

Edge Triggered Flip Flop

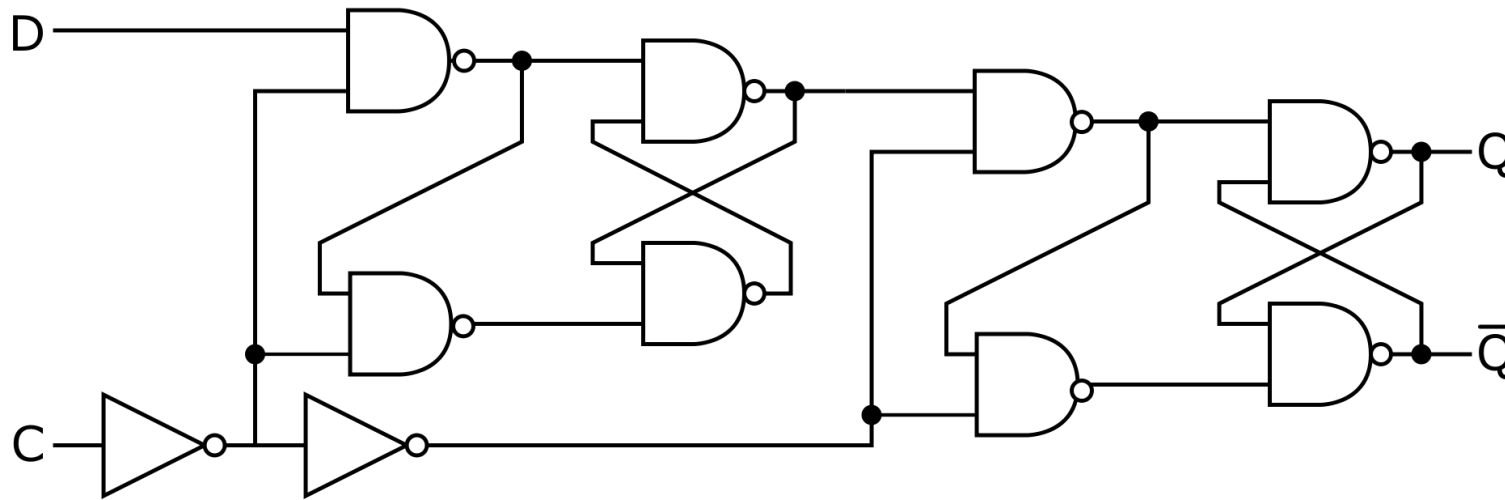
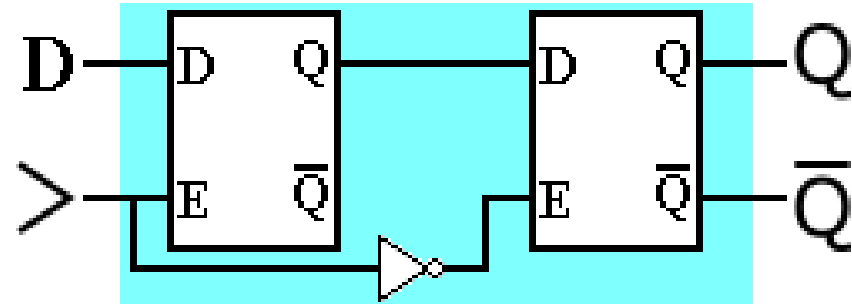
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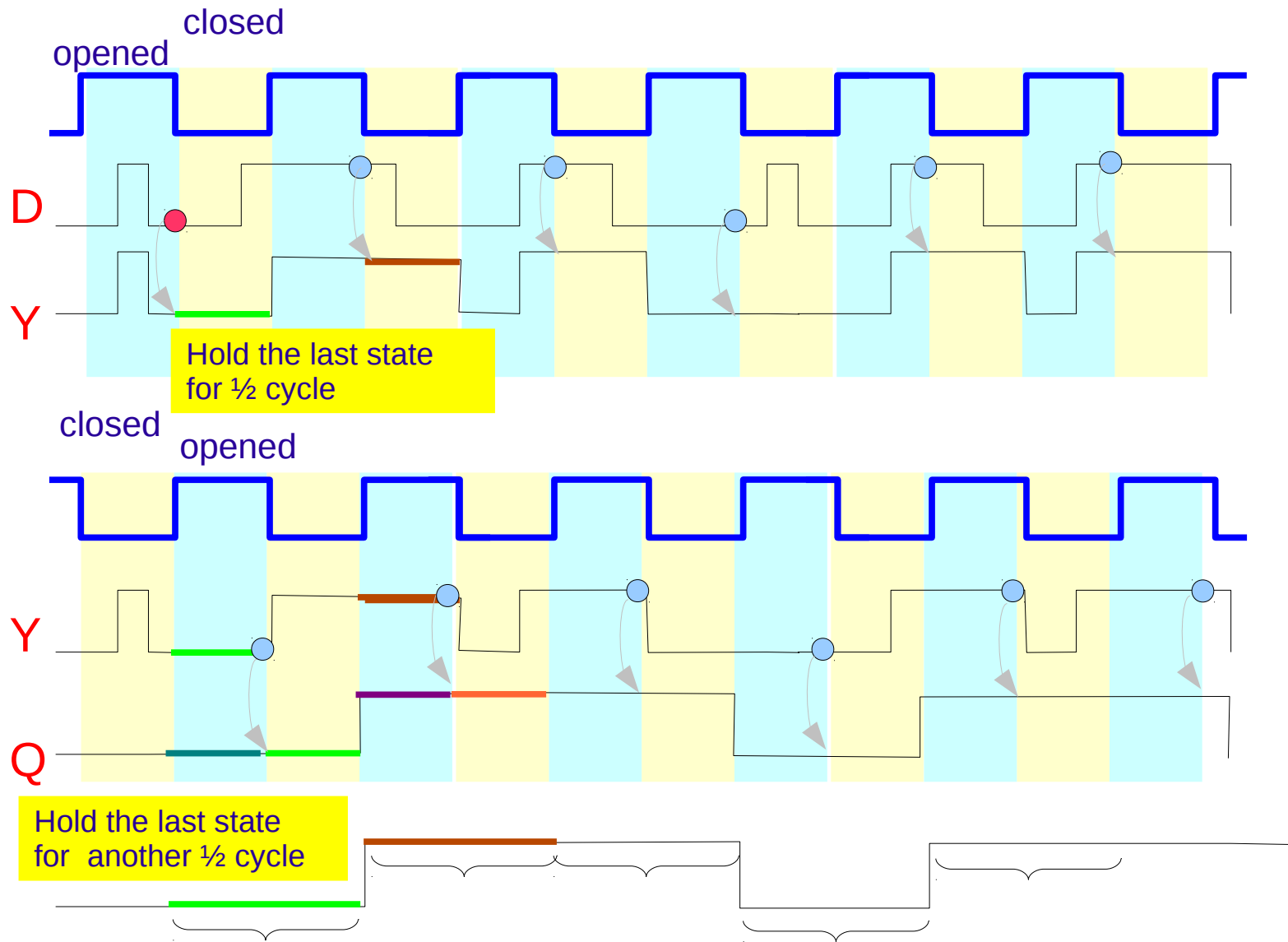
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Master-Slave FF

