

# Flip Flops Recitation

CompArch Fall 2020

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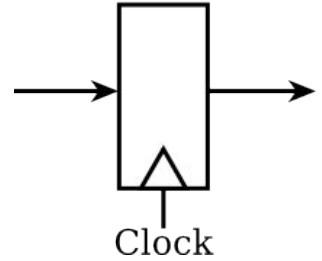
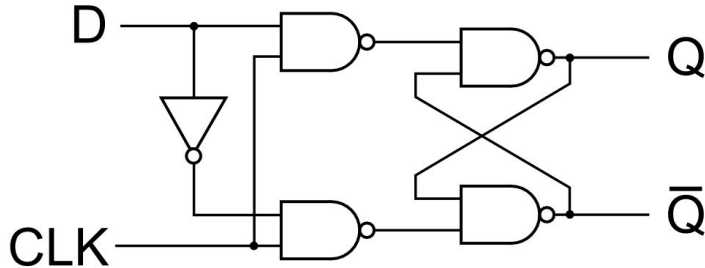
From class...

# What is a flip flop?

- A circuit that has 2 stable states
- Flip flop state changes in sync with clock edge (latches are asynchronous)

# D flip-flop

- Stores 1 bit of data
- Output updates on rising clock edge



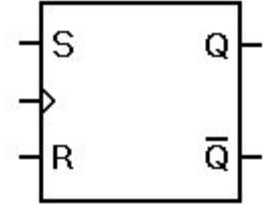
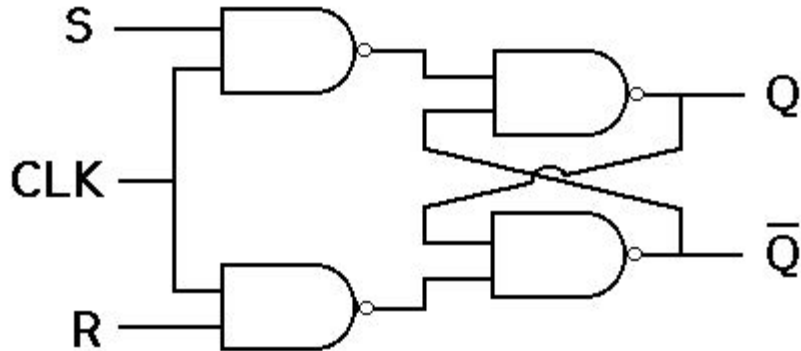
Clk	D	Q
↑	0	0
↑	1	1
Other	X	Q

Other types of flip flops...

# SR Flip Flop

Set reset

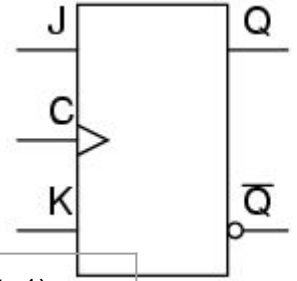
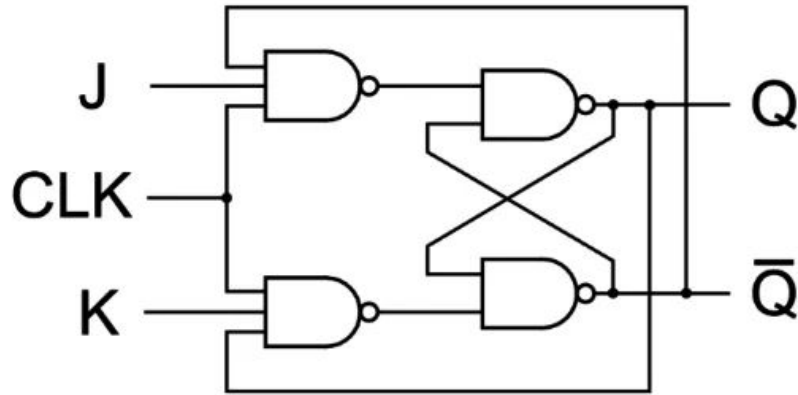
- Most basic flip flop
- Has invalid state when inputs are the same



