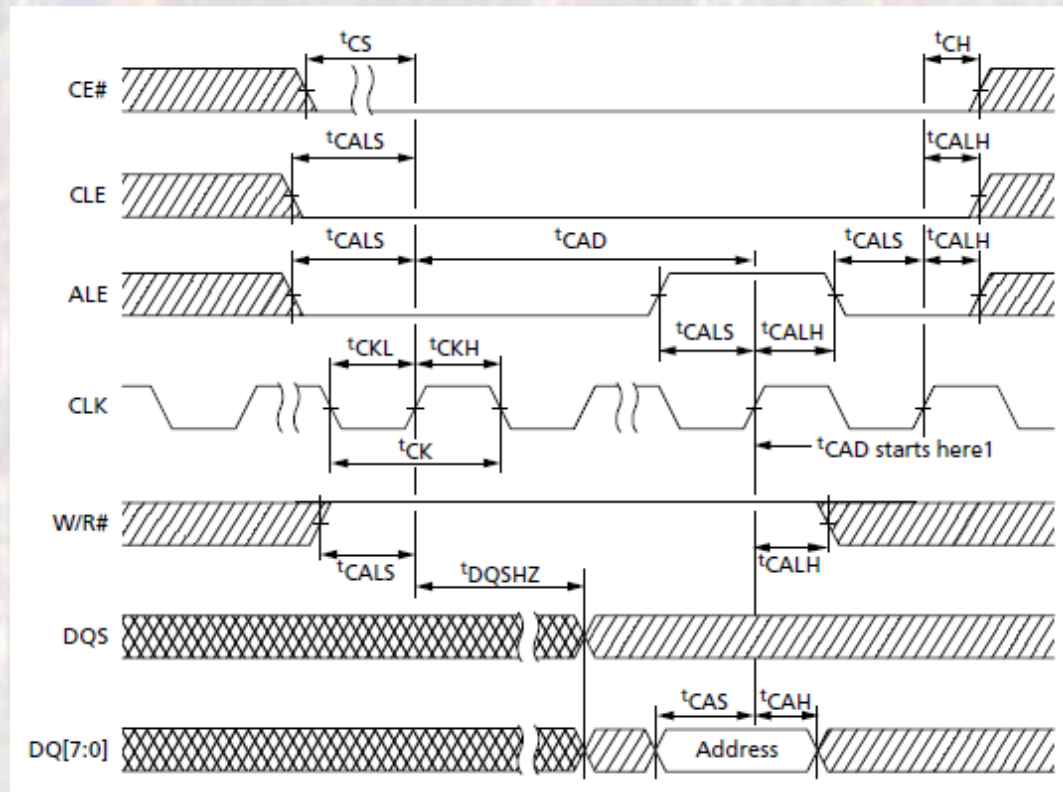
Memory – Flash Operation

- NAND
 - Synchronous Command



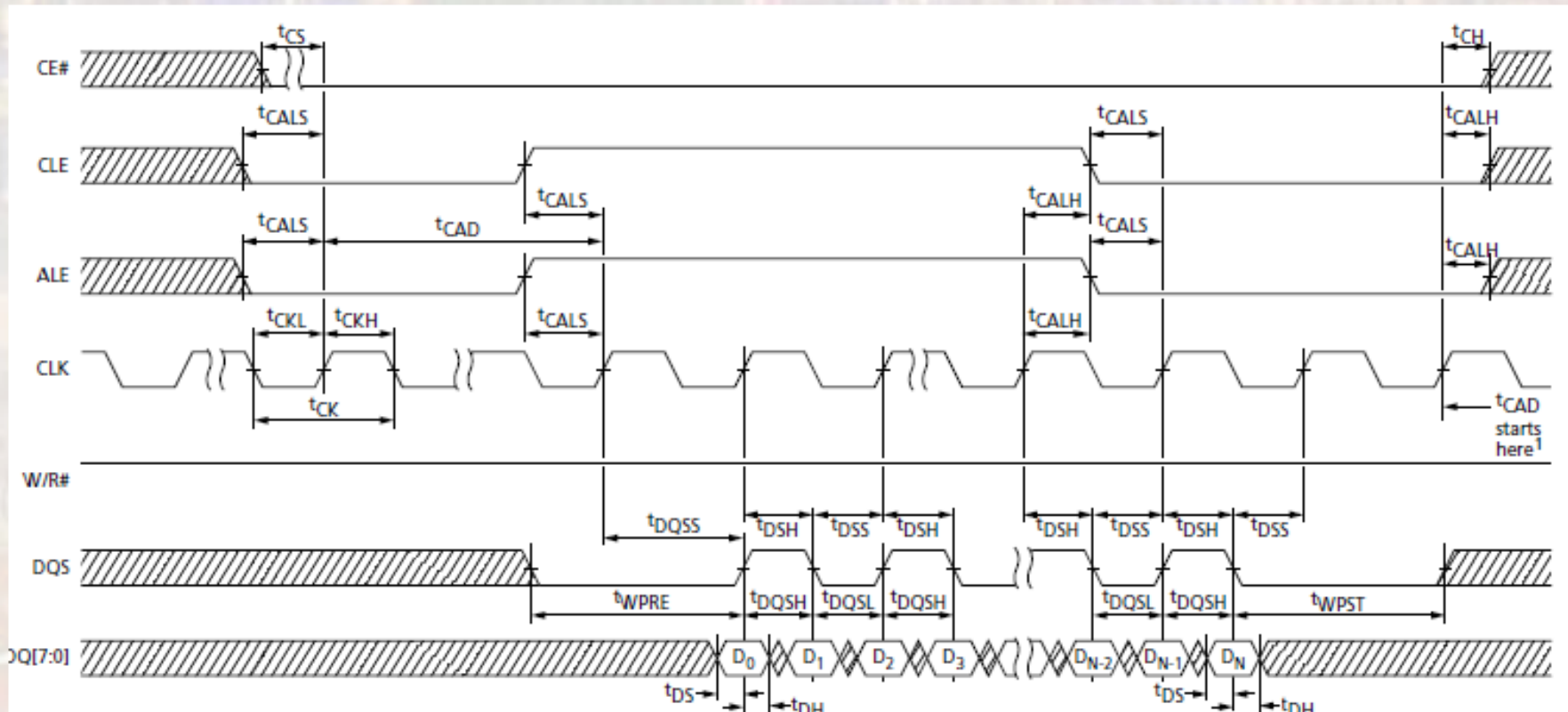
Memory – Flash Operation

- NAND
 - Synchronous Address



Memory – Flash Operation

- NAND
 - Synchronous Data In – DDR - to cache



Memory – Flash Operation

- NAND
 - Command Based Interface

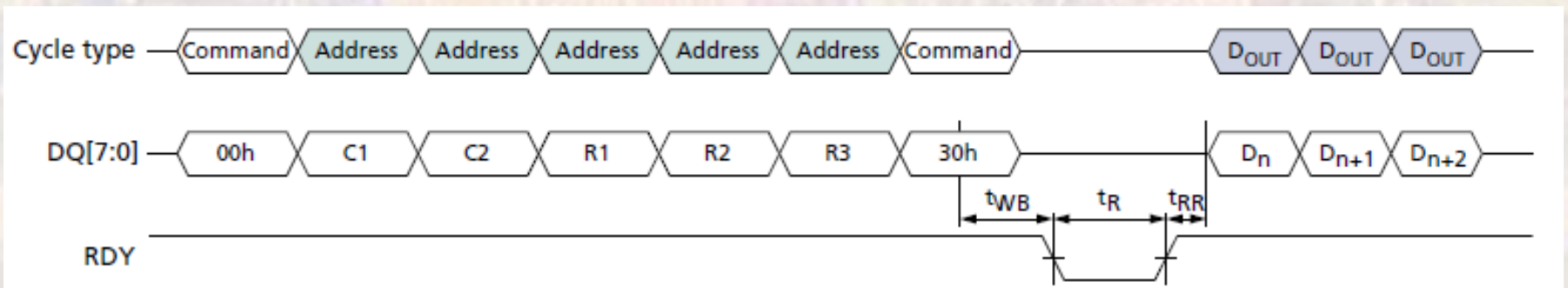
Command	Command Cycle #1	Number of Valid Address Cycles	Data Input Cycles	Command