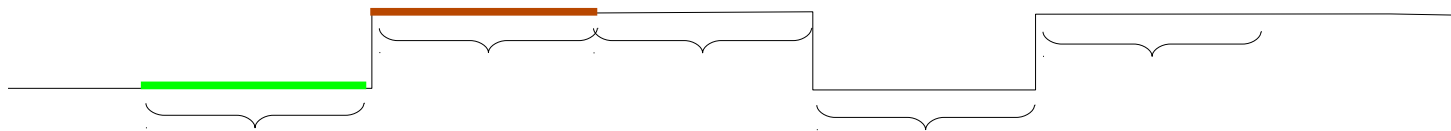
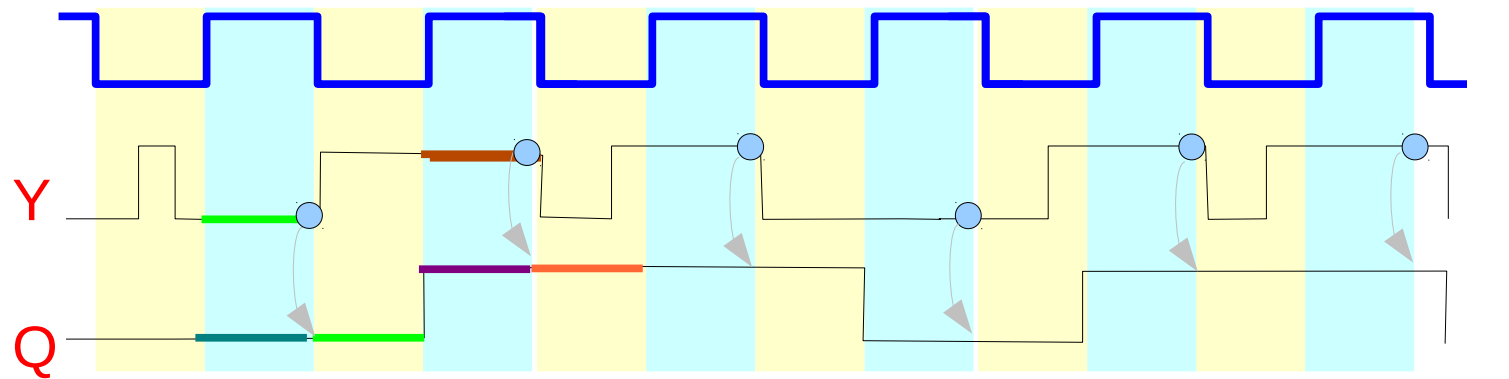
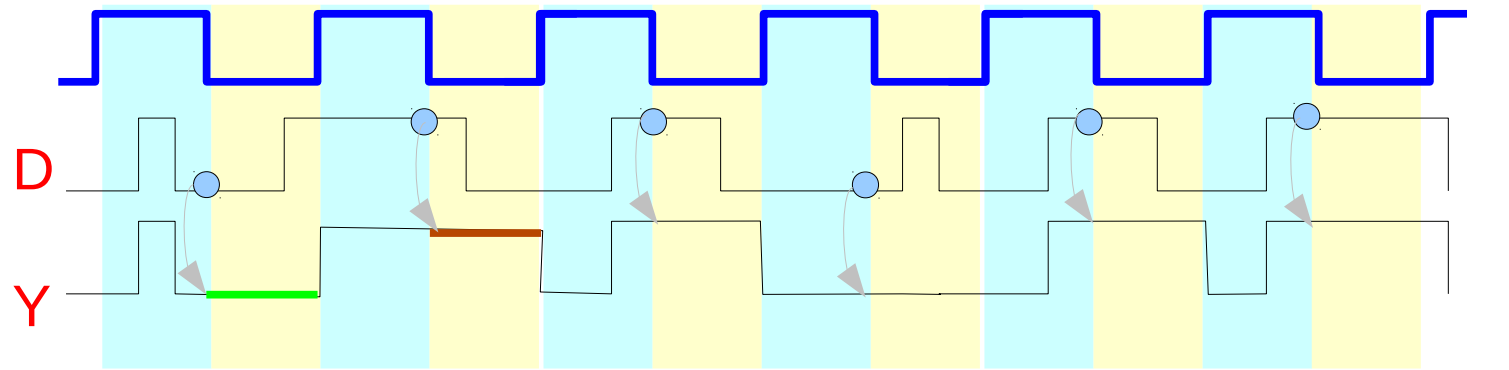