Q	J	K	Q(t+1)
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	Undefined
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	Undefined

# JK Flip Flop

- Similar to SR FF, but doesn't have an invalid state
- Most versatile type of flip flop

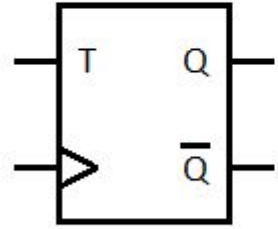
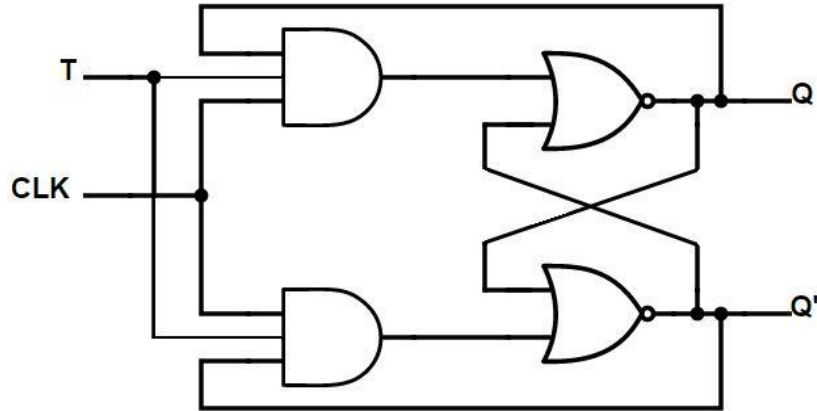


Q	J	K	Q(t+1)
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

# T flip flops

Toggle

- State toggles on each clock edge



T	Q	Q(t+1)
0	0	0
0	1	1
1	0	1
1	1	1

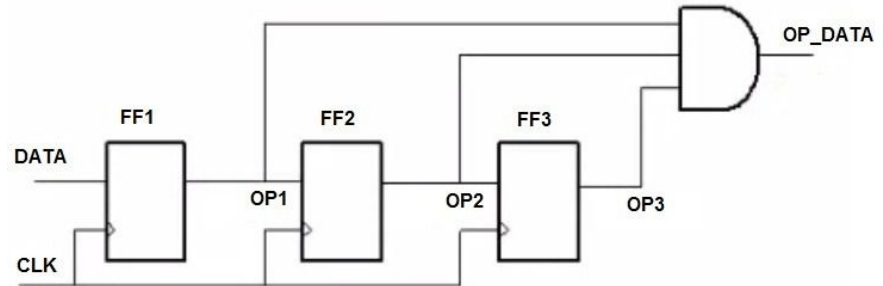
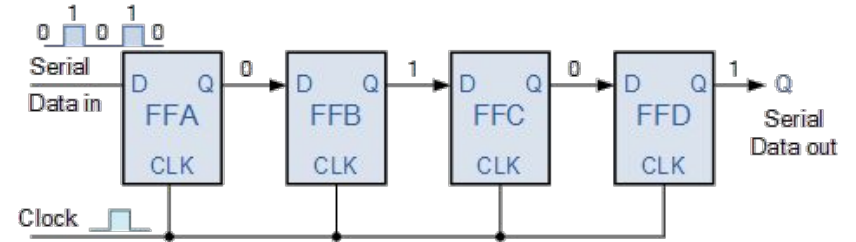


Application examples for D flip flops...

