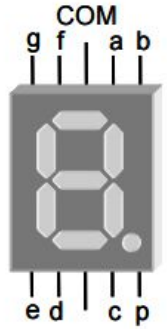
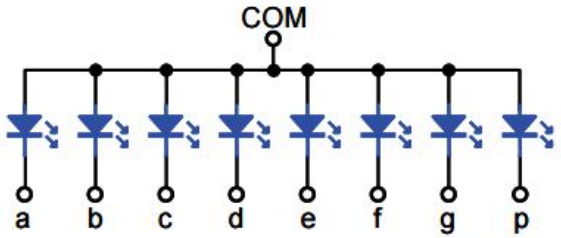
MPSL2020

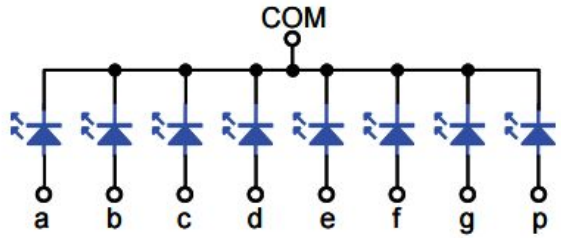
Lab4

7-Seg LED

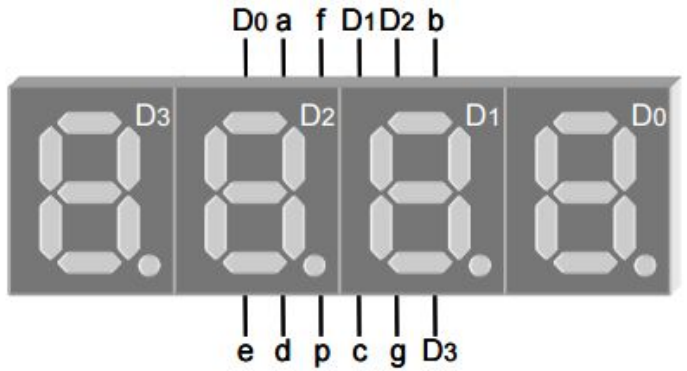


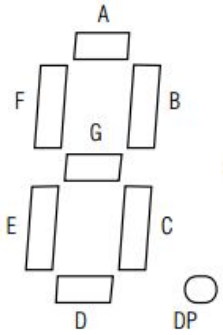


(a)共陽極結構



(b)共陰極結構





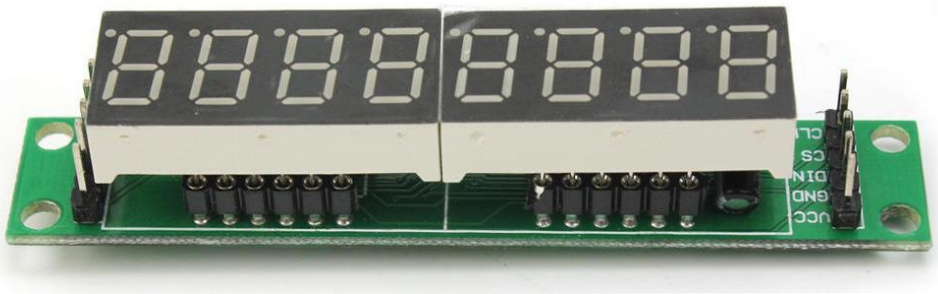
STANDARD 7-SEGMENT LED

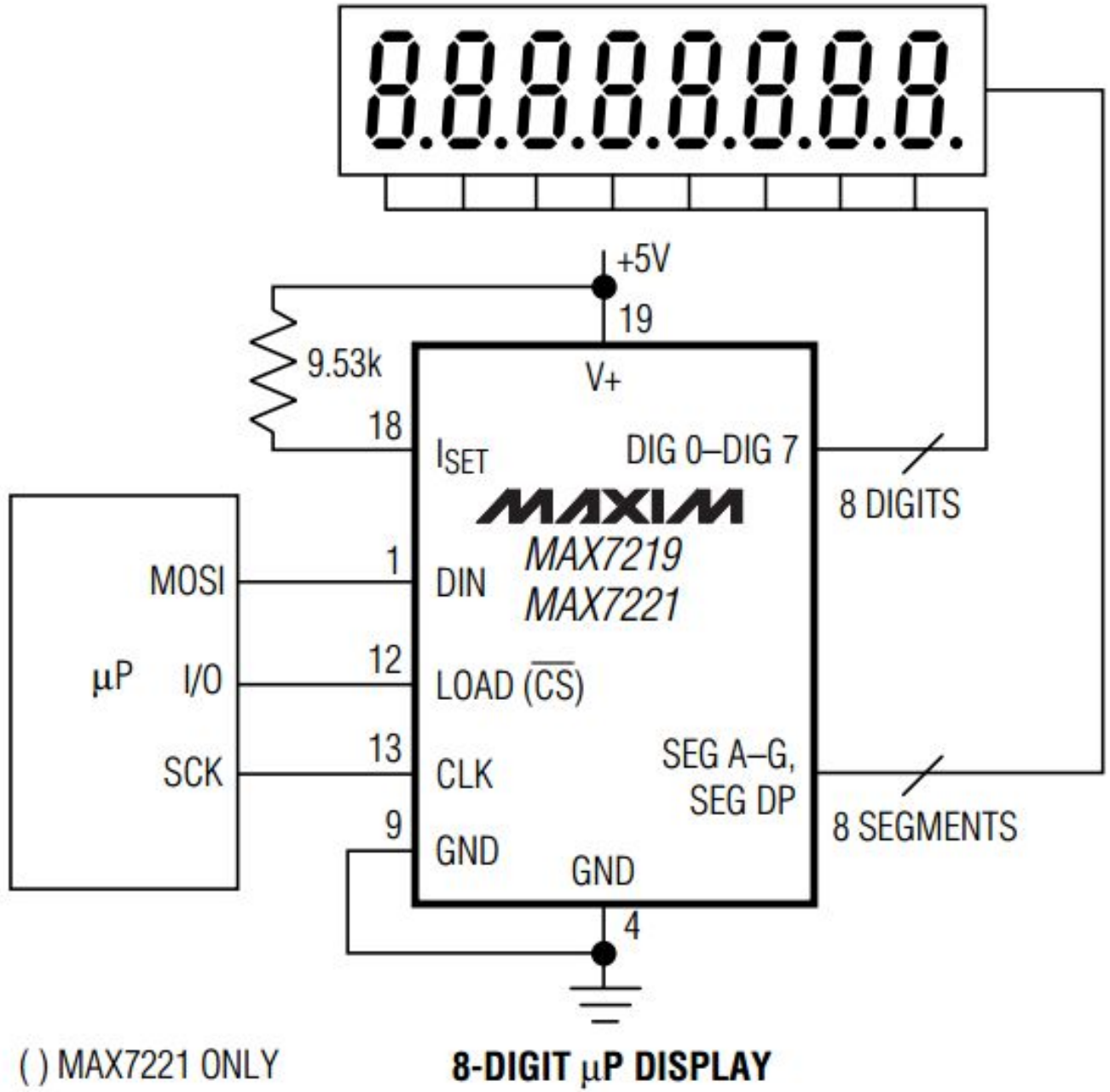
If we connect stm32 I/O pin on 7-Seg LED directly

- We use eight 7-Seg LED ➔ We will need 16 GPIO pin!
- We have to scan eight 7-Seg LED to show different number on it!