* figures from
wikipedia.org

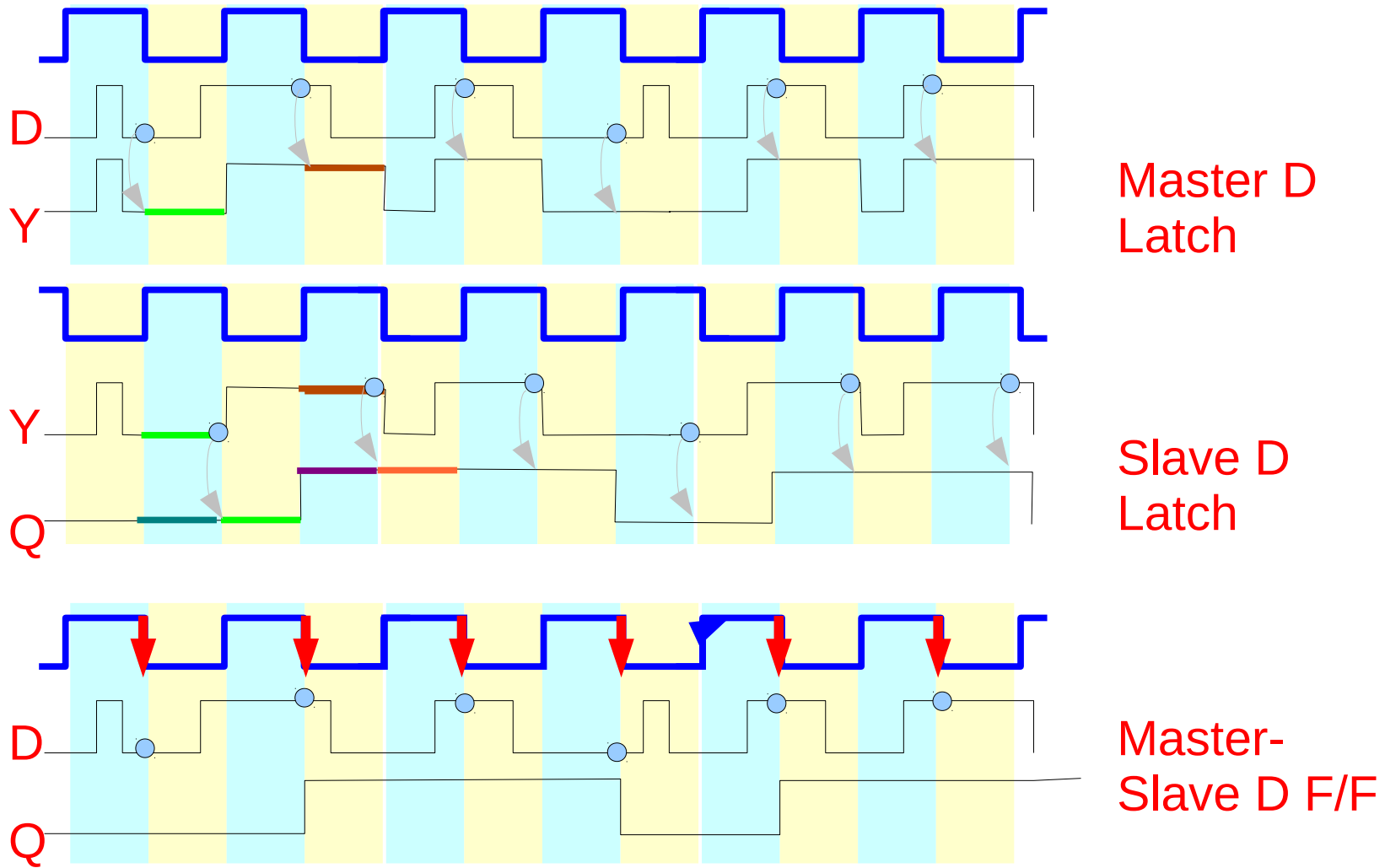
Master-Slave D FF



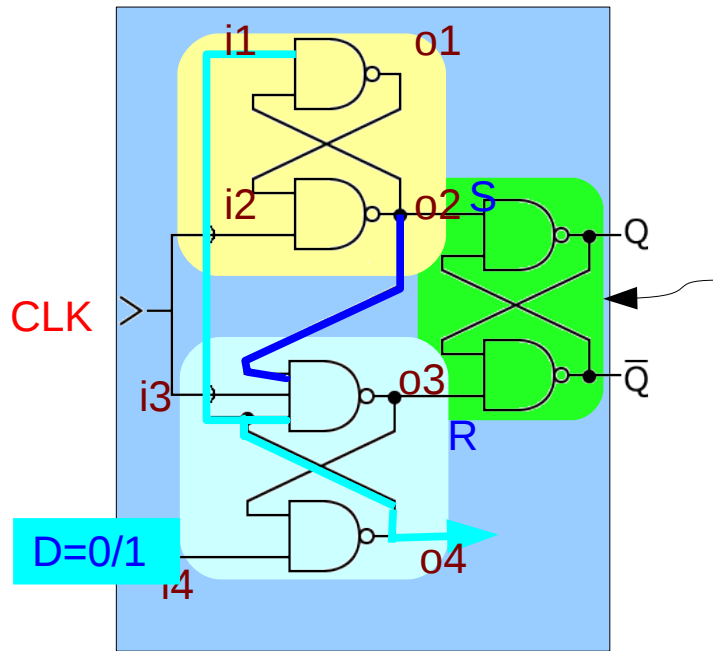
Master-Slave FF



Master-Slave FF

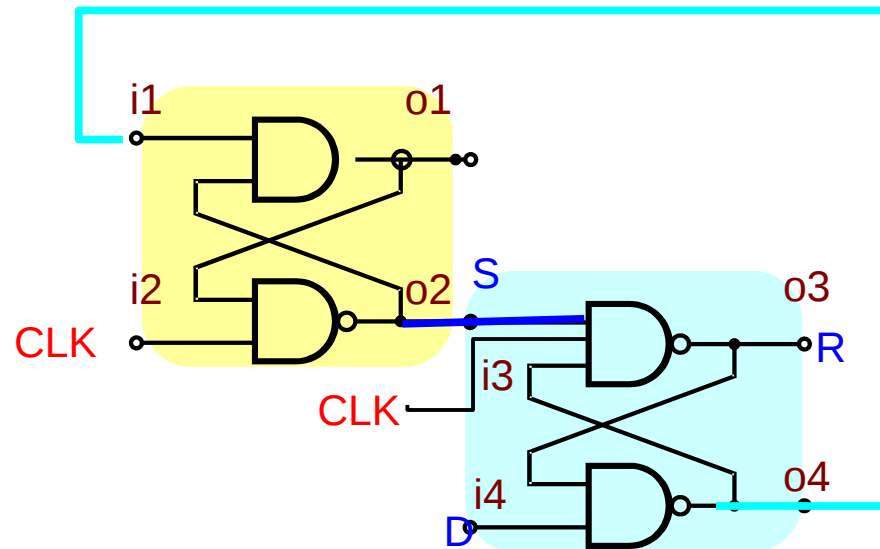
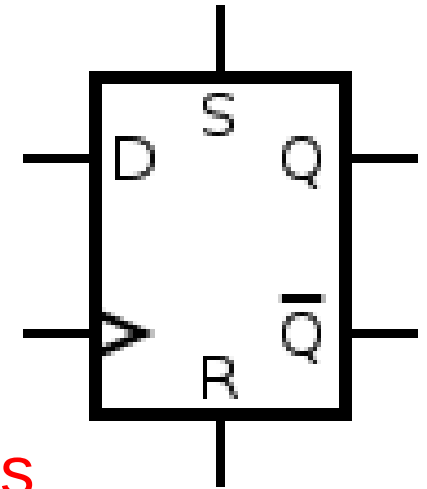