# Shift registers

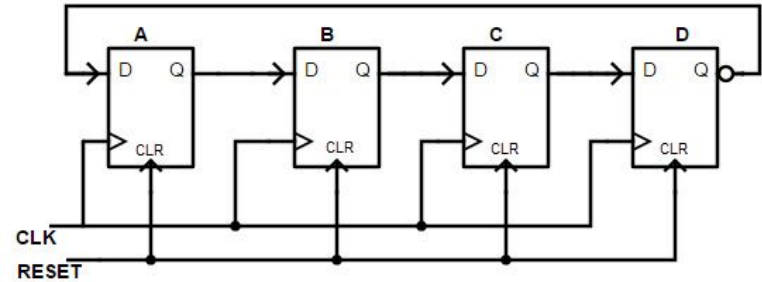
Serial in serial out (SISO):

- Useful for aligning data with system clk
- Useful for debouncing signals



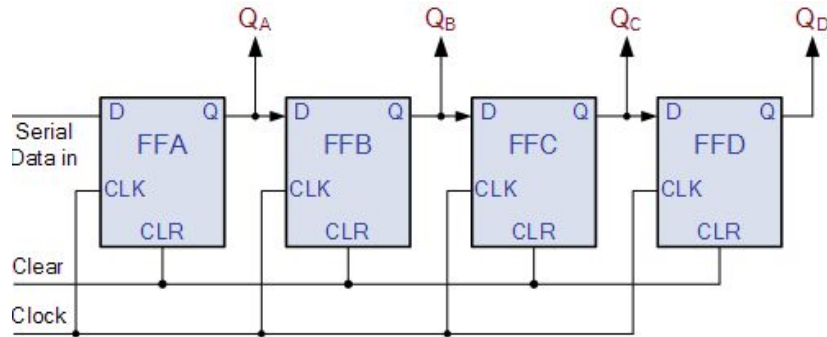
# Shift registers

- Counters (ex: ring counter)
  - Input a pattern, like 0001, where the 1 triggers some behaviour
  - Timing depends on clk rate and length of shift register

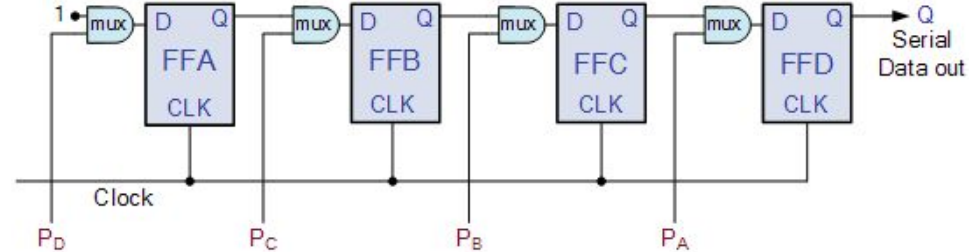


# Shift registers

Serial in parallel out (SIPO)



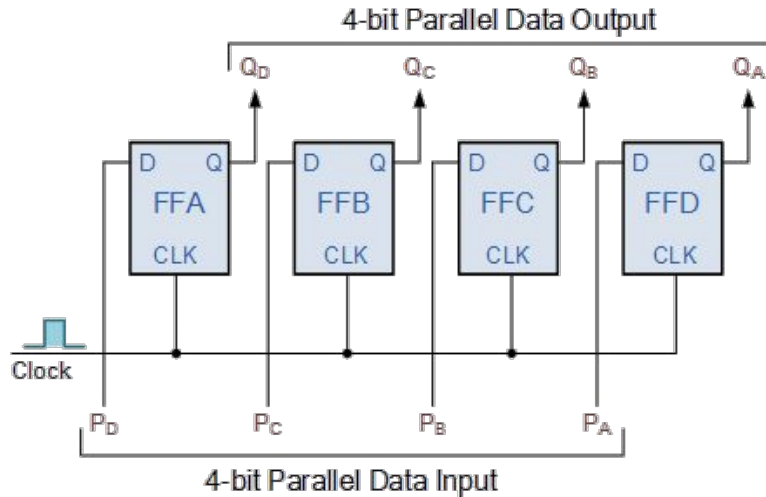
Parallel in serial out (PISO)