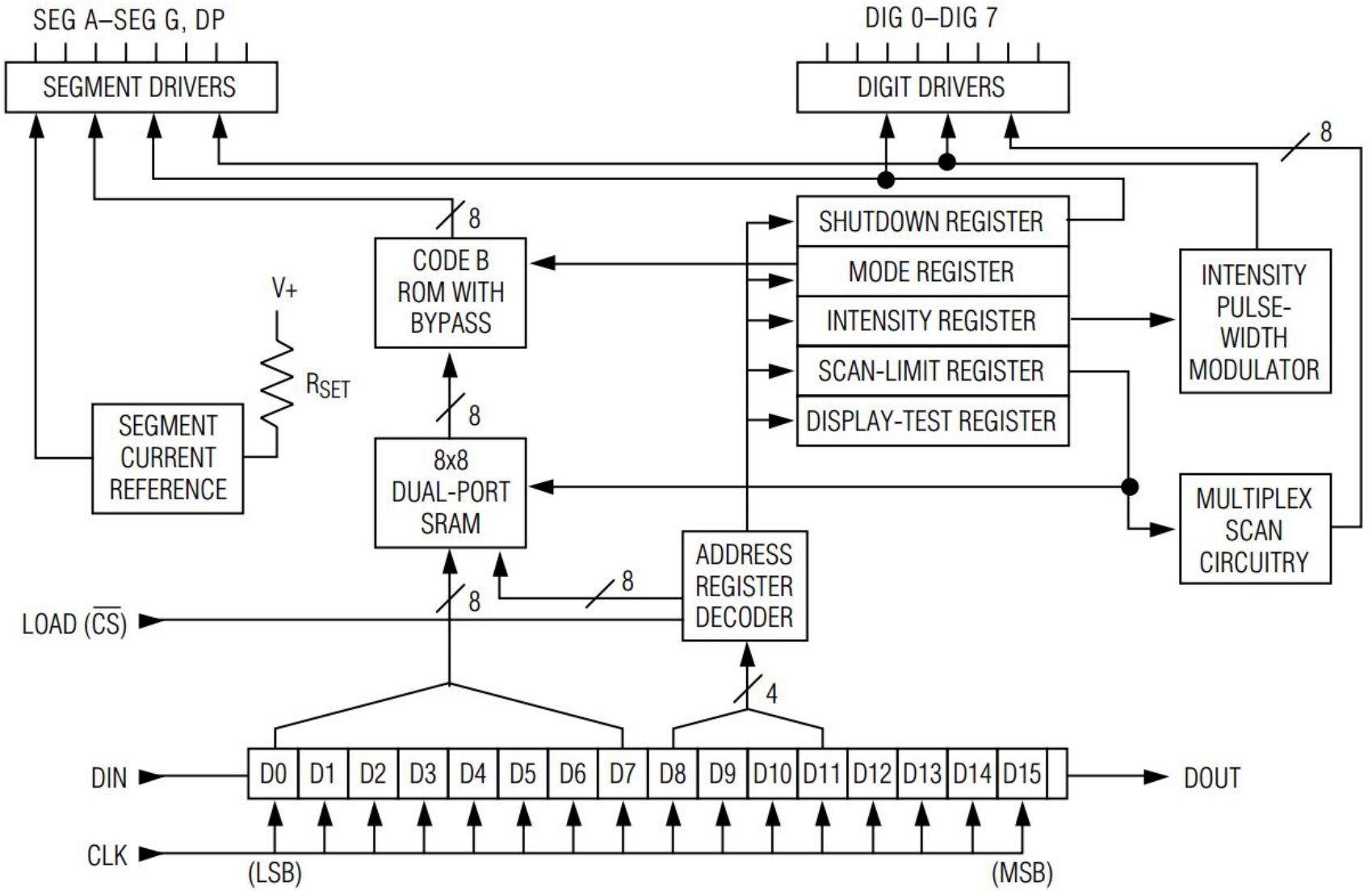
➔We use Max7219 to simplify our work!!

Max7219




+5V
19
9.53k
V+
18
ISET
DIG 0–DIG 7
MAXIM
MAX7219
MAX7221
8 DIGITS
MOSI
1
DIN
µP
I/O
12
LOAD (CS)
SCK
13
CLK
SEG A–G,
SEG DP
8 SEGMENTS
9
GND
GND
4
( ) MAX7221 ONLY
8-DIGIT µP DISPLAY

Max7219


SEG A–SEG G, DP
DIG 0–DIG 7
SEGMENT DRIVERS
DIGIT DRIVERS
8
SHUTDOWN REGISTER
MODE REGISTER
INTENSITY REGISTER
SCAN-LIMIT REGISTER
DISPLAY-TEST REGISTER
CODE B ROM WITH BYPASS
INTENSITY PULSE-WIDTH MODULATOR
V+
RSET
SEGMENT CURRENT REFERENCE
8x8 DUAL-PORT SRAM
MULTIPLEX SCAN CIRCUITRY
ADDRESS REGISTER DECODER
LOAD (CS)
4
DIN
D0 D1 D2 D3 D4 D5 D6 D7 D8 D9 D10 D11 D12 D13 D14 D15
DOUT
CLK
(LSB)
(MSB)

Max7219

- DIN: Serial-Data Input. Data is loaded into the internal 16-bit shift register on CLK's rising edge.
- CS: Load-Data Input. The last 16 bits of serial data are latched on LOAD(CS)'s rising edge.
- CLK: Serial-Clock Input. 10MHz maximum rate. On CLK's rising edge, data is shifted into the internal shift register.