Classical Edge Triggered FF



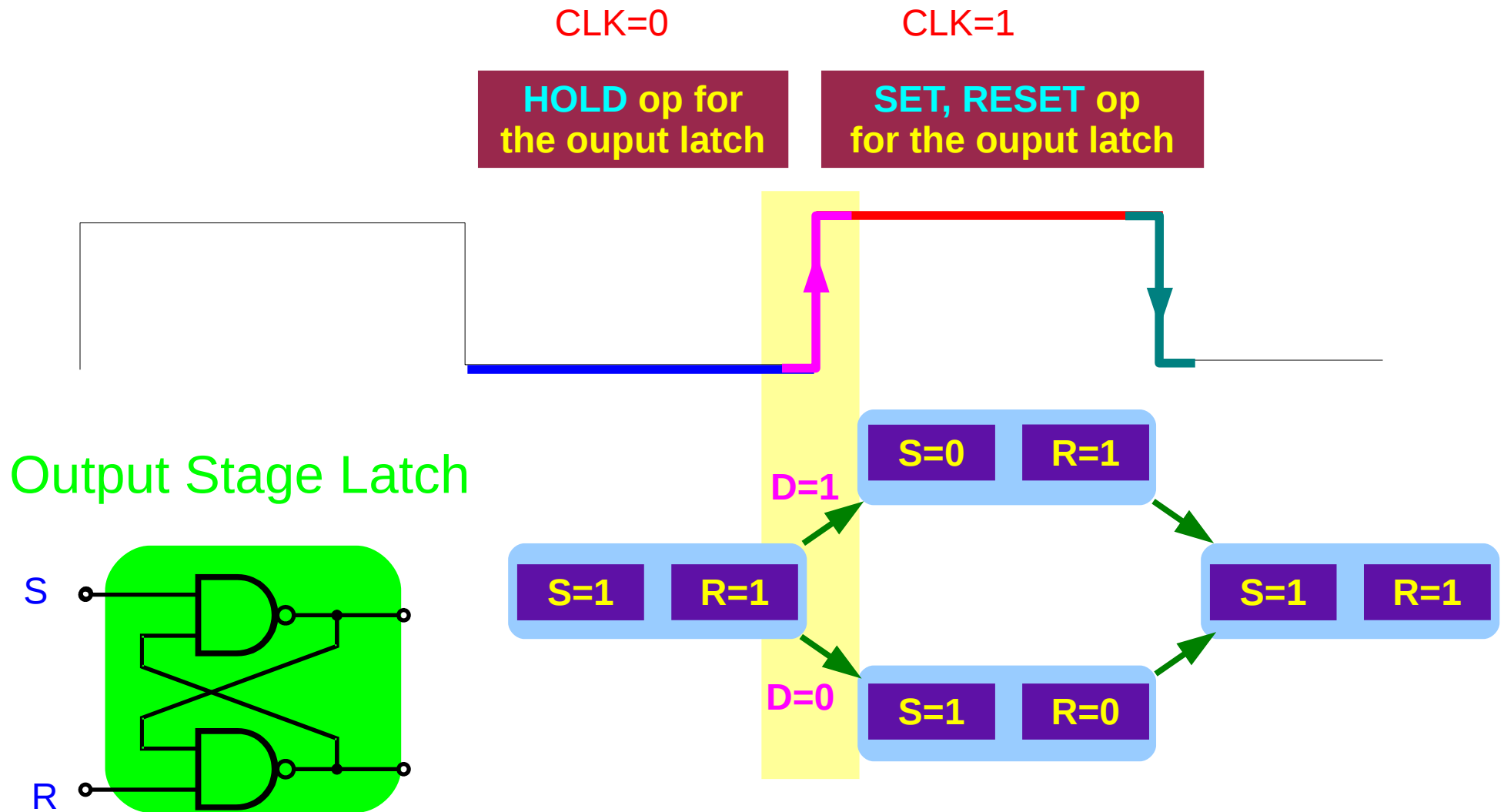
Output Stage Latch

Input Stage Latches

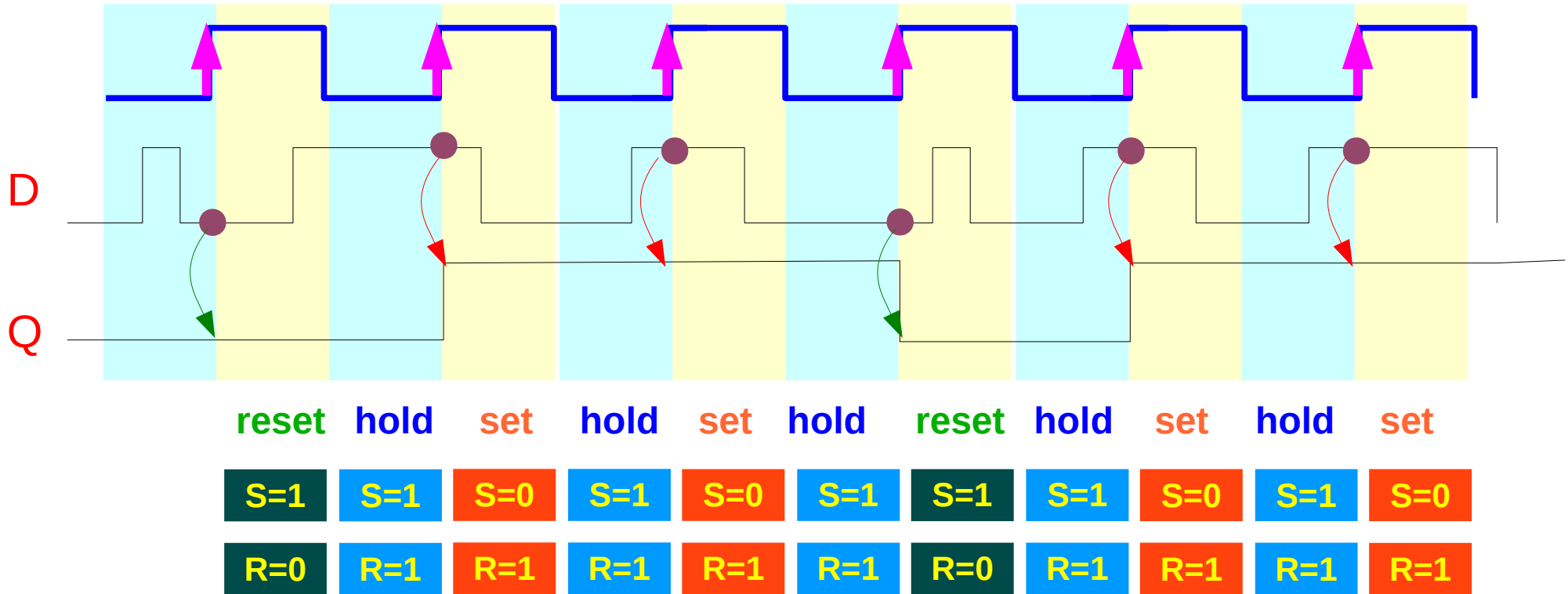


* figures from wikipedia.org

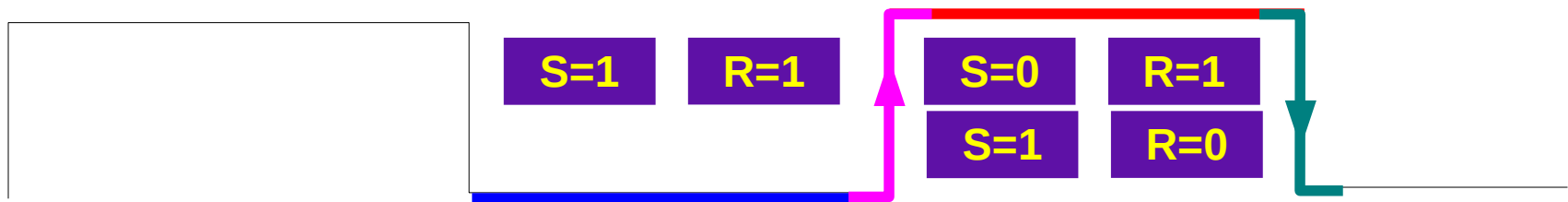
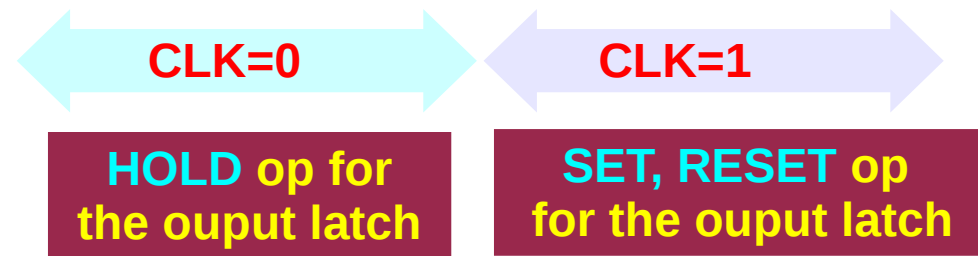
Classical Edge Triggered FF