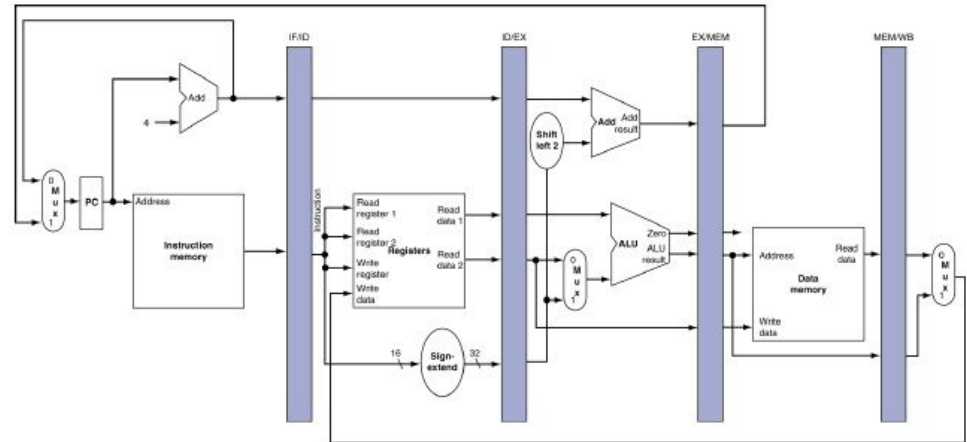
- Useful for converting between serial and parallel data streams
- Can be incorporated into encoding protocols

# Shift registers

Parallel in parallel out (PIPO)



- Useful for pipeline stages in CPU
- Need to hold data from previous stage until next stage is ready for it



# Sources

<https://www.electronicsforu.com/resources/learn-electronics/flip-flop-rs-ik-t-d>

<https://www.circuitstoday.com/flip-flops>

[https://www.google.com/search?q=pipio+shift+register&safe=strict&client=ubuntu&hs=uAU&channel=fs&sxsrf=ALeKk03A7W3wFrKMwuR1QLvO6rarvmtUw:1600634045324&source=inms&tbm=isch&sa=X&ved=2ahUKEwiuJL-9yvirAhVCoXIEHfwMCuQQ\\_AUoAXoECA0QAw&biw=1848&bih=942#mrc=pIdVYtzPAD8utM&imgdii=0uIouIzpwJ1UuM](https://www.google.com/search?q=pipio+shift+register&safe=strict&client=ubuntu&hs=uAU&channel=fs&sxsrf=ALeKk03A7W3wFrKMwuR1QLvO6rarvmtUw:1600634045324&source=inms&tbm=isch&sa=X&ved=2ahUKEwiuJL-9yvirAhVCoXIEHfwMCuQQ_AUoAXoECA0QAw&biw=1848&bih=942#mrc=pIdVYtzPAD8utM&imgdii=0uIouIzpwJ1UuM)

[https://www.google.com/search?q=sjipo+shift+register&safe=strict&client=ubuntu&hs=ubT&channel=fs&sxsrf=ALeKk01U9Wnx4V-2CZivKY4OxIzcTx\\_Q:1600631875281&source=inms&tbm=isch&sa=X&ved=2ahUKEwi7kd6yvwirAhVOknlEHaCnD7AQ\\_AUoAXoECA0QAw&biw=1848&bih=942#imgrc=3-X2E72voR00WM](https://www.google.com/search?q=sjipo+shift+register&safe=strict&client=ubuntu&hs=ubT&channel=fs&sxsrf=ALeKk01U9Wnx4V-2CZivKY4OxIzcTx_Q:1600631875281&source=inms&tbm=isch&sa=X&ved=2ahUKEwi7kd6yvwirAhVOknlEHaCnD7AQ_AUoAXoECA0QAw&biw=1848&bih=942#imgrc=3-X2E72voR00WM)

