

# THE DISCRETE SCHMITT TRIGGER

V15.3

A *Schmitt Trigger* is a comparator that can be made with discrete transistors. It has hysteresis, but the threshold voltage is somewhat limited and must be set by changing component values. The output voltage swing is also quite limited.

## Operation:

$Q_1$  and  $Q_2$  share an emitter resistor,  $R1$ . It is essential that  $Q_1$ 's collector resistor,  $R_{c1}$ , be larger than  $R_{c2}$ . When an increasing voltage is applied to the input of the circuit,  $Q_1$  begins to turn on when the input voltage exceeds the voltage at the emitters plus 1/2 volt. As  $Q_1$  turns on, it reduces the base current of  $Q_2$  and  $Q_2$  begins to turn off. However, since  $R_{c1}$  is greater than  $R_{c2}$ , the net current flow through  $R1$  decreases as  $Q_1$  turns on and  $Q_2$  turns off.

As a current through  $R1$  drops, the emitter voltage drops which increases the base current through  $Q_1$ .  $Q_1$  then turns on more, and the process continues. This results in "snap action" (hysteresis) as the circuit switches. This occurs because the turn-on threshold voltage will be slightly higher than the turn off threshold voltage.

A similar, but opposite effect occurs as the input voltage is reduced.

Note the following:

1. Resistor  $R1$  should be relatively small, typically in the range of a few hundred ohms.
2. The input resistance of the Schmitt trigger is very low ( $Q_1$  and  $R1$  do NOT make an emitter follower because it is a switching circuit). Also, the input resistance increases abruptly as the circuit switches ON.
3. Note that the voltage at the output does not get close to the negative rail. Also, the output drive capability is relatively low. There are better circuits for some situations.
4. Depending on values,  $R3$  may not be necessary

