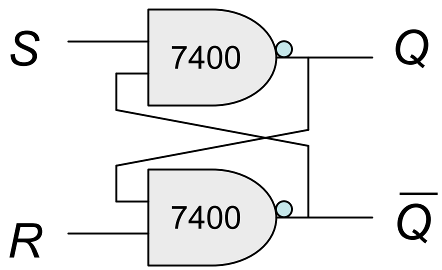
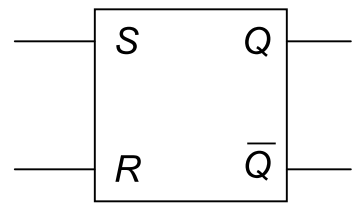
Digital Circuitry

Flip-Flops
LEDs - Seven Segment Decoder
Binary Counters
Multiplexing
Shift Registers
Adder
One Shot

Flip-Flop

•In a number of digital applications one needs a device whose outputs Q1,Q2 states go hi and low as the input states changes.
•Since S/R=1/0 and S/R=0/0 leave *Q=1* we have a bounceless switch!

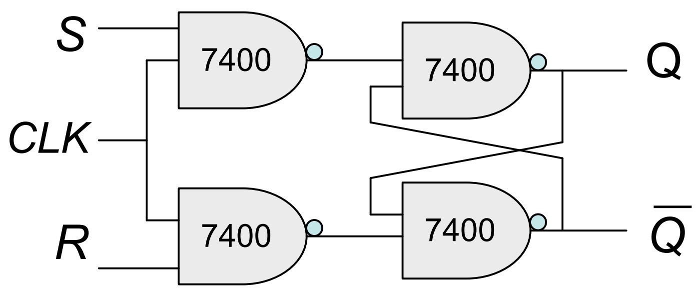


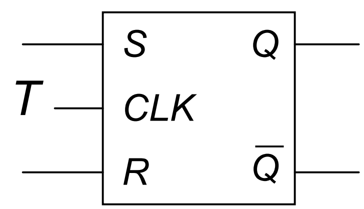


Set	*Reset*	*Q*	$\overline{Q}$
0	0	NC	NC
1	0	1	0
0	1	0	1
1	1	?	?

RST Flip-Flop (Latch)

- In a clocked RST-FF the state is only allowed to change if the clock is high.
- The clock signal thus *latches* (locks) the output state.

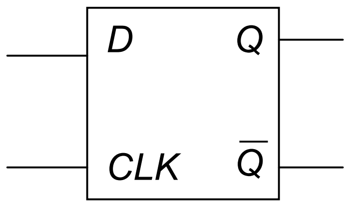


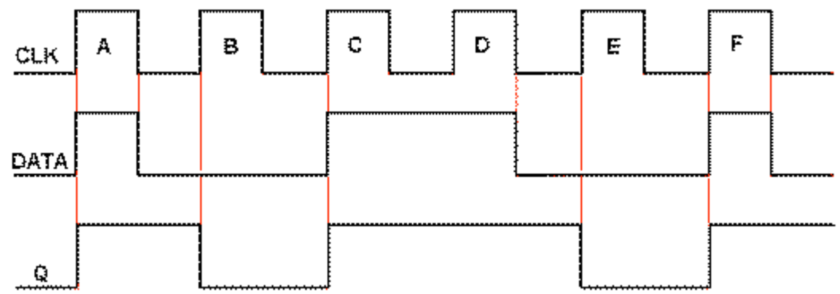


		CLK=1		*CLK=0*	
Set	*Reset*	*Q*	$\overline{Q}$	*Q*	$\overline{Q}$
0	0	NC	NC	NC	NC
1	0	1	0	NC	NC
0	1	0	1	NC	NC
1	1	?	?	NC	NC

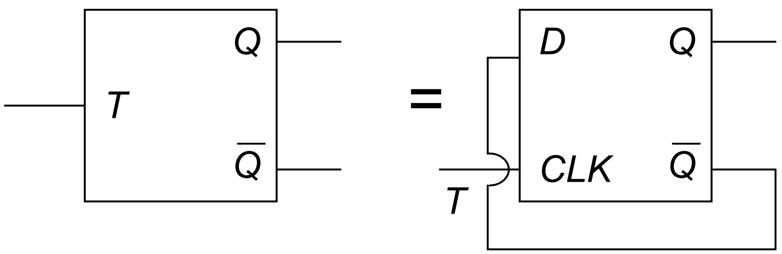
Data and Toggle Flip-Flops

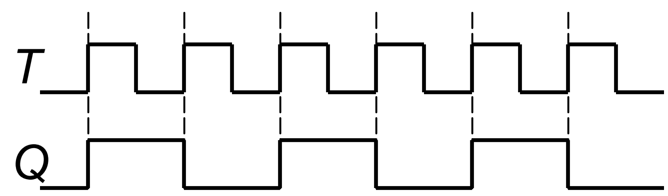
•A D flip-flop (DFF) avoids the indeterminant states (NR).
•When the CLK=hi   *Q* is set to D (0 or 1)
•When CLK = low   *Q* unchanged





