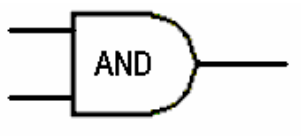
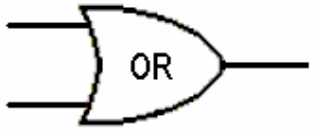
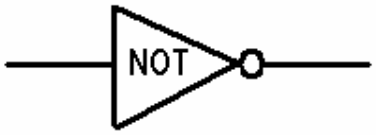
Logic Gates



A	B	$Y = A \bullet B$
0	0	0
0	1	0
1	0	0
1	1	1



A	B	$Y = A + B$
0	0	0
0	1	1
1	0	1
1	1	1



A	$Y = \overline{A}$
0	1
1	0

A	B	$Y = \overline{A \bullet B}$
0	0	1
0	1	1
1	0	1
1	1	0

A	B	$Y = \overline{A + B}$
0	0	1
0	1	0
1	0	0
1	1	0

A	B	$Y = A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

Boolean Algebra Properties

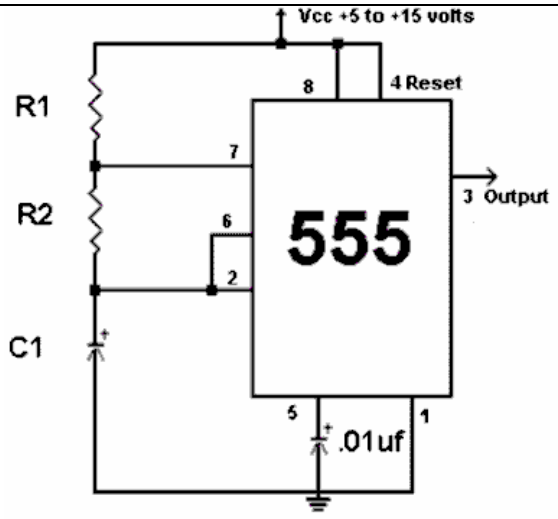
$A \bullet 0 = 0$
$A + 0 = A$
$A \bullet 1 = A$
$A + 1 = 1$
$A \bullet A = A$
$A + A = A$
$\overline{\overline{A}} = A$

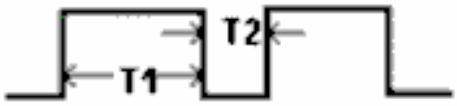
$A \bullet \overline{A} = 0$
$A + \overline{A} = 1$
$A \oplus B = \overline{A} \bullet B + A \bullet \overline{B}$
$\overline{A \oplus B} = \overline{A} \bullet \overline{B} + A \bullet B$
$A \bullet B = B \bullet A$
$A + B = B + A$

$A + A \bullet B = A$
$A \bullet (A + B) = A$
$A \bullet (\overline{A} + B) = A \bullet B$
$A + \overline{A} \bullet B = A + B$
$\overline{A} + A \bullet B = \overline{A} + B$
$\overline{A} + A \bullet \overline{B} = \overline{A} + \overline{B}$

$A \bullet (B + C) = A \bullet B + A \bullet C$
$A + B \bullet C = (A + B) \bullet (A + C)$
$A \bullet (B \bullet C) = (A \bullet B) \bullet C$
$A + (B + C) = (A + B) + C$
$\overline{A \bullet B} = \overline{A} + \overline{B}$
$\overline{A + B} = \overline{A} \bullet \overline{B}$

555-Timer





Charge Cycle: $T1 = 0.693(R1 + R2)C1$

$\tau 1 = (R1 + R2)C1$

Off Time: $T2 = 0.693(R2)C1$

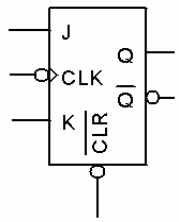
$\tau 2 = (R2)C1$

Frequency: $f = \dfrac{01.44}{(R1 + 2R2)C1}$

Period: $T = T1 + T2$

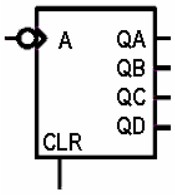
Duty Cycle (percentage): $D = \dfrac{T1}{T} \times 100$