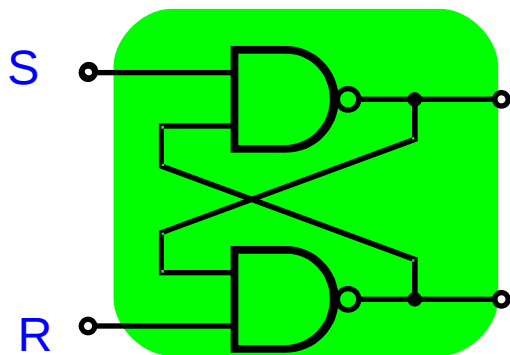
Classical Edge Triggered FF



Classical Edge Triggered FF



Output Stage Latch



↑

CLK=0 → 1

When **D=0**
HOLD → RESET

When **D=1**
HOLD → SET

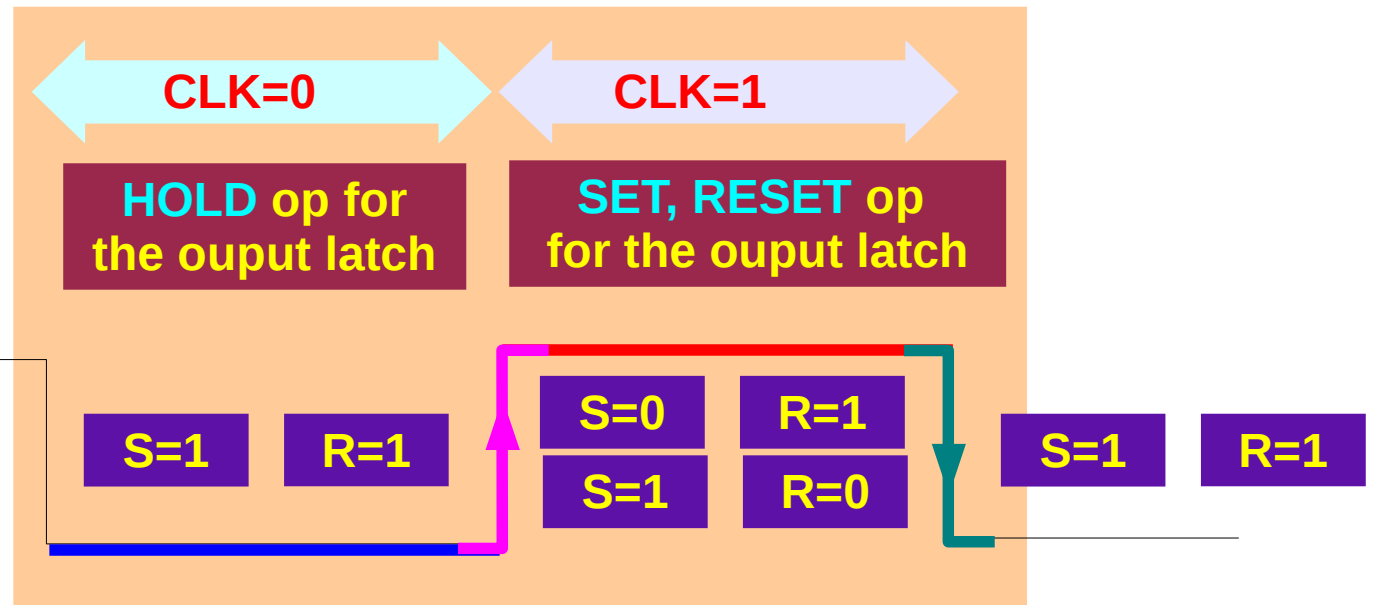
↓

CLK=1 → 0

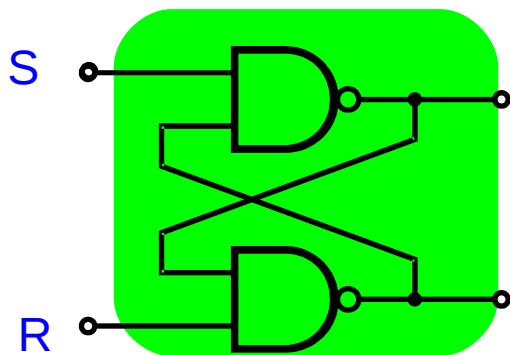
RESET → HOLD

SET → HOLD

Output Latch Operation (Classical Edge Triggered FF)



Output Stage Latch



CLK=0 → 1

When **D=0**
HOLD → RESET

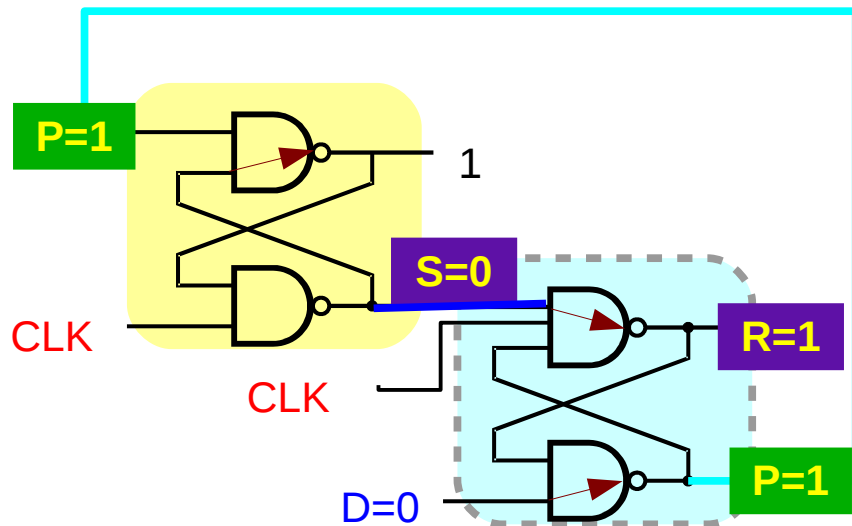
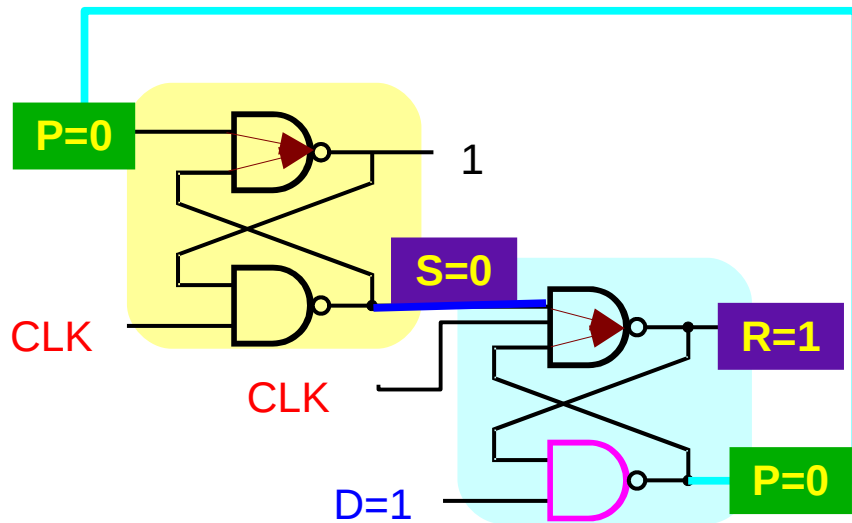
When **D=1**
HOLD → SET

CLK=1 → 0

RESET → HOLD

SET → HOLD

Set Operation (Classical Edge Triggered FF)