Table 1. Serial-Data Format (16 Bits)

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				MSB	DATA						LSB

Max7219

Table 2. Register Address Map

REGISTER	ADDRESS					HEX CODE
	D15–D12	D11	D10	D9	D8	
No-Op	X	0	0	0	0	0xX0
Digit 0	X	0	0	0	1	0xX1
Digit 1	X	0	0	1	0	0xX2
Digit 2	X	0	0	1	1	0xX3
Digit 3	X	0	1	0	0	0xX4
Digit 4	X	0	1	0	1	0xX5
Digit 5	X	0	1	1	0	0xX6
Digit 6	X	0	1	1	1	0xX7
Digit 7	X	1	0	0	0	0xX8
Decode Mode	X	1	0	0	1	0xX9
Intensity	X	1	0	1	0	0xXA
Scan Limit	X	1	0	1	1	0xXB
Shutdown	X	1	1	0	0	0xXC
Display Test	X	1	1	1	1	0xXF

Max7219—Shutdown Register

Table 3. Shutdown Register Format (Address (Hex) = 0xXC)

MODE	ADDRESS CODE (HEX)	REGISTER DATA							
		D7	D6	D5	D4	D3	D2	D1	D0
Shutdown Mode	0xXC	X	X	X	X	X	X	X	0
Normal Operation	0xXC	X	X	X	X	X	X	X	1

When the MAX7219 is in shutdown mode, the scan oscillator is halted, all segment current sources are pulled to ground, and all digit drivers are pulled to V+, thereby blanking the display. Data in the digit and control registers remains unaltered.

Max7219—Decode-Mode Register

Table 4. Decode-Mode Register Examples (Address (Hex) = 0xX9)

DECODE MODE	REGISTER DATA								HEX CODE
	D7	D6	D5	D4	D3	D2	D1	D0	
No decode for digits 7–0	0	0	0	0	0	0	0	0	0x00
Code B decode for digit 0 No decode for digits 7–1	0	0	0	0	0	0	0	1	0x01
Code B decode for digits 3–0 No decode for digits 7–4	0	0	0	0	1	1	1	1	0x0F
Code B decode for digits 7–0	1	1	1	1	1	1	1	1	0xFF

Max7219—Decode-Mode Register

Table 5. Code B Font

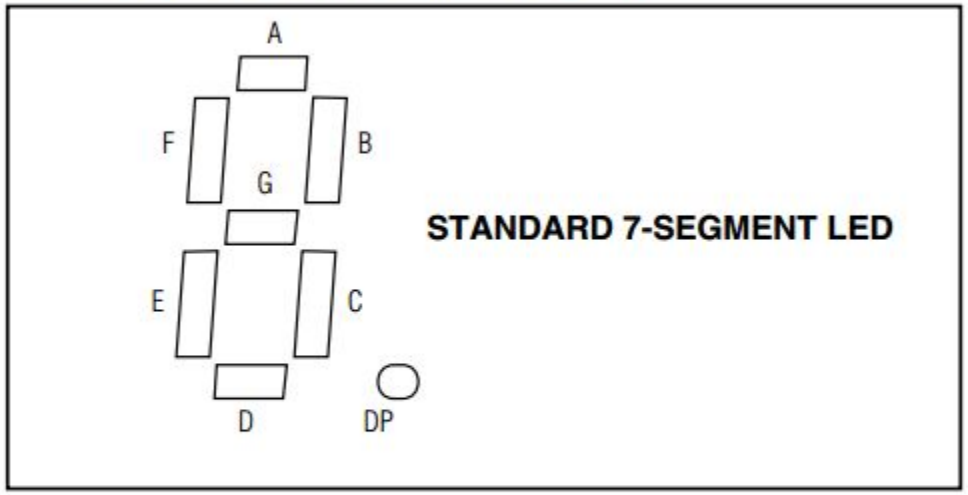
7-SEGMENT CHARACTER	REGISTER DATA						ON SEGMENTS = 1							
	D7*	D6–D4	D3	D2	D1	D0	DP*	A	B	C	D	E	F	G
0		X	0	0	0	0		1	1	1	1	1	1	0
1		X	0	0	0	1		0	1	1	0	0	0	0
2		X	0	0	1	0		1	1	0	1	1	0	1
3		X	0	0	1	1		1	1	1	1	0	0	1
4		X	0	1	0	0		0	1	1	0	0	1	1
5		X	0	1	0	1		1	0	1	1	0	1	1
6		X	0	1	1	0		1	0	1	1	1	1	1
7		X	0	1	1	1		1	1	1	0	0	0	0
8		X	1	0	0	0		1	1	1	1	1	1	1
9		X	1	0	0	1		1	1	1	1	0	1	1
—		X	1	0	1	0		0	0	0	0	0	0	1
E		X	1	0	1	1		1	0	0	1	1	1	1
H		X	1	1	0	0		0	1	1	0	1	1	1
L		X	1	1	0	1		0	0	0	1	1	1	0
P		X	1	1	1	0		1	1	0	0	1	1	1
blank		X	1	1	1	1		0	0	0	0	0	0	0

*The decimal point is set by bit D7 = 1

When the code B decode mode is used, the decoder looks only at the lower nibble of the data in the digit registers (D3–D0), disregarding bits D4–D6. D7, which sets the decimal point (SEG DP), is independent of the decoder and is positive logic (D7 = 1 turns the decimal point on)

Max7219—Decode-Mode Register

Table 6. No-Decode Mode Data Bits and Corresponding Segment Lines



	REGISTER DATA							
	D7	D6	D5	D4	D3	D2	D1	D0
Corresponding Segment Line	DP	A	B	C	D	E	F	G

When no-decode is selected, data bits D7–D0 correspond to the segment lines of the MAX7219/MAX7221.

Max7219—Intensity Register

Table 7. Intensity Register Format (Address (Hex) = 0xXA)

DUTY CYCLE		D7	D6	D5	D4	D3	D2	D1	D0	HEX CODE
MAX7219	MAX7221									
1/32 (min on)	1/16 (min on)	X	X	X	X	0	0	0	0	0xX0
3/32	2/16	X	X	X	X	0	0	0	1	0xX1
5/32	3/16	X	X	X	X	0	0	1	0	0xX2
7/32	4/16	X	X	X	X	0	0	1	1	0xX3
9/32	5/16	X	X	X	X	0	1	0	0	0xX4
11/32	6/16	X	X	X	X	0	1	0	1	0xX5
13/32	7/16	X	X	X	X	0	1	1	0	0xX6
15/32	8/16	X	X	X	X	0	1	1	1	0xX7
17/32	9/16	X	X	X	X	1	0	0	0	0xX8
19/32	10/16	X	X	X	X	1	0	0	1	0xX9
21/32	11/16	X	X	X	X	1	0	1	0	0xXA
23/32	12/16	X	X	X	X	1	0	1	1	0xXB
25/32	13/16	X	X	X	X	1	1	0	0	0xXC
27/32	14/16	X	X	X	X	1	1	0	1	0xXD
29/32	15/16	X	X	X	X	1	1	1	0	0xXE
31/32	15/16 (max on)	X	X	X	X	1	1	1	1	0xXF

