Module 911: A DC Voltage Control

Prerequisites

- Experience building an oscillator with potentiometer-controlled duty cycle.
- Experience with LED current-voltage responses.
- Experience using the oscilloscope.

Procedure (the build can be done at home, the measurements must be done in lab)

Build the following circuit. The $2\ k\Omega$ potentiometer may be replaced with a $1\ k\Omega$ potentiometer and the $680\ \Omega$ resistors may be replaced with anything in the range of $[100, 680]\ \Omega$. Use the rechargeable NiMH battery to power the Schmitt trigger inverter chip. There are portions of relevant datasheets in this document.

Turn on the oscilloscope and press the Default Setup button. Use ***only*** the horizontal and vertical scale adjustments and the trigger and meas menus to complete today's task.

Use the oscilloscope to view both voltages V_1 and V_2 as the $2\ k\Omega$ potentiometer is adjusted.

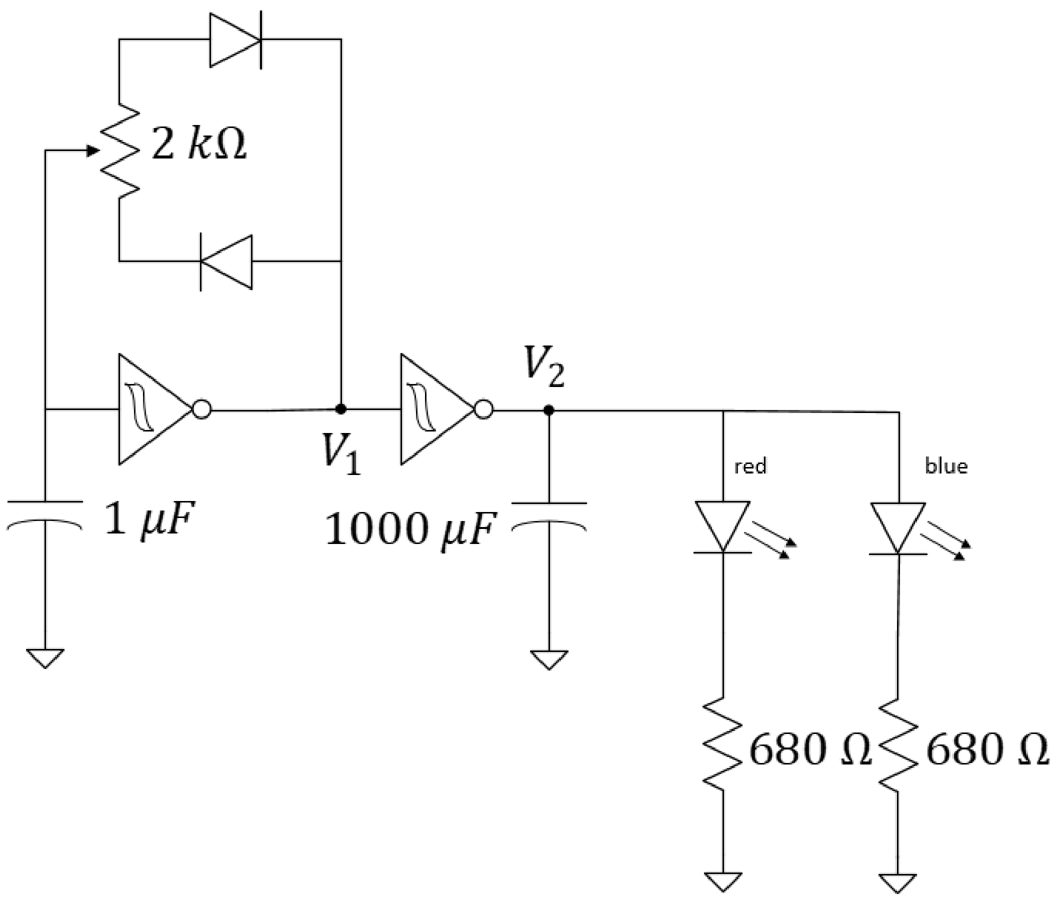


Figure 1: *DC voltage control using a PWM signal.*

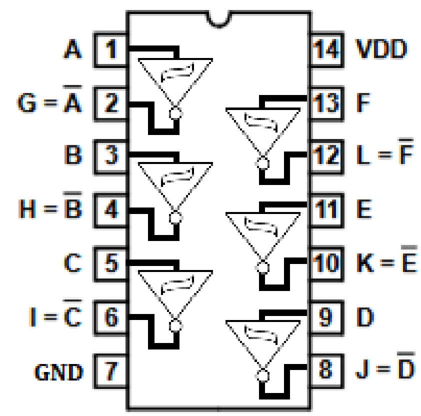
Verify that adjustment of the $2\ k\Omega$ potentiometer to increase the duty cycle will cause the red and blue LEDs to turn on in that same order, red, then blue. Determine the voltage V_2 (to two significant figures) that causes each LED to become (roughly) its brightest. Let your TA know you are ready for evaluation by sliding this paper beneath your circuit.

Evaluation

- Ability to map a circuit design onto the breadboard in a functional and clean manner.
- Ability to use the oscilloscope and to recover traces after alteration.
- Ability to troubleshoot problems that occur during a build.

CD40106 CMOS Hex Schmitt Triggers

CD40106BMS
TOP VIEW

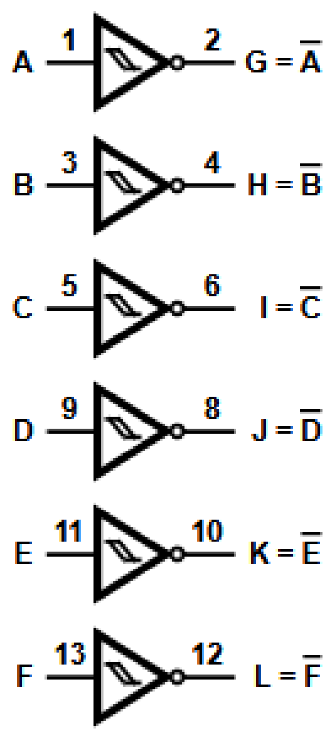


Description