Cycle #2	Valid While Selected LUN is Busy ¹	Valid While Other LUNs are Busy ²	Notes
Column Address Operations							
CHANGE READ COLUMN	05h	2	–	E0h		Yes	
CHANGE READ COLUMN ENHANCED	06h	5	–	E0h		Yes	
CHANGE WRITE COLUMN	85h	2	Optional	–		Yes	
CHANGE ROW ADDRESS	85h	5	Optional	–		Yes	5
Read Operations							
READ MODE	00h	0	–	–		Yes	
READ PAGE	00h	5	–	30h		Yes	6
READ PAGE MULTI-PLANE	00h	5	–	32h		Yes	
READ PAGE CACHE SEQUENTIAL	31h	0	–	–		Yes	7
READ PAGE CACHE RANDOM	00h	5	–	31h		Yes	6,7
READ PAGE CACHE LAST	3Fh	0	–	–		Yes	7

Memory – Flash Operation

- NAND
 - Read
 - Page Based – moves data for an entire page into the cache

Memory – Flash Operation

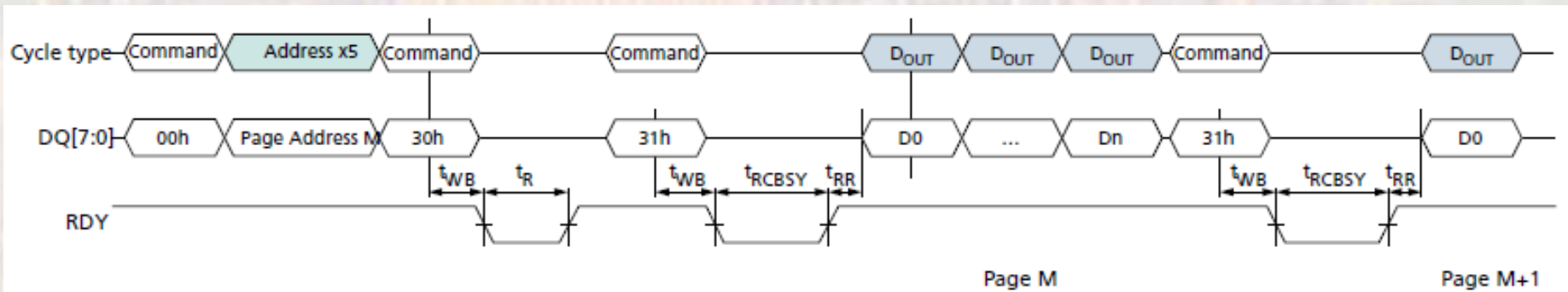
- NAND
 - Read Page



Not shown: RE#, DQS, CLK, ...

Memory – Flash Operation

- NAND
 - Read Page Cache Sequential
 - Increments the page address with each 31h command
 - Can be executed during a page read out