Max7219—Scan-Limit Register

Table 8. Scan-Limit Register Format (Address (Hex) = 0xXB)

SCAN LIMIT	REGISTER DATA								HEX CODE
	D7	D6	D5	D4	D3	D2	D1	D0	
Display digit 0 only*	X	X	X	X	X	0	0	0	0xX0
Display digits 0 & 1*	X	X	X	X	X	0	0	1	0xX1
Display digits 0 1 2*	X	X	X	X	X	0	1	0	0xX2
Display digits 0 1 2 3	X	X	X	X	X	0	1	1	0xX3
Display digits 0 1 2 3 4	X	X	X	X	X	1	0	0	0xX4
Display digits 0 1 2 3 4 5	X	X	X	X	X	1	0	1	0xX5
Display digits 0 1 2 3 4 5 6	X	X	X	X	X	1	1	0	0xX6
Display digits 0 1 2 3 4 5 6 7	X	X	X	X	X	1	1	1	0xX7

*See *Scan-Limit Register* section for application.

The scan-limit register sets how many digits are displayed, from 1 to 8. The number of scanned digits affects the display brightness,

Max7219—Display Test Register

Table 10. Display-Test Register Format (Address (Hex) = 0xXF)

MODE	REGISTER DATA							
	D7	D6	D5	D4	D3	D2	D1	D0
Normal Operation	X	X	X	X	X	X	X	0
Display Test Mode	X	X	X	X	X	X	X	1

Note: The MAX7219/MAX7221 remain in display-test mode (all LEDs on) until the display-test register is reconfigured for normal operation.

The display-test register operates in two modes: normal and display test. Display-test mode turns all LEDs on by overriding, but not altering, all controls and digit registers (including the shutdown register).

Max7219—register functions

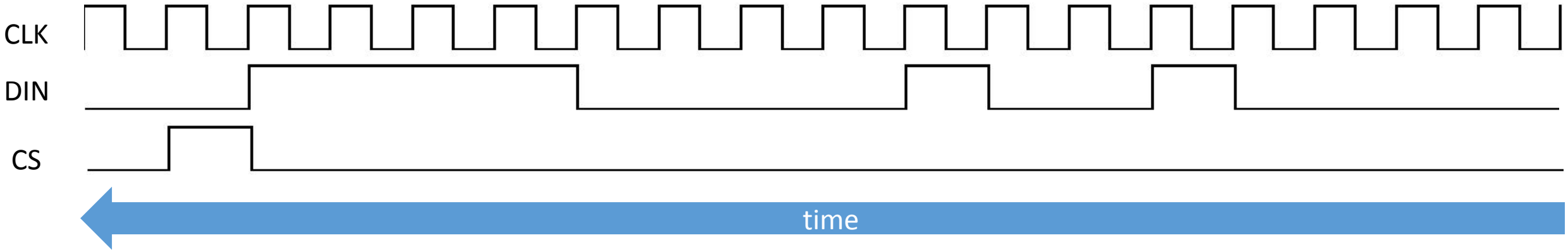
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				MSB	DATA						LSB

- Decode Mode: The value of D0~D3 will be decode as 7-Seg LED's 0~9,-E,H,L,P(space) if we set decode mode. Otherwise D0~D7 will display on 7-Seg LED directly(please check the picture of table 6)
- Intensity: To set the brightness of 7-Seg LED, increasing along with 0~15.
- Scan Limit: To set the number of digits will be display. 0 for 1 digit, 1 for 2 digit.....
- Shutdown: 7-Seg LED will be shutdown if we set the shutdown mode. It is a power saving mode.
- Display Test: For testing, will lighting all 7-Seg LED.

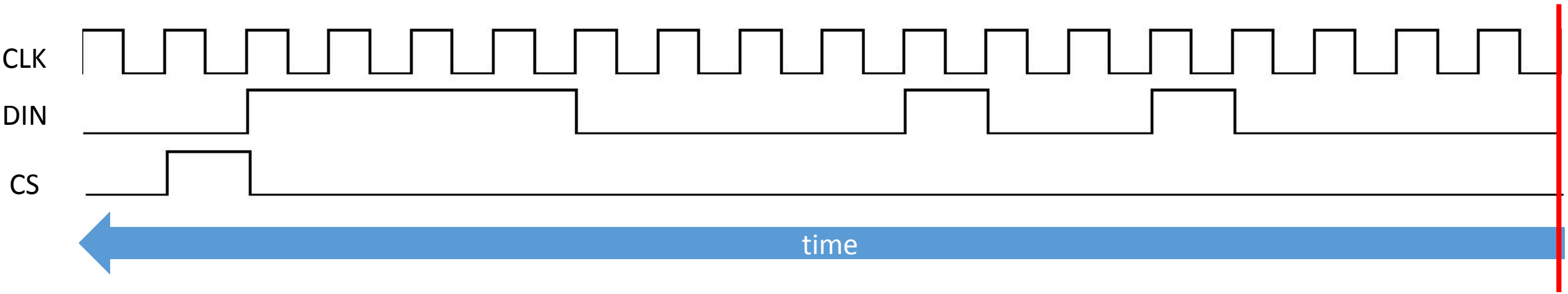
Example

I want to set decode mode(Code B decode for digit 0-3, no decode for digits 4-7), thus I have to set Serial-Data as below!
And then send a rising edge on CS pin to latch the Serial-Data!