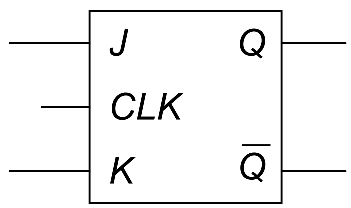
•A Toggle flip-flop (TFF) flips state upon a T=1 pulse.
•When T=1 *Q=0 -> Q=1* or *Q=1 -> Q=0*
•When T=0 No Change





JK Flip-Flops

- The J-K flip-flop can be wired to behave as most other types of flip-flop.
- It incorporates the functionality of the previous FFs.



•CLK=LO NC

•CLK=HIGH

If J is high and K is low, *Q* will set. (*Q=1*)

If K is high and J is low, *Q* will reset (*Q=0*)

If J and K are both low, *Q* will not change. (NC)

If J and K are both high, the output toggles on the clock pulse.

BCD to 7-Segment Decoder

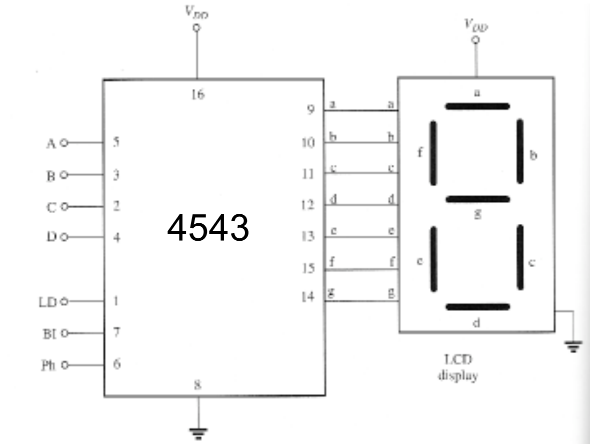
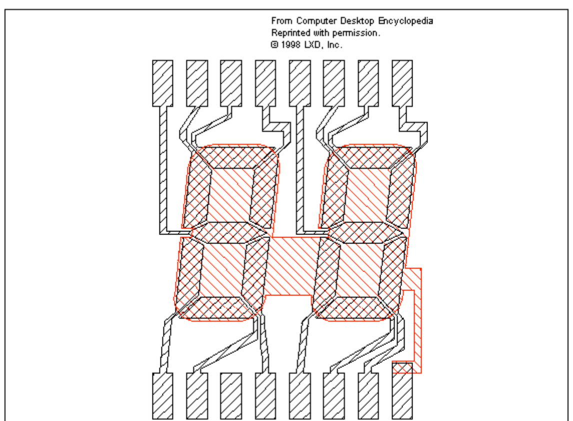


FIGURE 12.14 **BCD-to-seven-segment latch/decoder/driver for LCD display.**



Seven-segment Display
Using two seven-segment display units, this readout can show from 00 to 99. Each of the seven segments has its own contact to the outside electronics. *(Image courtesy of LXD, Inc.)*

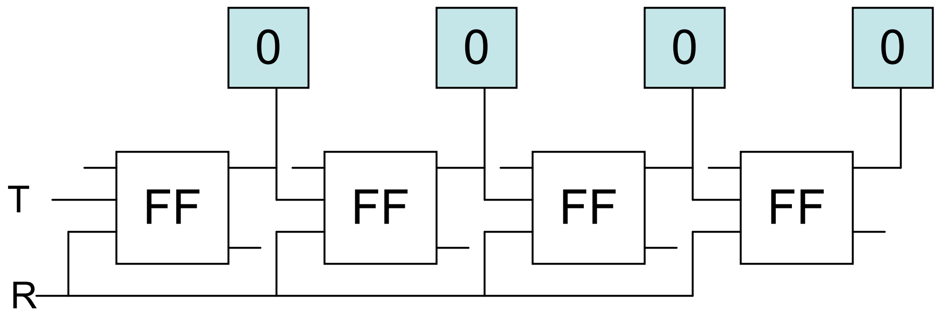
- Two 7-segment displays.