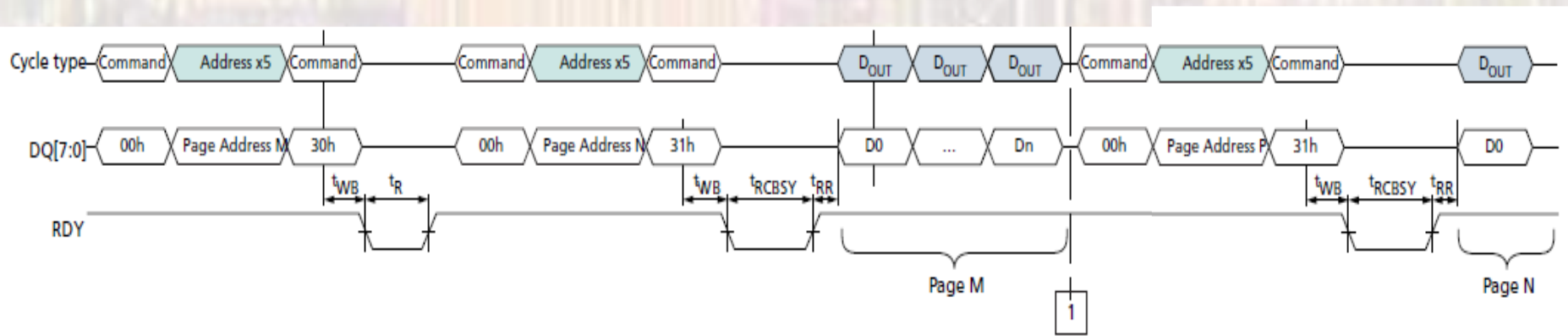
Not shown: RE#, DQS, CLK, ...

Memory – Flash Operation

- NAND

- Read Page Cache Random

- Provide a new page address during current data read out



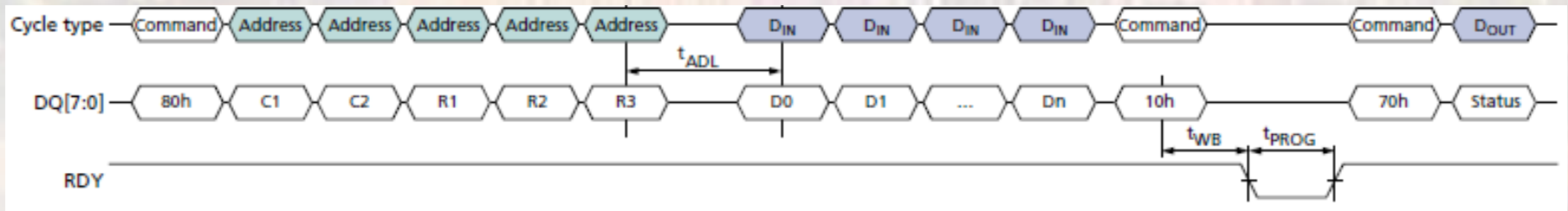
Not shown: RE#, DQS, CLK, ...

Memory – Flash Operation

- NAND
 - Program
 - Move data from Cache to the array
 - All Programming is Page based
 - Pages in a block must be programmed sequentially
 - Program operations must be checked for error codes
 - Failure
 - Dis-allowed data values