SET op for the output latch

When $CLK=1$, regardless of D

S=0 **R=1**

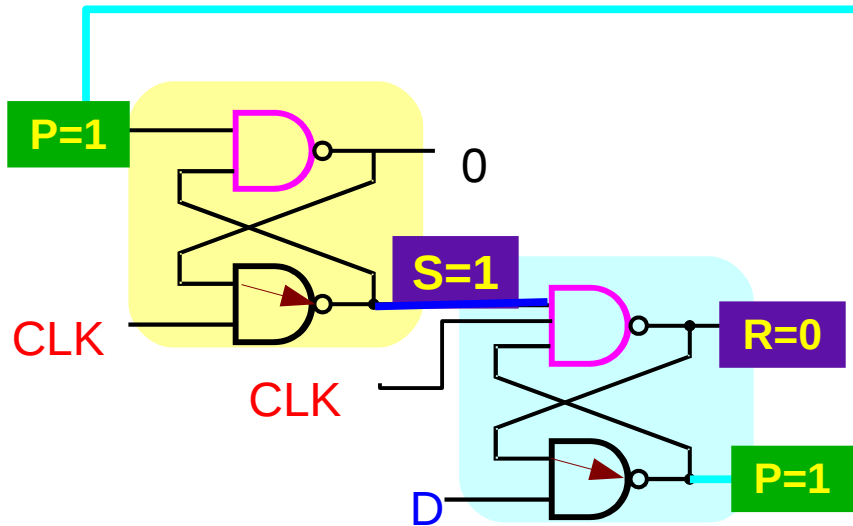
$CLK=0 \rightarrow S=1 \rightarrow CLK=1$

$D=1 \rightarrow P=0$

$CLK=0 \rightarrow S=1 \rightarrow CLK=1$

$D=0 \rightarrow P=1$

Reset Operation (Classical Edge Triggered FF)



RESET op for the output latch

When **CLK=1**, regardless of **D**

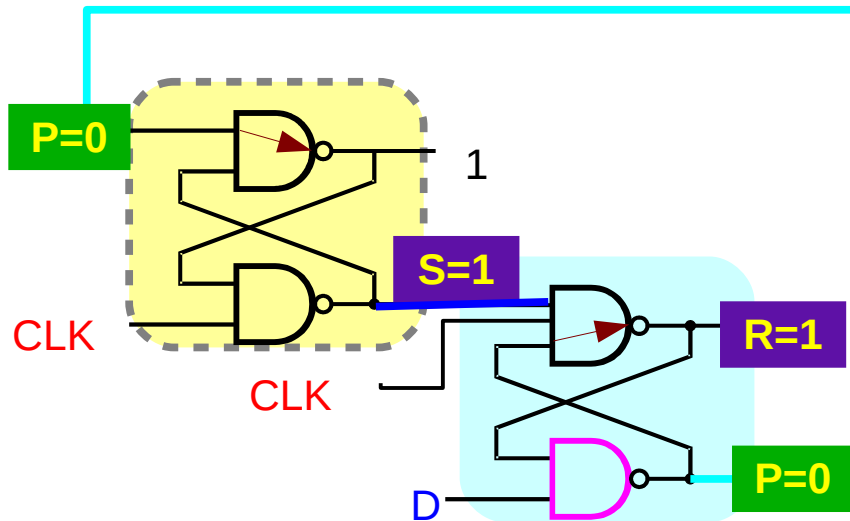
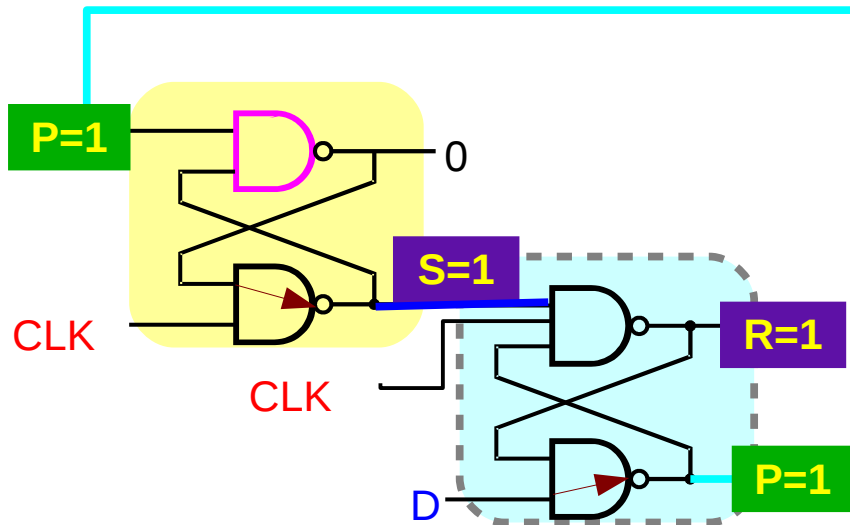
S=1

R=0

CLK=0 → ~~R=1~~ → CLK=1

D=0 / 1

Hold Operation (Classical Edge Triggered FF)