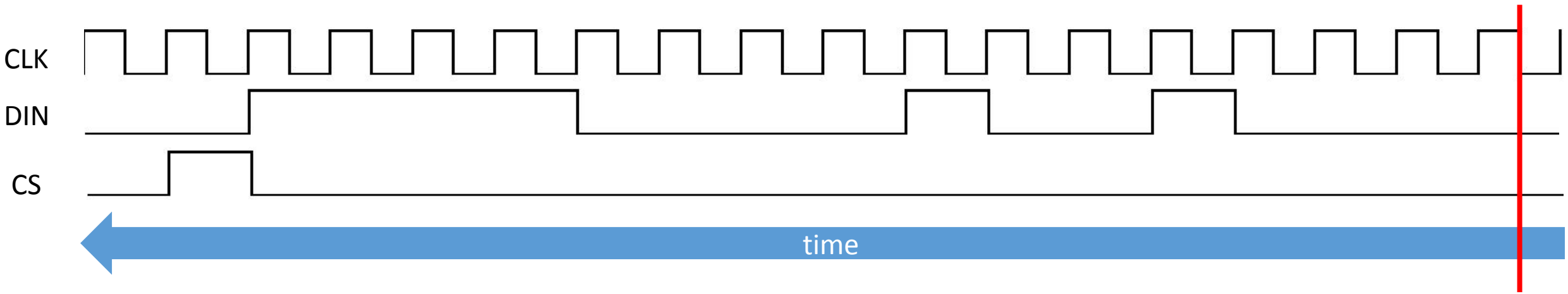
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	1	0	0	1	0	0	0	0	1	1	1	1



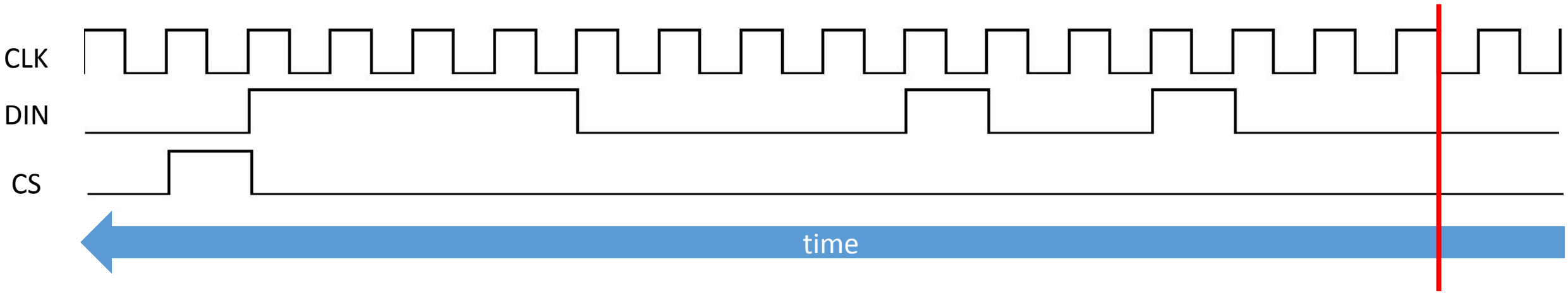
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X



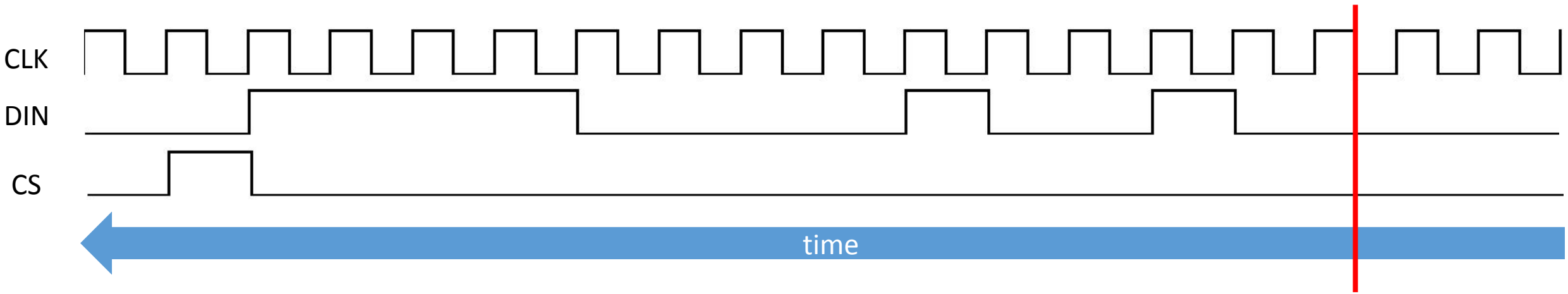
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0



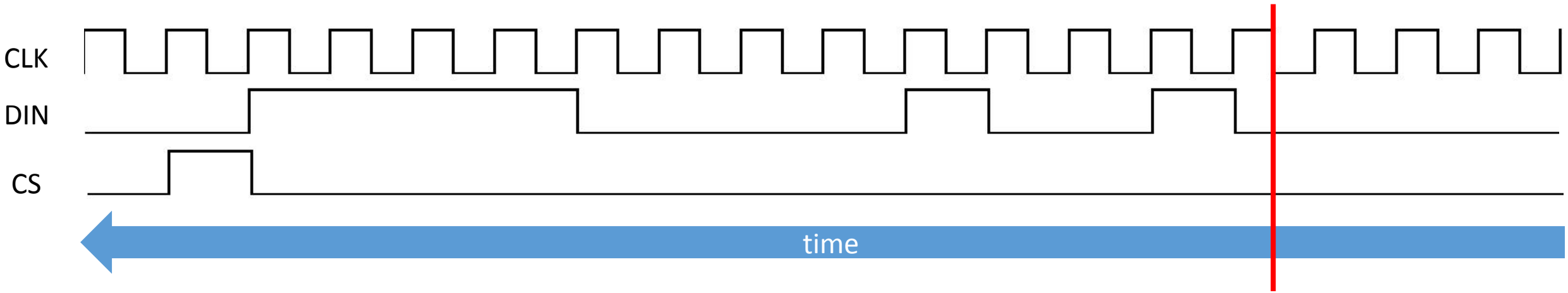
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	X	X	X	X	X	X	X	X	X	X	0	0



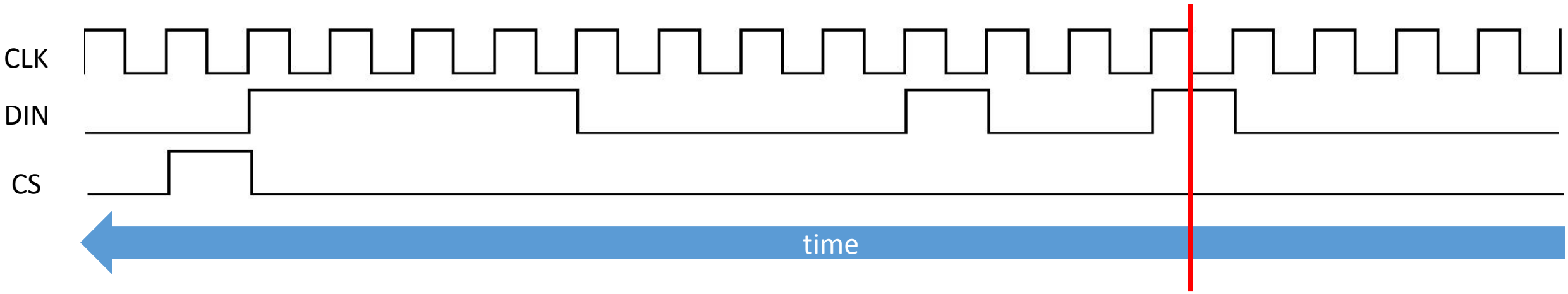
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	X	X	X	X	X	X	X	X	X	0	0	0