Memory – Flash Operation

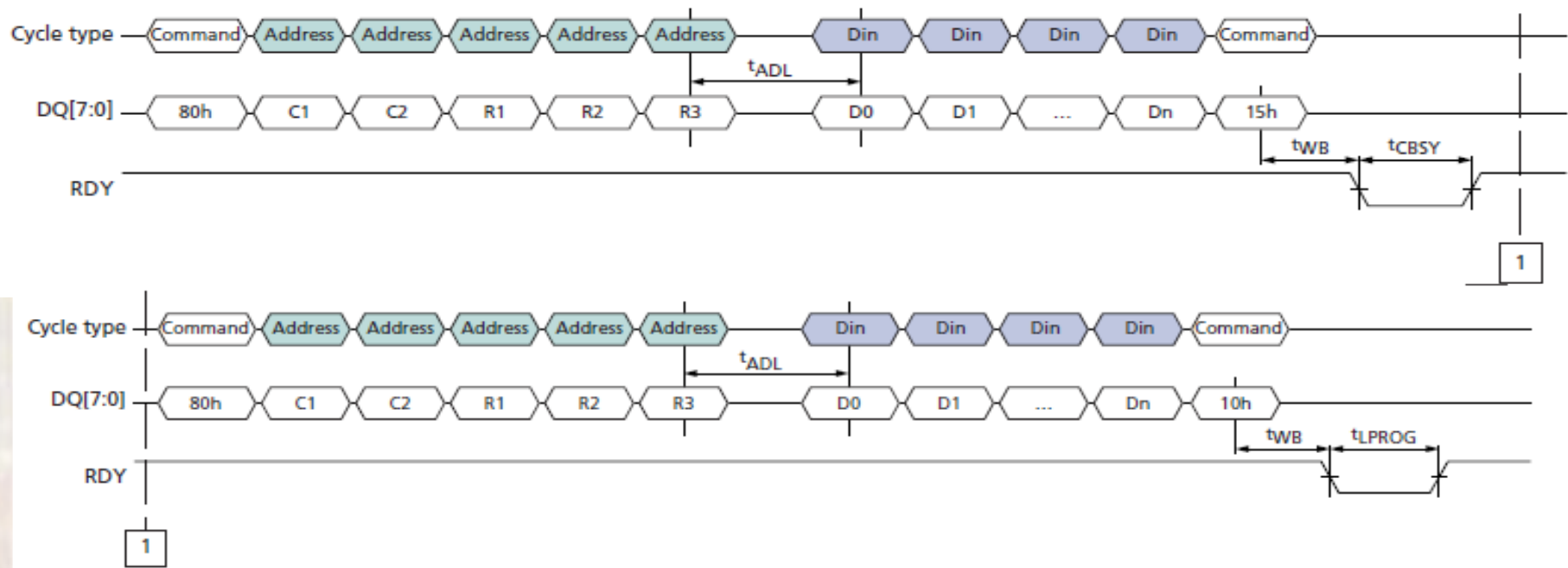
- NAND
 - Program Page
 - No cache utilization



Not shown: RE#, DQS, CLK, ...

Memory – Flash Operation

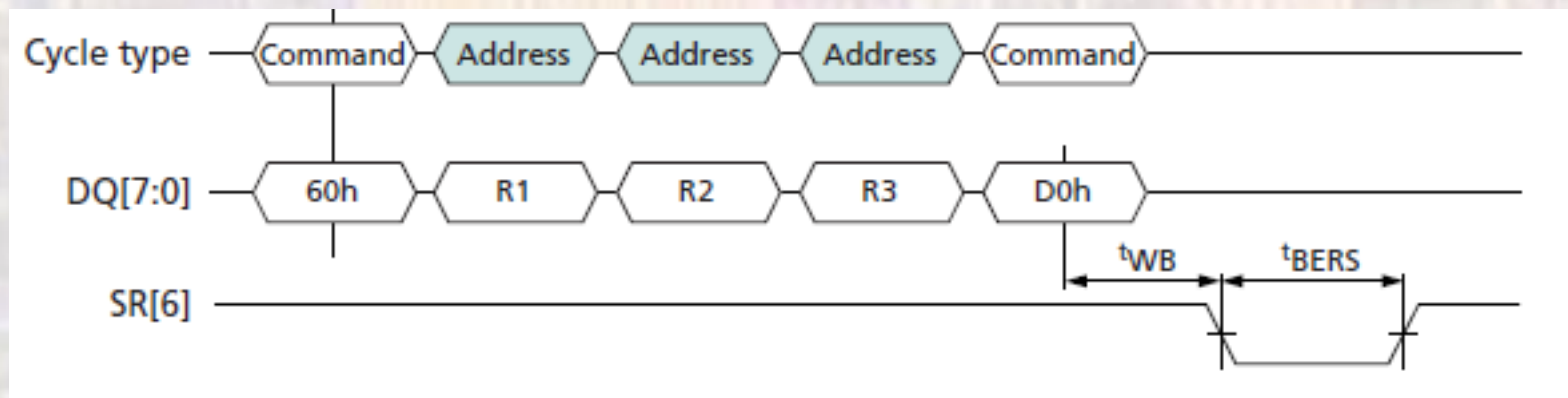
- NAND
 - Program Page Cache
 - Loads data into cache for later programming



Not shown: RE#, DQS, CLK, ...