[https://www.google.com/search?q=piso+shift+register&safe=strict&client=ubuntu&hs=KXo&channel=fs&sxsrf=ALeKk02k2MbOKawa1LzIpC6tU\\_7afipR6q:1600632874357&source=inms&tbm=isch&sa=X&ved=2ahUKEwi445CPxvirAhXcqnIEHV'sVD3sQ\\_AUoAXoECA0QAw&biw=1848&bih=942#imgrc=8fqBjJMaBYVn0M](https://www.google.com/search?q=piso+shift+register&safe=strict&client=ubuntu&hs=KXo&channel=fs&sxsrf=ALeKk02k2MbOKawa1LzIpC6tU_7afipR6q:1600632874357&source=inms&tbm=isch&sa=X&ved=2ahUKEwi445CPxvirAhXcqnIEHV'sVD3sQ_AUoAXoECA0QAw&biw=1848&bih=942#imgrc=8fqBjJMaBYVn0M)

[https://www.google.com/search?q=siso+shift+register&safe=strict&client=ubuntu&hs=cp8&channel=fs&sxsrf=ALeKk01wszt1qWnbZGHq6tXCBBpYcWw8w:1600631447926&source=inms&tbm=isch&sa=X&ved=2ahUKEwiZrfrmwPirAhU8oXIEHX4KDKIQ\\_AUoAXoECA0QAw&biw=1848&bih=942#imgrc=zXURnuRAaq5TpM](https://www.google.com/search?q=siso+shift+register&safe=strict&client=ubuntu&hs=cp8&channel=fs&sxsrf=ALeKk01wszt1qWnbZGHq6tXCBBpYcWw8w:1600631447926&source=inms&tbm=isch&sa=X&ved=2ahUKEwiZrfrmwPirAhU8oXIEHX4KDKIQ_AUoAXoECA0QAw&biw=1848&bih=942#imgrc=zXURnuRAaq5TpM)

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[https://www.google.com/search?q=t+flip+flop+symbol&safe=strict&client=firefox-b-d&sxsrf=ALeKk02BKcAAzXXh1P0bLqVqGhQQY-Hoq:1599298954488&source=inms&tbm=isch&sa=X&ved=2ahUKEwivg8nw3NHrAhW5lDQIHaeTDBYQ\\_AUoAXoECA8QAw&biw=1152&bih=521#imgrc=dZRB3jiagKFTNM](https://www.google.com/search?q=t+flip+flop+symbol&safe=strict&client=firefox-b-d&sxsrf=ALeKk02BKcAAzXXh1P0bLqVqGhQQY-Hoq:1599298954488&source=inms&tbm=isch&sa=X&ved=2ahUKEwivg8nw3NHrAhW5lDQIHaeTDBYQ_AUoAXoECA8QAw&biw=1152&bih=521#imgrc=dZRB3jiagKFTNM)

[https://www.google.com/search?q=ik+flip+flop+circuit&safe=strict&client=firefox-b-d&sxsrf=ALeKk02B5Qanh8hCYP\\_-EUHG0IRi4Wizq:1599297305043&source=inms&tbm=isch&sa=X&ved=2ahUKEwiuqlfe1HrAhXULH0KHcT6DHoQ\\_AUoAXoECA0QAw&biw=1152&bih=521#imgrc=EY8TOIx\\_PJlvaM](https://www.google.com/search?q=ik+flip+flop+circuit&safe=strict&client=firefox-b-d&sxsrf=ALeKk02B5Qanh8hCYP_-EUHG0IRi4Wizq:1599297305043&source=inms&tbm=isch&sa=X&ved=2ahUKEwiuqlfe1HrAhXULH0KHcT6DHoQ_AUoAXoECA0QAw&biw=1152&bih=521#imgrc=EY8TOIx_PJlvaM)