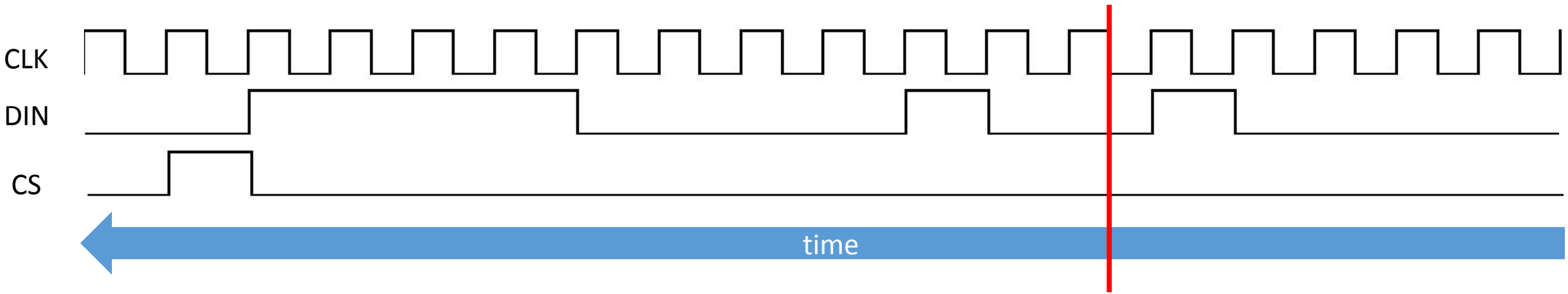
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	X	X	X	X	X	X	X	X	0	0	0	0



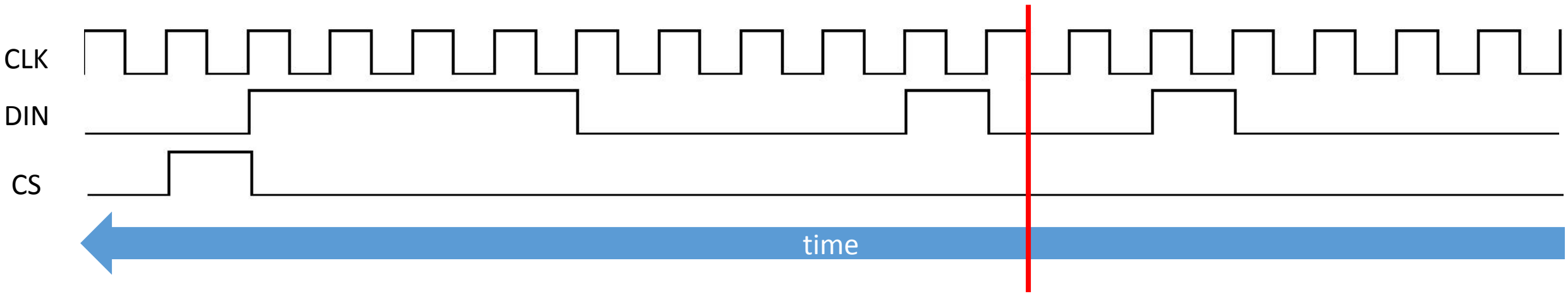
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	X	X	X	X	X	X	X	0	0	0	0	1



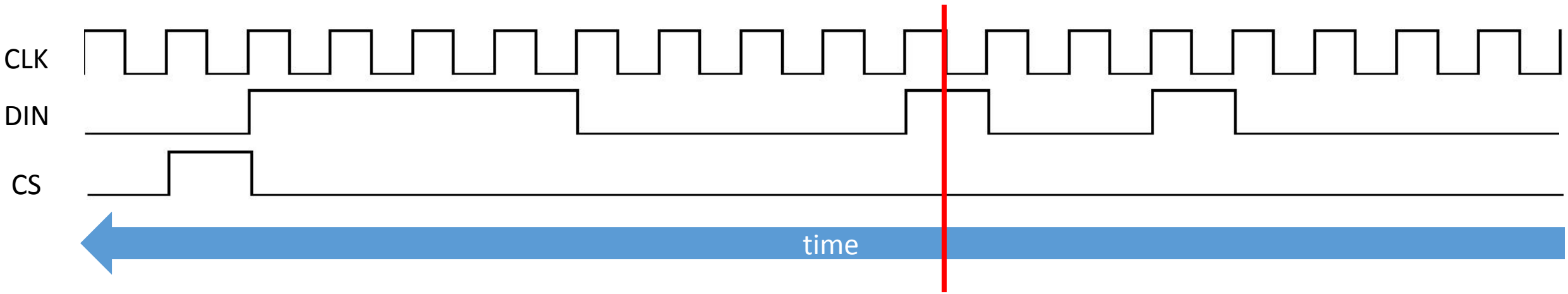
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	X	X	X	X	X	X	0	0	0	0	1	0



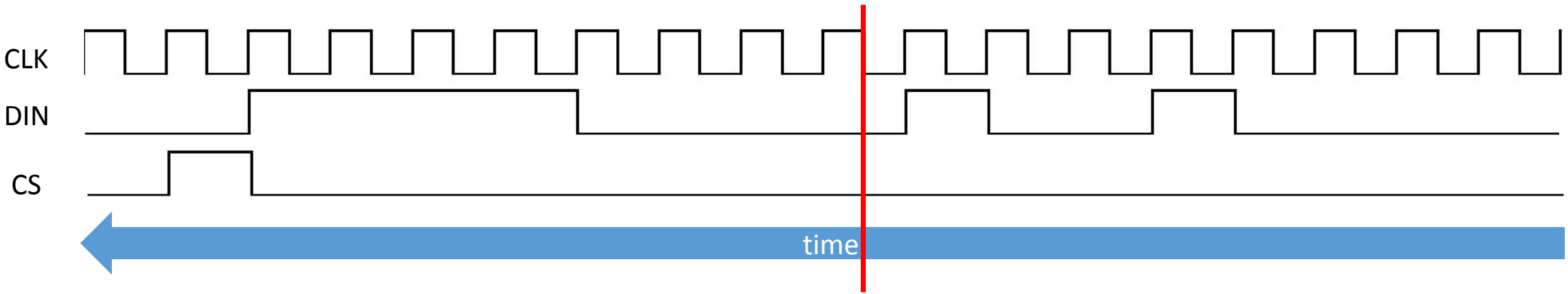
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	X	X	X	X	X	0	0	0	0	1	0	0



