

# Cockroft Walton charge pump using NMOS technology

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## Abstract

Cockroft Walton charge pump or Cockroft Walton generator is a circuit comprising of a ladder network of NMOS transistors and capacitors, which performs the operation of voltage multiplication. A low amplitude ac signal is used as the input to produce a high dc voltage. This circuit is used in applications where high voltage is required. This circuit also act as a charge pump circuit by pumping the charges towards the capacitors in the ladder network. These capacitors can store the electric charges to increase or decrease the output voltage.

## Reference Circuit details

A two stage Cockroft Walton charge pump is presented in this work. The number of stages of this circuit is determined by the number of capacitors between the output and the ground. Here NMOS transistors act as diodes. The voltage across each stage is equal to two times the peak value of the input ac voltage in a half wave rectifier.

Let us consider that the input ac voltage is  $V_i$  and let the peak value be  $V_p$ . The capacitors are uncharged initially. As the input ac voltage flows in the circuit and attains the negative peak  $-V_p$ , the capacitor  $C_1$  gets charged to  $V_p$  as the current passes through NMOS transistor  $N_1$ . When the polarity of the input signal is reversed and reaches the positive peak  $V_p$ , the current flows from capacitor  $C_1$  to capacitor  $C_2$  through NMOS transistor  $N_2$  and the capacitor  $C_2$  is charged to a voltage equal to two times of  $V_p$ . As the polarity of the input signal is reversed again, the current flows from capacitor  $C_2$  to capacitor  $C_3$  through NMOS transistor  $N_3$ , charging the capacitor  $C_3$  to a voltage of two times of  $V_p$ . Again, as the input signal changes its polarity, current flows from capacitor  $C_3$  to capacitor  $C_4$  through NMOS transistor  $N_4$ , charging the capacitor  $C_4$  to a voltage equal to twice of  $V_p$ . Each time the input voltage changes its polarity, current flows through the ladder network until all the capacitors are charged. Capacitor  $C_1$  is charged to  $V_p$  whereas the other three resistors are charged to voltage equalling twice of  $V_p$ .

As the output measures the voltage of series combination of capacitor  $C_2$  and capacitor  $C_4$ , the output voltage equals four times of  $V_p$ .

## Reference Circuit

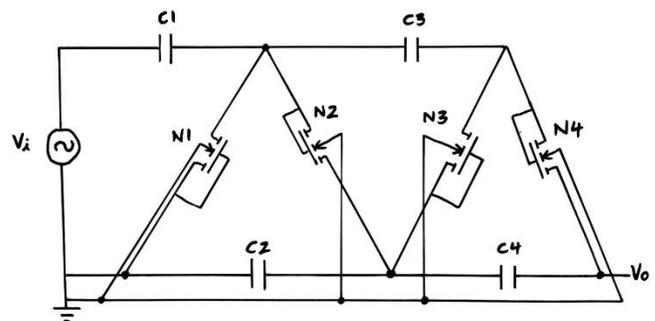


Figure 1. Reference Circuit Diagram

## Reference circuit waveforms

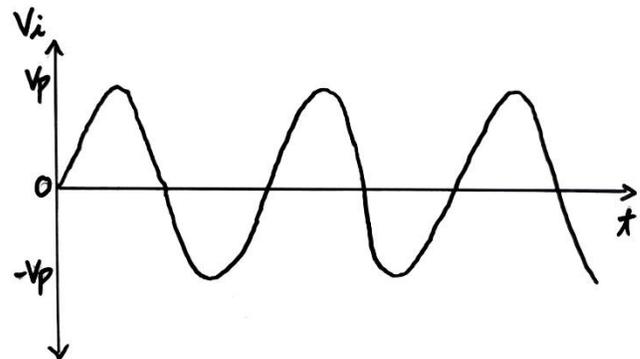


Figure 2. Input Voltage waveform

## References

- [1] Vipul V.Nandedkar, Nigrodh B.Narnaware, "Design and Implementation of a Cockcroft-Walton voltage Multiplier circuit", 2017 International Journal of Engineering Development and Research (IJEDR), Volume 5, Issue 2, ISSN: 2321-9939.

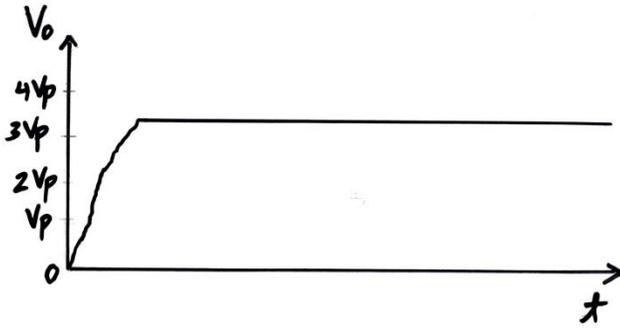


Figure 3. Output Voltage waveform