J-K flip-flop



J	K	C	Q	$\overline{Q}$
0	0	p	no change	
0	1	p	0	1
1	0	p	1	0
1	1	p	toggle	

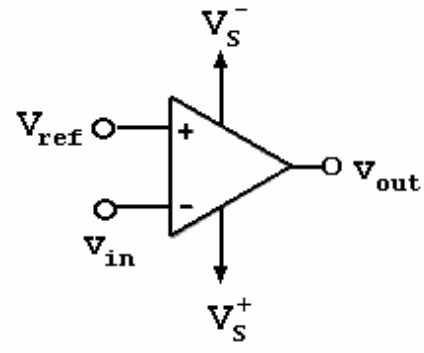
4-bit Counter



C	QD	QC	QB	QA
–	0	0	0	0
p	0	0	0	1
p	0	0	1	0
p	0	0	1	1
p	0	1	0	0
		(etc.)		

$$Q_D \times 2^3 + Q_C \times 2^2 + Q_B \times 2^1 + Q_A \times 2^0$$

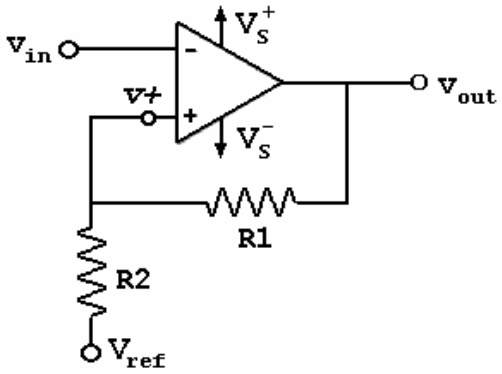
Inverting Comparator



$$if\ v_{in} > V_{ref}\ then\ v_{out} = V_S^-$$

$$if\ v_{in} < V_{ref}\ then\ v_{out} = V_S^+$$

Schmitt Trigger



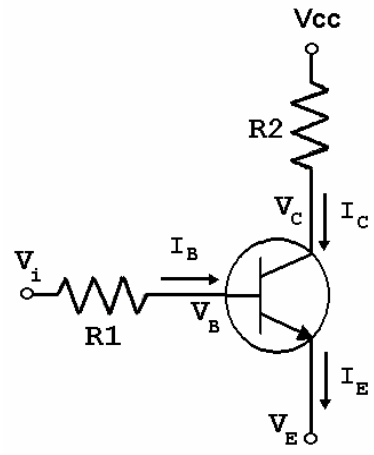
$$v+ = \left(\frac{R_2}{R_1 + R_2}\right)(v_{out} - V_{ref}) + V_{ref}$$

$$if\ v_{in} > v+\ then\ v_{out} = V_S^-$$

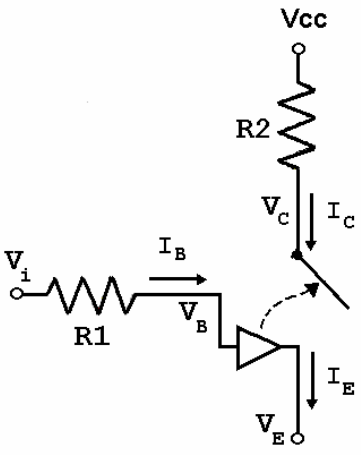
$$if\ v_{in} < v+\ then\ v_{out} = V_S^+$$

Transistor as a switch

Transistor circuit



Transistor model



if $(V_i - V_E) < 0.7$
* transistor is off
* switch is open
* $I_C = 0$ mA
* $V_C = V_{CC}$

if $(V_i - V_E) > 0.7$
* transistor is on
* switch is closed
* $I_C >> I_B$
* $(V_B - V_E) = 0.7$
* $V_{R1} = (V_i - (0.7 + V_E))$
* $V_C = V_E$