

Figure 34. Simple RC Oscillator Using Two 'HC04 Gates

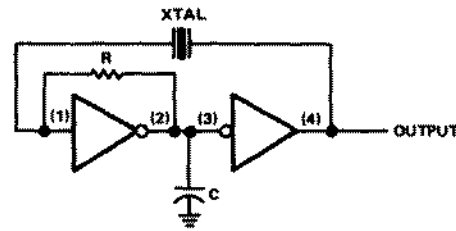


Figure 35. Oscillator Circuit Using a Crystal to Set the Period

VOLTAGE-CONTROLLED OSCILLATORS

Voltage-controlled oscillators (VCOs) can also be designed using a minimal number of components. Figure 36 shows a VCO using NAND and inverter gates. This VCO design exploits the phenomena of the slight variations in the propagation delay of an 'HC gate with changes in the supply voltage. The 'HC00 is connected as a three-stage ring oscillator with a buffer. As the control (supply) voltage V_C is varied, the ring oscillator's frequency changes according to the following:

$$f_{out} \approx 5.8 \times V_C$$

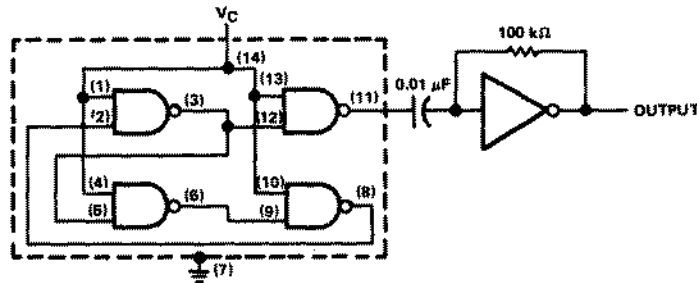


Figure 36. Voltage-Controlled Oscillator (VCO)

The inverter, which is powered by a separate voltage source, serves to restore the oscillator output voltage to 5 V peak-to-peak. This function is required, because the 'HC00 switches from rail-to-rail (as do all HC devices). The magnitude of the oscillator output voltage is thus dependent on V_C . The 100-kΩ resistor across the inverter provides bias such that operation will be within the linear operating region of the gate. The capacitor serves to ac-couple the oscillator to the inverter.

The VCO output is linear for control voltages in the range of 1.5 to 4.5 V (Figure 37).

To prevent oscillator "bleed-through" onto the V_{CC} line, adequate decoupling of the 'HC device power supply is required.

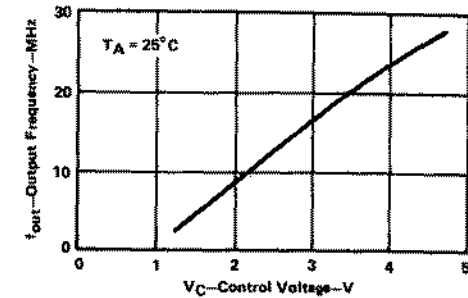


Figure 37. VCO Output Frequency vs Input Voltage

Drivers for LEDs and Relays

INTRODUCTION

SN54/74HC devices are capable of sinking or sourcing up to 25 mA (35 mA for high-current devices) per gate. As the device sinks or sources more current, V_{OHmin} or V_{OLmax} levels will begin to fall or rise respectively.

Because of these characteristics, SN54/74HC devices can be used to drive LEDs and relays.

DRIVING LEDs

Figure 38 shows an 'HC04 driving a TIL221 gallium phosphide light-emitting diode. The resistor performs the function of current limiter. The luminous intensity of the LED depends on the amount of forward current.

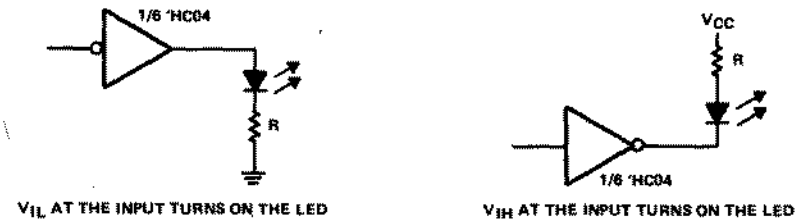


Figure 38. 'HC04 Driving a LED

Example: Using 10 mA forward current and 2.2 V forward voltage, the value of the current-limiting resistor can be calculated using the following equations:

$$\text{[for Figure 38(a)] } R = \frac{V_{OH} - 2.2 \text{ V}}{10 \text{ mA}}$$

$$\text{[for Figure 38(b)] } R = \frac{V_{CC} - 2.2 \text{ V} - V_{OL}}{10 \text{ mA}}$$

It should be noted that as used here, V_{OH} and V_{OL} are not the V_{OHmin} and V_{OLmax} specified in the data book. Figures 39 and 40 show typical values for V_{OH} and V_{OL} for an 'HC00.