- BCD #'s are decoded to turn on digit forming LEDs

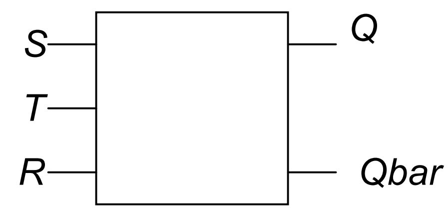
BCD inputs				*segment outputs*							*display*
D	*C*	*B*	*A*	*a*	*b*	*c*	*d*	*e*	*f*	*g*	
0	0	0	0	1	1	1	1	1	1	0	0
0	0	0	1	0	1	1	0	0	0	0	1
0	0	1	0	1	1	0	1	1	0	1	2
0	0	1	1	1	1	1	1	0	0	1	3
0	1	0	0	0	1	1	0	0	1	1	4
0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	0	0	1	1	1	1	1	6
0	1	1	1	1	1	1	0	0	0	0	7
1	0	0	0	1	1	1	1	1	1	1	8
1	0	0	1	1	1	1	0	0	1	1	9

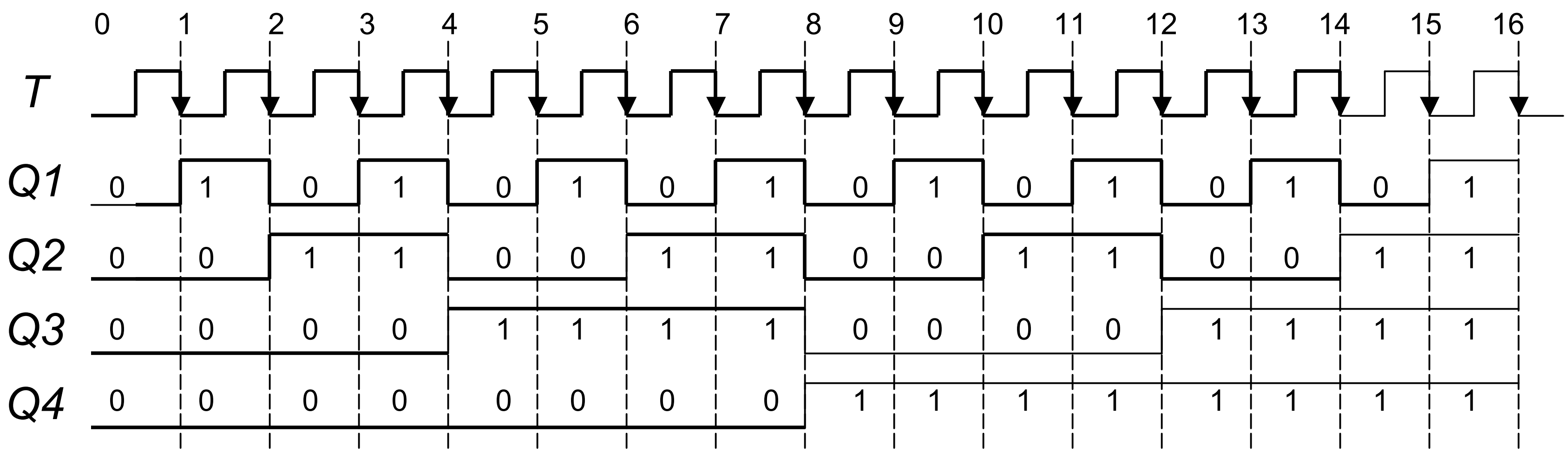
Ripple Counter

- A ripple counter uses RST flip-flops to perform binary counting.
- The *Q* of each FF toggles the next in the chain.
- Initially a reset *R=1* is issued setting all flip-flops to *Q=0.*
- The *true* RST FF changes on a down transition.



Ripple Counter





Multiplexer

- A multiplexer allows any of a number of inputs states to be translated to to an output state.
- A decimel input could be multiplexed to a binary output.
- A number of analogue inputs can be translated to a digital out.
- 16 digital inputs can be multiplexed to 4 outputs, thus a reduction in the number of cables.

Shift Register

- An register holds n bits of digital information to be used in further operations, usually constructed with a series of flip-flops.
- The bits in a *serial-shift register* can be shifted to the right or left in n clock cycles.
- The bits in a *parallel shift register* can be simultaneously shifted in or out in one clock cycle.

One Shot

- It is often needed that a digital pulse be created when an input signal makes a transition from low to high state. - *monostable multivibrator* (one-shot).
- The pulse duration can be controlled by an RC time constant. $\Delta T \sim RC$
- When signal A transitions above *B=0, the Q* output goes high for ΔT.