[https://www.google.com/search?q=ik+flip+flop+symbol&safe=strict&client=firefox-b-d&sxsrf=ALeKk022rKeira0h7zm1OeHJEdMDatqARA:1599298827394&source=inms&tbm=isch&sa=X&ved=2ahUKEwi3\\_uz3NHrAhXICQIHcroChcQ\\_AUoAXoECA4QAw&biw=1152&bih=521#imgrc=u3JAEpfmkfifm](https://www.google.com/search?q=ik+flip+flop+symbol&safe=strict&client=firefox-b-d&sxsrf=ALeKk022rKeira0h7zm1OeHJEdMDatqARA:1599298827394&source=inms&tbm=isch&sa=X&ved=2ahUKEwi3_uz3NHrAhXICQIHcroChcQ_AUoAXoECA4QAw&biw=1152&bih=521#imgrc=u3JAEpfmkfifm)

[https://www.google.com/search?q=sr+flip+flop+circuit&safe=strict&client=firefox-b-d&sxsrf=ALeKk02rGUUaZrNwZbU-0528U2JvJvire:1599296538096&source=inms&tbm=isch&sa=X&ved=2ahUKEwILqazw09HrAhWSKDQIHyoECbcQ\\_AUoAnoECA0QBA&biw=1152&bih=521#imgrc=mgCNL\\_QiC3rpdM](https://www.google.com/search?q=sr+flip+flop+circuit&safe=strict&client=firefox-b-d&sxsrf=ALeKk02rGUUaZrNwZbU-0528U2JvJvire:1599296538096&source=inms&tbm=isch&sa=X&ved=2ahUKEwILqazw09HrAhWSKDQIHyoECbcQ_AUoAnoECA0QBA&biw=1152&bih=521#imgrc=mgCNL_QiC3rpdM)

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[https://www.google.com/search?q=sr+flip+flop+truth+table&safe=strict&client=ubuntu&hs=3fU&channel=fs&sxsrf=ALeKk03BWIP\\_Zyqvd\\_kbohnurmY7di9l6w:1600635976737&source=inms&tbm=isch&sa=X&ved=2ahUKEwiggl\\_vW0firAhVclHIEHABWCooQ\\_AUoAXoECA0QAw&biw=1848&bih=942#imgrc=fatV\\_7lIDK6U3M](https://www.google.com/search?q=sr+flip+flop+truth+table&safe=strict&client=ubuntu&hs=3fU&channel=fs&sxsrf=ALeKk03BWIP_Zyqvd_kbohnurmY7di9l6w:1600635976737&source=inms&tbm=isch&sa=X&ved=2ahUKEwiggl_vW0firAhVclHIEHABWCooQ_AUoAXoECA0QAw&biw=1848&bih=942#imgrc=fatV_7lIDK6U3M)

[https://www.google.com/search?q=pipeline+register+circuit&tbm=isch&ved=2ahUKEwiAplai7firAhVf18KtSHGhDIAQ2-cCeqQIABAA&og=pipeline+register+circuit&gs\\_lcp=CgNpbWcQAzoAzoECCMQJzoECAAQGDoeCAAQHIDBIViKWDRCkmgAcAB4AIABIwGIAQFkqEDOC4xmAEAoAEBqgELZ3dZL\\_Xdpei1pbWIAAQE&client=img&ei=OeFnx4CkNuOs\\_AahwrgABQ&bih=942&biw=1848&client=ubuntu&hs=XbW&safe=strict#imgrc=iWxNUK-D8lvc4M&imgdii=TV2PDDeisJ5HzM](https://www.google.com/search?q=pipeline+register+circuit&tbm=isch&ved=2ahUKEwiAplai7firAhVf18KtSHGhDIAQ2-cCeqQIABAA&og=pipeline+register+circuit&gs_lcp=CgNpbWcQAzoAzoECCMQJzoECAAQGDoeCAAQHIDBIViKWDRCkmgAcAB4AIABIwGIAQFkqEDOC4xmAEAoAEBqgELZ3dZL_Xdpei1pbWIAAQE&client=img&ei=OeFnx4CkNuOs_AahwrgABQ&bih=942&biw=1848&client=ubuntu&hs=XbW&safe=strict#imgrc=iWxNUK-D8lvc4M&imgdii=TV2PDDeisJ5HzM)