HOLD op for the output latch

When $CLK=0$, regardless of D

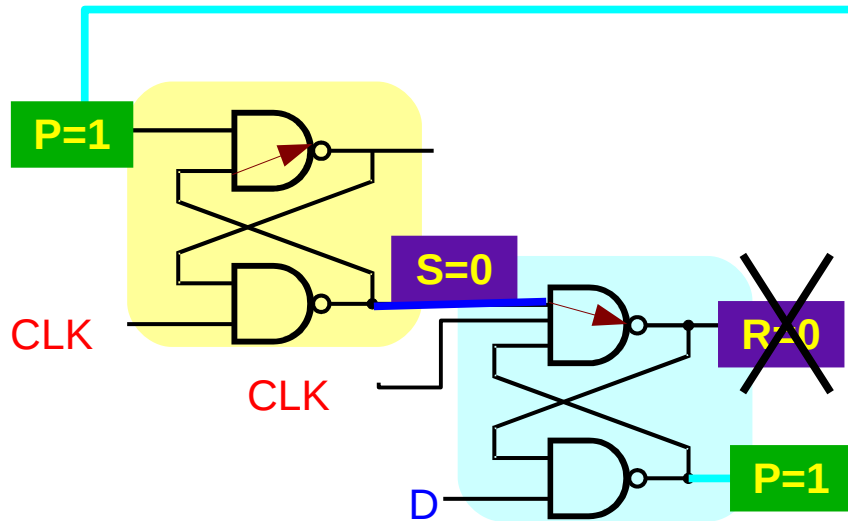
S=1

R=1

$CLK=1 \rightarrow R=0$ \rightarrow $CLK=0$
 $D=0 \rightarrow P=1$

$CLK=1 \rightarrow S=0$ \rightarrow $CLK=0$
 $D=1 \rightarrow P=1$

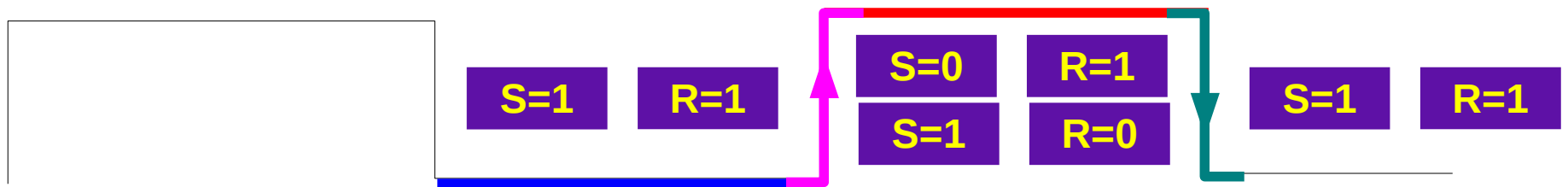
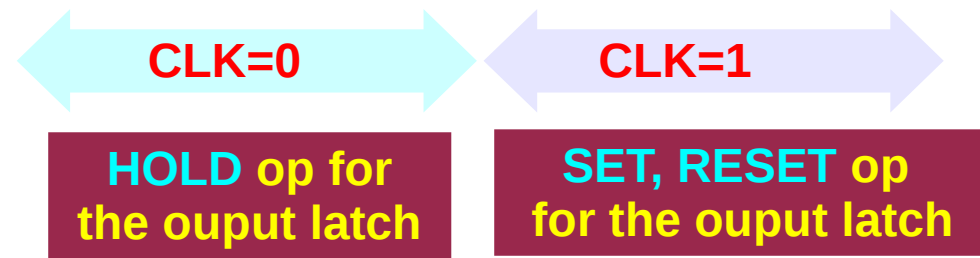
Forbidden Operation (Classical Edge Triggered FF)



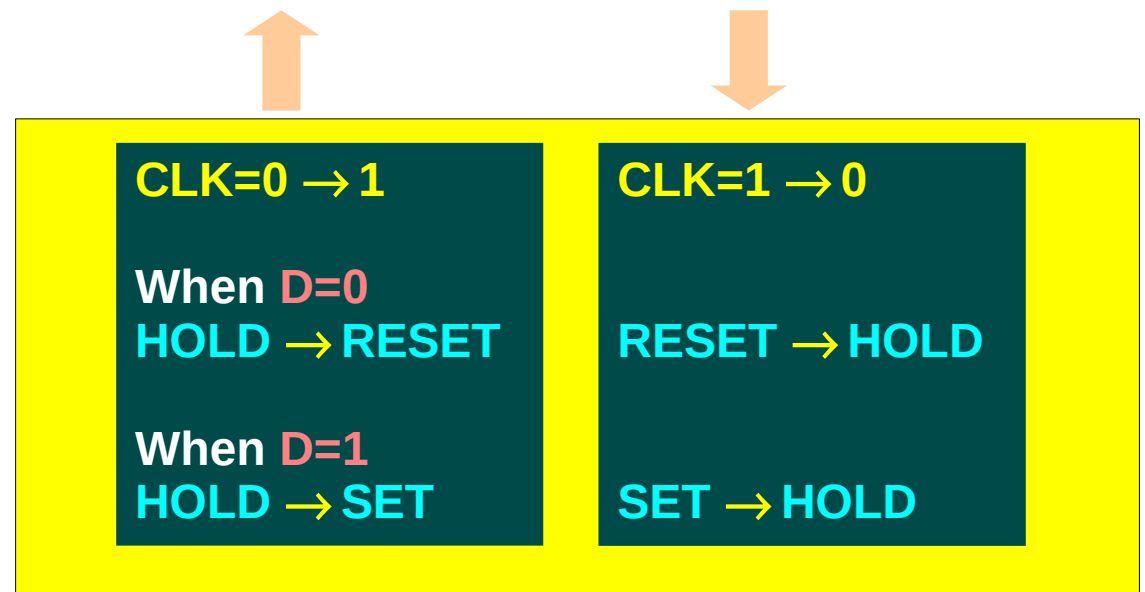
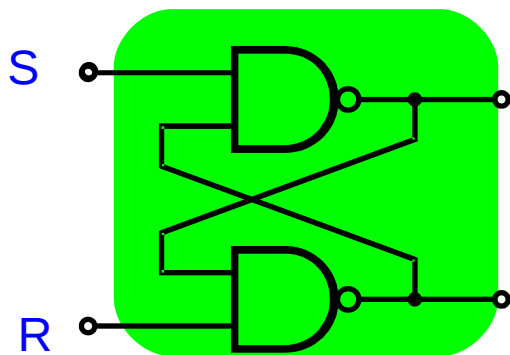
Forbidden for the output latch

Impossible to enter

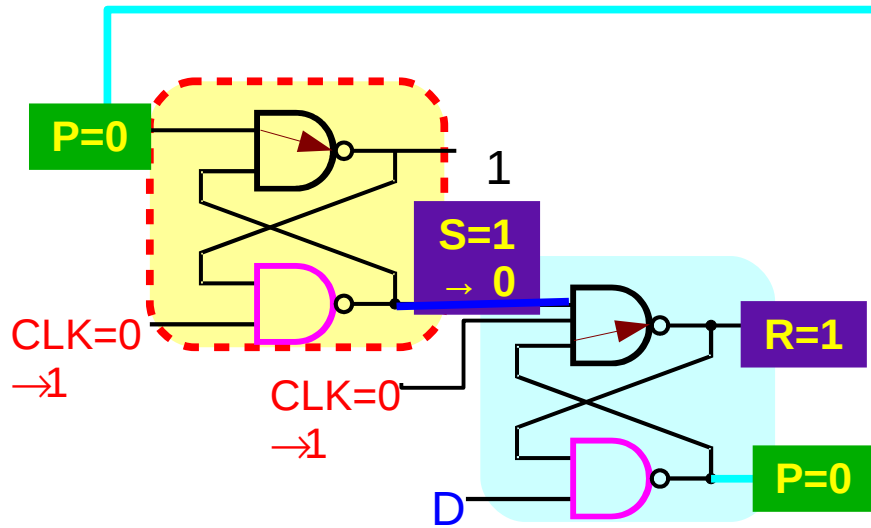
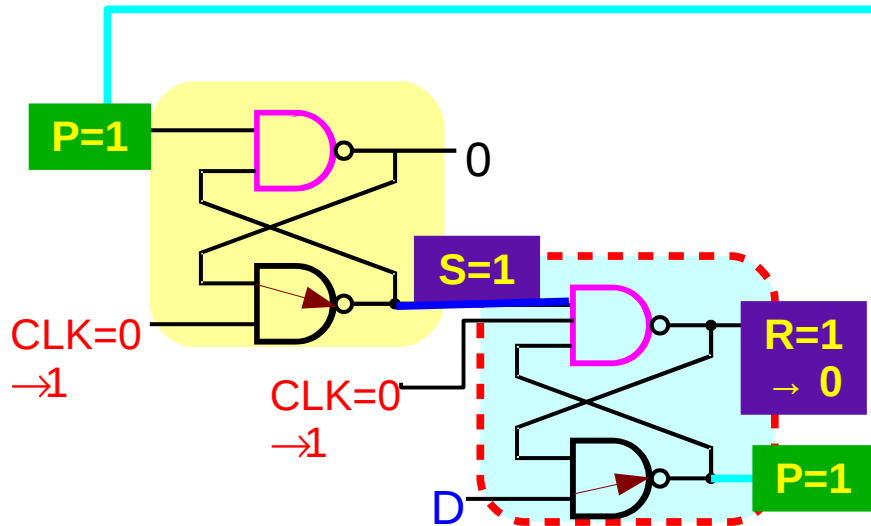
Clock Transition (Classical Edge Triggered FF)