Memory – Flash Operation

- NAND
- Block Erase

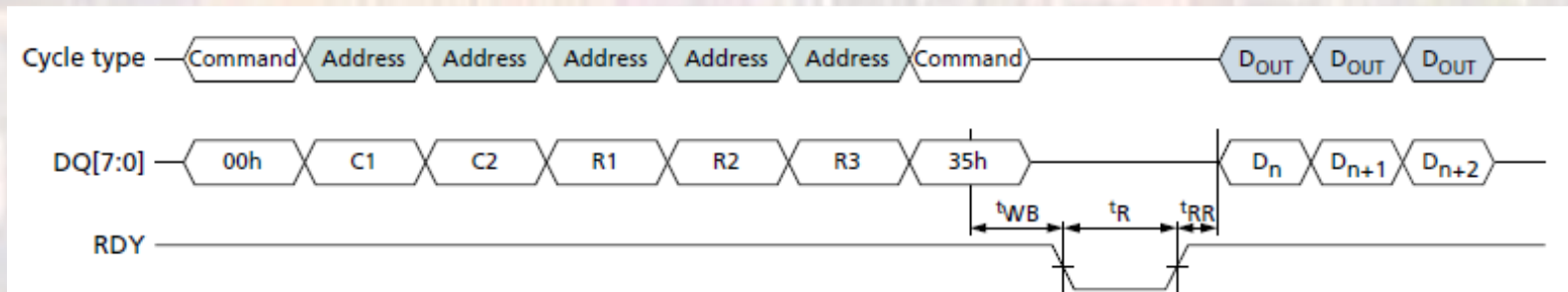


Not shown: RE#, DQS, CLK, ...

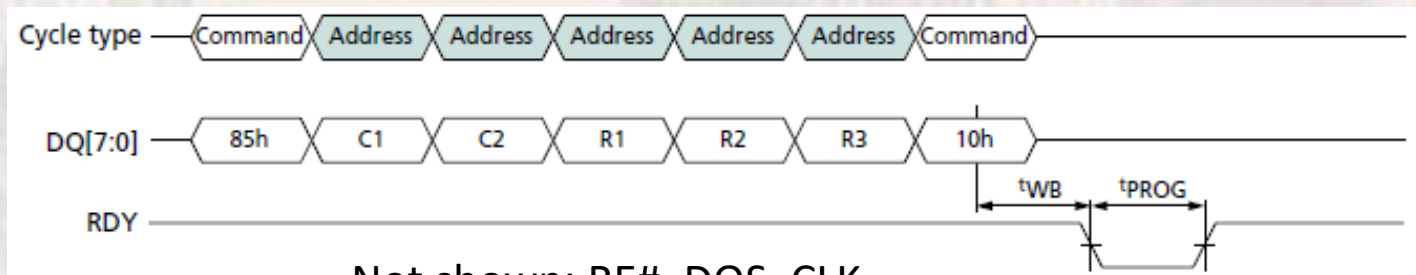
Memory – Flash Operation

- NAND
 - Copyback
 - Copies a block to a new location
 - Used for wear leveling

Read



Program



Not shown: RE#, DQS, CLK, ...

Memory – Flash Operation

- NOR - Parallel
 - Similar to NAND
 - Command based actions
 - Synchronous and asynchronous versions
 - Page based read/program supported
 - Block Erase
 - WORD based read/program possible

Memory – Flash Operation

- NOR - Serial
 - Low pin count SPI interface
 - Command based actions
 - Serial Read/Program operations
 - Page Program

Memory - Flash

- Performance Issues
 - Can 1 bad array element ruin an entire part?
 - Use redundant rows and columns in the array
 - Any bad cells are programmed out at final test
 - Some Memory Management Units (MMUs) can detect poorly performing cells and modify the virtual to physical address translation to remove them from the memory map