CD40106BMS consists of six Schmitt trigger circuits. Each circuit functions as an inverter with Schmitt trigger action on the input. The trigger switches at different points for positive and negative going signals. The difference between the positive going voltage (VP) and the negative going voltage (VN) is defined as hysteresis voltage (VH) (see Figure 17).

Features

- **High Voltage Type (20V Rating)**
- **Schmitt Trigger Action with No External Components**
- **Hysteresis Voltage (Typ.)**
  - **0.9V at VDD = 5V**
  - **2.3V at VDD = 10V**
  - **3.5V at VDD = 15V**
- **Noise Immunity Greater than 50%**
- **No Limit on Input Rise and Fall Times**
- **Low VDD to VSS Current During Slow Input Ramp**
- **100% Tested for Quiescent Current at 20V**
- **5V, 10V and 15V Parametric Ratings**
- **Maximum Input Current of 1μA at 18V Over Full Package Temperature Range; 100nA at 18V and +25°C**
- **Standardized Symmetrical Output Characteristics**
- **Meets All Requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"**



Name: ____________________

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Question 1: Using your knowledge of capacitors, explain why the PWM signal is able to produce a DC value with a controlled voltage value.

Question 2: Replace the $1000\ \mu F$ capacitor with a 1 or $0.1\ \mu F$ capacitor. Discuss how V_2 is different from before. What is the problem with using a capacitor that is too small?

Question 3: What might be a problem of using a capacitor that is too large?

Question 4: Think of another project that could utilize a controlled DC voltage. Describe that project below.

Comments: While it seems like DC voltage control could be done with a simple potentiometer in a voltage-divider circuit, problems will arise in an application like this. The output (in this case, the two-diode circuit) will be in parallel with the lower resistor of the voltage divider which will likely cause significant variation in the desired voltage control of the voltage divider.