Output Stage Latch



Rising Edge Transition (Classical Edge Triggered FF)



Rising edge CLK=0→1

HOLD → RESET / SET

If D=0 SR=11 → SR=10

If D=1 SR=11 → SR=01

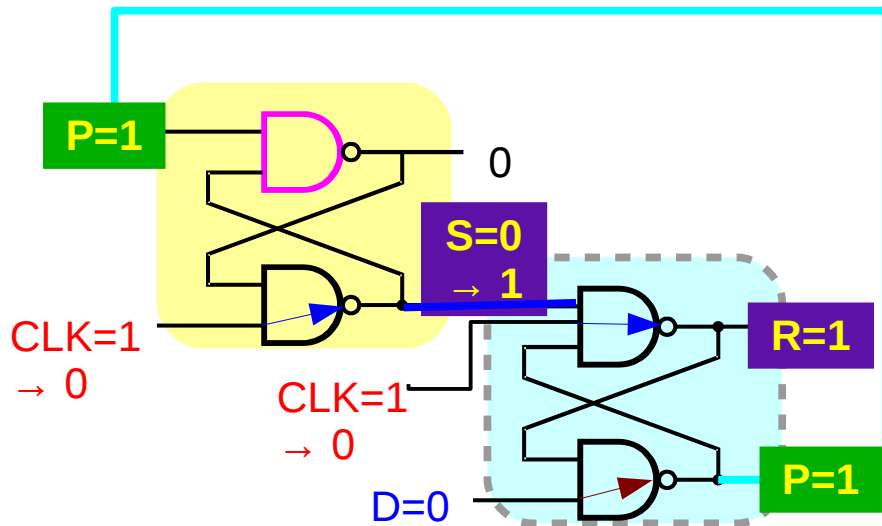
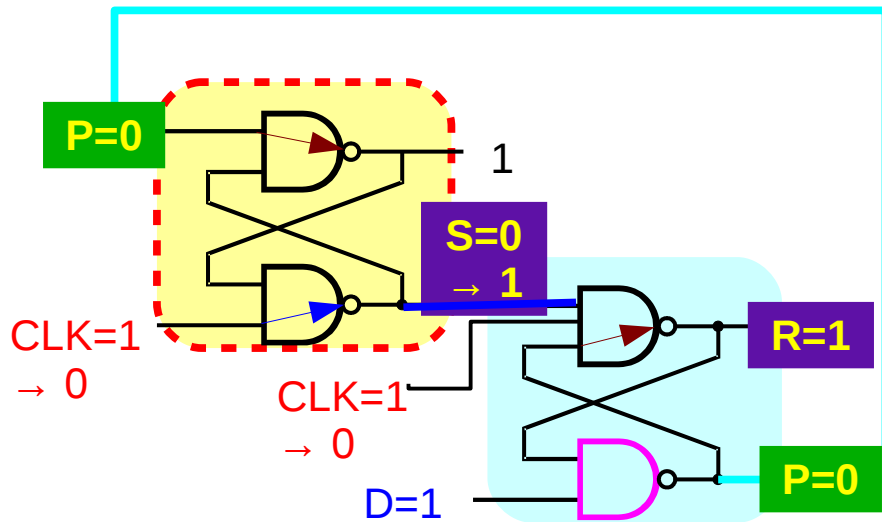
CLK=1 → R=0

D=0 → P=1

CLK=1 → S=0

D=1 → P=1

Falling Edge Transition (1) (Classical Edge Triggered FF)



Falling edge CLK=1 \rightarrow 0

SET \rightarrow HOLD

SR=01

SR=11

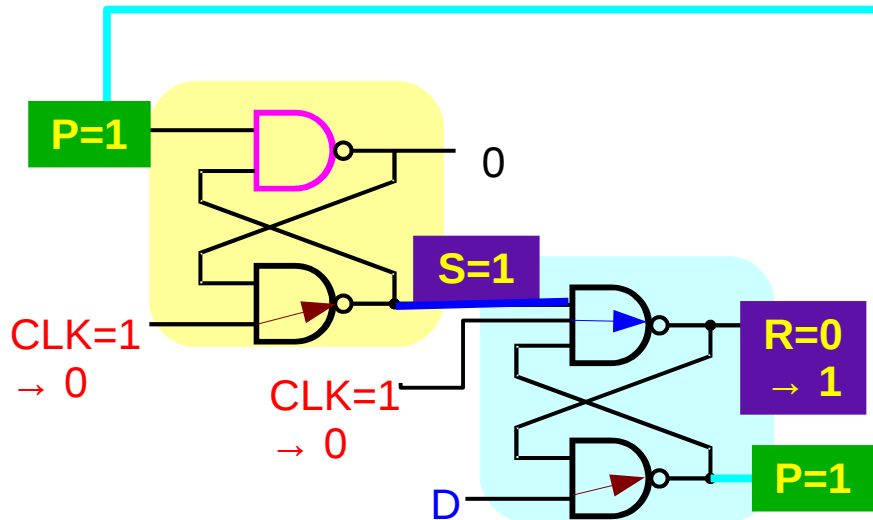
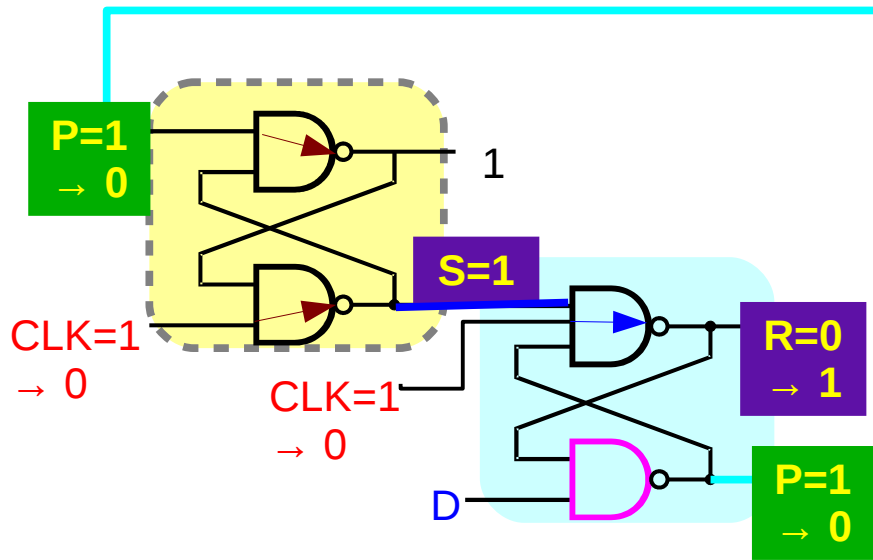
CLK=0 \rightarrow S=1

D=1 \rightarrow P=0

CLK=0 \rightarrow S=1

D=0 \rightarrow P=1

Falling Edge Transition (2) (Classical Edge Triggered FF)



Falling edge CLK=1→0

RESET → HOLD

SR=10

SR=11

CLK=0 → R=1

D=1

CLK=0 → R=1

D=0