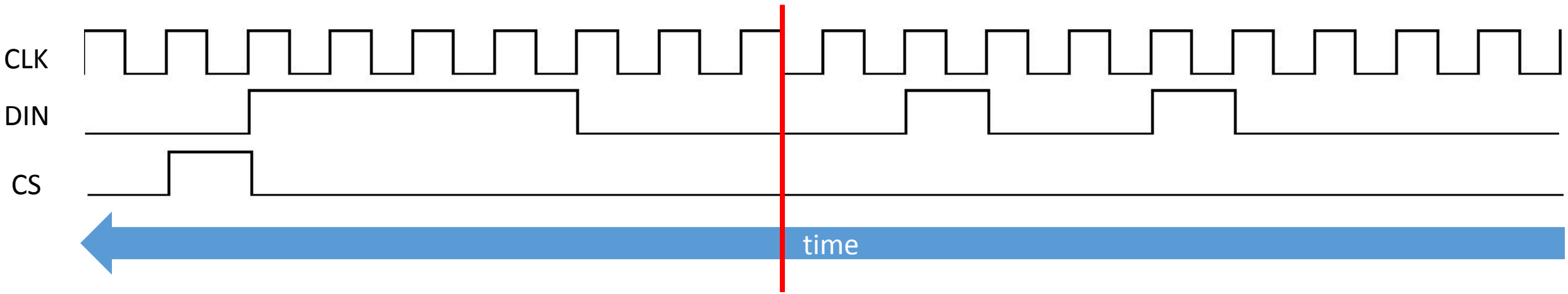
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	X	X	X	X	0	0	0	0	1	0	0	1



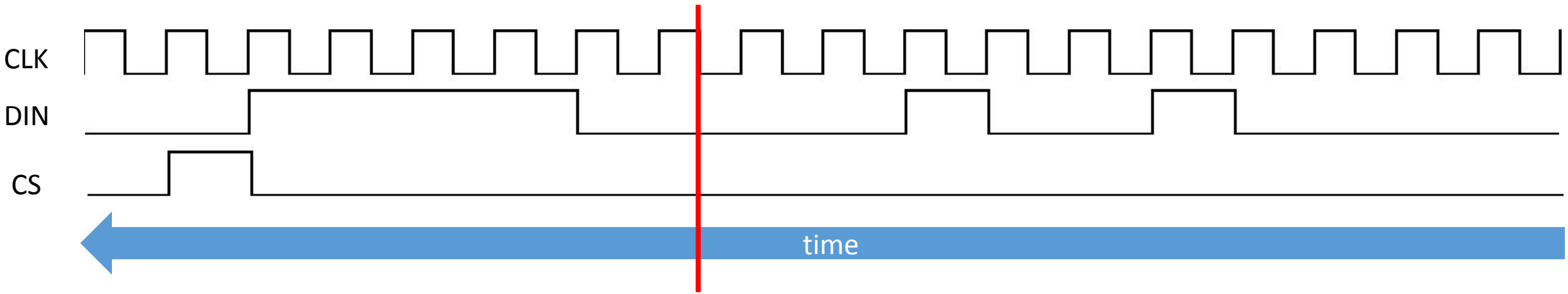
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	X	X	X	0	0	0	0	1	0	0	1	0



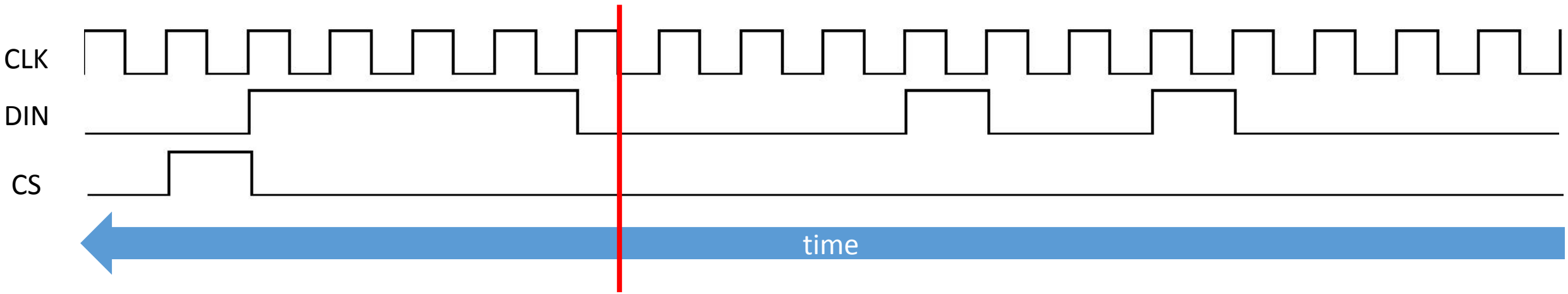
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	X	X	0	0	0	0	1	0	0	1	0	0



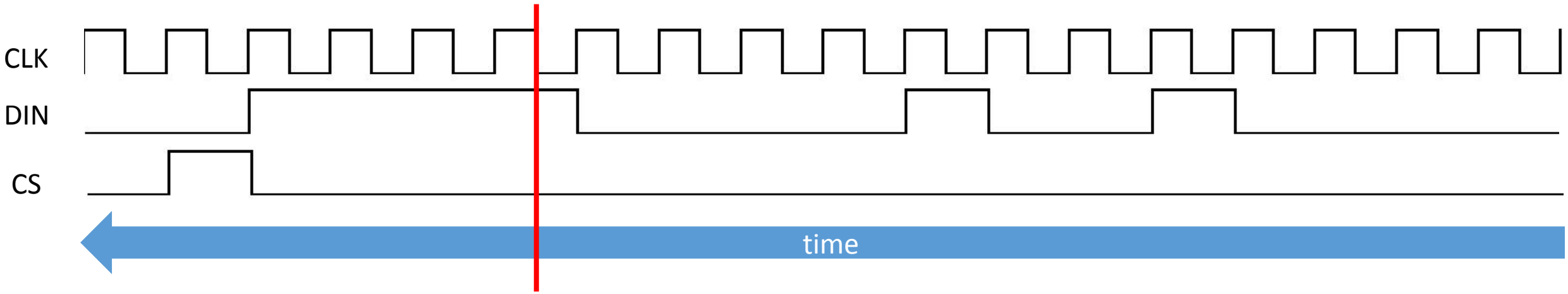
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	X	0	0	0	0	1	0	0	1	0	0	0



D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	X	0	0	0	0	1	0	0	1	0	0	0	0



D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
X	X	X	0	0	0	0	1	0	0	1	0	0	0	0	1



D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				DATA							
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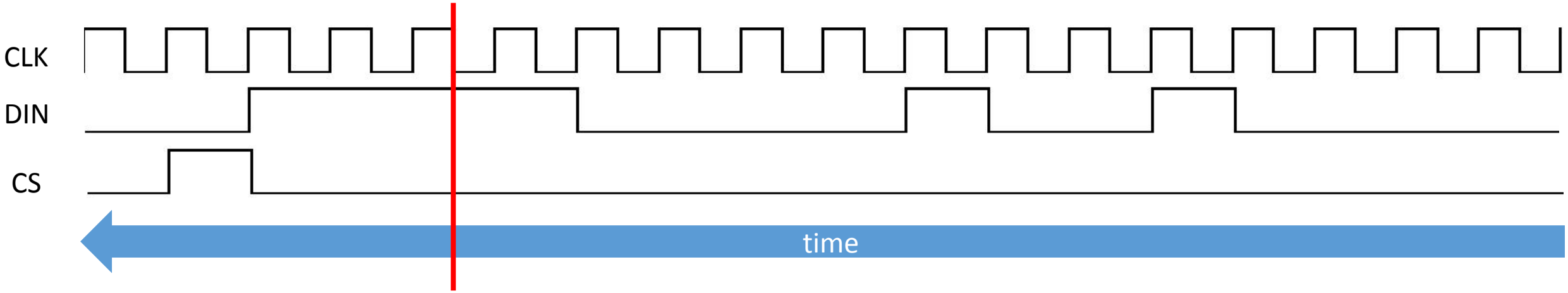

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X	X	X	X	ADDRESS				DATA							
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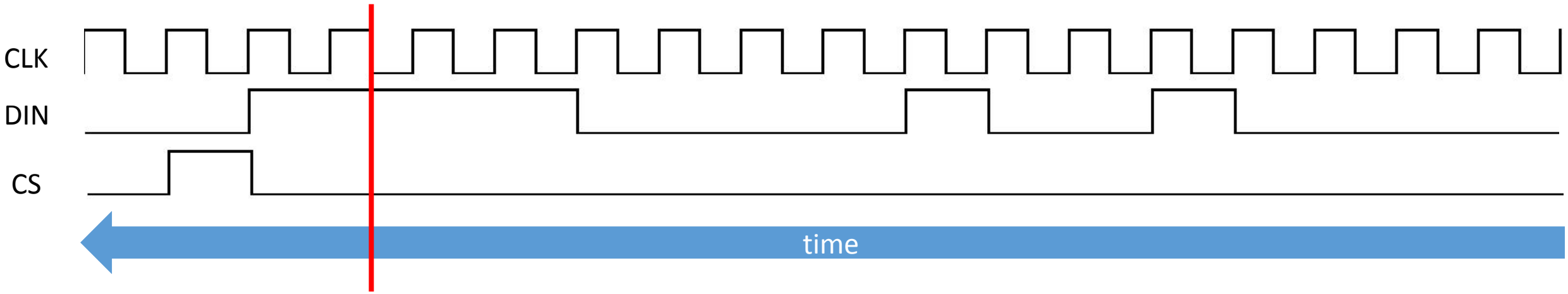

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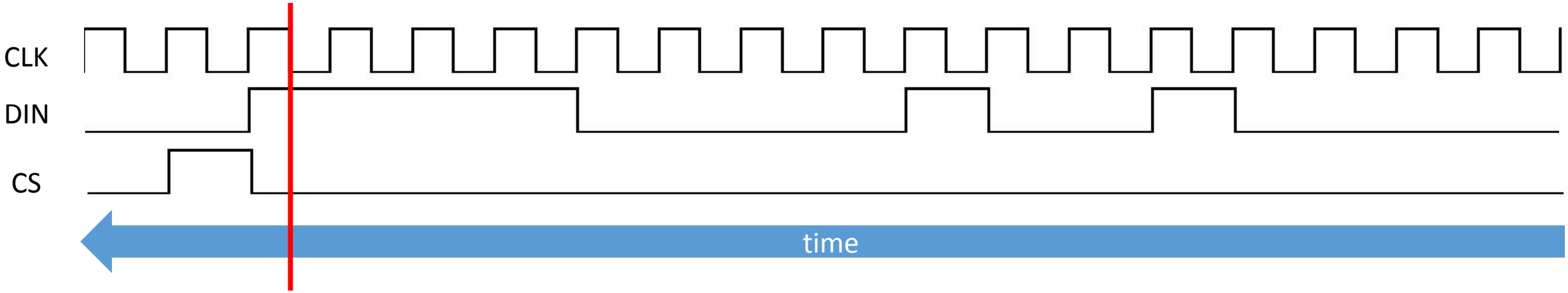

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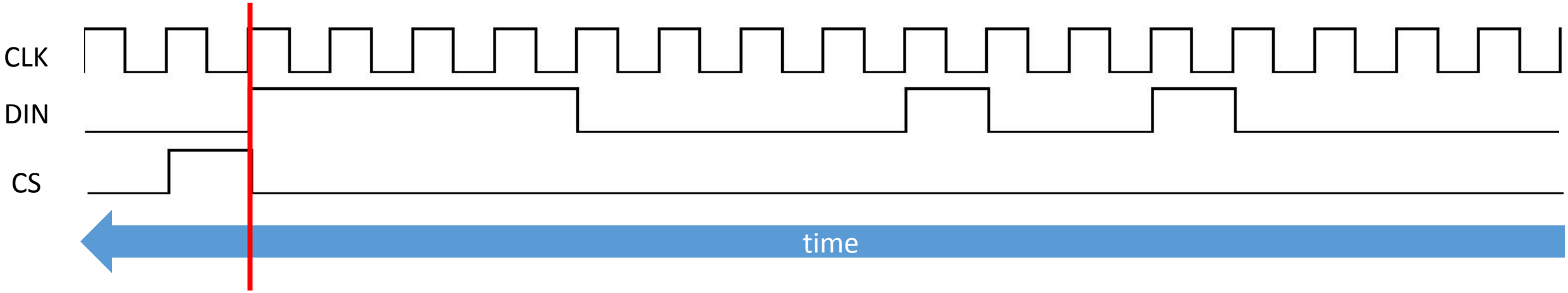

Reference

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